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Variation in stool testing for children with acute gastrointestinal infections

Jessica L. Markham, MD, MSc[1,2], **Matt Hall, PhD**[1,3], **Megan E. Collins, MD**[1], **Samir S. Shah, MD, MSCE**[4], **Matthew J. Molloy, MD, MPH**[4], **Paul L. Aronson, MD, MHS**[5], **Jillian M. Cotter, MD, MSCS**[6], **Michael J. Steiner, MD, MPH**[7], **Elisha McCoy, MD**[8], **Michael J. Tchou, MD, MSc**[6], **John R. Stephens, MD**[9]

[1]Department of Pediatrics, Children's Mercy Kansas City, University of Missouri-Kansas City School of Medicine, Kansas City, Missouri, USA

[2]Department of Pediatrics, University of Kansas School of Medicine, Kansas City, Kansas, USA

[3]Children's Hospital Association, Lenexa, Kansas, USA

[4]Department of Pediatrics, Cincinnati Children's Hospital Medical Center, Cincinnati, Ohio, USA

[5]Departments of Pediatrics and of Emergency Medicine, Yale School of Medicine, New Haven, Connecticut, USA

[6]Department of Pediatrics, University of Colorado School of Medicine, Aurora, Colorado, USA

[7]Department of Pediatrics, University of North Carolina, Chapel Hill, North Carolina, USA

[8]Department of Pediatrics, Le Bonheur Children's Hospital, University of Tennessee Health Science Center, Memphis, Tennessee, USA

[9]Department of Medicine, University of North Carolina, Chapel Hill, North Carolina, USA

Abstract

Background and Objective: Children with gastrointestinal infections often require acute care.The objectives of this study were to describe variations in patterns of stool testing across children's hospitals and determine whether such variation was associated with utilization outcomes.

Design, Settings and Participants: We performed a multicenter, cross-sectional study using the Pediatric Health Information System (PHIS) database. We identified stool testing (multiplex polymerase chain reaction [PCR], stool culture, ova and parasite, *Clostridioides difficile*, and other individual stool bacterial or viral tests) in children diagnosed with acute gastrointestinal infections.

Correspondence: Jessica L. Markham, MD, MSc, Department of Pediatrics, Children's Mercy Kansas City, University of Missouri-Kansas City School of Medicine, 2401 Gillham Rd, Kansas City, MO 64108, USA. jlmarkham@cmh.edu; Twitter: @jmarks614.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Main Outcome and Measures: We calculated the overall testing rates and hospital-level stool testing rates, stratified by setting (emergency department [ED]-only vs. hospitalized). We stratified individual hospitals into low, moderate, or high testing institutions. Generalized estimating equations were then used to examine the association of hospital testing groups and outcomes, specifically, length of stay (LOS), costs, and revisit rates.

Results: We identified 498,751 ED-only and 40,003 encounters for hospitalized children from 2016 to 2020. Compared to ED-only encounters, stool studies were obtained with increased frequency among encounters for hospitalized children (ED-only: 0.1%–2.3%; Hospitalized: 1.5%–13.8%, all $p < 0.001$). We observed substantial variation in stool testing rates across hospitals, particularly during encounters for hospitalized children (e.g., rates of multiplex PCRs ranged from 0% to 16.8% for ED-only and 0% to 65.0% for hospitalized). There were no statistically significant differences in outcomes among low, moderate, or high testing institutions in adjusted models.

Conclusions: Children with acute gastrointestinal infections experience substantial variation in stool testing within and across hospitals, with no difference in utilization outcomes. These findings highlight the need for guidelines to address diagnostic stewardship.

INTRODUCTION

Children with gastrointestinal infections often require an emergency department (ED) evaluation or hospitalization.[1–4] While viruses are the most frequent cause in the United States, bacteria and parasites are important to identify as they may warrant different management, including infection prevention interventions for school or childcare.[5–11] The Centers for Disease Control and Prevention guidelines for the management of acute gastrointestinal infections advocate for limited use of diagnostic tests such as stool cultures.[12] The guidelines have not been updated since publication in 2003 and do not address molecular tests (e.g., multiplex polymerase chain reaction [PCR] testing). Other available clinical practice guidelines, including the Infectious Diseases Society of America (IDSA) guidelines, are challenging to apply to a pediatric population and similarly do not address these newer diagnostic methods.[13–15]

Within the last decade, many hospitals across the United States have transitioned away from conventional diagnostic studies for gastroenteritis (e.g., culture, serology, and immunofluorescence assays) in favor of multiplex PCRs for the detection of multiple enteric organisms from a single specimen.[11,16] Multiplex PCR tests have advantages over conventional tests, including speed and increased sensitivity to identify gastrointestinal pathogens.[11,16–18] While these tests may contribute to earlier targeting and discontinuation of antimicrobials,[19] they may also lead to overidentification of nonpathogenic bacteria in healthy patients, contributing to inappropriate antibiotic use.[10,20]

Recent studies highlight low-value care practices for children hospitalized with acute gastrointestinal infections, including high rates of electrolyte testing and intravenous fluid administration among hospitalized children and increased multiplex PCR testing with minimal impact on patient outcomes.[19,21] Little is known, however, about how specific stool tests, including multiplex PCR tests, are being utilized for children presenting

with gastroenteritis. Defining patterns of stool testing may identify opportunities to curb unnecessary diagnostic testing in children. Therefore, we aimed to describe patterns of stool testing for gastroenteritis across children's hospitals and to determine if variation in testing was associated with hospital resource use including length of stay (LOS), costs, and 7- and 14-day revisits (ED revisit or readmission).

METHODS

Study design and data source

This multicenter, cross-sectional study of children with acute gastrointestinal infections utilized the Pediatric Health Information System (PHIS), an administrative and billing database of 49 tertiary care pediatric hospitals in the United States that are affiliated with the Children's Hospital Association (Lenexa, KS). Patient data are deidentified in PHIS; however, encryption of patient identifiers allows for tracking of individual patients across multiple visits to the same hospital. The Children's Hospital Association and participating centers jointly assure data quality and integrity. The study included data from 37 hospitals after excluding 12 hospitals with incomplete data during the study period or with LOS not reported in hours. This study was not considered human subjects research based on policies of the local Institutional Review Board.

Study population

Inclusion and exclusion criteria—Children ≤18 years of age with an ED-only encounter or an index hospitalization (i.e., inpatient/observation encounter, henceforth referred to as "hospitalized") for acute gastrointestinal infections at participating hospitals from January 1, 2016 through December 31, 2020 were eligible for inclusion. To identify children presenting primarily for acute gastrointestinal infection, we only included encounters with a primary discharge diagnosis of acute gastrointestinal infection or a primary diagnosis of dehydration, nausea/vomiting, or diarrhea and a secondary diagnosis of acute gastrointestinal infection, consistent with prior methods.[22–24] Encounters were identified by using previously utilized *International Classification of Diseases, 9th Revision* (ICD-9) codes cross-walked to equivalent ICD-10 codes using General Equivalence Mapping files.[25] Included ICD-10 codes are presented in Supporting Information: Appendix Table 1. We excluded hospital transfers due to the potential inability to capture diagnostic test use from the transferring hospital. To identify a group of otherwise healthy children with routine cases of acute gastroenteritis, we also excluded patients requiring admission to the intensive care unit at any point during their hospitalization, those undergoing surgery, and those with a complex chronic condition.[19] Finally, select diagnosis codes for potentially competing diagnoses (i.e., other potential causes of acute diarrhea) were also excluded (Supporting Information: Appendix Table 1).

Stool tests

Stool tests were grouped broadly into the following six categories: multiplex PCR, stool culture, *Clostridioides difficile*, ova and parasite (O&P), and individual stool bacterial, or individual stool viral tests. Due to the short LOS of these hospitalizations, we examined the obtainment of stool studies at any point during the encounter. To define multiplex PCR tests,

the study team utilized a previously described strategy[26] that involved: (1) Identification of ambiguous molecular testing codes among the index list of clinical transaction codes (CTC) used by the PHIS database; (2) Manual review of individual hospitals' charge description masters for detailed descriptions of tests that mapped to these ambiguous codes; and (3) Group consensus regarding which ambiguous CTC codes represented multiplex PCRs. Ambiguous CTC codes were identified as multiplex PCR tests if the hospital's charge description master utilized one or more of the following terms: GI/stool pathogen panel or >1 pathogen target listed in the test name. Validation was performed through manual chart review at the first author's institution to assess the accuracy of this strategy. A total of 150 charts, including all visits where a multiplex PCR was recorded in PHIS, as well as a random sample of charts where a multiplex PCR was not recorded were reviewed. Of the 150 charts reviewed, there was 100% agreement; all encounters where a multiplex PCR was documented in PHIS also had a corresponding multiplex PCR order/result. Conversely, for all encounters where no multiplex PCR was recorded, we observed no physician order or test result corresponding to a multiplex PCR test.

Main outcome measure

Our primary outcome included rates of stool testing across all encounters, stratified based on setting (ED-only and hospitalized). Our secondary outcomes included LOS measured in hours (hospitalized only), all-cause 7- and 14-day ED revisits and readmissions, and costs of the index encounter. Costs were estimated from charges using hospital-year specific cost-to-charge ratios and hospitalized encounters included any charges that occurred within the ED.

Patient demographics and clinical characteristics

We examined demographic characteristics including age, sex, primary payor, race/ethnicity, and childhood opportunity index (COI).[27] Race/ethnicity was examined as sociopolitical constructs and included in our analyses due to previously reported differential admission practices for children presenting with acute gastroenteritis.[28,29] COI is a multidimensional measure of resource availability at a neighborhood level. We examined patient characteristics including the number of noncomplex chronic conditions (e.g., asthma) using the chronic condition indicator[30] and severity using Hospitalization Resource Intensity Scores for Kids (H-RISK).[31] H-RISK was developed to quantify severity of illness among hospitalized children and assigns relative weights to each APR-DRG and severity of illness level, facilitating comparison across APR-DRG groups.

Statistical analysis

Data were stratified by ED-only and hospitalized encounters. Continuous data were described with median and interquartile ranges because of nonnormal distribution while categorical data were summarized with frequencies and percentages. Demographic and clinical characteristics were compared using χ^2 and Wilcoxon rank-sum tests for categorical and continuous variables, respectively. We calculated the overall testing rates and unadjusted hospital-level stool testing rates.

We generated a heat map to assess variation in stool testing across hospitals. For these analyses, single stool bacterial tests and *C. difficile* tests were excluded due to infrequent use across hospitals (i.e., rates of 0% for approximately half of all hospitals). For the four remaining stool studies, hospitals were first assigned a score of "0" if testing was not performed at that hospital. The remaining hospitals for each test were then divided into testing quartiles and assigned a score between 1 (lowest quartile) and 4 (highest quartile). Hospitals were ordered based on rates of any stool testing and divided into performance tertiles (low, moderate, and high testing). Generalized linear mixed models with binomial distributions for binary outcomes and log-normal distributions for continuous variables were then used to examine the association of hospital testing group and outcomes adjusting for age, presence of a chronic condition, and H-RISK severity while accounting for clustering of patients within hospitals. All statistical analyses were performed using SAS v.9.4 (SAS Institute), and $p < 0.05$ were considered statistically significant.

RESULTS

Demographic and clinical characteristics

A total of 538,754 children met inclusion criteria, of which 498,751 were seen in the ED-only and 40,003 were hospitalized (Figure 1, Table 1). The majority of encounters were for children aged 1–4 years, those with government insurance, those from lower COI areas, and those without any noncomplex chronic conditions. In comparison to ED-only encounters, there were increased proportions of hospitalized children who were non-Hispanic White (30.3% vs. 50.0%), had private insurance (24.7% vs. 37.5%), and were from higher COI areas (high: 14.8% vs. 18.1%; very high: 14.7% vs. 19.1%). We also observed increased proportions of children with noncomplex chronic conditions among those hospitalized.

Variation in diagnostic testing

Across all settings, the overall rates of obtainment of stool studies were low with multiplex PCRs, stool cultures, *C. difficile*, and ova and parasite testing occurring in 0.2%–3.2% of encounters (Table 1). Compared to ED-only encounters, stool studies were observed with increased frequency among hospitalized children (ED-only: 0.1%–2.3%; Hospitalized: 1.5%–13.8%, all $p < 0.001$). Multiplex PCR tests and stool cultures were the most frequently obtained tests regardless of setting.

We observed substantial variation in stool testing rates across hospitals and by setting (Figures 2 and 3). Of the individual stool studies examined, multiplex PCRs (ED-only: 0.01%–16.8%; Hospitalized: 0.05%–65.0%) and stool cultures (ED-only: 0.09%–7.7%; Hospitalized: 0.07%–38.1%) varied the most widely across hospitals in the proportion of encounters where stool testing was obtained. O&P testing rates ranged from 0% to 35.1% across hospitals. With some exceptions, hospitals with high rates of multiplex PCR testing had low rates of other testing, especially stool cultures.

Variation in testing and association with hospital outcomes

After categorizing hospitals as low, moderate, and high testing hospitals, we observed statistically significant but small absolute differences in outcomes across testing groups in

unadjusted analyses for both ED-only encounters and encounters for hospitalized children (Supporting Information: Appendix Table 2). When adjusted for important covariates, there were no statistically significant differences in outcomes across testing groups in either setting (Table 2).

DISCUSSION

In this large, multicenter study of children with acute gastrointestinal infections, we observed substantial variation in obtainment of stool studies within and across hospitals, which was most pronounced among hospitalized children. We observed no differences for all measured adjusted utilization outcomes across low, moderate, and high testing groups. Further, we identified differences in rates of hospitalization based on sociodemographic characteristics for children presenting with acute gastrointestinal infections. Our study highlights potential opportunities for diagnostic stewardship to standardize stool testing practices within and across hospitals and the need to examine factors contributing to sociodemographic disparities in care for acute gastrointestinal infections.

Variation in care occurs commonly in medicine. While some variation is clinically warranted, substantial variation in practice likely contributes to healthcare waste.[32,33] Guidelines can help reduce variation in care; however, available guidelines do not adequately address stool testing best practices in children, especially in the context of the emergence of newer diagnostic methodologies. For example, the 2017 IDSA clinical practice guidelines for all age groups strongly recommend stool testing for individuals presenting with fever, bloody or mucoid stools, severe abdominal cramping or abdominal tenderness, or signs of sepsis for the evaluation of enteric pathogens that may benefit from antimicrobials.[13] However, this may not be a cost-effective approach for children in whom fever and report of “moderate to severe” abdominal pain occurs frequently.[34–37] The British guidelines for children <5 years of age presenting with gastroenteritis advocate for microbiologic testing of stools under certain specific circumstances (e.g., travel, lack of improvement by Day 7, concern for septicemia, etc.). As with other guidelines for acute gastrointestinal infections, the British guidelines do not address when newer diagnostic methodologies (e.g., multiplex PCR testing) should be utilized. Thus, the substantial variability observed in our study represents a potential opportunity for future studies and guidelines to address unnecessary variation in practice by defining optimal diagnostic testing strategies for children presenting with acute gastrointestinal infections.

In our current study, O&P testing was obtained in <10% of all admitted children, though up to 35% of children with gastrointestinal infection at some hospitals received such testing. Two studies have highlighted the low utility of routine O&P testing, noting that only 1.4%–2.15% of submitted specimens were positive.[38,39] Thus, many clinical practice guidelines currently recommend against obtaining O&P testing for patients with <7 days of acute diarrhea in the absence of high-risk features, as many cases will be self-limited and resolve with supportive care.[13,40] While the current analysis cannot account for factors such as local community outbreaks, duration of symptoms, or patient travel patterns, further investigation of the high testing rates at these institutions is needed. A recent Choosing Wisely: Things We Do For No Reason publication in the *Journal of Hospital Medicine* discusses the low

sensitivity of these tests and the potential adverse consequences of testing in the context of low clinical suspicion and advocates for better risk-stratification and a “wait and see” approach to testing in the absence of high-risk features.[41] Thus, we hope our findings will encourage clinicians to evaluate their local testing practices and assess whether more targeted testing can be employed locally.

Multiplex gastrointestinal PCR panels have emerged over the course of the last decade with their use supplanting other conventional tests within some hospitals. While multiplex gastrointestinal PCR studies offer improved sensitivity, decreased time to results, and improved time to initiation of antimicrobials, Cotter et al. previously demonstrated a 21% overall increase in stool testing following their implementation with improvement in outcomes in only 3% of tested patients.[19] Some adult-focused studies demonstrate that use of multiplex PCRs can contribute to reductions in healthcare expenditures including reductions in associated resources including endoscopy, diagnostic imaging, and antimicrobial use[17,42]; however, at least one independent study reported doubling of costs compared to conventional methods and another study reported low conformity with institutional testing guidelines following local implementation of a real-time PCR test.[43,44] Other studies demonstrate that use of PCR tests can result in increased identification of *C. difficile* and other potential pathogens (e.g., *Salmonella*) in young children and healthy controls, potentially contributing to unnecessary treatment.[10,20,45,46] Taken together, these studies suggest that while multiplex PCRs may assist in healthcare delivery and cost savings, unrestricted use of these tests may contribute to low-value care and highlight the need for future guidelines to address optimal use of these studies. Further, the differential use of these tests across individual hospitals observed in our current study underscores the need to identify implementation strategies to best integrate these tests among other available stool testing.

Within our cohort, we observed increased proportions of non-Hispanic White children and those from higher areas of opportunity represented among those hospitalized. While the reasons for these differences cannot be elucidated within administrative data sets such as PHIS, these findings are consistent with other studies and should make us pause and assess health equity. Two recent studies of acute gastroenteritis highlight differential care based on race/ethnicity. Using electronic health record data collected for quality improvement, Congdon et al. identified that non-Hispanic Black, Hispanic, and non-Hispanic other race children were less likely to receive intravenous fluid hydration or to be hospitalized, and when they were hospitalized, they had shorter lengths of stay compared to non-Hispanic White children without a difference in patient revisits.[29] Dickerson-Young et al. reported differential use of ondansetron, intravenous fluid administration, and hospital admissions among children presenting to emergency room settings with acute gastroenteritis.[28] In the context of these prior studies, possible etiologies for our findings include discretionary overtreatment of non-Hispanic White children versus differential caregiver comfort/self-efficacy in providing care at home. Future research is needed to understand drivers of differential admission practices to ensure equitable and optimal healthcare delivery.

Our findings should be interpreted in the context of several limitations. First, PHIS is an administrative database and although we drew on prior literature to define our cohort, the

use of billing codes could contribute to misclassification bias. PHIS does not contain data related to the presence of concerning symptoms unless a diagnostic code was submitted (e.g., bloody stools, prolonged diarrheal course) or important historical features (e.g., local community outbreaks, travel/environmental exposures, or recent antibiotic use) that may indicate the need for microbiologic evaluation. Consequently, our ability to evaluate the appropriateness of diagnostic test use or to fully assess how local protocols and policies may influence testing patterns at individual institutions is limited. We observed infrequent performance of single stool bacterial tests and *C. difficile* tests across hospitals. While this could reflect failure of documentation (i.e., test performed but no charge issued) or differences in billing/coding practices, these findings may simply reflect provider preference for multiplex PCR/stool cultures to detect multiple pathogens simultaneously and guideline recommendations for *C. difficile* testing in a generally healthy subset of children presenting with signs/symptoms of gastrointestinal infection. Due to limitations within PHIS, we are unable to determine what proportion of testing for hospitalized patients occurred in the ED versus inpatient setting on the day of admission and some tests attributed to hospitalized children may have been ordered by an ED provider, artificially inflating the inpatient testing rates compared to ED-only. Hospitals also varied in the availability and types of multiplex PCR tests (e.g., test descriptions varied from 3 to 5 pathogens/targets to up to 25 pathogens/targets); heterogeneity of multiplex PCR tests could have contributed to the lack of differences in utilization outcomes. Although we accounted for important demographic characteristics within our models, unaccounted for differences in patient characteristics could have contributed to variability in our estimates, though we anticipate that these differences may be biased toward the null hypothesis. Finally, our analysis was restricted to tertiary and quarternary pediatric hospitals and our findings may not be generalizable to other settings.

CONCLUSION

In this large multicenter study of children with acute gastrointestinal infections, we observed substantial variation in stool testing. While there were differences in rates of stool testing across hospitals, we observed no difference in utilization outcomes among children seen in ED or inpatient settings. These findings highlight a critical need for updated guidelines addressing diagnostic stewardship practices and for future exploration of factors contributing to sociodemographic differences in care to ensure healthcare equity.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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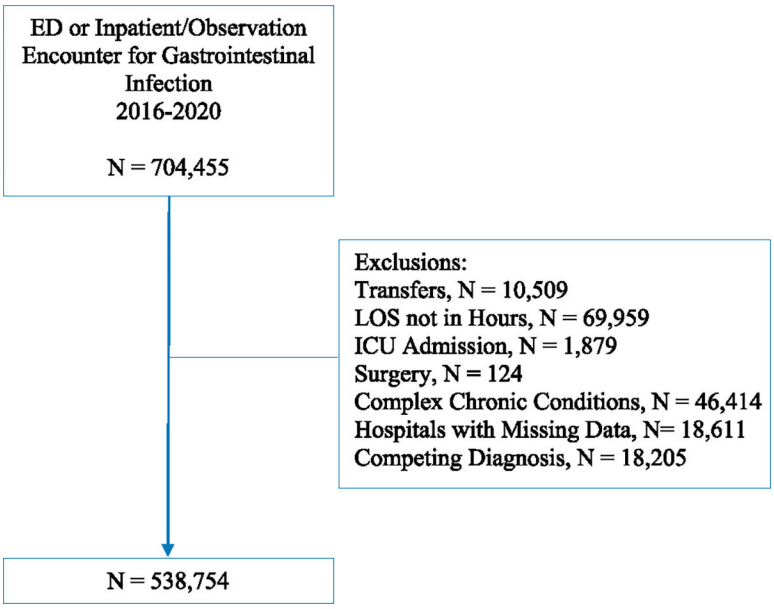

FIGURE 1.
Consort diagram. ED, emergency department; ICU, intensive care unit; LOS, length of stay.

Hospital	N Cases	Multiplex PCR	Stool Cultures	Ova & Parasites	Stool Viral	Any Stool Testing	Testing Group
1	14,070	16.84	1.18	0.14		16.89	HIGH
2	16,618	1.94	7.68	1.07		8.72	HIGH
3	6,940	7.33	1.30	0.19	0.03	7.44	HIGH
4	7,744		6.83	0.56	0.09	6.93	HIGH
5	20,545	0.97	4.51	0.06	0.08	5.43	HIGH
6	12,394		5.07	0.99	0.31	5.14	HIGH
7	25,729	0.14	4.70	1.01	0.25	4.85	HIGH
8	10,919		4.35	1.43	0.60	4.68	HIGH
9	8,222	3.24	1.16	0.77	0.10	4.50	HIGH
10	17,316	0.66	4.08	1.05	0.08	4.46	HIGH
11	16,239	0.35	3.82	1.26	0.94	4.22	HIGH
12	6,255	0.02	3.80	0.75	0.02	3.85	HIGH
13	18,043	3.00	1.40	0.17	0.08	3.82	MOD
14	29,122	3.56	0.45	1.92		3.64	MOD
15	36,429	1.48	2.11	1.61	1.54	3.47	MOD
16	3,364	3.45				3.45	MOD
17	10,434		3.34	1.18	0.02	3.43	MOD
18	11,551	2.16	1.27	0.11	0.20	3.34	MOD
19	7,251		2.87	0.77	0.29	2.98	MOD
20	6,528	2.79	0.64	0.08		2.86	MOD
21	12,709	2.40		1.36		2.59	MOD
22	26,839	0.01	2.44	0.91	0.27	2.57	MOD
23	30,130		2.42	0.24	0.03	2.55	MOD
24	4,353	2.23	0.25	0.18	0.02	2.53	MOD
25	7,712	0.01	2.46	0.01		2.48	MOD
26	2,262		2.48	0.93	0.04	2.48	LOW
27	7,278	0.16	2.24		0.05	2.39	LOW
28	7,330		2.18	0.29	0.30	2.26	LOW
29	9,314	1.05	1.05	0.54	0.13	2.13	LOW
30	12,940		1.24	0.99	1.14	2.13	LOW
31	15,147	0.01	2.01	0.24	0.07	2.05	LOW
32	16,435	0.57	0.09	0.85	0.56	1.82	LOW
33	17,705		0.67	0.99	0.31	1.81	LOW
34	9,115		1.57	0.36	0.49	1.63	LOW
35	5,267	1.10	0.17	0.49	0.30	1.46	LOW
36	4,109	0.61	0.66	0.39	0.05	1.39	LOW
37	24,393	0.01				0.01	LOW

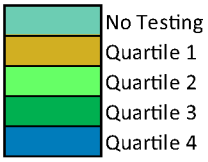

FIGURE 2.

Heat map of stool testing for ED-only encounters. ED, emergency department; MOD, moderate; PCR, polymerase chain reaction.

Hospital	N Cases	Multiplex PCR	Stool Cultures	Ova & Parasites	Stool Viral	Any Stool Testing	Testing Group
1	2,343	65.00	9.86	2.43		65.90	HIGH
2	965	53.47	33.58	7.88		60.73	HIGH
20	195	52.31	2.56	0.51		52.31	HIGH
3	456	47.81	6.36	0.22		48.03	HIGH
15	2,597	34.27	9.28	35.12	35.31	38.70	HIGH
4	987		38.10	6.18	2.74	38.40	HIGH
13	785	35.67	9.94	2.80	1.15	38.34	HIGH
9	542	23.99	9.78	5.54	2.58	33.95	HIGH
16	418	33.73				33.73	HIGH
5	792	12.37	22.47	3.54	2.78	33.33	HIGH
18	533	25.52	9.19	4.50	23.83	33.21	HIGH
14	1,067	31.21	4.31	16.68	0.09	31.40	HIGH
24	199	26.63	1.51	2.01	1.01	28.14	MOD
21	617	26.42	0.65	10.53	0.32	27.88	MOD
31	596	1.68	24.16	7.05	3.69	27.01	MOD
11	1,789	2.74	19.40	8.94	11.85	25.43	MOD
12	744	2.02	23.39	9.81	3.09	24.60	MOD
10	1,839	10.11	19.09	5.27	0.76	23.60	MOD
6	862		22.51	10.32	5.57	23.55	MOD
7	2,260	5.49	19.07	7.39	3.54	23.54	MOD
8	1,868	0.05	21.04	8.99	5.78	22.81	MOD
35	449	19.60	1.56	5.12	7.35	22.72	MOD
30	1,388		10.59	12.39	18.66	22.48	MOD
34	809		19.28	4.20	15.33	21.88	MOD
32	1,944	13.43	0.46	4.06	6.22	21.30	MOD
26	421	1.90	17.81	8.55	5.94	20.43	LOW
25	840	1.19	19.29	0.24		19.88	LOW
36	723	11.62	6.22	4.98	3.73	19.64	LOW
19	828		17.27	6.28	4.95	19.08	LOW
29	531	9.42	6.03	3.95	0.94	16.76	LOW
28	1,285		15.33	1.63	6.61	16.50	LOW
17	1,961	0.05	13.11	7.75	0.26	13.72	LOW
22	1,718	0.52	11.53	6.05	3.61	13.56	LOW
28	650	3.69	12.15		1.54	13.54	LOW
33	1,279		0.39	7.66	5.47	10.56	LOW
23	1,301		8.61	3.23	1.00	10.45	LOW
37	1,422	0.14	0.07	0.07	0.14	0.35	LOW

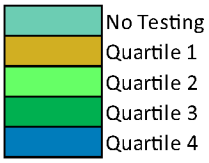

FIGURE 3.

Heat map of stool testing for encounters for hospitalized children. Hospitals in the figure are labeled consistent with Figure 2 to allow for comparisons of ED and inpatient data. ED, emergency department; Mod, moderate; PCR, polymerase chain reaction.

TABLE 1

Patient demographics and clinical characteristics.

	Overall	Hospitalized	ED-only	*p* Value
# Encounters	538,754	40,003	498,751	
Age at index admission (years)				
<1	120,921 (22.4)	11,632 (29.1)	109,289 (21.9)	<0.001
1–4	233,707 (43.4)	15,194 (38.0)	218,513 (43.8)	
5–9	109,510 (20.3)	6509 (16.3)	103,001 (20.7)	
10–14	47,546 (8.8)	3734 (9.3)	43,812 (8.8)	
15–18	27,070 (5.0)	2934 (7.3)	24,136 (4.8)	
Sex				
Female	260,211 (48.3)	19,523 (48.8)	240,688 (48.3)	0.035
Payor				
Government	357,094 (66.3)	22,523 (56.3)	334,571 (67.1)	<0.001
Private	137,948 (25.6)	14,986 (37.5)	122,962 (24.7)	
Other	43,712 (8.1)	2494 (6.2)	41,218 (8.3)	
Race/ethnicity				
Non-Hispanic White	170,968 (31.7)	19,996 (50.0)	15,0972 (30.3)	<0.001
Non-Hispanic Black	121,758 (22.6)	6405 (16.0)	115,353 (23.1)	
Hispanic	188,371 (35.0)	9573 (23.9)	178,798 (35.8)	
Asian	18,975 (3.5)	1187 (3.0)	17,788 (3.6)	
Other	38,682 (7.2)	2842 (7.1)	35,840 (7.2)	
Child opportunity index				
Very low	175,743 (32.8)	9232 (23.1)	166,511 (33.5)	<0.001
Low	107,037 (19.9)	7938 (19.9)	99,099 (20.0)	
Moderate	92,792 (17.3)	7859 (19.7)	84,933 (17.1)	
High	80,538 (15.0)	7227 (18.1)	73,311 (14.8)	
Very high	80,440 (15.0)	7633 (19.1)	72,807 (14.7)	
Number of chronic conditions using CCI				
0	490,708 (91.1)	25,098 (62.7)	465,610 (93.4)	<0.001
1	40,524 (7.5)	10,922 (27.3)	29,602 (5.9)	
2–3	7267 (1.3)	3787 (9.5)	3480 (0.7)	

	Overall	Hospitalized	ED-only	*p* Value
≥4	255 (0)	196 (0.5)	59 (0)	
Hospital region				
Midwest	173,208 (32.1)	13,023 (32.6)	160,185 (32.1)	<0.001
Northeast	50,442 (9.4)	5435 (13.6)	45,007 (9.0)	
South	168,622 (31.3)	14,869 (37.2)	153,753 (30.8)	
West	146,482 (27.2)	6676 (16.7)	139,806 (28.0)	
H-RISK	0.4 (0.1)	0.6 (0.3)	0.4 (0.1)	<0.001
Multiplex PCR	12,742 (2.4)	5505 (13.8)	7237 (1.5)	<0.001
Stool cultures	16,974 (3.2)	5276 (13.2)	11,698 (2.3)	<0.001
Clostridioides difficile	1292 (0.2)	590 (1.5)	702 (0.1)	<0.001
Ova and parasites	6943 (1.3)	3128 (7.8)	3815 (0.8)	<0.001
Stool viral	3988 (0.7)	2510 (6.3)	1478 (0.3)	<0.001
Stool bacteria	6439 (1.2)	2677 (6.7)	3762 (0.8)	<0.001

Note: Data are presented as *N* (%) with the exception of H-RISK which is presented as mean (standard deviation).

Abbreviations: CCI, chronic condition indicator; ED, emergency department; H-RISK, Hospitalization Resource Intensity Scores for Kids; PCR, polymerase chain reaction.

TABLE 2

Adjusted utilization outcomes among hospitals with low, moderate, and high stool testing for children with acute gastroenteritis.

	Low testing	Moderate testing	High testing	*p* Value
ED-only				
LOS (h)	–	–	–	–
ED revisit rates, % (95% CI)				
7 days	1.6 (0.8, 3)	2.8 (2, 4)	2.2 (1.4, 3.3)	0.25
14 days	1.9 (1.1, 3.3)	3.5 (2.3, 5.4)	2.4 (1.6, 3.5)	0.24
Readmission rates, % (95% CI)				
7 days	1.4 (1.2, 1.7)	1.4 (1.2, 1.7)	1.5 (1.3, 1.7)	0.87
14 days	1.8 (1.6, 2.1)	1.8 (1.6, 2.1)	1.8 (1.6, 2.1)	1.0
Cost ($), geometric mean (95% CI)	438 (365.9, 524.2)	361.3 (270.9, 481.8)	445.6 (357.4, 555.5)	0.51
Hospitalized				
LOS (h), mean (95% CI)	33 (30.4, 35.9)	35.8 (34.6, 37)	37.7 (35.2, 40.3)	0.15
ED revisit rates, % (95% CI)				
7 days	1.4 (0.9, 2.1)	2.2 (1.2, 3.8)	2.1 (1.1, 3.9)	0.39
14 days	1.7 (1.2, 2.6)	2.5 (1.5, 4.1)	2.4 (1.3, 4.3)	0.51
Readmission rates, % (95% CI)				
7 days	3.3 (2.8, 3.8)	3.1 (2.7, 3.5)	2.3 (1.9, 2.9)	0.15
14 days	4.2 (3.7, 4.7)	4.1 (3.6, 4.6)	3.2 (2.6, 3.8)	0.16
Cost ($), geometric mean (95% CI)	3784.9 (3072.3, 4662.7)	4009.6 (3293.2, 4881.9)	3916.8 (3090.9, 4963.3)	0.93

Abbreviations: CI, confidence interval; ED, emergency department; LOS, length of stay.