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Contemporary practice among pediatric surgeons in the use of bowel preparation for elective colorectal surgery: A survey of the American Pediatric Surgical Association

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ABSTRACT

Purpose: The goal of this study was to characterize contemporary practice among pediatric surgeons in the use of mechanical bowel preparation (MBP) and oral antibiotics (OA) for elective colorectal surgery.

Methods: A survey of the American Pediatric Surgical Association membership was conducted to characterize variation in the use of MBP and OA for commonly performed elective colorectal procedures in children.

Results: Three-hundred thirteen members completed the survey. The most common approach used was MBP alone (31.1%), followed by diet modification only (26.8%), MBP combined with OA (19.6%), no preparation or dietary modification (12.2%), and OA alone (5.4%). The most common MBP used was a polyethylene glycol-based solution (92.6%), and the most common OA approach was neomycin combined with erythromycin (55.9%). Although MBP alone was the preferred approach among pediatric surgeons, the greatest relative change reported over time was in the adoption of dietary modifications only or no preparation at all.

Conclusions: Significant variation exists in the use of bowel preparation among pediatric surgeons. Although use of MBP alone remains the preferred approach for most procedures, an increasing number of surgeons report abandoning this approach in favor of dietary modification alone or no preparation at all.

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Colorectal surgery is associated with high rates of surgical site infections in both children and adults [1]. Although prophylactic intravenous antibiotics are widely considered standard of care for decreasing surgical site infections, the benefits of a mechanical bowel preparation (MBP) and oral antibiotics in addition to intravenous antibiotics in the pediatric population are less clear because of the paucity of high-quality clinical evidence relevant to the pediatric population.

The lack of evidence supporting an optimal preoperative approach in children has led to marked variation in practice among pediatric surgeons in the timing, choice, and setting for bowel preparation [2,3]. In a previous analysis of practice patterns from 42 freestanding children's hospitals, nearly half of children undergoing elective colorectal surgery were preadmitted to the hospital one day before their scheduled procedure for administration of a bowel preparation [3]. Significant variation between hospitals was also found in the preparation approach used, with the frequency of MBP use alone ranging between 0% and 96%,

oral antibiotics alone between 0% and 92%, and MBP use combined with oral antibiotics between 0% and 84% [3].

As a step toward understanding where consensus guidelines and high-quality clinical evidence should be prioritized, we must first characterize the variability in contemporary practice among pediatric surgeons in all practice settings. Previous studies have been limited in this regard to the analysis of administrative data from freestanding children's hospitals, which may not be representative of practice in community and nonteaching hospitals, and were not able to capture practice in the ambulatory setting. The goal of this study was to provide the most comprehensive assessment of bowel preparation practices among pediatric surgeons in both inpatient and ambulatory settings through a survey of the American Pediatric Surgical Association (APSA) membership.

1. Methods

1.1. Survey design

Following guidelines established by the APSA Outcomes and Evidence-Based Committee Subcommittee on Survey Development

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and in collaboration with a survey-design epidemiologist at our institution, we developed a survey designed to query surgeons on their bowel preparation practices in children undergoing elective colorectal procedures. Demographic information was collected, including age, sex, years in practice, geographic region and type of practice (e.g. hospital setting and association with training programs), academic affiliation, number of partners, and perceived colorectal case volume relative to other surgeons in their practice.

In order to obtain a more detailed assessment of practice variation, surgeon practices were queried in the context of 4 clinical scenarios spanning a broad range of ages, colorectal conditions, and comorbidity profiles. These included (1) repair of a rectovestibular (posterior fourchette) fistula in a 9-month-old girl that has been managed in the outpatient setting with daily dilations, (2) pullthrough and colostomy closure in a 15-month-old boy with Hirschsprung's disease and a transition zone in the proximal sigmoid colon who was initially managed with a descending colostomy, (3) elective ileocecectomy with primary anastomosis in a 10-year-old boy with medically refractory Crohn's disease (not clinically obstructed), and (4) closure of a diverting descending colostomy in an otherwise healthy 16-year-old teenaged boy, 3 months after sustaining a penetrating injury to the pelvis.

For each scenario, surgeons were queried for their preferred approach to bowel preparation (no preparation or dietary modifications, dietary modification only, MBP alone, oral antibiotics alone, or MBP combined with oral antibiotics). Surgeons who reported use of an MBP (with or without oral antibiotics) were further queried whether they would preadmit their patient to the hospital specifically to have the preparation administered. For the purposes of the survey, an MBP was defined as an enterally administered polyethylene glycol or electrolyte-based preparation solution, and oral antibiotics included oral neomycin, erythromycin, or metronidazole given individually or in any combination. Surgeons were further queried on how their management has changed over time (increased use, unchanged, decreased use, or never used) with respect to each of the bowel preparation choices above.

1.2. Survey administration and data analysis

The survey was distributed using SurveyMonkey.com via a website link and e-mailed to all 1148 active APSA members over a 4-week period in January 2014 [4]. Reminder emails were sent weekly to nonresponders. Participation in the survey was anonymous and voluntary. Practice patterns were examined in aggregate and also stratified by major categories of demographic characteristics. These included age (younger or older than 55 years), years in practice (greater or fewer than 15 years), academic affiliation, number of partners in practice (greater or fewer than 6 partners), and relative colorectal case volume (greater vs equal to or less than colleagues in their practice). These cutoffs were chosen after a preliminary analysis of median values from survey responses for each demographic category.

Descriptive statistics were used for variation in demographic characteristics and preparation choices, and χ^2 statistics were used for the comparison of proportions. The Cochran–Mantel–Haenszel statistic for repeated tests of independence was used to examine differences in bowel preparation approach and preadmission across demographic characteristic while controlling for each of the 4 scenarios. Only responses from surgeons who completed the entire survey were included in the analysis. All statistical analyses were performed using Microsoft Excel (Microsoft, Redmond, WA) and SAS Enterprise Guide v. 5.1 (SAS Institute, Cary, NC). This study was approved by the institutional review board at our institution (BCH#P00005670).

2. Results

2.1. Characteristics of survey respondents

Surveys were completed by 313 of 1148 surgeons, for a response rate of 27%. Respondents were evenly distributed across age groups, years in practice, and geographic region (Table 1). The majority of respondents practiced at freestanding children's hospitals and were affiliated with a university or academic institution. Most respondents were in a practice with 6 or fewer surgeons, and most reported similar or lower colorectal case volume compared with their colleagues.

2.2. Variation in bowel preparation approach

The most common approach used for all procedures was an MBP alone (31.1%), followed by dietary modification only (26.8%), MBP combined with oral antibiotics (19.6%), no preparation or dietary modifications (12.2%), and oral antibiotics alone (5.4%). The remaining 4.8% of respondents provided a free-text response describing an approach other than the options given. The distribution of relative preferences was similar across all scenarios with the exception of ileocecectomy associated with inflammatory bowel disease (IBD), where the most common preparation used was dietary modification alone, followed by MBP alone, MBP with oral antibiotics, no preparation or dietary modification, and oral antibiotics alone (Fig. 1). Sixty-six percent of respondents (207/313) used an MBP alone in at least 1 of the 4 scenarios, and the most common MBP used was a polyethylene glycol-based solution (92.6%). Thirty-three percent (107/313) of surgeons reported using oral antibiotics (with or without an MBP) in at least 1 of the scenarios, with the most common approach being neomycin and erythromycin used together (55.9%) followed by neomycin as a single agent (14.1%)

Table 1
Demographic characteristics of pediatric surgeons who completed the survey.

Characteristics	n = 313 (%)
Male	242 (77.3)
Age (y)	
<45	114 (36.5)
45–54	97 (31.1)
55–64	66 (21.1)
65–74	28 (8.9)
>75	8 (2.6)
Years in practice	
<5	64 (20.4)
5–10	65 (20.8)
11–15	49 (15.7)
16–20	41 (13.1)
>21	94 (30.0)
Geographic region	
Northeast	75 (23.9)
Midwest	80 (25.6)
South	105 (33.5)
West	53 (16.9)
Academic/university-affiliated	250 (79.9)
Hospital setting	
Freestanding children's hospital	177 (56.6)
Children's hospital within a hospital	128 (40.9)
Nonchildren's hospital	8 (2.6)
Practice associated with	
Pediatric surgery fellowship	138 (44.1)
General surgery fellowship	275 (87.9)
Partners in group	
1–3	90 (28.8)
4–6	118 (37.7)
7–9	60 (19.2)
10–12	26 (8.3)
>12	19 (6.1)
Colorectal case volume	
Less than colleagues	42 (13.4)
Same as colleagues	204 (65.2)
More than colleagues	67 (21.4)

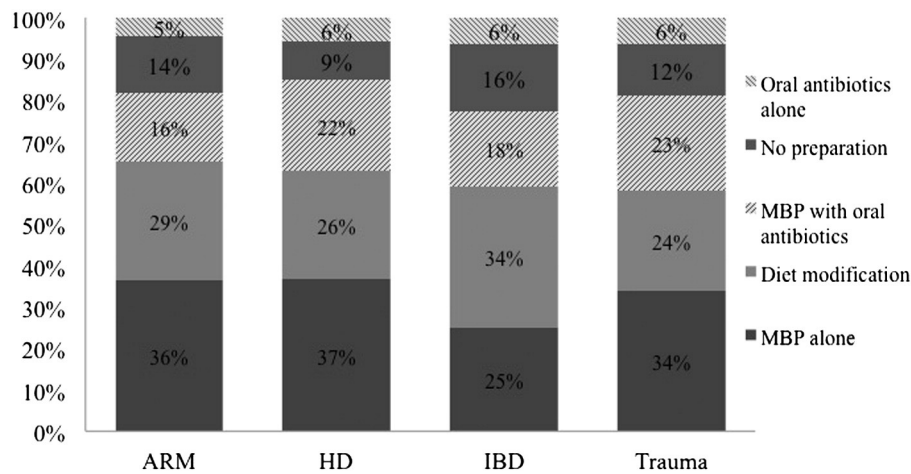


Fig. 1. Preferences in bowel preparation approach among pediatric surgeons for different elective colorectal procedures in children based on clinical scenario.

(Fig. 2). Fifty percent (157/313) of respondents reported using the same preoperative preparation strategy for all 4 scenarios.

Overall, the use of either dietary modification only or no preparation at all was more popular with surgeons who were younger (43.1% vs 30.6%, $P < .001$), had fewer years in practice (43.7% vs 33.0%, $P = .001$), had more than 6 partners in their practice (43.6% vs 36.8%, $P = .019$), and reported a higher colorectal case volume than their colleagues (48.9% vs 36.4%, $P < .001$). There were no significant differences in the use of dietary modification only or no preparation at all in surgeons practicing at academic vs nonacademic hospitals (39.6% vs 36.9%, $P = .431$).

The use of MBP alone was reported more often by surgeons at academic-affiliated hospitals (32.5% vs 25.4%, $P = .029$), those with few partners in practice (33.3% vs 26.7%, $P = .017$), and with colorectal volume less than or equal to their colleagues (32.8% vs 24.6%, $P = .009$). There were no significant differences in the use of MBP alone between younger and older surgeons (30% vs 33.3%, $P = .228$) or surgeons with fewer or more than 15 years in practice (29.1% vs 33.7%, $P = .079$).

Use of oral antibiotics (with or without an MBP) was more often reported by surgeons who were older (36.0% vs 26.9%, $P < .001$), had more years in practice (33.3% vs 27.3%, $P = .02$), and were not affiliated with academic institutions (37.7% vs 27.9%, $P = .002$). There were no significant differences in use of oral antibiotics among surgeons based on number of partners in practice (29.9% of surgeons with few partners vs 28.8% of surgeons with more partners, $P = .952$) or relative colorectal

case volume (30.8% of surgeons with less than or equal volume to their colleagues vs 26.5% of surgeons with more case volume, $P = .173$).

2.3. Variation in preadmission

The majority of responding surgeons (62.5%) reported they would preadmit their patients specifically for the administration of an MBP, although this was more common in the anorectal malformation and Hirschsprung's disease scenarios compared with the IBD or trauma scenarios (Fig. 3). Overall, the choice to preadmit a patient for an MBP was more often reported by younger surgeons (67.1% vs 58.4%, $P = .027$). The practice of preadmission was also reported more often by surgeons at nonacademic institutions (69.8% vs 62.1%, $P = .065$) and those with fewer partners in their practice (66.1% vs 58.4%, $P = .062$), although these differences did not reach significance. There was no significant difference in the choice of preadmission among surgeons who had fewer years in practice (62% vs 65.6%, $P = .352$) and with less colorectal case volume than their colleagues (64.7% vs 60%, $P = .314$).

2.4. Trends in practice

The greatest relative changes in practice over time reported by surgeons were in the adoption of dietary modification only (41%), followed by a transition to no preparation or dietary modification at all (20%). In contrast, the greatest relative decrease in practice was reported for the

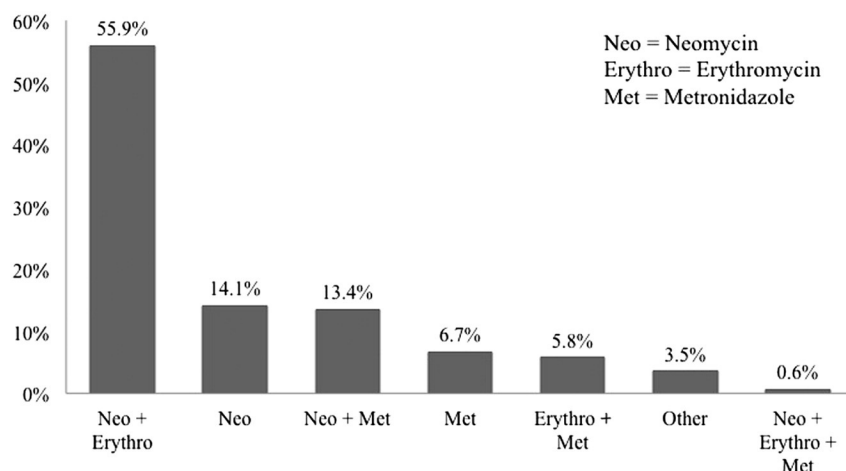


Fig. 2. Most commonly utilized oral antibiotics by pediatric surgeons for elective colorectal procedures.

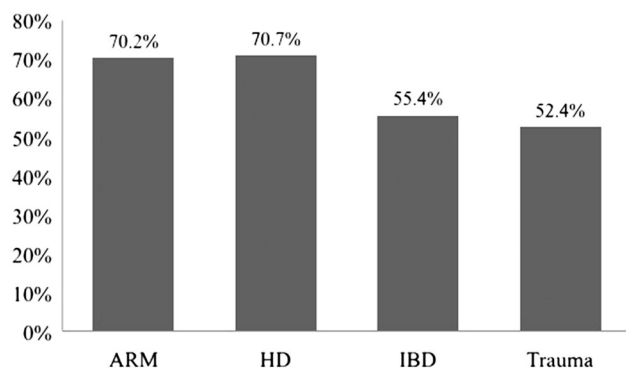


Fig. 3. Rates of preadmission for bowel preparation as reported by pediatric surgeons for common pediatric colorectal conditions.

use of MBP alone, oral antibiotics alone, and the use of MBP combined with oral antibiotics (Fig. 4). Thirty-nine percent of respondents reported a decrease in the use of MBP alone, compared to 17% who reported an increase during the same time period. Nine percent of respondents reported an increase in the use of oral antibiotics alone, whereas 33% reported a decrease in this approach. Forty-six percent of respondents reported decreased use of MBP combined with oral antibiotics, compared to 11% reporting increased use.

The increase in use of dietary modifications as the sole preparation was reported more frequently by younger surgeons (47.5% vs 28.6%, $P = .002$) as well as those with fewer years in practice (48.8% vs 31.5%, $P = .003$). Similarly, the shift toward increasing use of no preparation or dietary modification was reported more often by younger surgeons and those with fewer years in practice (23% vs 12%, $P = .03$, and 24% vs 13%, $P = .021$, respectively). Surgeons reporting higher relative colorectal case volume than their colleagues were more likely to report a relative increase in their use of no preparation or dietary modification only (28% vs 17%, $P = .026$).

The overall transition away from the use of oral antibiotics alone associated with older respondents. Seventy-eight percent of older respondents reported never using or decreasing the use of oral antibiotics alone vs 67% of younger respondents ($P = .041$). There were otherwise no differences in surgeon demographics and the use of oral antibiotics alone. Additionally, surgeon demographics were not specifically associated with the overall decreased use of MBP alone or MBP combined with oral antibiotics.

3. Discussion

In this survey of the APSA membership, reflecting a broad range of geographic locations and practice settings, we found significant variation among pediatric surgeons in the preferred approach toward

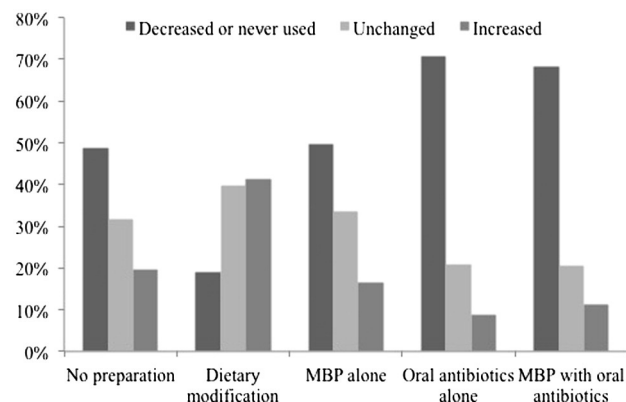


Fig. 4. Changes in bowel preparation preferences over time as reported by pediatric surgeons.

bowel preparation in children undergoing elective colorectal procedures. Furthermore, this variation was seen even when examining practice at the level of the individual procedures and colorectal conditions. Although the most commonly reported approach in all clinical scenarios, with exception of IBD scenario, was MBP used alone, practice varied considerably across and even within hospitals with no clear consensus for any of the procedures examined.

The results of this survey are consistent with previous studies that have examined practice variation surrounding bowel preparation in children. Using the Pediatric Health Information System database, Pennington et al found significant variation in the approach to bowel preparation for patients admitted to freestanding children's hospitals [3]. This study was limited, however, as it only captured practices for children who were preadmitted to the inpatient setting for their bowel preparation. As such, the results may not be representative of practice variation at nonfreestanding children's hospitals and, furthermore, did not capture patients who may have received (or did not receive) a bowel preparation at home. The study may have, therefore, underestimated the popularity of bowel preparation strategies that would not typically require an inpatient admission, such as the use of dietary modifications alone or even no preparation at all. The results of the present study would support this notion, as surgeons chose 1 of these 2 approaches nearly 40% of the time across all scenarios.

To our knowledge, only 1 prior survey has examined bowel preparation practices among pediatric surgeons. Nearly a decade ago, Breckler et al surveyed the APSA membership and found that 96% used an MBP [2]. Our survey demonstrated how contemporary practice patterns have evolved, with fewer surgeons reporting the use of an MBP alone. The use of oral antibiotics has also decreased among surgeons, from 44% in the previous survey to 25% in the present study. Our survey also demonstrated the increasing popularity of using dietary modification alone (as well as no preparation or dietary changes) and the parallel transition away from more conservative approaches using oral antibiotics and MBP.

With the exception of the IBD scenario, MBP alone was the most common bowel preparation approach chosen by surgeons, and the majority reported they would preadmit a patient to the hospital specifically to receive the MBP. For the anorectal malformation and Hirschsprung's disease scenarios, the high rates of preadmission may reflect the preference for closer monitoring in younger patients or the need for placement of a nasogastric tube to ensure adequate MBP administration. Although the rates of preadmission were lower in the IBD and trauma scenarios, the reason for preadmission for an MBP in these cases remains unclear, as the older patient population may arguably be more tolerant of receiving an MBP in the ambulatory setting. There are no studies to date that have explored the utility of preadmission for the specific indication of administering a bowel preparation in children, especially in patients where an MBP conceivably can be performed at home. These data would suggest that in addition to a lack of consensus around whether a formal MBP is needed, there is an equally strong lack of agreement surrounding which setting a bowel preparation is most effectively administered.

It is noteworthy that both the most common practice currently reported by pediatric surgeons (MBP alone) and that associated with the greatest change in practice over time (adoption of dietary modifications only or no preparation at all) are not currently supported by the published clinical evidence. In regard to MBP alone, extensive randomized controlled trials and meta-analysis data have shown that use of MBP alone has no benefit in reducing infectious complications [5–7]. Despite this, MBP alone remains the most popular approach in children undergoing most colorectal procedures [2,3,8–10]. Furthermore, despite high quality evidence from multiple randomized controlled trials and rigorous meta-analyses supporting the use of oral antibiotics (with or without an MBP) for decreasing infectious complications, oral antibiotics are infrequently used among pediatric surgeons and their use appears to be declining, especially among younger surgeons [11–15].

The reasons for the apparent lack of evidence-based practice among pediatric surgeons surrounding bowel preparation are unknown, and no study to date has explored the reasoning behind these observed practices. One possibility for this trend may be the fact that all of the high-quality evidence surrounding the efficacy of different bowel preparation strategies has originated from the adult colorectal experience. There may be, therefore, a lack of consensus among pediatric surgeons in the relevance of these data to pediatric surgical practice, especially in a younger patient who may require a nasogastric tube and preadmission for their preparation. Another possibility is that pediatric surgeons may not be aware of the number and quality of existing studies from the adult literature that support the use of oral antibiotics and argue against the use of MBP alone for colorectal prophylaxis. It is likely that the decision making among pediatric surgeons is multifactorial and may be influenced by all of these factors, among others, including technical considerations of the procedure. For example, the use of an MBP in order to decompress dilated bowel in patients with chronic constipation and high fecal load may make the operation technically easier, thus allowing for shorter anesthesia and operating time.

This study has important limitations that should be noted. Only 27% of APSA members responded to the survey, and the members who responded to the survey may differ in their demographic characteristics and practice patterns compared with those that did not. However, those that did respond were quite heterogeneous in their demographic and practice profiles, suggesting that this relatively small sample may be representative of broader practice within the pediatric surgical community. Furthermore, it is unlikely that additional responses would challenge the conclusions derived from the current sample, that is, that wide variation exists among pediatric surgeons in their approach toward bowel preparation. Finally, surgeons' reported responses toward simulated scenarios might not reflect their actual clinical practice, and the use of multiple choice answers may simplify otherwise complex and nuanced approaches to each of the clinical conditions in the survey.

In conclusion, we found wide variation in the utilization of bowel preparation among pediatric surgeons for common colorectal conditions in children. The preferred approach among most surgeons for all conditions remains preadmission to the hospital for MBP alone, although there appears to be a growing trend away from this practice (and other more traditional practices as well) in favor of dietary modification only and even no preparation at all. These practices have persisted despite fairly conclusive evidence in the adult literature that use of MBP alone confers no prophylactic benefit, and that use of oral antibiotics significantly decreases infectious complications following colorectal procedures [16]. Although ongoing controversy remains surrounding the need and extent of MBP as an adjunct to maximize the prophylactic benefit of oral antibiotics, the diminishing use of oral

antibiotics in children suggests that an increasing proportion of children undergoing colorectal procedures may not be receiving optimal prophylaxis. Such trends and ongoing practice variation highlight the need for dedicated, multicenter prospective studies to explore the relationship between preparation strategies, tolerance profiles and outcomes specific to different colorectal conditions in children, and to better understand factors that underlie the lack of consensus among pediatric surgeons.

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