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Implementation of a Clinical Decision Support Tool for Stool Cultures and Parasitological Studies in Hospitalized Patients

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ABSTRACT There is substantial evidence that stool culture and parasitological examinations are of minimal to no value after 3 days of hospitalization. We implemented and studied the impact of a clinical decision support tool (CDST) to decrease the number of unnecessary stool cultures (STCUL), ova/parasite (O&P) examinations, and *Giardia/Cryptosporidium* enzyme immunoassay screens (GC-EIA) performed for patients hospitalized >3 days. We studied the frequency of stool studies ordered before or on day 3 and after day 3 of hospitalization (i.e., categorical orders/total number of orders) before and after this intervention and denoted the numbers and types of microorganisms detected within those time frames. This intervention, which corresponded to a custom-programmed hard-stop alert tool in the Epic hospital information system, allowed providers to override the intervention by calling the laboratory, if testing was deemed medically necessary. Comparative statistics were employed to determine significance, and cost savings were estimated based on our internal costs. Before the intervention, 129/670 (19.25%) O&P examinations, 47/204 (23.04%) GC-EIA, and 249/1,229 (20.26%) STCUL were ordered after 3 days of hospitalization. After the intervention, 46/521 (8.83%) O&P examinations, 27/157 (17.20%) GC-EIA, and 106/1,028 (10.31%) STCUL were ordered after 3 days of hospitalization. The proportions of reductions in the number of tests performed after 3 days and the associated *P* values were 54.1% for O&P examinations ($P < 0.0001$), 22.58% for GC-EIA ($P = 0.2807$), and 49.1% for STCUL ($P < 0.0001$). This was estimated to have resulted in $8,108.84 of cost savings. The electronic CDST resulted in a substantial reduction in the number of evaluations of stool cultures and the number of parasitological examinations for patients hospitalized for more than 3 days and in a cost savings while retaining the ability of the clinician to obtain these tests if clinically indicated.

KEYWORDS O&P examinations, stewardship, stool culture, utilization

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The current migration from volume-based reimbursement to value-based health care delivery encourages health care leaders to reexamine practices to optimize cost-effective care delivery (1, 2). There is a substantial literature that demonstrates that clinical laboratory tests are often overused by health care providers (3, 4). Unnecessary testing not only results in inflated health care costs but may also result in patient harm secondary to iatrogenic anemia and false-positive test results that require retesting and other follow-up procedures.

Microbiologists have been among the earliest advocates for the appropriate use of laboratory studies (5). The value of cultures for bacterial enteric pathogens and parasitological examinations of the stool for patients who develop diarrhea after 3 days of hospitalization has been examined by many researchers over decades (6–9). It has been shown that there is no to very low detection of community-acquired pathogens (e.g., *Salmonella*, *Giardia*, et cetera), if patients develop diarrhea after 3 days of hospitalization. These findings justify interventions to stop unnecessary testing in this setting.

TABLE 1 Positivity rates and microorganisms detected before and after the intervention

Test category (total no. of tests)	Time frame (no. of tests; % of tests)	No. of positive test results; % of test results	Pathogen (s) and/or commensal protozoan detected (no. of positive test specimens)
Prior to the intervention			
O&P (670)	<Day 3 (541; 80.7)	1; 0.18	*Entamoeba coli*
	>Day 3 (129; 19.3)	1; 0.78	*Endolimax nana*
GC-EIA (204)	<Day 3 (157; 77.0)	2; 1.3	*Giardia* (1); *Cryptosporidium* (1)
	>Day 3 (47; 23.0)	1; 2.2	*Cryptosporidium* (1)
Stool culture (1,229)	<Day 3 (980; 79.7)	18; 1.8	*Campylobacter* species (9); *Salmonella* species (6); *Escherichia coli* O157:H7 (1); *Shigella flexneri* (1); *Aeromonas* species (1)
	>Day 3 (249; 20.3)	11; 4.4	*Campylobacter* species (10)[a]; *Salmonella* species (1)
After the intervention			
O&P (521)	<Day 3 (475; 91.2)	1; 0.21	*Blastocystis hominis*
	>Day 3 (46; 8.8)	2; 4.3	*Strongyloides stercoralis*[b]
GC-EIA (157)	<Day 3 (130; 82.8)	1; 7.7	*Giardia* (1)
	>Day 3 (27; 17.2)	0; 0.0	NA[c]
Stool culture (1,028)	<Day 3 (922; 89.7)	19; 2.1	*Shigella sonnei* (11), *Salmonella* species (5), *Shigella flexneri* (1); *Campylobacter* species (1); *Aeromonas* species (1)
	>Day 3 (106; 10.3)	0; 0.0	NA

[a]Two of the *Campylobacter*-positive specimens were from the same patient (i.e., the specimens represented an initial specimen and a repeat specimen).
[b]*Strongyloides stercoralis* was detected twice, but the specimens represented an initial specimen and a repeat specimen from the same patient.
[c]NA, not applicable.

There are, however, exceptions to this "3-day rule" where testing after 3 days of hospitalization is appropriate, such as for patients ≥65 years of age or with neutropenia or HIV infection; therefore, means to bypass interventions should be in place (6).

Elimination of routine stool culture and parasitological examinations of specimens from patients who develop diarrhea after 3 days of hospitalization represents an opportunity to reduce inpatient costs without compromising patient care. Challenges in implementing such programs in the past have been the time and labor needed to determine the length of hospitalization for each specimen submitted and the need for intervention for those submitted from patients who have been hospitalized for more than 3 days. Fortunately, the widespread use of computerized physician/provider order entry (CPOE) and the application of clinical decision support tools (CDST) provide an opportunity to eliminate the labor needed for intervention and to simultaneously notify the ordering physician/provider that the test will not be performed so that they may contact the laboratory in those rare instances where the testing is clinically warranted. We implemented such a test utilization initiative at the Cleveland Clinic and here review the ordering patterns, the pathogens recovered, and the impact before and after this intervention.

RESULTS

The positivity rates and microorganisms detected before and after the intervention are listed in Table 1. There were 670 stool ova/parasite (O&P) examination orders received in the 11 months prior to the intervention. A total of 541 (80.7%) of these were ordered within the first 3 days of hospitalization, with 1 (i.e., 0.18%) positive result detected, whereas 129 (19.3%) of these tests were ordered after 3 days of hospitalization, with 1 (0.78%) positive detected. There were 204 orders for *Giardia*/*Cryptosporidium* enzyme immunoassay screens (GC-EIA) received prior to the intervention. A total of 157 (77.0%) of these were ordered within the first 3 days of hospitalization, with 2 (1.3%) positives detected, whereas 47 (23.0%) were ordered after 3 days of hospitalization, with 1 (2.2%) positive detected. There were 1,229 stool cultures orders received prior to the intervention. Of these, 980 (79.7%) were ordered within the first 3 days of hospitalization, with 18 (1.8%) positives detected, whereas 249 (20.3%) were ordered after 3 days of hospitalization, with 11 (4.4%) positives detected.

There were 521 stool O&P examination orders received in the 11 months after

the CDST intervention was activated. A total of 475 (91.2%) of these were ordered within 3 days of hospitalization, with 1 (0.21%) positive detected, whereas 46 (9.7%) orders were placed after 3 days of hospitalization, with 2 (4.3%) positives detected; both of the latter positive results represented the same species isolated from the same patient with specimens submitted 1 day apart. There were 157 GC-EIA orders placed after the intervention. Of these, 130 (82.8%) were placed within the first 3 days of hospitalization, with 1 (0.77%) positive detected, whereas 27 (17.2%) were placed after 3 days of hospitalization, with no positives detected. A total of 1, 028 stool cultures were ordered in the time frame studied after the intervention. A total of 922 (89.7%) of these were received within 3 days of hospitalization, with 19 (2.1%) positives detected, whereas 106 (10.3%) were ordered after 3 days of hospitalization, with no positives detected.

DISCUSSION

The overuse and the low yield of stool cultures for enteropathogenic bacterial and parasitological studies for patients hospitalized for more than 3 days have been well described (6–9). Valenstein et al. reported the findings of a College of American Pathologist Q-Probe, which demonstrated that when interventions are not in place, almost 40% of stool cultures may be submitted after the third day of hospitalization, with a yield of only 0.6% (10). It is also well known that diarrhea that develops after hospitalization is more likely to be associated with *Clostridium difficile*, medications, enteral feedings, or the underlying illness (11, 12). Exceptions to the "3-day rule," however, have been described. Elderly or immunocompromised individuals and patients with a significant travel history may require testing after 3 days in the hospital and may demonstrate community-acquired pathogens (6). Therefore, mechanisms by which physicians can bypass utilization interventions should be provided.

The time and labor required to contact providers and discuss requests have been among the major challenges of instituting manual interventions. Best practice dictates that providers should be contacted in a timely manner and informed that their test will not be performed; they should also be given the opportunity to discuss the clinical circumstances and, if the clinical scenario is supportive, to proceed with the order. The ability to both stop unnecessary testing and afford the provider the opportunity to override the electronic blockage using CDSTs has been described and implemented at our institution for stopping same-day duplicate orders and expensive molecular genetic tests (13–15). Therefore, we developed a CDST that would electronically assess the days of hospitalization and stop stool cultures and parasitologic examations for patients who had been hospitalized for more than 3 days. The alert gave providers instructions regarding how to obtain the desired test, if they thought it was truly medically necessary. All requests to continue with tests were honored. Potential improvements to the CDST described here would include an assessment of when the clinical symptoms manifested (i.e., whether these were present at admission and the stool studies were inadvertently not ordered or whether the diarrhea truly manifested after hospitalization). Additionally, links to evidence-based guidance for testing would be provided within the CDST, so that meaningful information, if needed, would be readily available for the provider at the time of order entry.

We studied the effect of this intervention by examining the percentage of orders that occurred for patients hospitalized for $\leq$3 and $>$3 days for 11 months before and 11 months after the intervention. The proportions of reduction in the number of tests performed in the $>$3-day category and the associated *P* values were as follows: 54.1% for O&P examinations ($P < 0.001$), 22.58% for GC-EIA ($P = 0.2807$), and 49.1% for stool cultures ($P < 0.001$). This resulted in an estimated \$8,108.84 in cost savings, based on materials and labor.

Very few parasites were detected in the either the $\leq$3 days of hospitalization category or the $>$3 days of hospitalization category before the intervention, which is consistent with the prevalence of enteric parasites in our patient population; one parasite was detected in the $\leq$3-day category and no parasites were detected in the

>3-day category after the intervention. However, there was a decrease in the number of enteropathogenic bacteria detected in patients hospitalized for more than 3 days after the intervention. Before the intervention, 11 (4.4%) of 249 stool cultures were found to contain enteropathogenic bacteria, whereas after the intervention, none (0.0%) of the 106 stool cultures, which were placed because the clinician overrode the intervention, were positive ($P = 0.028$).

We have speculated that providers may have become more prompt in placing the orders for these stool studies within the first 3 days of hospitalization to avoid having to call the laboratory, which, although not an onerous task, is more time-consuming than simply completing the order in the computer system. It is possible that this electronic intervention may be responsible for an avoidance behavior that, in turn, is driving the providers to get their orders placed within the first 3 days of hospitalization; if so, we view this positively, as it would result in the earlier detection of community-associated causes of infectious enteritis.

Although the materials for traditional stool culture and parasitological studies are inexpensive, these assays are labor intensive and occur in laboratory areas where highly skilled technologists are at a premium. The electronic CDST presented here enabled avoidance of the use of medical technologist and laboratory staff to intervene when orders were placed for patients hospitalized for >3 days but preserved the option for providers to place the order, if they determined that the test was truly indicated. Another advantage of using a CDST to stop unnecessary orders is that order intervention is achieved prior to specimen collection, which has an impact, although not captured here, on medical operations, particularly with respect to nursing. This intervention resulted in cost savings and a substantial reduction in the rate of evaluation of stool cultures and parasitological examinations for patients hospitalized more than 3 days, in accordance with standard recommendations. An even greater cost savings could be anticipated if molecular tests were to be employed for the detection of enteric pathogens. Patient care was in no way compromised, as the providers had the authority to override this intervention. Importantly, there were no patients detected with enteropathogenic bacteria and only one patient with a parasitic (*Strongyloides*) infection detected, when the provider chose to override the intervention and order studies after 3 days of hospitalization; the patient with the *Strongyloides* infection did not present with diarrhea, and therefore stool specimens were not submitted upon admission.

This report reiterates the validity of the "3-day rule" for the detection of enteropathogenic bacteria other than *C. difficile* and parasites. Our intervention decreased the percentage of orders placed for patients after 3 days of hospitalization for the three tests studied, and these differences were statistically significant for bacterial stool cultures and O&P examinations. Unlike other interventional studies, we demonstrated the safe and effective use of a clinical decision support tool to effect this change, which decreased the need for manual interventions but preserved the provider's ability to continue with the order if deemed medically necessary.

MATERIALS AND METHODS

The Cleveland Clinic uses Epic (Epic, Verona, WI) as the hospital information system. A custom-programmed clinical decision support tool (CDST) (i.e., the hard-stop alert tool) was designed in Epic and implemented on 25 March 2014 at the Cleveland Clinic. Providers were made aware of this change prior to implementation through regular informational updates. This CDST stopped any stool culture, ova/parasite (O&P) examination, and *Giardia*/*Cryptosporidium* enzyme immunoassay screens (GC-EIA) for patients hospitalized for more than 3 days. The alert read as follows. "There is substantial evidence that stool culture and examinations for ova and parasites are of minimal-to-no value for diarrhea that begins after 3 days of hospitalization. Other causes of hospital-acquired diarrhea, such as *C. difficile* and medication-induced diarrhea should be considered." The alert also notified providers that they could override the electronic intervention by calling the laboratory client service department if doing so were clinically indicated. All requests to override the intervention were honored.

To assess the effectiveness of the intervention and the associated cost savings, we performed a retrospective data search to include all patients with stool cultures and parasitologic stool studies (i.e., O&P examinations and GC-EIA) 11 months before and 11 months after the month of the intervention (i.e., April 2013 to February 2014 and April 2014 to February 2015). We analyzed the proportion of tests (i.e., categorical orders/total number of orders) performed on patients hospitalized for ≤3 days and >3 days before and after the intervention. We also retrieved the result from

any positive tests within these time periods. Comparative statistics (i.e., chi-square analysis statistics) were employed to determine significance, and cost savings were estimated based on our internal reagent and labor costs.

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