One-year impact of a bowel management program in treating fecal incontinence in patients with anorectal malformations

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**A B S T R A C T**

Background: Many patients with anorectal malformations (ARM) need a bowel management program (BMP) to manage lifelong problems of fecal incontinence or severe constipation. We aimed to evaluate the sustainability of the results in such a program.

Methods: A single-institution retrospective review was performed in children with ARM who attended our BMP (2015–2019). Standardized definitions and validated tools were used to assess fecal continence (Bayelor Continence Scale), constipation (Cleveland Constipation Scoring System), urinary symptoms (Vancouver Symptoms Score), and the Pediatric Quality of Life (PedsQL) and health-related quality of life (HRQOL) at the start of BMP and 1-year after completion of the program.

Results: 222 patients with ARM at a median age of 6.7 (IQR, 4.9–10.1) years were identified. All (100%) soiled at intake with 149 (67.1%) patients being treated with rectal or antegrade enemas and 73 (32.9%) with oral laxatives. At 1 year 150 (70.4%) were clean, 72.7% were on enemas and 27.3% were on laxatives (p = 0.08). 109 out of 148 (73.6%) patients were clean on enemas. A further 41 out of 66 (62.1%) patients were continent on laxatives with voluntary bowel movements and clean. In the group that was clean, there was improvement in Baylor Continence Scale (25 vs. 13.0, p < 0.0000000002), Vancouver (11 vs. 6, p = 0.0110) scores, and clinically relevant improvement in the total PedsQL HRQL (78–85) and the PedsQL HRQL physical function (86–92) and psychosocial domain (77–82). There was no improvement in Cleveland (10 vs. 9, p = 0.31) score.

Conclusion: An intensive BMP offers significant benefits in the treatment of fecal incontinence in ARM. It appears that to also improve urinary incontinence and urinary voiding, as well as the patient's quality of life. These changes are sustainable over at least one year.

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1. Introduction

Anorectal malformations (ARM) are rare congenital defects which affect 1 in 5000 infants [1]. Many patients experience lifelong difficulties with fecal and less commonly urinary incontinence [2]. The first publications on the utility of bowel management in the treatment of fecal incontinence and severe constipation in ARM patients appeared in the literature in 2009 [3, 4]. Results were quite favorable, however the results presented were only after at one week after starting the program.

In the decade since, multiple authors have discussed the utility of emptying the colon mechanically with antegrade enemas or trans-anal (retrograde) irrigations [5–7]. This practice allows the colon to be mechanically cleaned and with the goal to prevent incontinence episodes until stool moves around to the rectum, which is then emptied with a subsequent enema or flush. In most patients with ARM this allows for 24 h without bowel movements and these patients can therefore be clean and wear normal underwear without necessarily being continent, i.e. having the capacity to have voluntary bowel control. In addition, patients with good potential for bowel control may have overflow soiling due to constipation (encopresis). Many patients in this group can be rendered

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continent with the effective use of stimulant laxatives and water soluble fiber to add bulk [4]. This combination allows them to pass formed stools on a regular basis. These original principles of bowel management have remained largely unchanged over time. Because of this success, a devoted and intensive one-week bowel management program (BMP) has been adopted by multiple centers around the world.

While several authors have reported successful short-term results with BMP [3, 4], none have reported long term results. The week of bowel management occurs away from the patient and family’s home and is a very artificial environment. Therefore, we felt it vital to examine longer term outcomes to understand the value of this intense intervention in the everyday lives of these patients and their families. In addition, it is important to assess parent reported outcomes measures (PROMS) and determinants of quality of life using standardized definitions and validated tools in order to objectively assess the overall effects of a BMP on the patient and their family.

2. Methods

2.1. Study design and population

Following local Institutional Review Board approval, we performed a single-institution, retrospective review of children with an ARM who completed our one-week BMP from April 2014 to March 2019. All patients treated in our BMP consented prospectively and completed serial longitudinal follow-up surveys by phone or email.

2.2. Measures

The primary endpoint of this study was patient continence for stool which is defined by the presence of voluntary bowel movements and ≤1 stooling accident per week. The standardized definition of one or less accident per week was defined by the Rome criteria [8]. Patients were grouped into one of two groups. Those on enema-based regimen or on a laxative-only regimen were considered fecally continent if they had voluntary bowel movements and ≤1 stooling accident per week, respectively. Whereas those who experienced 2 or more stooling accidents per week were considered not continent for stool. We counted any passage of stool, a stain, a smear or a full bowel movement, as a stooling accident, and did not designate between daytime and nighttime accidents. This determination was made in person at the start of BMP and either in person at routine follow up clinic appointments or via telephone.

Secondary outcomes of interest include the following validated scores: the Baylor Continence Scale (BCS) (if >4 years) [9], the Cleveland Constipation Scoring System (Cleveland) (if >3 years) [10], the Vancouver Symptoms Score (Vancouver) (if >3 years) [11], and the age-appropriate PedsQL HRQL Measurement Model (PedsQL) [12]. BCS is a 23-question survey, validated in children with ARM that is effective in differentiating from control patients, and is completed by children or their parents using a psychometric response Likert scale. It is observer-independent. BSC scores ranges from 2 to 84, with lower scores reflecting better social continence. The Vancouver Symptom Score is a 14-item 5-point Likert scale questionnaire for which a score of ≥11 indicating dysfunctional elimination syndrome (DES) or bladder bowel dysfunction [11]. DES is defined as abnormal voiding habits associated with defecation symptoms. The Cleveland constipation score is a scoring system that was derived to obtain a universally objective definition of constipation. The score tabulated from a validated questionnaire ranges from 0 to 30, with 0 indicating normal and 30 indicating severe constipation [10]. The PedsQL HRQL improvement score (scale, 0–100) is composed of four domains: (1) physical functioning, (2) physical symptoms (3) social functioning, and (4) school functioning [13]. We reported the PedsQL score as physical and psychosocial scores, with the latter composing of the emotional, social and school functioning scores. A 4.4 change in the PedsQL Total Scale Score for child self-report has been determined as a minimal clinically meaningful difference, while a 4.5 change in PedsQL Total Scale Score for parent proxy-report was determined as a minimal clinically meaningful difference [12–14]. Each questionnaire was filled out at routine intervals using a secure Research Electronic Data Capture (REDCap) [15] survey link sent via e-mail.

2.2.1. Bowel management program week

The BMP is a week-long outpatient program that is used to treat constipation and/or fecal incontinence for patients with ARM. The week is comprised of three clinic visits, five consecutive days of abdominal x-rays, and patient reports by phone or email. The patient’s bowel regimen is changed daily as needed based on the parent report and assessment of the stool content on the x-ray with the goal of finding the regimen that achieves social continence. Patients are placed on a medical regimen (stimulant laxatives for hypomotility or medications to slow motility for hypermotility) or a mechanical regimen (rectal enemas or antegrade flushes per cecostomy or Malone appendicostomy).

The week starts with a parent lecture given by one of the team’s surgeons and advanced practice providers to discuss the goals and expectations of the week with the families. Concurrent to this session is a psychosocial group for the patients at which they meet with the team of psychologists, social workers, and child life specialists. Each patient then has a clinic visit with a colorectal surgeon or nurse practitioner who determine the starting treatment plan. The team of colorectal surgeons, nurse practitioners, and nurses meets each day to review the x-rays and parent reports. The team determines the patient’s plan for the next day which is then communicated to the parent by their assigned nurse. The patients are seen midweek in clinic after obtaining their daily abdominal x-ray. There are also two more group meetings with the families through the week. One is led by the nursing team to discuss any concerns or questions regarding the treatment plans conducted in a group setting. The other is a group led by the psychologist and social workers to discuss any psychosocial needs. The last day of the program is a final clinic visit at which the patient is sent home with a daily bowel regimen that empties their colon and keeps them clean. The planned follow-ups are at 3 and 12 months. The ultimate goal of a BMP is to treat the child as a whole and help them along with their parents deal with the psychosocial and social issues that are associated with this diagnosis.

2.3. Statistical analysis

Patient characteristics were reported as medians and interquartile ranges (IQR) for continuous variables and frequencies and percentages for categorical variables. Categorical variables were compared using the nonparametric chi square test. A chi-square test was used to compare the change in fecal continence or cleanliness from prior to beginning the BMP and 12 months post-completion. Continuous variables were compared using the two-tailed Student’s t-test where a paired t-test was performed to assess changes in the Baylor, Cleveland, and Vancouver over the same time period. An improvement of 4.4 in PedsQL was considered minimal clinically meaningful difference. A significance threshold of p < 0.05 was utilized for all tests. All statistical analyses for this study were performed using Stata 14.0 (StataCorp LP, College Station, Texas, USA).

Table 1
Baseline patient characteristics of patients with anorectal malformation undergoing the bowel management program (BMP) from 2014 to 2017.

<table>
<thead>
<tr>
<th>Total patients, n (%)</th>
<th>222 (100.0)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, median years (IQR)</td>
<td>6.7 (4.9–10.1)</td>
</tr>
<tr>
<td>Male, n (%)</td>
<td>123 (59.5)</td>
</tr>
<tr>
<td>BMP type</td>
<td>Enema</td>
</tr>
<tr>
<td></td>
<td>Laxatives</td>
</tr>
<tr>
<td></td>
<td>Retrograde</td>
</tr>
<tr>
<td></td>
<td>Antegrade</td>
</tr>
</tbody>
</table>

3. Results

222 patients with an ARM were enrolled in the study period from April 2014 to March 2019. One hundred and twenty-three (59.5%) patients were male and the median age was 6.7 (IQR, 4.9–10.1) years. All 222 patients (100%) started the program with daily soiling. There were two distinct cohorts of patients at the start of BMP week. One hundred and forty-nine (67.1%) patients were treated with enemas (antegrade or retrograde) and 73 (32.9%) with oral stimulant laxatives. On further review of the enema group, there was a slight predilection to patients on antegrade enemas, with 79 (53.0%) patients using either a ceocolostomy or an appendicostomy, compared to 70 (47.0%) who were on rectal enemas (Table 1).

The outcomes for this cohort are reported at the beginning of the bowel management week and one year after the conclusion of the program. At one year, 150 (70.4%) of all the patients were clean. Of these, 109 out of 148 (73.6%) patients were clean on enemas. A further 41 out of 66 (62.1%) patients were continent on laxatives with voluntary bowel movements and clean. 25 patients were found to be soiling on laxatives at 1 year after bowel management. Of these, 24 were converted to enemas and 21 of them were able to be clean on enemas. 1 patient elected to remain on laxatives in spite of ongoing soiling accidents.

139 (62.6%) patients completed PedsQL surveys at intake and 84 (37.8%) at the one-year time point. 143 (64.4%) patients returned Baylor continence surveys at intake and 89 (40.1%) did so at one year. The BCS significantly improved from a mean of 26.0–15 (p = 0.0001). 112 (50.4%) patients returned Vancouver elimination surveys at intake and 72 (32.4%) did so at one year (Table 2). A further sub-analysis of patients who were clean at 1 year showed that there was a significant improvement in the Baylor (25 vs 13, p < 0.005), Vancouver (11 vs 6, p < 0.05), and clinically relevant improvements in total PedsQL (78 vs 85), from intake to one year post BMP. There was also minimal clinically meaningful difference in the PedsQL HRQoL physical function and psychosocial scores (86 vs 92 and 77 vs 82 respectively) over the study period. There were not statistically different Cleveland constipation scores, (p = 0.311) (Table 3).

4. Discussion

ARMs often result in lifelong difficulties with defecation resulting in marked loss for a child’s self-esteem and can have profound effects on the child’s physical and mental health. To combat these, the principles of an intensive bowel management to treat fecal incontinence in patients with ARMs have been established for over a decade. However, sustainability of an effective BMP has not been previously reported. This study demonstrates that the improvement in being clean at the end of the one-week BMP can be maintained for the majority of patients through one year with objective improvements in patient reported outcomes, and can improve a patient’s quality of life.

For patients who underwent bowel management with enemas, 70% reported being clean at one year. These patients have returned home, to school and their normal lives, and have managed to maintain very good results. The standardized definition of one or less accident per week was defined by the Rome criteria [8]. While 70% clean is a good result, it is not perfect. Other publications have reported higher rates of clean patients; however, these reports were only over a one-week period, in an artificial environment away from home and school. In addition, no mention was made of using standardized definitions of “continence” or “being clean” in these publications [4]. The fact that 30% of our patients on enemas continue to have soiling accidents is a source of concern, especially when one considers the negative implications of ongoing soiling on not just the quality of life and psychological development of the child but also the added stress to the family unit. Furthermore, strategies of how to manage patients who continue to have soiling accidents despite intensive bowel management is an area of ongoing research.

The results for patients on laxatives also need to be viewed in context. The use of laxatives in patients with anorectal malformations are generally for patients with a good prognosis (i.e. patient with a low ARM lesion, sacral ratio > 0.7 and absence of a tethered cord), to help them to empty their rectum and sigmoid colon effectively on a daily basis. They are usually given in combination with water soluble fiber in order to bulk the stool. Adding fiber to provide bulk, with a stimulant laxative to provoke soiling allows patients with anorectal malformations, who by definition have abnormal sensation, to sense stool when formed stool leads to rectal distension. Many of the patients who we were able to help achieve continence on laxatives, have been previously treated at other institutions with regimens heavily reliant on stool softeners. Predicting which patients will do well on laxatives is based on three components; the type of malformation, the sacral development (sacral ratio), and the presence or absence of a spinal abnormality [2]. While we know all the above factors affect continence, the exact interactions between these various factors and a determination of which of these are independent risk factors are more significant for incontinence is the subject of an ongoing investigation. Another important component is the age of the child.

In time we expect more of the laxative patients to become continent as they mature. Strategies to manage patients with ARM, who have soiling accidents on laxatives, despite intensive management, usually entails converting them to an enema program. As stated above many of our patients with soiling at 1 year on laxatives were able to be transitioned successfully on to enemas with 21/24 clean on subsequent review. Patients may then be offered a laxative trial again in the future when the clinical team believe they are in a better position to be successful.

The use of patient and parent reported outcomes measures (PROMS), was an important component of this study. The BCS [9] is effective in differentiating from control patients. Brandt et al. in their series determined the mean BCS from 34 ARM patients was 28.0 (range, 2–56, median 29) whereas in our cohort of 131 ARM patients the mean reported BCS score was 17.5, median 15 (IQR, 11–20). Our patients demonstrated significantly improved Baylor scores and this correlated well with their improved outcomes of being clean and continent respectively. The use of both standardized definitions and PROMS in this study was important to advance this field of research. Without the definitions, it would have been hard to correlate a statistically significant improvement with a clinically significant one. The other advantage of using PROMS is to eliminate various forms of bias. Over the long term we plan to track patient’s PROM scores, and significant changes will be used to prompt further investigations.

Studies have previously reported the fact that urological outcomes improve with improved bowel function and emptying [16].
There are several proposed mechanisms for this; improved bladder filling and less pressure on the trigone, with effective rectal emptying [17, 18]. We chose to use the Vancouver Symptom score for DES or bladder bowel dysfunction in our patient cohort. While not validated for children with anorectal malformations specifically, we hoped to show improvement in dysfunctional voiding in an objective way. The threshold for diagnosis of DES, was set at a score of 11 with a Test-retest reliability set at 84.5% in the original study. Our results for patients, pre and post bowel management, mirror those of patients with DES and healthy controls. Pre bowel management, the mean score was 11 and one year later it was 6 (p < 0.05). We were pleased that this study showed that many patients had diagnostic criteria for DES pre-treatment and this went away after successful management of their bowel. We have included a table (Table 3) to illustrate how differently patients do in terms of PROMS scores depending on whether they are able to be achieve continence or not.

We further used the Cleveland Constipation Score to assess our patients. This PROMS measure has been validated in adult patients with functional constipation. [10] The score runs from 0 to 30 and the threshold of 15 has been set as diagnostic for significant constipation. The mean score in our cohort never reached this threshold and we were unable to show that there was any statistical significance (p = 0.31). Review of the original description of this score, shows that the patients in this study all had objective obstructive stooling due to pelvic floor dysynergia, rectoceles, recto-anal intussusception, and rectal prolapse. While obstructive stooling is reported in children with anorectal malformations, our study has questioned the use of this score in the study population altogether, and we may eliminate this in the future in an attempt to reduce questionnaire fatigue.

Our study sought to examine the changes in patient’s and family’s quality of life before and after bowel management. Both the physical function score and the psychosocial score components of the PedsQL HRQOL showed minimal clinically meaningful improvements (86 vs 92 and 77 vs 82 respectively). This is in the context of all patients soiling at intake and 70% being reliably clean or continent at the subsequent time point. As much as bowel management has been previously shown to be effective over the short term, and we have now shown it to be effective over a longer period, it is an intensive strategy for treating stooling dysfunction and fecal incontinence. Patients on laxatives are expected to take daily doses of stimulant laxatives and water-soluble fiber, watch their diet and fluid intake, and sit on the toilet regularly for significant periods of time. Patients on enemas take around 15 min to administer their enema (antegrade or retrograde) and then sit on the toilet for around 45 min to allow the stool and enema to pass. Patient experience and patient reported experience measures (PREMS) are believed to be extremely important in determining quality of care and clinical effectiveness in health services [19]. Our group recently published the validation of such a PREMS measure to assess the burden of therapy in this patient population [20]. We hope to understand the interactions between functional outcomes and burden of therapy better in the future, in order to better counsel families and inform care.

Finally, mention should be made of the fact that many patients will require some additional input from the team once they have returned to their home environment. Ongoing availability and advice, as well as minor regimen changes, may be required to maintain good outcomes. Much of this can be done remotely using technology, however sometimes additional outpatient visits may be necessary. This does place a requirement of ongoing availability on the care team and should not be underestimated. In addition, we see patients annually, either virtually or in person, depending on their needs. This over the long term leads to a great deal of ongoing care. The institutional commitment to adequate staffing in order to achieve these positive results cannot be overemphasized. An APN or RN on call monitors and responds to the inquiries on daily basis (either via email or via mychart). There are 6–8 APN’s and 6–7 RN’s at our institution. On the weekdays they are avail-

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**Table 2**

Continence and quality of life scores in patients with ARM undergoing BMP.

<table>
<thead>
<tr>
<th>Intake</th>
<th>Median (IQR)</th>
<th>12 Months</th>
<th>Median (IQR)</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baylor</td>
<td>26 (19–34)</td>
<td>89* (11–20)</td>
<td>&lt;0.005</td>
<td></td>
</tr>
<tr>
<td>Cleveland</td>
<td>9 (7–12)</td>
<td>75* (7–10.5)</td>
<td>0.165</td>
<td></td>
</tr>
<tr>
<td>Vancouver</td>
<td>11 (7–16)</td>
<td>72* (4–12)</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>PedsQL</td>
<td>82 (70–89)</td>
<td>84 (68–90)</td>
<td>0.31</td>
<td></td>
</tr>
<tr>
<td>PedsQL physical function</td>
<td>87 (75–97)</td>
<td>42 (98–100)</td>
<td>0.77</td>
<td></td>
</tr>
<tr>
<td>PedsQL psychosocial function</td>
<td>77 (68–90)</td>
<td>43 (61–90)</td>
<td>0.165</td>
<td></td>
</tr>
<tr>
<td>% Clean</td>
<td>Overall 213</td>
<td>150</td>
<td>70.4%</td>
<td></td>
</tr>
<tr>
<td>Dx</td>
<td>Laxatives 41</td>
<td>62.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Enemas</td>
<td>109</td>
<td>74.1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* 131 patients completed 12 months Baylor scores, 137 patients completed 12 months Cleveland scores, and 131 patients completed 12 months Vancouver scores. But the analysis was only performed in the patients who completed both intake and 12 months scores.

**Table 3**

Change in the scoring from over one year in patients who are clean vs the patients who are not clean.

<table>
<thead>
<tr>
<th>Clean</th>
<th>Intake Median (IQR)</th>
<th>12 Months Median (IQR)</th>
<th>p value*</th>
<th>Not clean</th>
<th>Intake Median (IQR)</th>
<th>12 Months Median (IQR)</th>
<th>p value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baylor</td>
<td>25 (19–37)</td>
<td>13 (10–18)</td>
<td>&lt;0.005</td>
<td>27 (19–33)</td>
<td>17 (15–29)</td>
<td>0.0319</td>
<td></td>
</tr>
<tr>
<td>Vancouver</td>
<td>11 (7–15)</td>
<td>6 (4–12)</td>
<td>&lt;0.005</td>
<td>14 (9–18)</td>
<td>12 (6–16)</td>
<td>0.3150</td>
<td></td>
</tr>
<tr>
<td>Cleveland</td>
<td>10 (7–12)</td>
<td>9 (6–11)</td>
<td>0.311</td>
<td>9 (8–11)</td>
<td>8 (7–10)</td>
<td>0.297</td>
<td></td>
</tr>
<tr>
<td>PedsQL</td>
<td>78 (64–86)</td>
<td>85 (66–92)</td>
<td>0.75</td>
<td>76 (66–97)</td>
<td>77 (67–91)</td>
<td>0.75</td>
<td></td>
</tr>
<tr>
<td>Psychosocial</td>
<td>77 (59–85)</td>
<td>82 (63–89)</td>
<td>0.78</td>
<td>78 (65–100)</td>
<td>78 (65–93)</td>
<td>0.78</td>
<td></td>
</tr>
<tr>
<td>Physical functioning</td>
<td>86 (73–91)</td>
<td>92 (66–97)</td>
<td>0.94</td>
<td>77 (60–100)</td>
<td>86 (81–100)</td>
<td>0.94</td>
<td></td>
</tr>
</tbody>
</table>

* 2 tailed t-test.

**Clinically relevant improvements in total PedsQL and in PedsQL psychosocial and physical functioning scores in the clean group.**
able from 6a-10p. and on the weekends they are available from 9a-9p. In addition, there's a colorectal surgeon on call each day who is available to answer questions regarding regimen changes. But, if one looks at the clinical impact of improved care, and the potential health cost, such an investment in a bowel management program seems very appropriate [21].

5. Conclusion

Bowel management is an effective method of treating fecal incontinence in children with anorectal malformations. We have demonstrated durable results of a BOPM over a much longer period than has previously been reported. Depending on the patient’s likely ability to have their own bowel control, they can be treated with either laxatives or enemas. In addition, treating fecal incontinence appears to be an effective way to treat DES and urinary incontinence in this population. Furthermore, we have shown an improvement in quality of life, as measured by PedsQL HRQOL.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

CRediT authorship contribution statement

Richard J. Wood: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing. Alejandra Vilanova-Sanchez: Data curation, Formal analysis, Writing – review & editing. Yousef El-Gohary: Data curation, Formal analysis, Writing – original draft. Hira Ahmad: Formal analysis, Writing – original draft, Writing – review & editing. Devin R. Halleran: Data curation, Formal analysis, Writing – original draft, Writing – review & editing. Rebecca Rentea: Formal analysis, Writing – review & editing. Yuri Sebastian: Formal analysis, Writing – review & editing. Onnalisa Nash: Data curation, Writing – review & editing. Kristina Booth: Data curation, Writing – review & editing. Case Trimble: Data curation, Writing – review & editing. Pooja Zahora: Data curation, Writing – review & editing. Cheryl Baxter: Data curation, Writing – review & editing. Sarah Driesbach: Data curation, Writing – review & editing. Ibah Halaweish: Writing – review & editing. Alessandra C. Gasior: Writing – review & editing. Marc A. Levitt: Conceptualization, Formal analysis, Writing – original draft, Writing – review & editing.

References