Pediatric Abdominal Radiograph Use, Constipation, and Significant Misdiagnoses

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Objective To determine the proportion of children diagnosed with constipation assigned a significant alternative diagnosis within 7 days (misdiagnosis), if there is an association between abdominal radiograph (AXR) performance and misdiagnosis, and features that might identify children with misdiagnoses.

Study design We conducted a retrospective cohort study of consecutive children <18 years who presented to a pediatric emergency department in Toronto, between 2008 and 2010. Children assigned an *International Statistical Classification of Diseases and Related Health Problems 10th Revision* code consistent with constipation were eligible. Misdiagnosis was defined as an alternative diagnosis during the subsequent 7 days that resulted in hospitalization or an outpatient procedure that included a surgical or radiologic intervention. Constipation severity was classified employing text word categorization and the Leech score.

Results 3685 eligible visits were identified. Mean age was 6.6 ± 4.4 years. AXR was performed in 46% (1693/3685). Twenty misdiagnoses (0.5%; 95% CI 0.4, 0.8) were identified (appendicitis [7%], intussusception [2%], bowel obstruction [2%], other [9%]). AXR was performed more frequently in misdiagnosed children (75% vs 46%; *P* = .01). These children more often had abdominal pain (70% vs 49%; *P* = .04) and tenderness (60% vs 32%; *P* =.01). Children in both groups had similar amounts of stool on AXR (*P* = .38) and mean Leech scores (misdiagnosed = 7.9 ± 3.4; not misdiagnosed = 7.7 ± 2.9; *P* = .85).

Conclusions Misdiagnoses in children with constipation are more frequent in those in whom an AXR was performed and those with abdominal pain and tenderness. The performance of an AXR may indicate diagnostic uncertainty; in such cases, the presence of stool on AXR does not rule out an alternative diagnosis. *(J Pediatr 2014;164:83-8)*.

Constipation represents 3% of all pediatrician office visits and 10%-45% of pediatric gastroenterology consultations.[1,2] In primary care settings, 50% of children with abdominal pain are diagnosed with constipation.[3] Although abdominal radiographs (AXRs) lack validity and reliability when employed in the context pediatric abdominal pain[4] and have a limited ability to predict constipation,[5,6] they are performed in 75% of children diagnosed with constipation in a pediatric emergency department (ED).[7]

Because 50% of AXRs performed in children with major abdominal diagnoses are interpreted as being normal, their role in children with nonspecific abdominal pain is questionable.[8] Both pediatricians[9] and pediatric radiologists[4] recommend that radiographs not be performed in most children in whom constipation is suspected. Emergency physicians suggest limiting AXR use to specific subgroups of patients (eg, prior abdominal surgery, suspected foreign body ingestion, abdominal distention).[8] A multidisciplinary team commissioned by the National Institute for Health and Clinical Excellence concluded that clinicians should "not use a plain abdominal radiograph to make a diagnosis of idiopathic constipation."[10]

Further, constipation occasionally is the initial diagnosis in patients ultimately diagnosed with an alternative condition, such as appendicitis.[11] In a study limited to 39 missed appendicitis cases, the 2 most common initial diagnoses were gastroenteritis (51%) and constipation (26%). Of note, 74% of misdiagnoses complained of abdominal pain. While highlighting the importance of the overlap in symptoms between appendicitis and constipation, the small sample size and focus on appendicitis limits the conclusions that can be drawn. The primary objective was to determine the proportion of significant misdiagnoses in children initially suspected of having constipation. Secondary objectives were to determine if there was an association between the performance of an

AXR	Abdominal radiograph
ED	Emergency department

AXR and a significant misdiagnosis and to identify clinical, laboratory, or diagnostic imaging features that might be associated with significant misdiagnoses.

Methods

This retrospective cohort study includes data from a consecutive series of children <18 years of age who presented to the ED of The Hospital for Sick Children, a tertiary care hospital in Toronto, Canada, between November 2008 and October 2010.

Research Ethics Board approval was obtained for the conduct of a record review of children assigned, in the ED, an *International Statistical Classification of Diseases and Related Health Problems 10th Revision* discharge code consistent with constipation. Patients who developed constipation during their hospitalization were excluded. Data was abstracted from electronic patient charts employing a standardized collection instrument. All visits during the subsequent 7 days were reviewed. Misdiagnosis was defined as an alternative diagnosis assigned within 7 days, meeting all the following criteria: (1) resulted in hospitalization or outpatient procedure; (2) required a surgical or radiologic intervention (eg, air enema, bone marrow aspirate, cardiac catheterization); (3) likely related to the index visit as determined by 3 evaluators; and (4) not identified at index visit. The principal investigator reviewed the medical record of all potential misdiagnosis cases.

Data abstractors were trained by the principal investigator. To minimize the potential bias associated with data abstraction, we used specific, restrictive key words for subjective data fields. Unavailable data was coded as missing except for particular presenting symptoms (eg, fever, vomiting, abdominal pain), past medical history, the presence of hypotension, and the performance of diagnostic testing, for which the absence of a specific description in the chart was interpreted as "not present" or "not done." When multiple documentation sources were present, that of the most senior physician was used. If physician documentation was unavailable, nursing documentation was reviewed. Historical variables were documented prior to reviewing the outcome, investigations, and laboratory results.

Chief complaints were abstracted from the documentation performed by the triage nurse. Past medical history was considered as a 3-level categorical variable: none, chronic illness but unlikely to cause abdominal disease, and chronic illness potentially associated with abdominal disease. General appearance was classified as well ("well appearing," "no apparent distress," "alert," "normal mental status," "interactive," "smiling") or unwell ("sick," "toxic," "shocky," "decreased mental status," "lethargic," "unresponsive," "irritable," "fussy," "inconsolable," "not looking well," "poor or decreased perfusion," "decreased pulses").[12] Descriptors that did not meet the above definitions were labeled as "unclear."[13] Rectal examination documentation was classified as consistent ("firm," "hard," "full," "loading," "impacted," "large") or inconsistent ("soft," "none," "empty," "small,"

"liquid") with constipation. The presence/absence of abdominal pain and tenderness at the time of presentation (ie, prior to treatment) were based on the history and examination documented by the most senior physician in the medical record.

The amount of stool on AXR was categorized according to key words in the final radiology report as normal ("unremarkable," "normal study," "no evidence of constipation," "mild," "some," "a bit," "stool is within normal limits," "discrete," "minimal," "not significant," "no excessive amount," "usual amount"), or consistent with constipation ("small to moderate," "fair amount," "consistent with constipation," "moderate to large," "fecal loading," "significant stool throughout," "extensive," "severe," "marked," "prominent," "considerable," "substantial," "notable," "remarkable," "overload"). A pediatric radiologist, blinded to participant classification, assigned Leech scores[14] to all AXRs performed in misdiagnosis cases and a random sample of 20% of the remaining AXRs. The Leech score, which is calculated by assigning a score (0-5) based on the amount of feces in each of the 3 segments of the colon, has been demonstrated to have a high correlation with colonic transit time and gastrointestinal symptoms and good inter-observer reproducibility.[15,16]

Statistical Analyses

Our pilot review of 385 charts found the misdiagnosis rate to be 1.3% and the AXR performance rate to be 60%. Given the seriousness of the misdiagnoses identified, we desired a very tight estimate of their occurrence. We estimated that a sample of 3405 patients will produce a 99% CI equal to our proportion (1.3%) with an error around this proportion of 0.5%. Sample size calculations were conducted with the use of PASS 2008 (NCSS, LLC, Kaysville, Utah).

Frequency counts and percentages are given for discrete variables; means, medians, SD, and IQR are provided for continuous variables. Between-group differences in continuous variables were analyzed employing the 2-sample t test and Mann–Whitney U test for normally and non-normally distributed data, respectively. When the number of observations in any given cell of the contingency table was <10, Fisher exact test was used. The association between a significant misdiagnosis and the performance of an AXR and other plausible predictors thereof were assessed employing the χ^2 test and 2-sample t test as appropriate. The association between constipation severity on AXR (ie, Leech score and radiology report) and misdiagnosis was analyzed employing Fisher exact test. Owing to the small number of children with clinically significant misdiagnoses, regression analysis was not performed.[17]

A random number generator (Microsoft Office Excel 2007, Redmond, Washington) was used to identify 10% of charts for review in a blinded fashion by an independent reviewer to enable the evaluation of inter-observer reliability and Leech score assignment. Inter-observer agreement was evaluated with the Cohen kappa (κ) statistic for the following variables: history of abdominal pain, significant past medical