Bolia Rishi (Orcid ID: 0000-0003-1505-9761)

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Paediatric constipation for general paediatricians : Review using a case-based and evidence-based approach.

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Review article

Full names and affiliations of the authors

Rishi Bolia [1], Mark Safe [2], Bridget R. Southwell [3], Sebastian K. King [4], Mark Oliver [5].

1. Division of Paediatric Gastroenterology, All India Institute of Medical Sciences, Rishikesh, India
2. Department of Gastroenterology and Clinical Nutrition, Royal Children's Hospital, Melbourne
3. Surgical Research Group, Murdoch Children's Research Institute; Department of Urology, Royal Children's Hospital, Melbourne; Department of Paediatrics, University of Melbourne, Melbourne.
4. Department of Paediatric Surgery and Department of Gastroenterology and Clinical Nutrition, Royal Children's Hospital, Melbourne; Surgical Research Group, Murdoch Children's Research Institute, Melbourne; Department of Paediatrics, University of Melbourne, Melbourne
5. Department of Gastroenterology and Clinical Nutrition, Royal Children's Hospital, Melbourne, Department of Paediatrics, University of Melbourne, Melbourne.

Corresponding author

Mark R Oliver

Department of Gastroenterology and Clinical Nutrition

Royal Children's Hospital Melbourne

Ph. 613 93455060

Fax 613 93456240

Email – mark.oliver@rch.org.au

Conflicts of Interest

RB has no conflict of interest

MS has no conflict of interest

BS has been a consultant to GI Therapies, a company developing devices for electrical stimulation to treat constipation. BS holds patents for electrical stimulation to treat constipation.

SKK has no conflict of interest

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Abstract

Constipation is a common problem in childhood. The most common type of constipation is functional, accounting for 90-95% of all cases. The aim of this review is to provide clinical scenarios with treatment using evidence-based information, and management strategies and a clinical algorithm to guide the management of constipation in children. Recent guidelines and online information sites are detailed. Clinical red flags and organic causes of constipation are included.

Four clinical scenarios are presented: case (1) 4-month child with constipation since birth and likely Hirschsprung disease; case (2) 6-month infant with infant dyschezia; case (3) 4 year old with functional constipation; and; case (4) 9 year old with treatment resistant constipation. Children with functional constipation need a thorough history and physical exam to rule out the presence of any “red flags” but do not require laboratory investigations. Management includes education and demystification, disimpaction followed by maintenance therapy with oral laxatives, dietary counselling and toilet training.

Treatment options differ between infants and children. Disimpaction and maintenance regimens for common laxatives are presented. On treatment failure or on suspicion of organic disease the patient should be referred for further evaluation. The radionuclide intestinal transit study (scintigraphy) is a useful modality for evaluation and planning of management in treatment-resistant children. Treatment options for treatment-resistant patients are presented. High level evidence (meta-analyses) for pharmalogical and non-pharmalogical

treatment modalities are reviewed and an algorithm for assessment and treatment are presented.

Key words – constipation, functional, slow–transit constipation, Hirschsprung disease, paediatric.

Key Points –

1. The majority (95%) of children with constipation have functional constipation. It may be diagnosed by the absence of red flags on history and by physical examination. Management includes laxatives (disimpaction followed by long-term maintenance therapy), dietary counselling and toilet training (posture and timing).
2. Children with “red flags”, or those who do not respond to conventional treatment, should be evaluated for organic causes, including celiac disease, hypothyroidism and Hirschsprung disease.
3. Slow transit constipation is a cause for refractory constipation and may be diagnosed by colonic transit studies. Treatment options include stool softeners/stimulants, transcutaneous electrical stimulation, trans-anal irrigation and surgery (appendicostomy).

Introduction

Constipation is a common problem in childhood. The prevalence varies according to the geographical location, lifestyle factors and stressful life events and ranges from 0.7% to 29.6%, with a pooled prevalence of 9.5%.[1,2] It accounts for 1% to 5% of paediatric primary care visits and up to 25 – 30 % of gastroenterology consultations [3] and poses a significant healthcare burden on the already overstretched health budgets of many countries. According to estimates, in Victoria alone it costs public hospitals ~A$5.5 million/year [4]

The vast majority of cases in children are said to be functional [95%] with a minority having a specific organic aetiology.[5,6] In this review, we will discuss the clinical presentation, approach and management of a child with constipation in a "case–based" manner to illustrate the common clinical scenarios. We will also discuss the treatment, which will be based on currently available evidence.

There are a number of published guidelines relating to constipation, with many of them directed specifically towards children. There is also information about paediatric constipation for both clinicians and patients on a number of hospital websites. Interested readers may refer to these publications and websites for further in-depth reading. **(Table 1).**

Case 1

A 4-month old male child presents to a Paediatric Gastroenterologist with a history of constipation since the neonatal period. He is passing stools once in 5-7 days. The parents describe the stool as ribbon - like. Growth with respect to weight gain has been suboptimal. Various laxatives have been used with a limited response. On examination there is a generalized abdominal distension, normal neurological examination (power, tone and reflexes of lower limbs, anal tone and perianal reflex). Digital rectal examination (DRE) reveals an empty rectum with gush of stools & air on withdrawal of finger.

Approach

When dealing with a child with constipation, the first step is to determine whether it is functional or organic. Presence of any "red – flags" on history or examination may suggest an organic aetiology (**Table 2**).[6] So while taking the history and examining the child it is imperative for the clinician to keep the points tabulated in **Table 2** in mind and ensure that they are not present.

There are a number of red – flags in the history of this child (early onset, severe abdominal distension, failure to thrive) suggesting an organic pathology. Hirschsprung disease (HD) is the most common organic cause (1 in 5–10,000 deliveries with a male predominance, male-to-female ratio 4:1).[7] Other important organic causes and their clinical features are enumerated in **Table 3**.

In this child the early onset, ribbon stools, failure to thrive, abdominal distension and characteristic DRE findings suggest possible HD. Delayed passage of meconium is the

classic presenting symptom for HD, but it must be remembered that up to 50% babies with HD pass meconium in the first 48 h of life.[6]

A barium enema may suggest a HD diagnosis by showing a reversal of recto-sigmoid ratio (sigmoid becomes more dilated than rectum) and documentation of transition zone. However, the sensitivity is only around 80%. Anorectal manometry, when demonstrating an absent Rectoanal Inhibitory Reflex (RAIR) i.e. the inability to relax the internal anal sphincter in response to rectal distension has a 90% sensitivity. Rectal biopsy is the gold standard. The biopsy site should be at least 1.5 cm above the dentate line because the distal rectum normally does not have ganglion cells. Also, biopsies taken too high may miss very short segment HD limited to the distal rectum. Most surgeons take biopsies at three different levels (1,2 & 3 cm.) to overcome these problems.[8] With acetylcholinesterase or calretinin staining to identify aganglionosis and hypertrophic nerves, the correct diagnosis has been shown to have a specificity of up to 99%.[9]

The majority (80%) of patients with HD are diagnosed in the first few months, but in about 20% of cases, the diagnosis is made later in life. Surgical intervention with resection of aganglionic bowel is the principal treatment. It can be done as two-stage (with an initial diverting colostomy) or as single-stage procedure. Up to 60% of children continue to have problems after corrective surgery that need to be managed, which include ongoing constipation, incontinence, enterocolitis and adverse response to foods.[10–14]

Food intolerance is a newer area for consideration in this group and breath tests to reveal intolerance to particular sugars followed by its dietary exclusion produces improvement in older children with HD post-surgery.[15]

Case 2

A 6-month old infant is brought to her family doctor with complaints of excessive straining and crying during the passage of stool. She is passing stool daily, which is soft or liquid. The child is growing well and examination is unremarkable. She had been exclusively breast – fed for the initial few months of her life and has recently been put on formula feeds.

Approach

This child does not have any red flags (**Table 2**), nor does she satisfy the criteria for Functional Constipation (FC) which has been tabulated in **Table 4**.

What we are dealing with here is "Infant Dyschezia" which is often misinterpreted as constipation by the caregivers. It occurs as a result of the infants' inability to coordinate increased intra-abdominal pressure with relaxation of the pelvic floor muscles. The infants often strain, scream, cry or turn red or purple in the face while making an effort to defecate. It may last for 10-20 minutes and is associated with the successful or unsuccessful passage of stools. The incidence of dyschezia decreases from 3.9% at 1 month of age to 0.9% at 9 months.[16] Parents need to be educated and reassured as this condition is self-limiting. Infant dyschezia does not lead to infant functional constipation.

Even though this infant does not have constipation, it is not uncommon for infants to develop constipation at the time of introduction of formula and / or complementary feeds. When standard infant formula is introduced to breastfed infants, fewer and firmer stools are produced. This is because breast milk contains oligosaccharides which improve osmotic balance and stool consistency.[17]

When an infant is constipated, juices which contain sorbitol may help.[18] Sorbitol is an indigestible and osmotically active carbohydrate that attracts water. It is naturally contained

in prune, pear, and apple. Infants who are eating solids can be given fruit purees instead, but at the same time one should take care as fructose intolerance is high in infants with gastrointestinal symptoms.[19] Other options include lactulose in a dose of 3-5 ml/day. If this is not effective, a small amount of polyethylene glycol with electrolytes may be trialled and guidance sought from a paediatric gastroenterologist. For immediate relief, a glycerine suppository may help.

There is some conflicting evidence regarding the association between cows–milk protein (CMP) allergy and constipation and 2-4-week trial of avoidance of CMP may be tried in a child with intractable constipation.[6,20]

Case 3

M, a 4 yr. old boy whose parents have sought a consultation with their family doctor because he is passing a stool once a week. The parents described it as “hard lumps” and may pass some fresh blood. They have also noted that he often strains after bracing himself against furniture and crosses his legs in an attempt to defecate and that he occasionally soils his clothes. The child is well grown and on examination there is a perception of a faecal mass in the left lower quadrant of the abdomen.

Approach

Our patient M fulfils the criteria for Functional Constipation **(Table 4)** and is the prototype of a constipated child presenting to a GP or paediatrician. Parents often interpret “retentive posturing” as the child straining and trying to defecate. Withholding behaviour includes - going stiff, clenching buttocks, crossing legs, bracing against furniture or walking on tip toes. M also has “faecal incontinence” which results from chronic faecal impaction with passive

overflow during withholding. Faecal impaction occurs as a consequence of withholding, as the colonic mucosa absorbs water from the faeces and the retained stools become progressively harder. Almost 30% to 75% of constipated children and more than 90% of children with faecal incontinence have faecal impaction. [21]

Here the parents describe the stool as “hard lumps”. The description of stool consistency is subjective, and parents and children may often be unsure of how to describe it. The modified Bristol stool chart (mBSC) may be a useful tool in such a situation. The m BSC which has 5 instead of 7 scores (see reference 22), has been validated in children unlike the 7 point one. Type 1 and 2 stools suggest the presence of constipation. It is reliable in children aged 6 and above and in younger children parents may identify the stool type.[22]

FC is equally present in both sexes and its incidence is independent of cultural influences and dietary practices. [1]The median age of onset is 2.3 years. The precipitant for FC is the instinct to avoid defecation because of pain or social reasons (starting of schooling, travelling, while playing etc.). Early (< 2 years) and forced toilet training and inter-current illnesses are other potential triggers. There is some literature to suggest that children with behavioural issues, ADHD and autism spectrum disorders may have a higher incidence of FC.[23]

The diagnosis of FC is entirely based on history and examination as enumerated above. An abdominal radiograph or digital rectal examination (DRE) is indicated only if just one of the ROME IV criteria are present and the clinician is unsure about a faecal mass in the rectum on abdominal examination. Routine testing for celiac disease, hypothyroidism, hypercalcaemia or allergies is not recommended. [24,25]

Treatment consists of non-pharmacological and pharmacological interventions -

Non-pharmacological interventions

It involves education and demystification, dietary counselling, toilet training and a defecation diary.

- *Education* - Information on the initiating and perpetuating factors, treatment options, and prognosis should be provided. It is important to actively involve the child in the conversation. They often feel embarrassed, especially about episodes of fecal incontinence and it is important to explain to them how overflow incontinence occurs.
- *Diet and activity* - Normal fibre and fluid intake is encouraged. The rule of thumb to calculate the recommended daily total fibre intake for children is "age plus 5 g".[26] A diet low in fibre is associated with FC. The diet should be balanced and should include fruits, cereals and vegetables. Physical activity (~ 60min/day) should be encouraged as it is associated with a decreased risk of constipation.[27]
- *Toilet training* - It is an integral part of constipation management. The correct sitting position - leaning forward with a straight back, elbows on knees and leg supported (use a stool) with knees higher than hips is vital (see https://www.continence.org.au). They should sit on the toilet for only 2 minutes and push. The child should be encouraged to sit on the toilet after meals as the gastrocolic reflex facilitates defecation. The child should be praised for his/ her effort. A chart / diary may be kept to record bowel frequency.

Pharmacological treatment

It comprises three steps: disimpaction, maintenance treatment, and weaning off.

- *Disimpaction* – It is the removal of the hard faecal mass in the rectum and is required before commencing maintenance therapy for constipation. High dose polyethylene glycol (PEG) is used 3-6 days for disimpaction.[28] A combined high dose of polyethylene glycol with sodium picosulphate (SPS) shortens the time needed [29] (Table 5A)
- *Maintenance treatment* - Once disimpaction has been achieved it is important to continue maintenance therapy for at least 2 months and all symptoms should have resolved at least 1 month before discontinuing treatment. Early stoppage is an important reason for refractory and recurrent constipation. Emphasis should be placed on attention to adherence and taking the laxatives daily and preferably at the same time of day. PEG is the drug of choice for maintenance therapy. Lactulose is an alternate option. Dosages are summarised in Table 5B.
- *Weaning* - It is advisable to taper laxatives gradually over a period of 1 - 3 months. They should never be stopped abruptly. In the developmental stage of toilet training, medication should only be stopped once toilet training and establishment of a regular stooling pattern is achieved. Dietary and toilet training advice should continue even after stoppage of laxatives

Other medical treatments

- Stimulant laxatives (bisacodyl, SPS) act directly on the intestinal mucosa and stimulate intestinal motility. They may be considered as second-line or additional treatment if treatment with osmotic laxatives (PEG, lactulose) is insufficient. They are particularly useful as a short course in refractory cases or as a rescue therapy.

- Recently, studies have revealed dysbiosis of the gut microbiome may occur in patients with constipation.[30] Targeting treatments for the dysbiosis of constipation by probiotics, prebiotics, antibiotics have been popular and have been evaluated in a number of trials. However, the current evidence does not support the use of probiotics as a single or coadjuvant therapy in the treatment of constipation [31–33] Recently 'Faecal Microbiota Transplant' has been introduced in adults as a new and promising therapeutic option [34.] However, there is no data in children and it is not recommended at present.
- Prucalopride a highly specific 5-HT4 receptor agonist with enterokinetic properties and has been found to safe to use in children with FC. However, it's role in the management of childhood constipation has not been defined properly.[35] Even though found to be efficacious in adults, there is limited data about the use and safety of lubiprostone (oral chloride channel protein-2 activator), linaclotide (cystic fibrosis transmembrane conductance regulator) and tegaserod (a partial 5-HT4 receptor agonist) in children.[36]

Outcomes

A systematic review showed that only 61% of children with FC could be taken off laxatives 6–12 months after starting treatment.[37] One-fourth of children with functional constipation continue to experience symptoms at adult age. Older age at onset, longer delay between onset and first visit to pediatric gastroenterology clinic and lower defecation frequency at study entry are associated with a poorer outcome. [38]

Case 4

A 9 yr. old boy presents to a pediatric gastroenterologist with constipation for the last 3 years. He passes stools once in 10 – 12 days, which are generally soft. He can have severe abdominal pain at times and is often bloated. Laxatives do not help and fibre supplements make it worse. Faecal incontinence occurs occasionally. He has a history of a delayed passage of meconium. He had been hospitalized on a number of occasions for colonic lavage using nasogastric washouts with both clinical and radiological confirmation of an empty colon. However, he will relapse within weeks, despite adequate laxative use. He has had a full -thickness rectal biopsy to ensure that he does not have HD. Coeliac disease, hypothyroidism and food allergies have been excluded. On examination, the child has a distended abdomen. No faecal masses are palpable on abdominal examination or DRE.

Approach

This is a child with refractory constipation as he has not responded to adequate therapy for a duration of > 3 months.[6] While dealing with such a child it is first important to make sure that the child has been on an adequate dose of a laxative for an adequate time and has been compliant to treatment. It has also important to ensure that dis-impaction has been achieved as has been the case with this boy.

More than half of this group of children with true treatment-resistant refractory constipation have organic rather than psychological causes of constipation.[39] Slow-transit constipation (STC) is an important differential in such a situation and is often underdiagnosed because stools in STC condition are nearly always soft.[40] Most children (~ 25 %) have symptoms beginning at birth, although many present when toilet training fails (~52 %). A history of delayed passage of meconium (> 24 hrs.) is present in around a third of the patients and more than half report faecal incontinence.[41] The pathophysiology is unknown, though recently

deficiency of substance P or vasoactive intestinal peptide in the axons supplying the circular muscle of the colon has been implicated.[42]

In such a situation, colonic transit studies are warranted. Nuclear scintigraphy studies have largely replaced plastic marker studies in Australia. Images are taken at regular intervals (up to 48 hrs.) following a bolus of radioactivity. This technique gives real time image of transit through the stomach, small bowel, colon and rectum. Generally, 3 categories – are recognised: (i) normal transit constipation, (ii) functional outlet obstruction or dyssynergic defecation and (iii) STC. The diagnostic criteria for separating these 3 transit types are detailed in an open access book chapter which interested readers may refer to for a more detailed description .[43] In general, in normal transit, radioactivity reaches the caecum within 6 hours and passes through the mid transverse colon by 24 hours and into the descending colon, rectosigmoid colon and toilet by 48 hours. Paediatric slow colonic transit is identified as the midpoint of radioactivity not reaching the mid transverse colon at 24 hours and/or not reaching the top of the descending colon at 48 hours. Anorectal retention is defined as retention of more than 60% of the radioactivity in the rectosigmoid at 48 hours.

The clinical importance of carrying out a transit study is that the approach and management strategy differs for individuals with different transit patterns. Identifying anorectal retention may indicate functional constipation, dyssynergic defecation (paradoxical contraction or failure of relaxation of external anal sphincter and puborectalis muscle with or without increased rectal pressure), internal sphincter achalasia (absent RAIR in presence of normal rectal biopsy) or rarely an anatomic cause such as a rectocele (herniation of the front wall of the rectum). Further testing (detailed below) helps in delineating the cause. Establishing

normal transit reassures that this is functional constipation and further behavioural and medical management is needed. The most difficult to manage is the group with STC. Clinical differentiation between outlet obstruction and STC is generally not possible, though soft stools occurs more often in STC and a higher response to standard therapy is seen in outlet obstruction.[44]

Recently a 4th pattern was described called 'rapid transit constipation (RTC). In this subgroup there is an unusual pattern of intestinal transit with rapid transit through the proximal bowel. However, it is not yet widely – accepted. It has been linked to food intolerance. [45]

Colonic manometry (either antegrade in a child with an appendiceal stoma or retrograde by colonoscopy) can be used to measure and describe High Amplitude Propagating Contractions (HAPC) in children with constipation. Children with STC are more likely to have a reduction in the number of HAPCs, abnormal HAPCs, and/or a loss of normal physiological patterns such as response to meals and morning wakening[46]. Adults and older children (> 5 years) have an average of 6–10 HAPCs per day while younger children (< 5 years) have more frequent HAPCs. The motor response of the colon to bisacodyl stimulation can also provide an insight into the underlying pathophysiology with globally reduced amplitude of contraction suggestive of myopathy, whereas disorganised propagation and an abnormal response to stimulation suggesting a neuropathic subtype.[47]

For assessment of outlet obstruction, anorectal manometry helps in detection of dyssynergic defecation and the contentious entity of internal sphincter achalasia. The description of dyssynergia has poor specificity and is limited by the non-physiological nature of recording

pelvic muscle activity while lying in a left lateral position but can be helpful to direct families towards further behavioural and physical therapy.

The management options in a child with refractory constipation include –

- *Diet* – A meta-analysis in 2018 (Table 6) concluded that adequate fibre intake is recommended for functional constipation. However, high fibre may be detrimental in children with STC due to weak propulsive action of the colon. Children with RTC may have symptoms consistent with possible food intolerance [44] Carrying out sugar – specific dietary exclusions identified with the help of a breath analysis can help.[48] (Evidence level- low)
- *Transcutaneous electrical stimulation* - It is effective in treating children with STC, with long-lasting effects.[49] It uses 4 electrodes on the skin, 2 on the abdomen and 2 on the back. Two currents with slightly offset frequencies are applied, producing an interferential current. It can even be performed daily at home using a portable device. [50,51] It has also been tested in children with outlet obstruction with some success.[52] (Evidence level- low). It is still an experimental technique and assistance may be required from specialist centers or from physical therapists with experience in electrical stimulation.
- *Biofeedback* – It is effective in reducing symptoms in some children with pelvic dysnnergia. This technique requires a child to be able to understand complex instructions.[53] (Evidence level- low). It is still an experimental technique and assistance may be required from specialist centers.

- *Behavioural therapy* combined with laxatives may be useful in the sub-set of children with incontinence with refractory constipation [54] (Table 6). This therapy consists of intensive medical management (use of enemas or high dose laxatives for cleanout, followed by sufficient dose of laxatives or stool softeners to ensure regular bowel movements), enhanced toilet training and anal sphincter biofeedback therapy. Enhanced toilet training includes 6 behavioral components: (1) education on psychophysiology and mechanisms of bowel movements; (2) description and explanation of paradoxical constriction of the external anal sphincter and how this impedes defecation; (3) instructions, modelling, and practising effective straining (proper defecation dynamics); (4) strategies for reducing parent-child conflicts; (5) treating phobic reactions to the toilet and defecation; and; (6) addressing social isolation and other related difficulties (i.e., problems at school). Psychological factors like physical or sexual abuse are likely to cause the symptoms in some.[54]
- *Botulinum* - Intrasphincteric botulinum toxin injection may be used in children with internal sphincter achalasia. There is some data to suggest that it may be useful in children irrespective of anorectal dynamics.[55] (Evidence level – Low)
- *Transanal irrigation* (TAI) involves a large-volume water irrigation of the rectum and colon performed by introducing a catheter through the anus. Recent studies using TAI in children have reported success, both in clinical bowel outcomes and in improvement of quality of life.[56] However, the literature regarding its safety and efficacy is limited (Evidence level – Low)

- *Surgery* - In children with refractory constipation despite good adherence to all medical treatments with sufficient dose and duration, an appendix stoma for antegrade enemas (ACE) may be offered.[57,58] Improvement in colonic motility as assessed by colonic manometry may help in predicting ACE outcome.[59] The stoma may be placed in two ways (with the appendix brought through the skin to create a Malone appendicostomy, or by inserting a caecostomy tube through the skin and into the caecum (Table 6). Results for continence are similar [58].
- Colostomies and colectomies are often the last resort when everything else fails. If needed colonic manometry may also identify the length of the affected colonic segment, providing information useful to the surgeon at the time of a colonic resection. Overall, surgical management and outcome(s) for refractory constipation are based on low-quality evidence. [60]

In general, evidence for these treatments is low level. Evidence (meta-analyses) for the use of the different pharmacological and non- pharmacological modalities is summarised in **Table 6**. Access to biofeedback, TES and ACE is limited and patients will need to be referred to specialists.

An algorithm approach to a child with constipation is detailed in **Figure 1**.

References

1. Mugie SM, Benninga MA, Di Lorenzo C. Epidemiology of constipation in children and adults: a systematic review. Best Pract Res Clin Gastroenterol. 2011 Feb;25(1):3–18.

2. Koppen IJN, Vriesman MH, Saps M, Rajindrajith S, Shi X, van Etten-Jamaludin FS, et al. Prevalence of Functional Defecation Disorders in Children: A Systematic Review and Meta-Analysis. J Pediatr. 2018;198:121–130.e6.

3. Di Lorenzo C. Childhood constipation: finally some hard data about hard stools! J Pediatr. 2000 Jan;136(1):4–7.

4. Ansari H, Ansari Z, Lim T, Hutson JM, Southwell BR. Factors relating to hospitalisation and economic burden of paediatric constipation in the state of Victoria, Australia, 2002-2009. J Paediatr Child Health. 2014 Dec;50(12):993–9.

5. Loening-Baucke V. Chronic constipation in children. Gastroenterology. 1993 Nov;105(5):1557–64.

6. Tabbers MM, DiLorenzo C, Berger MY, Faure C, Langendam MW, Nurko S, et al. Evaluation and treatment of functional constipation in infants and children: evidence-based recommendations from ESPGHAN and NASPGHAN. J Pediatr Gastroenterol Nutr. 2014 Feb;58(2):258–74.

7. Best KE, Addor M-C, Arriola L, Balku E, Barisic I, Bianchi F, et al. Hirschsprung's disease prevalence in Europe: a register based study. Birth Defects Res A Clin Mol Teratol. 2014 Sep;100(9):695–702.

8. Nataraja RM, Ferguson P, King S, Lynch A, Pacilli M. Management of Hirschsprung disease in Australia and New Zealand: a survey of the Australian and New Zealand Association of Paediatric Surgeons (ANZAPS). Pediatr Surg Int. 2019 Apr;35(4):419–23.

9. Friedmacher F, Puri P. Rectal suction biopsy for the diagnosis of Hirschsprung's disease: a systematic review of diagnostic accuracy and complications. Pediatr Surg Int. 2015 Sep;31(9):821–30.

10. Sood S, Lim R, Collins L, Trajanovska M, Hutson JM, Teague WJ, et al. The long-term quality of life outcomes in adolescents with Hirschsprung disease. J Pediatr Surg. 2018 Dec;53(12):2430–4.

11. Chumpitazi BP, Nurko S. Defecation disorders in children after surgery for Hirschsprung disease. J Pediatr Gastroenterol Nutr. 2011 Jul;53(1):75–9.

12. Catto-Smith AG, Trajanovska M, Taylor RG. Long-term continence after surgery for Hirschsprung's disease. J Gastroenterol Hepatol. 2007 Dec;22(12):2273–82.

13. Collins L, Collis B, Trajanovska M, Khanal R, Hutson JM, Teague WJ, et al. Quality of life outcomes in children with Hirschsprung disease. J Pediatr Surg. 2017 Dec;52(12):2006–10.

14. Zimmer J, Tomuschat C, Puri P. Long-term results of transanal pull-through for Hirschsprung's disease: a meta-analysis. Pediatr Surg Int. 2016 Aug;32(8):743–9.

15. Stathopoulos L, King SK, Southwell BR, Hutson JM. Nuclear transit study in children with chronic faecal soiling after Hirschsprung disease (HSCR) surgery has revealed a

group with rapid proximal colonic treatment and possible adverse reactions to food. Pediatr Surg Int. 2016 Aug;32(8):773–7.

16. Kramer EAH, den Hertog-Kuijl JH, van den Broek LMCL, van Leengoed E, Bulk AMW, Kneepkens CMF, et al. Defecation patterns in infants: a prospective cohort study. Arch Dis Child. 2015 Jun;100(6):533–6.

17. Nowacki J, Lee H-C, Lien R, Cheng S-W, Li S-T, Yao M, et al. Stool fatty acid soaps, stool consistency and gastrointestinal tolerance in term infants fed infant formulas containing high sn-2 palmitate with or without oligofructose: a double-blind, randomized clinical trial. Nutr J. 2014 Nov 5;13:105.

18. Xinias I, Mavroudi A. Constipation in Childhood. An update on evaluation and management. Hippokratia. 19(1):11–9.

19. Jones HF, Burt E, Dowling K, Davidson G, Brooks DA, Butler RN. Effect of age on fructose malabsorption in children presenting with gastrointestinal symptoms. J Pediatr Gastroenterol Nutr. 2011 May;52(5):581–4.

20. Iacono G, Cavataio F, Montalto G, Florena A, Tumminello M, Soresi M, et al. Intolerance of cow's milk and chronic constipation in children. N Engl J Med. 1998 Oct 15;339(16):1100–4.

21. Loening-Baucke V. Encopresis. Curr Opin Pediatr. 2002 Oct;14(5):570–5.

22. Lane MM, Czyzewski DI, Chumpitazi BP, Shulman RJ. Reliability and validity of a modified Bristol Stool Form Scale for children. J Pediatr. 2011 Sep;159(3):437–441.e1.

23. McKeown C, Hisle-Gorman E, Eide M, Gorman GH, Nylund CM. Association of constipation and fecal incontinence with attention-deficit/hyperactivity disorder. Pediatrics. 2013 Nov;132(5):e1210-5.

24. Hyams JS, Di Lorenzo C, Saps M, Shulman RJ, Staiano A, van Tilburg M. Functional Disorders: Children and Adolescents. Gastroenterology. 2016 Feb 15;

25. Choung RS, Rubio-Tapia A, Lahr BD, Kyle RA, Camilleri MJ, Locke GR, et al. Evidence Against Routine Testing of Patients With Functional Gastrointestinal Disorders for Celiac Disease: A Population-based Study. Clin Gastroenterol Hepatol. 2015 Nov;13(11):1937–43.

26. Williams CL, Bollella M, Wynder EL. A new recommendation for dietary fiber in childhood. Pediatrics. 1995 Nov;96(5 Pt 2):985–8.

27. Driessen LM, Kiefte-de Jong JC, Wijtzes A, de Vries SI, Jaddoe VW V, Hofman A, et al. Preschool physical activity and functional constipation: the Generation R study. J Pediatr Gastroenterol Nutr. 2013 Dec;57(6):768–74.

28. Thomson MA, Jenkins HR, Bisset WM, Heuschkel R, Kalra DS, Green MR, et al. Polyethylene glycol 3350 plus electrolytes for chronic constipation in children: a double blind, placebo controlled, crossover study. Arch Dis Child. 2007 Nov;92(11):996–1000.

29. Lamanna A, Dughetti LD, Jordan-Ely JA, Dobson KM, Dynan M, Foo A, et al. Treatment of fecal impaction in children using combined polyethylene glycol and sodium picosulphate. JGH open an open access J Gastroenterol Hepatol. 2018

Aug;2(4):144–51.

30. Ohkusa T, Koido S, Nishikawa Y, Sato N. Gut Microbiota and Chronic Constipation: A Review and Update. Front Med. 2019;6:19.

31. Jin L, Deng L, Wu W, Wang Z, Shao W, Liu J. Systematic review and meta-analysis of the effect of probiotic supplementation on functional constipation in children. Medicine (Baltimore). 2018 Sep;97(39):e12174.

32. Huang R, Hu J. Positive Effect of Probiotics on Constipation in Children: A Systematic Review and Meta-Analysis of Six Randomized Controlled Trials. Front Cell Infect Microbiol. 2017;7:153.

33. Harris RG, Neale EP, Ferreira I. When poorly conducted systematic reviews and meta-analyses can mislead: a critical appraisal and update of systematic reviews and meta-analyses examining the effects of probiotics in the treatment of functional constipation in children. Am J Clin Nutr. 2019 May 25;

34. Ding C, Fan W, Gu L, Tian H, Ge X, Gong J, et al. Outcomes and prognostic factors of fecal microbiota transplantation in patients with slow transit constipation: results from a prospective study with long-term follow-up. Gastroenterol Rep. 2018 May;6(2):101–7.

35. Mugie SM, Korczowski B, Bodi P, Green A, Kerstens R, Ausma J, et al. Prucalopride is no more effective than placebo for children with functional constipation. Gastroenterology. 2014 Dec;147(6):1285–95.e1.

36. Ford AC, Suares NC. Effect of laxatives and pharmacological therapies in chronic

idiopathic constipation: systematic review and meta-analysis. Gut. 2011 Feb;60(2):209–18.

37. Pijpers MAM, Bongers MEJ, Benninga MA, Berger MY. Functional constipation in children: a systematic review on prognosis and predictive factors. J Pediatr Gastroenterol Nutr. 2010 Mar;50(3):256–68.

38. Bongers MEJ, van Wijk MP, Reitsma JB, Benninga MA. Long-term prognosis for childhood constipation: clinical outcomes in adulthood. Pediatrics. 2010 Jul;126(1):e156-62.

39. Southwell BR, King SK, Hutson JM. Chronic constipation in children: organic disorders are a major cause. J Paediatr Child Health. 41(1–2):1–15.

40. Hutson JM, Chase JW, Clarke MCC, King SK, Sutcliffe J, Gibb S, et al. Slow-transit constipation in children: our experience. Pediatr Surg Int. 2009 May;25(5):403–6.

41. Wheatley JM, Hutson JM, Chow CW, Oliver M, Hurley MR. Slow-transit constipation in childhood. J Pediatr Surg. 1999 May;34(5):829-32-3.

42. King SK, Sutcliffe JR, Ong S-Y, Lee M, Koh TL, Wong SQ, et al. Substance P and vasoactive intestinal peptide are reduced in right transverse colon in pediatric slow-transit constipation. Neurogastroenterol Motil. 2010 Aug;22(8):883–92, e234.

43. Yik, Y. I., D. J. Cook, D. M. Veysey, S. J. Rutkowski, C. F. Tudball, B. S. King, T. M. Cain, B. R. Southwell and J. M. Hutson (2011). Targeting the causes of intractable chronic constipation in children: The nuclear transit study (NTS). Radioisotopes-Applications in Bio-medical Science. N. Singh, Intech Open Access: 305-320

44. Shin YM, Southwell BR, Stanton MP, Hutson JM. Signs and symptoms of slow-transit constipation versus functional retention. J Pediatr Surg. 2002 Dec;37(12):1762–5.

45. Yik YI, Cain TM, Tudball CF, Cook DJ, Southwell BR, Hutson JM. Nuclear transit studies of patients with intractable chronic constipation reveal a subgroup with rapid proximal colonic transit. J Pediatr Surg. 2011 Jul;46(7):1406–11.

46. King SK, Catto-Smith AG, Stanton MP, Sutcliffe JR, Simpson D, Cook I, et al. 24-Hour colonic manometry in pediatric slow transit constipation shows significant reductions in antegrade propagation. Am J Gastroenterol. 2008 Aug;103(8):2083–91.

47. Giorgio V, Borrelli O, Smith V V, Rampling D, Köglmeier J, Shah N, et al. High-resolution colonic manometry accurately predicts colonic neuromuscular pathological phenotype in pediatric slow transit constipation. Neurogastroenterol Motil. 2013 Jan;25(1):70-8-9.

48. Waingankar K, Lai C, Punwani V, Wong J, Hutson JM, Southwell BR. Dietary exclusion of fructose and lactose after positive breath tests improved rapid-transit constipation in children. JGH open an open access J Gastroenterol Hepatol. 2018 Dec;2(6):262–9.

49. Hutson JM, Dughetti L, Stathopoulos L, Southwell BR. Transabdominal electrical stimulation (TES) for the treatment of slow-transit constipation (STC). Pediatr Surg Int. 2015 May;31(5):445–51.

50. Ismail KA, Chase J, Gibb S, Clarke M, Catto-Smith AG, Robertson VJ, et al. Daily transabdominal electrical stimulation at home increased defecation in children with

slow-transit constipation: a pilot study. J Pediatr Surg. 2009 Dec;44(12):2388–92.

51. Yik YI, Hutson J, Southwell B. Home-Based Transabdominal Interferential Electrical Stimulation for Six Months Improves Paediatric Slow Transit Constipation (STC). Neuromodulation. 2018 Oct;21(7):676–81.

52. Yik YI, Stathopoulos L, Hutson JM, Southwell BR. Home Transcutaneous Electrical Stimulation Therapy to Treat Children With Anorectal Retention: A Pilot Study. Neuromodulation. 2016 Jul;19(5):515–21.

53. Benninga MA, Büller HA, Taminiau JA. Biofeedback training in chronic constipation. Arch Dis Child. 1993 Jan;68(1):126–9.

54. Freeman KA, Riley A, Duke DC, Fu R. Systematic review and meta-analysis of behavioral interventions for fecal incontinence with constipation. J Pediatr Psychol. 2014 Sep;39(8):887–902.

55. Zar-Kessler C, Kuo B, Belkind-Gerson J. Botulinum toxin injection for childhood constipation is safe and can be effective regardless of anal sphincter dynamics. J Pediatr Surg. 2018 Apr;53(4):693–7.

56. Mosiello G, Marshall D, Rolle U, Crétolle C, Santacruz BG, Frischer J, et al. Consensus Review of Best Practice of Transanal Irrigation in Children. J Pediatr Gastroenterol Nutr. 2017;64(3):343–52.

57. King SK, Sutcliffe JR, Southwell BR, Chait PG, Hutson JM. The antegrade continence enema successfully treats idiopathic slow-transit constipation. J Pediatr Surg. 2005 Dec;40(12):1935–40.

58. Li C, Shanahan S, Livingston MH, Walton JM. Malone appendicostomy versus cecostomy tube insertion for children with intractable constipation: A systematic review and meta-analysis. J Pediatr Surg. 2018 May;53(5):885–91.

59. Rodriguez L, Nurko S, Flores A. Factors associated with successful decrease and discontinuation of antegrade continence enemas (ACE) in children with defecation disorders: a study evaluating the effect of ACE on colon motility. Neurogastroenterol Motil. 2013 Feb;25(2):140-e81.

60. Siminas S, Losty PD. Current Surgical Management of Pediatric Idiopathic Constipation: A Systematic Review of Published Studies. Ann Surg. 2015 Dec;262(6):925-33

61. Bardisa-Ezcurra L, Ullman R, Gordon J, Guideline Development Group. Diagnosis and management of idiopathic childhood constipation: summary of NICE guidance. BMJ. 2010 Jun 1;340:c2585.

62. American Gastroenterological Association, Bharucha AE, Dorn SD, Lembo A, Pressman A. American Gastroenterological Association medical position statement on constipation. Gastroenterology. 2013 Jan;144(1):211–7.

63. Lindberg G, Hamid SS, Malfertheiner P, Thomsen OO, Fernandez LB, Garisch J, et al. World Gastroenterology Organisation global guideline: Constipation--a global perspective. J Clin Gastroenterol. 2011 Jul;45(6):483–7.

64. Burgers RE, Mugie SM, Chase J, Cooper CS, von Gontard A, Rittig CS, et al. Management of functional constipation in children with lower urinary tract symptoms:

report from the Standardization Committee of the International Children's Continence Society. J Urol. 2013 Jul;190(1):29–36.

65. Stienen JJC, Tabbers MM, Benninga MA, Harmsen M, Ouwens MMTJ. Development of quality indicators based on a multidisciplinary, evidence-based guideline on pediatric constipation. Eur J Pediatr. 2011 Dec;170(12):1513–9.

66. Bengtsson M, Ohlsson B. Retrospective study of long-term treatment with sodium picosulfate. Eur J Gastroenterol Hepatol. 2004 Apr;16(4):433–4.

67. Noergaard M, Traerup Andersen J, Jimenez-Solem E, Bring Christensen M. Long term treatment with stimulant laxatives - clinical evidence for effectiveness and safety? Scand J Gastroenterol. 2019 Jan;54(1):27–34.

68. Piccoli de Mello P, Eifer DA, Daniel de Mello E. Use of fibers in childhood constipation treatment: systematic review with meta-analysis. J Pediatr (Rio J). 94(5):460–70.

69. Tabbers MM, Boluyt N, Berger MY, Benninga MA. Nonpharmacologic treatments for childhood constipation: systematic review. Pediatrics. 2011 Oct;128(4):753–61.

70. Chen S-L, Cai S-R, Deng L, Zhang X-H, Luo T-D, Peng J-J, et al. Efficacy and complications of polyethylene glycols for treatment of constipation in children: a meta-analysis. Medicine (Baltimore). 2014 Oct;93(16):e65.

71. Gordon M, MacDonald JK, Parker CE, Akobeng AK, Thomas AG. Osmotic and stimulant laxatives for the management of childhood constipation. Cochrane database Syst Rev. 2016 Aug 17;(8):CD009118.

Table 1: Recent guidelines and online sites

Published Guidelines			
Guideline (Ref)	Society	Year	Remarks
Functional Disorders: Children and Adolescents (24)	Rome IV	2016	Diagnostic criteria for functional constipation in children
Constipation in Infants and Children: evidence-based approach (6)	ESPGHAN and NASPGHAN	2014	Paediatric guidelines in which nine clinical questions addressing diagnostic, therapeutic, and prognostic topics were formulated and addressed. Intended to be used in daily practice and as a basis for further clinical research
Diagnosis and management of idiopathic childhood	NICE	2010	These paediatric recommendations are based on systematic reviews of best available evidence and explicit consideration of cost effectiveness

constipation: summary of NICE guidance (61)			
Position statement on constipation (62)	American Gastroenterology Association	2013	Adult guidelines which address clinically related questions and summarize key points about constipation
Global guideline: Constipation--a global perspective (63)	World Gastro Org	2011	This guideline focuses on adult patients and does not specifically discuss children or special groups of patients
Management of functional constipation in children with lower urinary tract symptoms(64)	International Childrens Continence Society	2013	Guidelines on the assessment, and pharmacological and nonpharmacological management of functional constipation in children with lower urinary tract symptoms
Development of quality indicators based on a multidisciplinary, evidence-based guideline on pediatric constipation(65)		2011	This study describes a systematic method to develop a set of seven process and structure quality indicators that can be used to monitor quality of health care for children with functional constipation.
Hospital guidelines/ advice			
Royal Children's Hospital, Melbourne	https://www.rch.org.au/clinicalguide/BBD/Bowel_and_bladder_dysfunction/ https://www.rch.org.au/clinicalguide/guideline_index/Constipation/ https://www.rch.org.au/clinicalguide/guideline_index/Constipation_flowchart/		
Sydney Children's Hospital, Sydney	https://www.schn.health.nsw.gov.au/files/factsheets/constipation-en.pdf		
Nationwide children's Hospitals, USA	https://www.nationwidechildrens.org/conditions/chronic-constipation		

Table 2. "Red Flags" on history and examination (6)

History	Examination
Constipation starting extremely early in life (< 1 month)	Severe abdominal distension
Passage of meconium > 48 hours	Decreased lower extremity strength/tone/reflex
Family history of Hirschsprung's disease	Tuft of hair on spine or Sacral dimple

Ribbon stools	Abnormal position of anus or gluteal cleft deviation
Failure to thrive	Absent anal or cremasteric reflex
Fever	Perianal fistula
Bilious vomiting	Abnormal thyroid gland
Blood in the stools in the absence of anal fissures	Anal scars

Table 3. "Organic" causes of constipation

	Cause	**Clinical Features**

Endocrine	MEN 2B	Nodules on the tongue
	Hypothyroidism	Thyroid swelling. developmental delay, open posterior fontanel
	Diabetes insipidus	Polyuria , polydipsia
Neurological	Neurofibromatosis	Cutaneous markers
	Spinal cord abnormalities: Spinal dysraphism, tethered cord, spinal cord tumour, sacral agenesis	Abnormal gait, delayed walking, spinal dimple / tuft of hair or any abnormal neurological examination
	Cerebral palsy, Neurodegenerative disorders	Developmental delay, regression of mile stones, seizures, feeding difficulties
Metabolic	Hypercalcaemia	Stones (kidney or biliary) Bones (*bone pain*) Groans (Abdominal pain, nausea)
	Renal tubular acidosis	Polyuria, rickets
Pharmacological	Vincristine Neuropathy Anticholinergics Opioid analogues Anti-spasmodic	A history of the intake of these drugs
Obstructive	Anal stenosis	Small anal opening
	Presacral tumour	Rectal fullness
Allergy	Food allergy	Anal fissures, eczema, atopic dermatitis, vomiting, wheezing, "red" umbilicus
Others	Hirschsprung disease	Abdominal distention, enterocolitis, ribbon stools, digital rectal examination reveals empty rectum with gush of stools & air on withdrawal of finger
	Celiac disease	Anaemia, growth failure, abdominal pain
	Cystic fibrosis	Meconium ileus, recurrent respiratory infections, failure to thrive

Table 4. Diagnostic criteria for Functional Constipation- Rome IV (24)

Functional constipation(FC) is diagnosed in the absence of red flags according to the ROME IV definition (24) must include 2 or more of the following occurring at least once per week for a minimum of 1 month:
1. Two or fewer defecations in the toilet per week
2. At least 1 episode of faecal incontinence per week*
3. History of retentive posturing or excessive volitional stool retention
4. History of painful or hard bowel movements
5. Presence of a large faecal mass in the rectum
6. History of large diameter stools that can obstruct the toilet

*"fecal incontinence with at least one episode a week" is not applicable in infants and toddlers who are not toilet –trained and wear diapers.

Table 5A. Disimpaction regimens

Manufacturers instructions	Age (years)	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
PEG* sachets	1-5	1	2	2	3	3	4	4
	6-11	2	3	4	5	6	6	6
	12-18	8	8	8				
PEG@ small scoops	1-5	2	3	3	4	5	6	6
	6-11	3	4	6	8	9	9	9
Combination (29)								
PEG* sachets	4-5 6-11 12-18	4 6 6-8	2-3 5-6 4-8	1-2 2-3 2-3	1 1 1			
SPS# drops	4-11 12-18	- -	12 15	15 20	10 15			

*Movicol™ (polyethylene glycol [PEG] and electrolytes 13.8 g/sachet). Max dose, 4-5yo 4 sachets, 6-11yo 6 sachets, 12yo or older 8 sachets. Double the dose if using Movicol™ Junior/Half sachet.
@OsmoLax™ (polyethylene glycol [PEG] without electrolytes, available in tin with double – ended scoop) – small scoop(8.5g)
#Dulcolax SPS (drops 0.5 mg/drop)

Table 5B. Maintenance and rescue laxative dosages for children
(Adapted from https://www.rch.org.au/clinicalguide/guideline_index/Constipation/ (Accesed on 14th April,2019)

Laxative / class	Usage	Dosage	Side - effects
Polyethylene Glycol (osmotic laxative)	Maintenance Therapy	0.5-1g/kg /day*	Nausea, bloating, cramps, vomiting
Lactulose *(osmotic laxative)*	Maintenance therapy	1-12 months 3-5mL/day 1-5yo 5-10mL/day 5-14yo 10-40mL/day	Abdominal distension Discomfort

Sodium picosulfate drops (*stimulant laxative)* (Dulcolax SPS liquid, 1 drop = 0.5mg)	Rescue therapy$	6mo-4yrs - 0.25mg/kg (max 5mg) 4-10yo - 5-10 drops >10yo - 10 drops (single bedtime dose)	Abdominal pain, nausea, and diarrhea ~ 50%
Bisacodyl *(stimulant laxative)* Dulcolax tablets (10mg/tablet)	Rescue therapy^	3-10yo - ½ tablet >10yo - 1-2 tablets (single bedtime dose)	Short term usage is free from side effects. Prolonged use may produce abdominal cramps, diarrhea or,hypokalemia.
Prucalopride	? Refractory constipation	0.04 mg/kg/day	Diarrhea, headache, nausea and abdominal discomfort

*****[Movicol™ Half/Junior (6.9 g/sachet), 1-12mo ½-1 sachet, 1-6yo 1-4 sachet (max 4/day), 6-12yo 2-8 sachet (max 8/day) , Movicol™ full strength(13.8g/sachet) >12yo 1-4/day (max 8 sachets).]

OsmoLax™ (8.5g./small scoop, 17g/large scoop) – 2-6 years – 1 small scoop/day, 6-12 years – 1 large scoops/day, > 12 years – 1-2 large scoops/day.

$ Retrospective cohort studies have demonstrated long – term efficacy with no serious side – effects or development of tolerance.(66,67) May be considered for intermittent rescue therapy if required.

^Evidence does not support usage for longer than 4 weeks (66)

Table 6. Summary of meta-analyses for the management of childhood constipation

Treatment modality	Reference	Number of trials included	Conclusions
Fibre	Piccoli Mello et al. 2018 (68)	9 RCTs n = 680	Adequate fiber intake should be recommended for functional constipation, and fiber supplementation should not be prescribed
Fluid	Tabbers et al. 2011 (69)	1 RCT n = 108	Evidence does not support the use of extra fluid intake in the treatment of functional constipation.
Probiotics	Jin et al. 2018 (31)	4 RCTs n = 382	Probiotics have no significant effect on treatment success rate compared with placebo. Probiotic supplementation might result in reduced frequency of glycerin enema use and abdominal pain.
	Harris et al. 2019 (33)	17 RCTs n = 965	Current evidence thus does not support the use of probiotics as a single or coadjuvant therapy for treatment of functional constipatio n in children and refutes recently

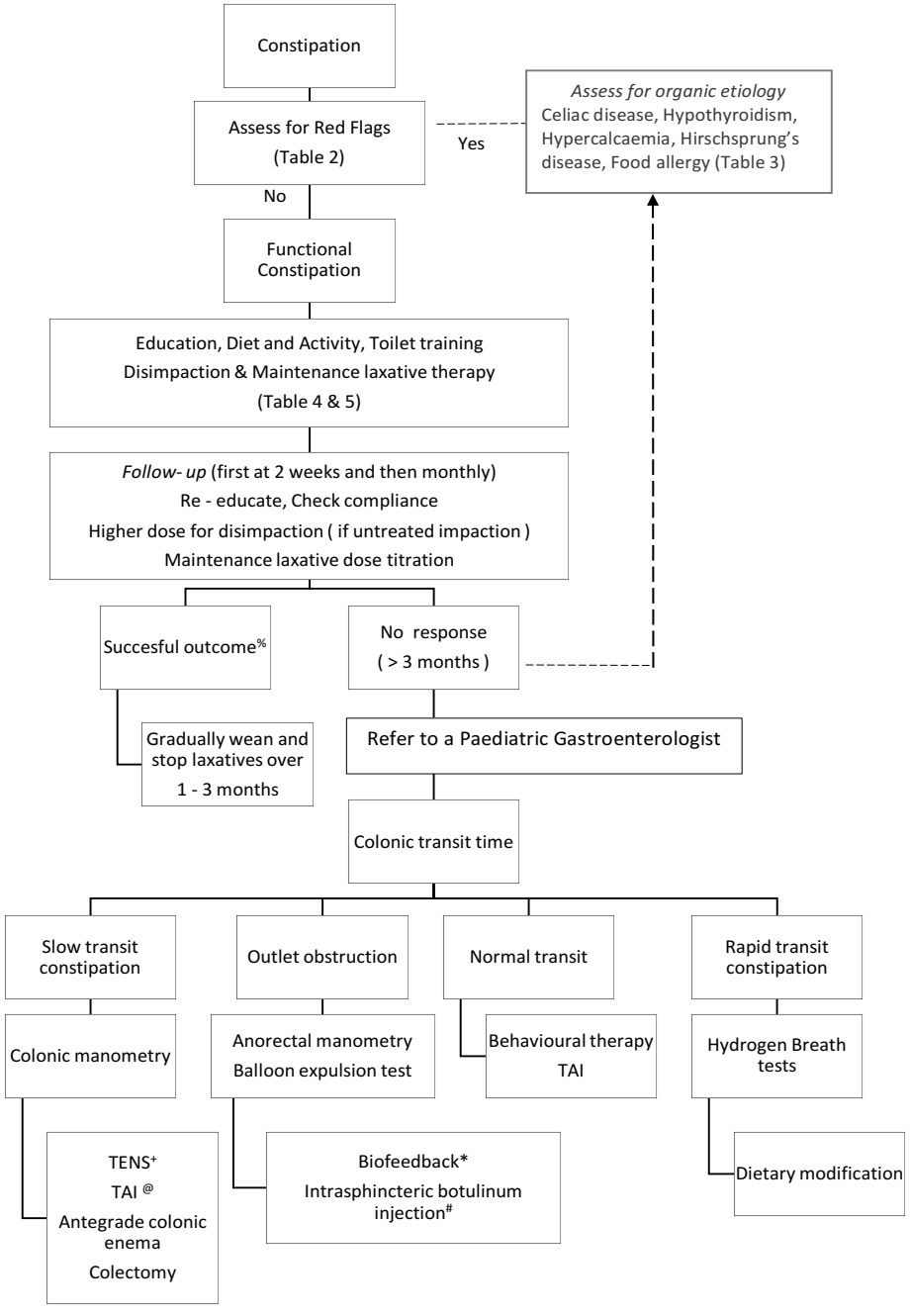
			published reviews reporting favorable effects of probiotics
Behavioural treatments	Freeman et al. 2014 (54)	4 RCTs n = 216	Although evidence supports behavioural treatments for faecal incontinence with constipation in children, available evidence is limited
Laxatives (Paediatric)	Chen et al. 2014 (70) Gordon et al. 2016 (71)	10 RCTs n = 1052 25 RCTs n = 2310	Patients treated with PEG experienced more successful disimpaction compared with those treated with non-PEG laxatives. Children's acceptance of PEG-based laxatives appears to be better than non-PEG laxatives. PEG preparations may be superior to placebo, lactulose and milk of magnesia for childhood constipation.
Laxatives and pharmacological therapies (Adults)	Ford et al. 2011 (36)	21 RCTs (laxatives-8, prucalopride - 7, lubiprostone,- 3, linaclotide- 3)	Laxatives, prucalopride, lubiprostone and linaclotide are all more effective than placebo for the treatment of CIC.
Appendix Stomas	Li et al. 2018 (58)	3 retrospective observational studies n = 166	Malone appendicostomy and cecostomy tube insertion are comparable in terms of achieving continence. Children treated with Malone appendicostomy appear to be more likely to require additional surgery due to early or late complications.
Surgery	Siminas et al. 2015 (60)	45 reports n = 1157	Antegrade continence enema operation (ACE)- was judged as successful in 82% of cases, Colon resection and pull through operations had "good" outcome(s) in 79%, Permanent colostomy was considered successful in 86% No single operation was considered "best practice."

Long-term results of transanal pull-through for Hirschsprung disease	Zimmer et al. 2016 (14)	Six studies with 316 patients	Nearly 15 % of all patients operated with transanal pull-through for HD continue to experience persistent bowel symptoms with constipation as the main problem.

*PEG – Polyethylene Glycol

Legend to Figure

Figure 1. Algorithm Approach to Pediatric Constipation



% A successful outcome is - mean bowel frequency of ≥3/week
+ Transcutaneous electric nerve stimulation
@ Transanal Irrigation
*for Pelvic floor dyssnergia
#for Internal anal achalasia