

Delayed Diagnoses in Children with Constipation: Multicenter Retrospective Cohort Study

Stephen B. Freedman, MDCM, MSc¹, Jonathan Rodean, MPP², Matthew Hall, PhD², Elizabeth R. Alpern, MD, MSCE³, Paul L. Aronson, MD⁴, Harold K. Simon, MD, MBA⁵, Samir S. Shah, MD, MSCE⁶, Jennifer R. Marin, MD⁷, Eyal Cohen, MD, MSc⁸, Rustin B. Morse, MD, MMM^{9,10}, Yiannis Katsogridakis, MD, MPH³, Jay G. Berry, MD, MPH¹¹, and Mark I. Neuman, MD, MPH¹²

Objective The use of abdominal radiographs contributes to increased healthcare costs, radiation exposure, and potentially to misdiagnoses. We evaluated the association between abdominal radiograph performance and emergency department (ED) revisits with important alternate diagnosis among children with constipation.

Study design Retrospective cohort study of children aged <18 years diagnosed with constipation at one of 23 EDs from 2004 to 2015. The primary exposure was abdominal radiograph performance. The primary outcome was a 3-day ED revisit with a clinically important alternate diagnosis. RAND/University of California, Los Angeles methodology was used to define whether the revisit was related to the index visit and due to a clinically important condition other than constipation. Regression analysis was performed to identify exposures independently related to the primary outcome.

Results A total of 65.7% (185 439/282 225) of children with constipation had an index ED visit abdominal radiograph performed. Three-day revisits occurred in 3.7% (10 566/282 225) of children, and 0.28% (784/282 225) returned with a clinically important alternate related diagnosis. Appendicitis was the most common such revisit, accounting for 34.1% of all 3-day clinically important related revisits. Children who had an abdominal radiograph performed were more likely to have a 3-day revisit with a clinically important alternate related diagnosis (0.33% vs 0.17%; difference 0.17%; 95% CI 0.13-0.20). Following adjustment for covariates, abdominal radiograph performance was associated with a 3-day revisit with a clinically important alternate diagnosis (aOR: 1.39; 95% CI 1.15-1.67). Additional characteristics associated with the primary outcome included narcotic (aOR: 2.63) and antiemetic (aOR: 2.35) administration and underlying comorbidities (aOR: 2.52).

Conclusions Among children diagnosed with constipation, abdominal radiograph performance is associated with an increased risk of a revisit with a clinically important alternate related diagnosis. (*J Pediatr* 2017;■■■:■■■-■■■).

Because no objective test confirms a diagnosis of constipation, historical features and examination findings commonly are used to establish the diagnosis.^{1,2} Although the routine use of abdominal radiographs to diagnose constipation is discouraged,³⁻⁵ they are performed in up to 70% of children diagnosed with constipation in emergency department (ED) settings.⁶⁻⁸ Despite having poor diagnostic test characteristics,⁹ the use of abdominal radiographs contributes to increased healthcare costs, radiation exposure,¹⁰ and potentially to misdiagnoses.⁸

Diagnostic errors, including inaccurate or delayed diagnoses, harm up to 12 million patients in the US each year.¹¹ Although major misdiagnoses are uncommon in children diagnosed with constipation in EDs (0.4%-0.8%),⁸ an accurate diagnostic approach is needed because it accounts for more than 250 000 visits to the ED in the US annually.¹² Appendicitis is a leading missed diagnosis in children and is a particular concern in the ED setting, where continuity of care and clinical follow-up may be uncertain.^{13,14} A single-center report associated abdominal radiograph performance with misdiagnosis in 20 children initially diagnosed with constipation who had a variety of other conditions, most commonly appendicitis, intussusception, and bowel obstruction.⁸ Other reports have identified constipation as a common initial diagnosis in children subsequently diagnosed with appendicitis.¹⁵⁻¹⁷

CBC	Complete blood count
ED	Emergency department
ICD-9	International Classification of Diseases, Ninth Revision
PHIS	Pediatric Health Information System

From the ¹Sections of Pediatric Emergency Medicine and Gastroenterology, Department of Pediatrics, Alberta Children's Hospital, Alberta Children's Hospital Research Institute, University of Calgary, Calgary, AB, Canada; ²Department of Analytics, Children's Hospital Association, Lenexa, KS; ³Division of Emergency Medicine, Ann and Robert H. Lurie Children's Hospital of Chicago, Northwestern University Feinberg School of Medicine, Chicago, IL; ⁴Section of Pediatric Emergency Medicine, Departments of Pediatrics and Emergency Medicine, Yale School of Medicine, New Haven, CT; ⁵Division of Emergency Medicine, Departments of Pediatrics and Emergency Medicine, Emory University School of Medicine, and Children's Healthcare of Atlanta, Atlanta, GA; ⁶Divisions of Hospital Medicine and Infectious Diseases, Department of Pediatrics, Cincinnati Children's Hospital Medical Center, Cincinnati, OH; ⁷Departments of Pediatrics and Emergency Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA; ⁸Division of Pediatric Medicine, Department of Pediatrics, The Hospital for Sick Children, University of Toronto, Toronto, ON, Canada; ⁹Department of Pediatrics, Children's Health System of Texas; ¹⁰Department of Pediatrics, University of Texas Southwestern, Dallas, TX; ¹¹Division of General Pediatrics, Department of Medicine; and ¹²Division of Emergency Medicine, Boston Children's Hospital, Harvard Medical School, Boston, MA

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Given the small sample sizes included in previous reports, we sought to conduct a large, multicenter study that would be capable of identifying features that are associated independently with clinically important alternate diagnoses in children initially diagnosed with constipation in the ED. Specifically, we sought to determine whether abdominal radiograph performance, given its poor diagnostic test characteristics,⁹ is associated with ED revisits within 3 days with a clinically important alternate diagnosis.

Methods

We conducted a multicenter retrospective cohort study of children diagnosed with constipation in an ED between July 2004 and June 2015. Patients were longitudinally followed to identify ED revisits. RAND/University of California, Los Angeles methodology was used to categorize the relatedness and clinical importance of diagnoses assigned at revisits.

Data were obtained from the Pediatric Health Information System (PHIS). The Children's Hospital Association (Overland Park, Kansas), Truven Health Analytics (Ann Arbor, Michigan), and the participating tertiary care pediatric hospitals jointly ensure data quality.¹⁸ Institutions provide deidentified individual-level data to Truven Health Analytics quarterly, along with encrypted medical record numbers that enable the tracking of patients across hospital visits. Data quality audits are performed.¹⁹ Sites receive alerts if reviewed data are of poor quality or incomplete. The Boston Children's Hospital institutional review board approved this study.

Children aged <18 years with an index ED visit between July 1, 2004, and June 30, 2015, who received a primary *International Classification of Diseases, Ninth Revision* (ICD-9) discharge diagnosis code of constipation (564.0x [constipation], 560.3x [impaction of intestine], or 307.7 [encopresis]) were eligible. Individuals with one of the aforementioned diagnostic codes listed as a secondary diagnosis also were eligible if their primary diagnostic code was 789.0x (abdominal pain). Children transferred to the participating institution, those admitted at the index visit, and those with a secondary ICD-9 code classified as a "clinically important alternate related diagnosis" (Table I; available at www.jpeds.com) were excluded. For children with >1 ED visit occurring within a 7-day period, the first visit was labeled as the index visit and was included. Subsequent visits within the 7-day period were categorized as follow-up visits and were analyzed as being associated with the index visit. For all patients, the database search was extended to include the 7-day window before July 1, 2004, and the 7-day window after June 30, 2015, to confirm whether the visit was the index visit or a revisit to enable accurate classification.

Our primary exposure was the performance of an abdominal radiograph during the index ED visit, which was assessed by the use of billing codes. Other diagnostic imaging (ie, ultrasound and computed tomography), laboratory testing, and medication administration during the index visit also were identified with the use of billing codes. Classification of the identified billing codes was performed by 3 study investigators using

a consensus approach (Table II; available at www.jpeds.com). Serum laboratory testing included performance of complete blood counts (CBCs); inflammatory markers (C-reactive protein and erythrocyte sedimentation rate); and biochemistry profiles (electrolytes, liver function tests, and lipase). Medications were categorized into the following groups: non-narcotic analgesics, narcotic analgesics, antiemetics, and enema/suppository/laxatives (Table III; available at www.jpeds.com). The presence of any complex chronic condition and the subcategory of gastrointestinal complex chronic conditions were assessed via version 2 of the ICD-9 methodology.^{20,21} Participants were classified as having a previous history of constipation if they had a previous primary ICD-9 discharge diagnosis code of constipation or an ICD-9 discharge diagnosis code of constipation as a secondary code with abdominal pain as the primary code within 3 years of the index visit.

Revisits were evaluated based on the assigned primary ICD-9 diagnosis code and categorized first into whether the revisit was due to an "alternate related diagnosis" and furthermore whether the revisit was due to a "clinically important alternate related diagnosis." There were 879 potential "alternate related diagnoses" identified (Table IV; available at www.jpeds.com) for study participants who experienced a revisit and in whom the primary ICD-9 diagnostic code for that revisit was not listed at the index visit. Eight study investigators independently assessed each diagnosis based on its likelihood of being related (yes/maybe/no) to the index visit using the following definition: "a new alternate diagnosis where the symptoms commonly overlap with the symptoms of constipation." Examples provided were intussusception and appendicitis (yes), streptococcal pharyngitis, vomiting, and diarrhea (maybe), and trauma (no). A modified RAND/University of California, Los Angeles Appropriateness Method was applied to quantify the appropriateness of considering a diagnosis as related to the index visit.²² RAND methodology uses a modified Delphi process to inform classification by combining expert opinions to quantify varying scenarios while providing experts an opportunity to discuss judgments. It has high content, construct, and predictive validities for developing appropriateness criteria.^{23,24} Median scores and degree of agreement were used to guide "relatedness" classification. Reviewers classified 59 revisit diagnoses as "related," 537 as "not related," and 283 as "maybe related." It was determined a priori that the study definition of "alternate related diagnoses" would include all diagnoses classified as "related" and "maybe related."

Study investigators independently and in a blinded manner assessed all "alternate related diagnoses" for inclusion as a "clinically important alternate related diagnosis" by coding (yes/maybe/no) their response to the following statement: "the condition being evaluated represents a condition that, if left untreated, may result in significant morbidity or mortality." Examples provided were appendicitis (yes; likely to perforate and lead to sepsis if untreated); streptococcal sore throat (maybe; likely to resolve on its own with low likelihood of complication); flatulence, eructation, and gas pain (no; no likelihood of leading to morbidity or mortality). Diagnoses were considered clinically important if $\geq 50\%$ of the investigators

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