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Review Article

Behind the bellyache: a comprehensive review and the novel SAFE child diagnostic algorithm for abdominal pain in children

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ABSTRACT

Abdominal pain is one of the most common presenting complaints in pediatric practice, spanning a spectrum from self-limited functional discomfort to acute surgical emergencies. The diagnostic challenge is compounded in young children by limited symptom articulation, overlapping presentations across organic and functional disorders, and inconsistent application of validated screening criteria in routine practice. This narrative review synthesises current evidence on the epidemiology, classification, etiology, red-flag recognition, and diagnostic and management approach to abdominal pain in children, drawing on clinical practice guidance from the American Academy of Family Physicians, NASPGHAN, and Rome Foundation criteria, and introduces an original structured clinical algorithm the SAFE-Child Algorithm (Systematic Assessment For Evaluating abdominal pain in Children) unifying triage, age-based differential diagnosis, alarm-symptom screening, and Rome IV functional classification into one stepwise pathway. Acute abdominal pain requires first-pass triage for surgical emergencies (appendicitis, intussusception, malrotation/volvulus, incarcerated hernia) using age-specific differential diagnosis and localizing signs. Chronic or recurrent abdominal pain (RAP), present in up to 19% of children in population-based studies, is functional in the large majority of cases, with an organic cause identified in only 5-10%; a validated alarm-symptom screen and Rome IV criteria allow most children to be confidently classified without unnecessary invasive investigation. The SAFE-Child Algorithm operationalises this evidence into a six-step pathway spanning emergency triage through biopsychosocial management and structured follow-up. A structured, stepwise diagnostic approach can reduce unnecessary investigation in functional abdominal pain while ensuring timely recognition of organic and surgical disease.

Keywords: Pediatric abdominal pain, Functional gastrointestinal disorder, Rome IV criteria, Appendicitis, Diagnostic algorithm, SAFE-child

INTRODUCTION

Abdominal pain accounts for a substantial proportion of pediatric outpatient, primary care, and emergency department visits, with acute presentations alone responsible for up to 10% of pediatric emergency department consultations.[1] The differential diagnosis is exceptionally broad, ranging from benign, self-limited causes such as constipation and viral gastroenteritis to life-threatening surgical emergencies such as appendicitis, intussusception, and intestinal volvulus.[1,2] Diagnostic uncertainty is amplified by the limited ability of young children to localise or describe pain, the overlapping symptomatology of organic and functional disorders, and the wide variation in disease prevalence across age groups.[2]

A separate but related clinical challenge concerns chronic or RAP, which affects a substantial minority of school-age children and adolescents, with population-based prevalence estimates ranging from 0.3% to 19% (median approximately 8%).[5,6] The overwhelming majority of these children have a functional gastrointestinal disorder (FGID) rather than an identifiable organic disease, with

organic pathology found in only 5-10% of children formally evaluated for RAP.[13] The Rome IV criteria, published by the Rome Foundation, provide the current international reference standard for classifying pediatric abdominal pain related FGIDs into functional dyspepsia, irritable bowel syndrome (IBS), functional abdominal pain-not otherwise specified (FAP-NOS), and abdominal migraine.[7,10]

Despite the existence of validated criteria and alarm-symptom screens, clinical practice varies considerably in how systematically these tools are applied, contributing both to missed or delayed diagnosis of organic disease and to unnecessary invasive investigation of children with functional pain.[12,13] This review consolidates the current evidence base on epidemiology, etiology, red-flag recognition, and management of pediatric abdominal pain, and proposes an original, unified clinical algorithm the SAFE-Child Algorithm intended to standardise the stepwise clinical approach from initial presentation through definitive management.

REVIEW METHODOLOGY

This narrative review synthesises literature identified through PubMed/PMC, the Rome Foundation criteria repository, and clinical practice resources including American Academy of Family Physicians (AAFP) clinical reviews and the NASPGHAN/American Academy of Pediatrics technical report on chronic abdominal pain in children.[1,12,13] Sources published between 1958 (the original Apley and Naish field survey establishing RAP epidemiology) and 2025 were included, with priority given to systematic reviews, meta-analyses, and society clinical guidance. As a narrative review, formal risk-of-bias scoring and meta-analysis were not performed. The SAFE-Child Algorithm presented in Section 6 was independently constructed by the author for this review by integrating the evidence-based decision points identified across the reviewed literature into a single sequential pathway; it is not a reproduction of any single existing published algorithm.

EPIDEMIOLOGY

Acute abdominal pain is exceedingly common in pediatric practice, accounting for up to 10% of pediatric emergency department visits, though most causes are self-limited.[1] Acute appendicitis, the most common surgical cause of acute abdominal pain in children, is diagnosed in 1-8% of children presenting to pediatric emergency departments with abdominal pain and remains the most frequent indication for emergency abdominal surgery in this age group.[3]

Recurrent or chronic abdominal pain shows wide prevalence variation across studies, from 0.3% to 19% (median approximately 8.4%) in Western population-based surveys, with peak prevalence between 4-6 years of age and again in early adolescence, and a female predominance in most cohorts.[15] Meta-analytic pooled estimates of pediatric functional abdominal pain disorders show even wider variation (1.6-41.2%) depending on diagnostic criteria used and geographic region, with several Asian and South American cohorts reporting higher prevalence than European series.[16] Among children formally referred for specialist evaluation of RAP, functional (non-organic) disorders account for the large majority of diagnoses, with organic disease confirmed in only 5-10% of cases.[13]

CLASSIFICATION OF PEDIATRIC ABDOMINAL PAIN

For clinical purposes, pediatric abdominal pain is most usefully classified along two axes: (i) duration and pattern acute (a single episode, typically under two weeks) versus chronic/recurrent (Rome IV: pain present for at least two months, or at least four episodes per month for two months, with symptom onset at least six months before diagnosis); and (ii) presumed etiological category organic (an identifiable structural, infectious, inflammatory, or biochemical cause) versus functional (a disorder of gut brain interaction without an identifiable structural or biochemical abnormality).[7,10,13] This classification underpins the structure of the SAFE-Child Algorithm presented in section 6.

ETIOLOGY

Acute abdominal pain, age-based differential diagnosis

The differential diagnosis of acute abdominal pain in children varies substantially by age. In infants under two years, intussusception, incarcerated inguinal hernia, and malrotation with volvulus are the surgical emergencies of greatest concern, alongside the common benign diagnosis of infantile colic. In preschool-age children (2-5 years), viral or bacterial gastroenteritis, functional constipation, urinary tract infection, and mesenteric lymphadenitis predominate. In school-age children and adolescents, appendicitis, constipation, functional abdominal pain, and in post-menarchal females' gynecological causes such as ovarian torsion or pelvic inflammatory disease become increasingly relevant considerations.[1,2]

Acute appendicitis remains the diagnosis of greatest concern across all age groups due to its frequency and the consequences of delayed diagnosis, including perforation, reported in 17-33% of cases in some series.[3] Clinical findings suggestive of appendicitis include right lower quadrant tenderness with rebound, decreased or absent bowel sounds, and positive psoas, obturator, or Rovsing signs; anorexia, nausea, and vomiting accompany the majority of confirmed cases.[1,4] Mesenteric lymphadenitis is an important benign mimic of appendicitis, and differentiating between the two remains clinically challenging, prompting interest in adjunctive laboratory markers such as C-reactive protein and the neutrophil-to-lymphocyte ratio.[4,5] A retrospective primary-care cohort

study found that a CRP cut-off of ≥10 mg/L had a sensitivity of 0.87 and specificity of 0.77 for appendicitis among children presenting with acute abdominal pain, supporting its role as an adjunct not a substitute for clinical assessment and imaging.[5]

Chronic/RAP-functional gastrointestinal disorders

Under the Rome IV framework, pediatric abdominal-pain-related FGIDs (AP-FGIDs) are subdivided into functional dyspepsia (further split into postprandial distress syndrome and epigastric pain syndrome), irritable bowel syndrome, functional abdominal pain not otherwise specified, and abdominal migraine.[7,9,10] AP-FGIDs collectively affect an estimated 20% of children worldwide, with IBS accounting for approximately 45% of pediatric AP-FGID diagnoses.[11] Compared with the earlier Rome III criteria, Rome IV has been shown in prospective cohort studies to shift diagnostic distribution increasing the proportion of children classified with functional dyspepsia while decreasing the proportion classified with IBS without materially changing the overall proportion of children diagnosed with a functional (as opposed to organic) disorder.[8,9]

The pathophysiology of functional abdominal pain is understood as a disorder of gut-brain interaction, involving visceral hypersensitivity, altered gastrointestinal motility, dysregulated mucosal immune function, microbiome alterations, and central nervous system processing, shaped by early-life events, genetic predisposition, and psychosocial factors.[11]

Organic causes of chronic/ RAP

Although comprising only 5-10% of children evaluated for RAP, organic causes remain an essential diagnostic consideration and include celiac disease, inflammatory bowel disease, Helicobacter pylori-associated gastritis or peptic disease, chronic constipation with overflow, lactose or other carbohydrate malabsorption, urinary tract abnormalities, and, less commonly, hepatobiliary or pancreatic disease.[12,13] Regional variation in organic disease prevalence is notable for example, *H. pylori* infection has been identified in up to 65% of some cohorts of children presenting with RAP and dyspepsia in certain populations, substantially higher than rates seen in Western cohorts, underscoring the importance of considering local epidemiology when structuring the diagnostic work-up.[16]

THE SAFE-CHILD ALGORITHM: A NOVEL STRUCTURED DIAGNOSTIC PATHWAY

To translate the evidence reviewed in sections 3-5 into a single, reproducible clinical pathway, this review proposes the SAFE-Child Algorithm. The algorithm was constructed specifically for this review by the author, integrating validated decision points from the reviewed literature surgical danger-sign triage, age-based acute differential diagnosis, the NASPGHAN/AAP alarm-symptom framework, and Rome IV functional classification into a unified six-step sequential pathway not published in this combined form elsewhere. The full flowchart is presented in Figure 1.

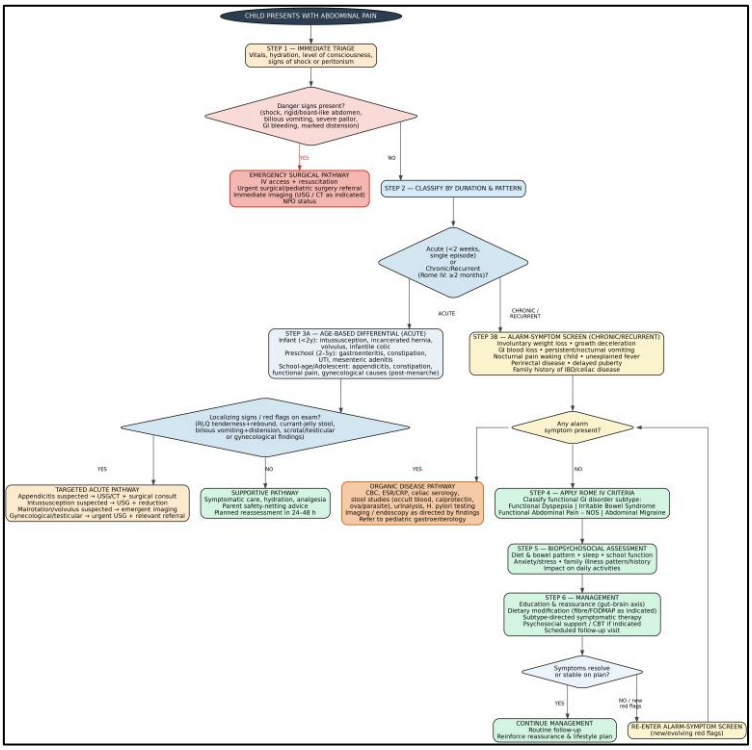

Figure 1: Dr. Venugopal's SAFE-Child Algorithm an original stepwise clinical pathway for the diagnostic approach to abdominal pain in children, developed for this review.

STEP BY STEP DESCRIPTION

Step 1 immediate triage

Every child presenting with abdominal pain undergoes rapid assessment of vital signs, hydration status, level of consciousness, and signs of shock or peritonism before any further history-taking proceeds.[1]

Danger-sign decision point

The presence of shock, a rigid or board-like abdomen, bilious vomiting, severe pallor, gastrointestinal bleeding, or marked abdominal distension triggers immediate entry into the Emergency Surgical Pathway intravenous access and resuscitation, urgent surgical or pediatric surgery referral, immediate imaging, and nil-by-mouth status bypassing sequential work-up.[1,2]

Step 2 classification by duration and pattern

In the absence of danger signs, the child's presentation is classified as acute (a single episode, under two weeks' duration) or chronic/recurrent (meeting Rome IV duration criteria of at least two months).[7,13]

Step 3A age-based differential (acute pathway)

For acute presentations, the differential diagnosis is narrowed by age band (infant, preschool, school-age/adolescent) as detailed in Section 5.1, followed by assessment for localizing signs or red flags on examination. Presence of localizing findings directs the clinician into a Targeted Acute Pathway (appendicitis, intussusception, malrotation/volvulus, or gynecological/testicular pathways as clinically indicated); absence of such findings supports a Supportive Pathway with symptomatic care, parental safety-netting advice, and planned reassessment within 24-48 hours.[1,2,4,5]

Step 3B alarm-symptom screen (chronic/recurrent pathway)

For chronic or recurrent presentations, a structured screen for alarm symptoms involuntary weight loss, growth deceleration, gastrointestinal blood loss, persistent or nocturnal vomiting, pain that wakes the child at night, unexplained fever, perirectal disease, delayed puberty, and family history of inflammatory bowel disease or celiac disease is applied before any further classification.[12,13]

Step 4 Rome IV classification

Children without alarm symptoms proceed to classification into a specific functional GI disorder subtype (functional dyspepsia, IBS, FAP-NOS, or abdominal migraine) using Rome IV criteria, supporting a symptom-based diagnosis without automatic recourse to invasive testing.[7,10]

Step 5 biopsychosocial assessment

Diet and bowel pattern, sleep, school functioning, anxiety or stress, and family illness patterns are systematically assessed, reflecting the biopsychosocial model that underlies contemporary understanding of pediatric functional abdominal pain.[11]

Step 6 management and structured follow-up

Management combines education and reassurance regarding the gut-brain axis, dietary modification where indicated, subtype-directed symptomatic therapy, psychosocial support (including cognitive behavioural therapy where appropriate), and a scheduled follow-up visit. At follow-up, children whose symptoms resolve or remain stable continue routine management; those with new or evolving alarm symptoms re-enter the alarm-symptom screen (Step 3B), ensuring the pathway remains responsive to a changing clinical picture over time rather than treating the initial classification as permanent.[11,12]

Rationale and intended use

The SAFE-child algorithm is intended as a bedside cognitive aid for primary care physicians, pediatricians, and trainees, consolidating decision points that are individually well-validated in the literature but not previously presented as a single integrated pathway spanning both acute surgical triage and chronic functional classification. It is designed to reduce two opposing risks documented in the literature: delayed recognition of organic or surgical disease, and unnecessary invasive investigation of children with functional abdominal pain who lack alarm features.[12,13] As with any clinical algorithm, it is intended to support not replace clinical judgment, and requires prospective validation before formal adoption into clinical protocols.

DIAGNOSTIC WORK-UP

History and examination

A focused history should characterise pain location, character, timing (including any nocturnal component), relationship to meals and defecation, associated symptoms (fever, vomiting, diarrhea, weight change), menstrual history in post-menarchal females and family history of gastrointestinal disease. Examination findings warranting further work-up include weight loss or growth faltering, jaundice, costovertebral tenderness, hepato-splenomegaly, an abdominal mass/localized tenderness.[13]

Laboratory and imaging investigations

For children with alarm symptoms or organic features, initial investigations typically include a complete blood

count, inflammatory markers (ESR/CRP), stool studies (occult blood, calprotectin, ova and parasites), urinalysis, celiac serology, and *H. pylori* testing, with abdominal imaging or endoscopy directed by specific findings rather than performed indiscriminately.[12,13] For suspected appendicitis, ultrasonography is favoured as a first-line imaging modality given its lack of ionising radiation and specificity of 68-90% in children, with CT reserved for equivocal cases.[3] Endoscopic evaluation (esophagogastroduodenoscopy) is reserved for children with alarm symptoms, failure of empiric therapy, or suspicion of specific organic disease such as celiac disease or *H. pylori* infection, consistent with current pediatric gastroenterology practice.[18]

Critically, in the absence of alarm symptoms, the evidence does not support routine extensive laboratory or endoscopic evaluation for children meeting Rome IV criteria for a functional abdominal pain disorder; diagnosis in this context is primarily symptom-based.[10]

MANAGEMENT

Organic and surgical disease

Management of organic disease is directed by the specific diagnosis identified surgical referral for appendicitis, intussusception, or volvulus; disease-specific therapy for celiac disease, inflammatory bowel disease, or *H. pylori*-associated disease; and treatment of underlying urinary, hepatobiliary, or metabolic conditions as identified.[1,12]

Functional abdominal pain

Management of functional abdominal pain disorders rests on a biopsychosocial model, beginning with clear communication of the diagnosis and its basis in disordered gut brain interaction rather than the absence of "real" symptoms, to reduce parental and patient anxiety and unnecessary further testing. Dietary interventions with evidence of benefit include soluble fibre supplementation and, in IBS specifically, a low-FODMAP diet or exclusion of lactose or fructose where malabsorption is identified. Pharmacologic and complementary options with reported benefit include peppermint oil, certain probiotic strains, and antispasmodic agents, while psychosocial interventions particularly cognitive behavioural therapy have evidence of benefit in reducing symptom burden and improving functioning, particularly where anxiety or stress is a prominent contributing factor.[11]

Special considerations

Regional and resource-setting variation is clinically important. In settings with higher background prevalence of *H. pylori* infection, intestinal parasitosis, or abdominal tuberculosis, the pretest probability of organic disease in a child presenting with RAP may be meaningfully higher than in the Western cohorts from which much of the Rome IV validation data derive, supporting a lower threshold for targeted investigation (for example, *H. pylori* testing or stool microscopy) even in the absence of classical alarm symptoms.[16] Clinicians should also remain alert to atypical presentations, including abdominal pain as a presenting feature of extra-abdominal or systemic illness (for example, multisystem inflammatory syndrome in children following SARS-CoV-2 infection, which can mimic appendicitis), reinforcing that any diagnostic algorithm must be applied with ongoing clinical judgment rather than as a rigid, non-adaptive checklist.[20]

Limitations

This review has several limitations. As a narrative rather than systematic review, formal quality appraisal and meta-analysis were not performed, and publication and selection bias cannot be excluded. The SAFE-Child Algorithm, while grounded entirely in previously validated individual decision points, has not itself been prospectively validated in a clinical cohort; its sensitivity, specificity, and impact on clinical outcomes (time to diagnosis, rate of unnecessary investigation) remain to be formally studied. Prevalence and etiology data are drawn predominantly from North American, European, and selected Asian cohorts, and may not generalise fully to all clinical settings.

CONCLUSION

Abdominal pain in children spans a wide clinical spectrum, from benign self-limited discomfort to acute surgical emergencies and chronic functional gastrointestinal disorders. A structured, stepwise approach combining early triage for surgical danger signs, age-appropriate differential diagnosis, systematic screening for alarm symptoms, and Rome IV-based functional classification allows clinicians to identify organic and surgical disease promptly while avoiding unnecessary invasive investigation in the majority of children whose pain proves functional. The SAFE-Child Algorithm presented in this review consolidates this evidence base into a single, reproducible clinical pathway intended to support though not replace careful clinical judgment, and is offered as a candidate framework for future prospective validation.

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