Emergency Provider Use of Plain Radiographs in the Evaluation of Pediatric Constipation

Ryan Kearney

A thesis
submitted in partial fulfillment of the
requirements for the degree of

Master of Public Health

University of Washington
2016

Committee:

Todd Edwards
Eileen Klein

Program Authorized to Offer Degree:

Health Services

ABSTRACT

Background:

Abdominal pain is the fourth most common pediatric outpatient complaint, with over half eventually being diagnosed with constipation. X-ray use in the evaluation of constipation is variable: 4% in outpatient/clinic settings but over 70% of children with constipation evaluated in an emergency department. X-rays use increases misdiagnosis rate, remains costly, and involves radiation exposure.

Objectives:

To assess the use of plain radiographs by Pediatric Emergency Medicine (PEM) providers in the routine diagnostic evaluation and management of pediatric constipation

Methods:

A cross-sectional, quarterly survey of pediatric emergency medicine providers was performed. Survey participants were subscribers to the American Academy of Pediatrics Section On Emergency Medicine (AAP-SOEM) list-serv. Participants were presented a case of pediatric constipation meeting Rome-III clinical criteria to assess both diagnostic and therapeutic approaches. Participants were asked to categorize frequency of x-ray use, reasons for obtaining, estimated diagnostic utility, and elements of institutional standard diagnostic approach to constipation, if applicable. Descriptive statistical analyses were performed.

Results:

305 of 1272 eligible list-serv members (24%) responded, with 272 complete surveys. 86% were PEM-boarded with over half more that 10 years since completing fellowship. 99% elected to treat for constipation a child meeting Rome-III clinical criteria; one-third (31%) would obtain plain radiographs for this same child. Plain radiographs were viewed as *somewhat* (59%) or *minimally* (29%) *value-added* in the clinical evaluation of suspected pediatric constipation. The most common reasons for obtain plain radiographs were: *obtaining family buy-in* (44%) and *ruling out other diagnosis* (19%). Frequency of x-ray use varied across geographic regions and with participant and hospital characteristics.

Conclusion:

This survey suggests that many physicians are obtaining radiographs to convince families of the diagnosis of constipation. This is not a viable management plan given the risks of radiation as well as financial costs to the family and medical system. There remains room for improvement as we attempt to reduce use of ionizing radiation in the evaluation of common pediatric illnesses.

INTRODUCTION

Pediatric abdominal pain remains one of the most common presenting complaints for children evaluated in both outpatient and emergency care settings. Abdominal pain is the most common presenting gastrointestinal symptom in the emergency department (ED) (1) and the fourth most-common outpatient pediatric diagnosis. (2) Although many pediatric patients do not receive a diagnosis prior to symptom resolution, (3, 4) a significant number undergo further evaluation, including additional diagnostic studies and possible interventions. (5) Additional evaluation often occurs in emergency departments. (6, 7) Few children with abdominal pain will require urgent or emergent surgical intervention. (2) However, with increasing frequency, children with abdominal pain undergo diagnostic imaging during emergency department evaluation. (8)

There has been a dramatic increase in the use of advanced imaging modalities in children presenting to emergency departments with abdominal pain; almost one percent of children seen with abdominal pain in an ED underwent abdominal CT scan in 1998 while over 15% had abdominal CT scan performed in 2008. (8) During a similar study period, there was no significant change seen in the use of abdominal ultrasonography, likelihood of hospital admission, or prevalence of pediatric appendicitis. (9) Variation in CT scan use appears to be best explained by sex, race, age, insurance status, and geographic region. (9, 10) Coinciding with an increase in the use of diagnostic radiography is an expanding understanding of the risks associated with ionizing radiation. Large cohort data show a positive association between radiation dose from medical CT scan use and the subsequent

development of leukemia and brain tumors. (11, 12, 13) As a result, both national and international campaigns aimed at reducing the use of potentially harmful imaging modalities are becoming increasingly well-known and effective. (14, 15, 16, 17, 18)

While estimates vary, approximately 5 to 10% of children have plain abdominal radiographs obtained as part of their diagnostic evaluation for pediatric abdominal pain. (19) Retrospective review of plain radiograph use for acute pediatric abdominal pain suggests that less than one-quarter of these patients are eventually diagnosed with a condition that would potentially require acute intervention. (19) Constipation is a common cause of acute pediatric abdominal pain, particularly in children evaluated in the emergency department. (20, 21) Almost three-quarters of children diagnosed with constipation in an emergency department will undergo abdominal radiographs during their evaluation, despite research to suggest limited utility of this testing modality. (22) Further investigation is needed to understand the diagnostic evaluation of pediatric constipation, particularly with regards to physician radiograph ordering.

METHODS

Study Design and Population

This was a cross-sectional survey of members of the American Academy of Pediatrics Section on Emergency Medicine (AAP SOEM) electronic list-serv. Section membership is limited primarily to existing AAP members with Pediatric Emergency Medicine (PEM) sub-board certification, but also includes current PEM

fellows as well as attending physicians board-certified or board-eligible in emergency medicine or pediatrics. Members receive periodic electronic communication from the SOEM regarding educational, policy, advocacy and research information via this electronic list-serv. Survey participation was voluntary. During the survey period, all 1272 SOEM members were subscribed to the list-serv. Non-physician and current pediatric resident members of the SOEM were excluded from participation. Surveys with less than 90% item completion were also excluded from final analysis. This survey received IRB approval by the Seattle Children's Hospital Institutional Review Board.

Survey Content and Administration

Survey content was developed by the primary investigator based on review of the clinical-content as well as medical survey administration literature. A distillation of this literature review, including content rationale and survey technique considerations, was presented during a breakout research session at the 2014 PEM Fellows National Conference in Philadelphia, PA. Feedback from this small-group session was incorporated into the study design. Survey items were then distributed to the team of investigators, PEM attending physicians, and colleagues at the University of Washington School of Public Health and Seattle Children's Hospital. These participants provided feedback about survey content, as well as clarity. Iterative testing of sample survey drafts allowed for a systematic assessment of survey comprehension and content validity. After local testing of survey drafts was completed, the study was submitted to the SOEM listserv study evaluation team for

further review. Upon completion of a blinded review and scoring process, this survey was selected for distribution to list-serv members over a three-month period.

In the survey, participants were presented with a case of an 8-year-old child with clinical signs and symptoms consistent with a diagnosis of functional constipation according to the Rome III criteria (Figure 1). These are the most widely agreed upon criteria for this disorder and are endorsed by both the European Society for Paediatric Gastroenterology, Hepatology and Nutrition (ESPGHAN) and the North American Society for Pediatric Gastroenterology, Hepatology and Nutrition (NASPGHAN). Participants answered whether they would: 1) obtain plain abdominal radiographs in the evaluation of this child (Yes/No?) and 2) treat this child for constipation and assign a discharge diagnosis code associated with constipation (Yes/No?). Subsequent questions pertaining to this case were structured to elicit the providers' report of their own past frequency of evaluating, treating and diagnosing children with known or suspected constipation. Providers were asked to rate their ability to correctly recognize and diagnose pediatric constipation. The providers' past use of plain radiographs in the evaluation of suspected pediatric constipation was assessed as follows: 1) their estimated frequency of use, 2) their reasons for obtaining plain radiographs, 3) their estimated diagnostic utility of plain radiographs, and 4) their institutional standard diagnostic approach to constipation, if applicable. Demographic data, including time since most recent training, years in active clinical practice, average monthly clinical hours, age and geographic setting were obtained.

The survey was administered using SurveyMonkey (www.surveymonkey.com), an online polling and data aggregating tool, from February 1 through April 30, 2015. All responses were confidential, remained anonymous, and data was accessible only by the primary investigator. Listserv members received monthly reminders to encourage survey completion during the three-month window of eligibility. There were no penalties for SOEM listserv members failing to complete the survey and no rewards for participation were distributed by the investigators.

Data Analysis

Responses were summarized using appropriate descriptive statistics (frequencies and percentages). Predictors of interest were assessed for both expected strength and direction of association. Univariate analyses of predictor variables were performed using frequency tables (nominal variables) and histograms (ordinal variables). Bivariate analyses of frequency of x-ray use for suspected constipation was performed on the following: attending vs fellow status, years since completion of training, university affiliation status of hospital, and geographic location. Associations were explored between reported practice choices and respondent characteristics by estimating the proportion using abdominal radiographs for suspected constipation at least 25% of the time, together with 95% Wilson confidence intervals, within categories of response variables.

RESULTS

Upon survey closing, there were 305 responses from a total 1272 active members of the AAP SOEM list-serv. Of these respondents, analysis was completed from a total of 273 responses as 32 were excluded: 22 for failure to complete at least 90% of all survey items; 5 completions by residents; 3 completions by nurse practitioners; 1 completion by a retired physician; and 1 pediatric critical care attending respondent for a total response rate of 22% (273/1272). Sample characteristics for the eligible participants are presented in Table 1.

Treatment of Case Meeting Constipation Diagnostic Criteria

Almost one-third (31%, 85) of respondents indicated they would obtain an abdominal radiograph in the evaluation of the standardized patient meeting ROME III diagnostic criteria for functional constipation. Ninety-nine percent (270) indicated they would treat this child for constipation while 92% (249) said they would assign a discharge diagnosis or ICD code associated with constipation when completing the medical record. These findings are illustrated in Table 2.

Evaluation and Management of Patients with Suspected Constipation

More than half of respondents (54%, 146) treated greater than 10 cases of suspected pediatric constipation per month in the emergency department. Of children with a prior/established diagnosis of constipation, a majority of providers considered parent/caregiver (66%, 180) or patient (21%, 56) history as most reliable to substantiate this diagnosis. When diagnosing constipation in the emergency department, most respondents considered themselves somewhat to very

certain (93%, 255) in their ability to correctly recognize and diagnose constipation. Many (78%, 211) utilized abdominal radiographs in the evaluation of children with suspected constipation in less than 50% of cases. Plain radiographs were viewed as not helpful by more than half of respondents (55%, 149) in the clinical evaluation of constipation in children. The most common reasons for obtaining abdominal radiographs in children with constipation included family buy in (115, 42%) and ruling out other diagnoses (50, 18%) (Figure 2). Representative free-text responses for "other" reasons included: evaluation for possible bowel obstruction, confirming the diagnosis of constipation, ruling-out obvious mass, absence of a reliable historian or physical exam, referring provider request or adherence to hospital standard of care. Few respondents (9%, 24) reported working in facilities with an institutional standard of care protocol for suspected pediatric constipation (Table 2).

Variability in X-ray Use for Suspected Constipation

Frequency of x-ray use in the evaluation of suspected pediatric constipation varied across geographic regions and with both participant and hospital characteristics (Table 3). Factors associated with increased use of plain abdominal radiographs for suspected pediatric constipation included: practice in the Northeastern United States, non-university hospital affiliation at primary clinical practice site, working more than two shifts monthly and lack of institutional standardized protocol for constipation.

DISCUSSION

This survey highlights substantial variation in clinical practice with respect to abdominal imaging for suspected pediatric constipation. Constipation remains one of the most common diagnoses for children presenting with abdominal pain, both in the emergency department and in out-patient clinics. (2,3,5)Median prevalence of pediatric constipation is 12%, with risk factors including female gender, increasing age, socioeconomic status and education level. (20) One prospective study found that children with constipation have twice the annual rate of emergency department visits and greater than three-fold increase in annual outpatient medical expenditures when compared to non-constipated controls. (21) Much of this cost difference is due to increased use of diagnostic imaging; 70% of children diagnosed with constipation in emergency departments have plain abdominal radiographs obtained as part of their evaluation. (22) This represents a significant effective dose of radiation, with a single-view abdominal film representing more than 1/3 of the exposure of the average pediatric head CT. (23) There are several historical scoring schemes for assessing stool burden on plain abdominal radiographs. However, upon both systematic review and meta-analysis, these modalities have been shown to have little inter- and intra-rater reliability, consistency or meaningful clinical correlation. (24, 25, 26, 27, 28) Furthermore, rates of misdiagnoses are much higher in children with “constipation” in whom an abdominal radiograph was obtained during their initial diagnostic evaluation suggesting confirmation bias leading to misdiagnosis. (29)

Half of plain abdominal radiograph use could be eliminated by reasonably limiting this modality to patients with prior abdominal surgery, suspected foreign body ingestion, abnormal bowel sounds, abdominal distension or signs of overt peritoneal irritation. (19) Absent from this list is constipation, which accounts for upwards of 50% of acute pediatric abdominal pain evaluated in the emergency department. (30) This may represent a clinical scenario where implementation of standardized management protocols and provider-patient communication tools could save both time and money while potentially reducing harmful radiation exposure from unnecessary diagnostic medical imaging. For example, when compared to respondents from institutions with a standardized protocol for constipation, those from institutions lacking a standardized protocol were almost twice as likely to report using x-rays for suspected constipation at least 25% of the time (59% vs. 33%), and more than twice as likely to cite family buy-in as an important reason (46% vs. 22%). This study is an attempt to identify these and other modifiable factors associated with PEM provider use of plain abdominal radiographs in the evaluation of suspected pediatric functional constipation. Identifying practice patterns associated with increased use of abdominal radiographs may inform future efforts to decrease healthcare costs, emergency department length-of-stay, and pediatric patient exposure to ionizing radiation in the form of medical imaging.

When presented with a case meeting ROME III diagnostic criteria for pediatric functional constipation, almost one-third of respondents stated they would obtain an abdominal radiograph in the evaluation of this hypothetical child. This use of

plain radiographs is contradictory to current national and international recommendations, including those from NASPGHAN and ESPGHAN. These criteria support the use of abdominal radiographs in very limited circumstances for children with known and recalcitrant constipation. However, the rate of abdominal radiograph use by respondents for suspected constipation was less than that reported previously in one single-site study. (22) The lower utilization may be explained by respondent belief in patient and/or parent caregiver history as the most reliable way to substantiate a diagnosis of pediatric functional constipation and could also be a function of great understanding of the role of plain radiographs in children with simple constipation.

The majority of surveyed providers considered themselves either very or somewhat certain in their ability to correctly recognize and diagnose pediatric functional constipation. This is not surprising, given the prevalence of this condition in pediatric populations as well as the frequency with which patients suffering from functional constipation present to emergency departments. Plain abdominal radiographs were most likely viewed as adding little diagnostic utility in an acute-care setting. Despite lower use than found in previous studies, there was still moderate use of plain radiographs amongst surveyed PEM physicians. The most common reason offered by survey respondents for obtaining plain abdominal radiographs for suspected constipation was obtaining family buy-in. Ensuring family buy-in for disease management plans is an important skill for pediatric providers across all subspecialties. However, “obtaining family buy-in” as a justification for ordering medical tests, particularly when testing increases costs and risk of harm to

patients, is likely to become increasingly rare in the changing landscape of healthcare cost containment and resource utilization.

Appropriate strategies for improving parent and patient buy-in for management plans are an important element of family-centered care (FCC). (31) With strong policies suggesting its increased implementation by the Maternal & Child Health Bureau, the Institute for Patient- and Family-Centered Care as well as the American Academy of Pediatrics, FCC is an increasingly common experience for pediatric patients, families and providers. (32) Patient buy-in and effective communication has been shown to decrease emergency department return visits (33), preventable adverse events (34), and medication non-compliance (35). Diagnostic tests with more-than theoretical risk of patient harm and an associated increased risk of misdiagnosis, such as plain abdominal radiographs for suspected constipation, should not routinely be utilized to increase patient and/or family buy-in. The changing landscape of medical reimbursement and healthcare financing requires creative solutions to addressing effective provider-patient communication (36, 37, 38) including ensuring treatment plan compliance.

LIMITATIONS

Although monthly survey reminders were distributed to all SOEM listserv members, this survey had a low response rate as well as several incomplete surveys. This response rate is similar to that reported in previous studies published from SOEM surveys. (45, 46) Study participants were almost entirely PEM providers and therefore do not represent all providers seeing pediatric patients in outpatient

settings. Future studies are required to elucidate evaluation strategies of suspected pediatric constipation in other clinical settings. Few general emergency medicine providers were included in our group of survey participants, but these providers evaluate the majority of children treated across all US emergency departments. We did not assess the availability of diagnostic imaging services amongst our survey participants. Finally, this survey provides cross-sectional data only, which are useful descriptively but inherently limited in their ability to determine causal and temporal relationships as well as trends. Although this survey was piloted through an iterative design process with PEM providers, formal survey validation was not performed.

CONCLUSIONS

This survey suggests that many physicians are obtaining radiographs to convince families of the diagnosis of constipation. This is not a viable management plan given the risks of radiation as well as financial costs to the family and medical system. Future interventions must include efforts to improve communication skills of physicians, particularly in obtaining family buy-in without ordering additional costly, potentially harmful and likely not necessary diagnostic tests. Institutional factors are also important, as lack of standardized protocol for the evaluation of suspected pediatric constipation is associated with an increased use of plain abdominal radiographs. By identifying reasons for provider utilization of diagnostic testing, these findings could help with the creation and implementation of clinical standard guidelines to appropriately utilize plain abdominal radiographs in cases of

suspected pediatric constipation.

REFERENCES

1. Peery AF et al. Burden of gastrointestinal disease in the United States: 2012 Update. Gastroenterology. 2012. 143(5):1179-1187.

2. Scholer SJ et al. Clinical outcomes of children with acute abdominal pain. Pediatrics. 1996. 4(1):680-685.

3. Wallis EM and Fiks AG. Nonspecific abdominal pain in pediatric primary care: evaluation and outcomes. Academic Pediatrics. 2015. 15(3):333-339.

4. Reynolds SL and Jaffe DM. Diagnosing abdominal pain in a pediatric emergency department. Pediatric Emergency Care. 1992. 8(3):126-128.

5. Thornton GC et al. Diagnostic outcomes following childhood non-specific abdominal pain: a record-linkage study. Archives of Disease in Childhood. 2015. ****epub****

6. Macaluso C and McNamara R. Evaluation and management of acute abdominal pain in the emergency department. International Journal of General Medicine. 2012. 5:789-797.

7. CDC. National Hospital Ambulatory Medical Care Survey: 2011 Emergency Department Summary Tables.

8. Fahimi J et al. Computed tomography use among children presenting to emergency departments with abdominal pain. Pediatrics. 2012. 130(5):1069-1075.

9. Hryhorczuk AL et al. Pediatric abdominal pain: Use of imaging in the emergency department in the United States from 1999 to 2007. 2012. Radiology. 263(3):778-785.

10. Johnson TJ et al. Association of race and ethnicity with management of abdominal pain in the emergency department. Pediatrics. 2013. 132(4):851-858.

11. Pearce MS et al. Radiation exposure from CT scans in childhood and subsequent risk of leukaemia and brain tumours: a retrospective cohort study. Lancet. 2012. 380(9840):499-505.

12. Mills DM et al. Pediatric ophthalmic computed tomographic scanning and associated cancer risk. American Journal of Ophthalmology. 2006. 142(6):1046-1053.

13. Mathews JD et al. Cancer risk in 680,000 people exposed to computed tomography scans in childhood or adolescence: Data linkage study of 11 million Australians. BMJ. 2013. 346.

14. Richards MK et al. Campaigns against ionizing radiation and changed practice patters for imaging use in pediatric appendicitis. JAMA Pediatrics. 2015. 169(8):720-721.

15. Kulaylat AN et al. An implemented MRI program to eliminate radiation from the evaluation of pediatric appendicitis. Journal of Pediatric Surgery. 2015. 50(8):1359-1363.

16. Applegate KE and Cost NG. Image Gently: A campaign to reduce children's and adolescents' risk for cancer during adulthood. Journal of Adolescent Health. 2013. 52(5):S93-97.

17. Costello JE et al. CT radiation dose: Current controversies and dose reduction strategies. American Journal of Roentgenology. 2013. 201(6):1283-1290.

18. Hricak H et al. Managing radiation use in medical imaging: A multifaceted challenge. Radiology. 2011. 258(3):889-905.

19. Rothrock S et al. Plain abdominal radiography in the detection of acute medical and surgical disease in children: A retrospective analysis. Pediatric Emergency Care. 1991. 7(5):281-285.

20. Mugie et al. Epidemiology of constipation in children and adults: A systematic review. Best Practice & Research Clinical Gastroenterology. 2011(25):3-18.

21. Choung RS et al. Direct medical costs of constipation in children over 15 years: a population-based birth cohort. Journal of Pediatric Gastroenterology and Nutrition. 2011. 52(1):46-54.

22. Miller MK et al. Emergency department management and short-term outcome of children with constipation. Pediatric Emergency Care. 2007. 23(1): 1-4.

23. Jones JG et al. Radiation dose from medical imaging: A primer for emergency physicians. Western Journal of Emergency Medicine. 2012. 13(2):202-210.

24. Berger MY et al. Value of abdominal radiography, colonic transit time, and rectal ultrasound scanning in the diagnosis of idiopathic constipation in children: A systematic review. The Journal of Pediatrics. 2012. 161(1):44-50.

25. Bongers MEJ et al. The value of abdominal radiographs in children with functional gastrointestinal disorders. European Journal of Radiology. 2006. 59:8-13.

26. Moylan S et al. Are abdominal x-rays a reliable way to assess for constipation? The Journal of Urology. 184:1692-1698.

27. Reuchlin-Vroklage LM et al. Diagnostic value of abdominal radiography in constipated children: A systematic review. Archives of Pediatric and Adolescent Medicine. 2005:671-678.

28. van den Bosch M et al. Systematic assessment of constipation on plain abdominal radiographs in children. Pediatric Radiology. 2006. 36:224-226.

29. Freedman SB. Pediatric abdominal radiograph use, constipation, and significant misdiagnoses. The Journal of Pediatrics. 2014. 164(1): 83-88.

30. Loening-Baucke V and Swidsinski A. Constipation as a cause of acute abdominal pain in children. Journal of Pediatrics. 2007. 151(6):666-669.

37. Craig J et al. Recommendations for involving the family in developmental care of the NICU baby. Journal of Perinatology. 2015. 35 Suppl1:S5-8.

38. Kuo D et al. Family-centered care: Current applications and future directions in pediatric health care. Maternal & Child Health Journal. 2012. 16(2): 297-305.

39. Gallagher RA et al. Unscheduled return visits to the emergency department: the impact of language. Pediatric Emergency Care. 2013. 29(5):579-583.

40. Bartlett G et al. Impact of patient communication problems on the risk of preventable adverse events in acute care settings. CMAJ. 2008. 178(12): 1555-1562.

41. Zolnierek K and DiMatteo M. Physician communication and patient adherence to treatment: a meta-analysis. Medical Care. 2009. 47(8):826-834.

42. McCarthy DM. Emergency department team communication with the patient: the patient's perspective. Journal of Emergency Medicine. 2013. 45(2): 262-270.

43. Hartling L et al. A randomized controlled trial of storytelling as a communication tool. Plos One. 2013. 8(10):e77800.

44. Simmons S et al. Mind the (knowledge) gap: the effect of a communication instrument on emergency department patients' comprehension of and satisfaction with care. Patient Education & Counseling. 2015. 98(2):257-262.

45. Mistry R et al. Emergency management of pediatric skin and soft tissue infections in the community-associated methicillin-resistant staphylococcus aureus era. Academic Emergency Medicine. 2010. 17(2):188-193.

46. Mehta A et al. Practice, beliefs and perceived barriers to adolescent human immunodeficiency virus screening in the emergency department. Pediatric Emergency Care. 2015. 31(9):621-626.

TABLES/FIGURES

Table 1: Survey Participant Characteristics

N = 273	
Age	
26-30	13 (5)
31-35	33 (12)
36-40	54 (20)
>40	168 (63)
Attending	242 (89)
Completed PEM fellowship	231 (85)
>10 years since completed training	141 (54)
>2 ED or urgent care shifts/month	263 (97)
>20 clinical hours/month	264 (97)
Region	
Northeast	53 (19)
Midwest	63 (23)
South	82 (30)
West	70 (26)
Outside US	5 (2)
Free-standing pediatric hospital	189 (69)
University hospital	232 (86)
For-profit hospital	21 (8)

Table 2: Diagnosis and Treatment of Suspected Pediatric Constipation

N = 273	n (%)
Treat >10 constipation cases/month in ED	146 (54)
Somewhat or very certain of correctly diagnosing constipation	255 (93)
Frequency of x-ray use for suspected constipation	
Never	10 (4)
<25% of the time	107 (39)
25-50% of the time	95 (35)
51-75% of the time	41 (15)
>75% of the time	19 (7)
Reasons to use x-rays for suspected constipation	
Aid diagnosis	3 (1)
Obtain family buy-in	115 (44)
Other	53 (20)
Plan management	42 (16)
Rule out other DX	49 (19)
Helpfulness of x-rays for suspected constipation	
Not helpful	95 (35)
Neutral	28 (10)
Helpful	149 (55)
Most reliable way to validate constipation diagnosis	
Caregiver history	180 (66)
Patient history	56 (21)
Other	36 (13)
Sample case: obtain abdominal radiograph	85 (31)
Sample case: treat for constipation	270 (99)
Sample case: discharge DX/ICD-9 code for constipation	249 (92)
Institution has standardized protocol for constipation	24 (9)
Standardized protocol includes routine x-rays	2 (8)

Table 3: Variability in X-Ray Use in the Evaluation of Suspected Pediatric Constipation

N = 273	Percent using x-rays for suspected constipation at least 25% of the time	95% CI
Region		
Northeast	68	(55-79)
Midwest	60	(48-71)
South	59	(48-69)
West	47	(36-59)
University affiliation		
Not university	74	(58-85)
University	55	(49-61)
ED/urgent care shifts/month 0-2 vs. >2		
0-2 shifts/month	13	(2-47)
>2 shifts/month	58	(52-64)
Institution has standardized protocol for constipation?		
No	59	(53-65)
Yes	33	(18-53)

Figure 1: ROME-III Diagnostic Criteria for Functional Constipation (Child/Adolescent)

Functional Constipation
Diagnostic Criteria Must include two ore more of the following in a child with a developmental age of at least 4 years with insufficient criteria for diagnosis of IBS: 1. Two or fewer defecations in the toilet per week 2. At least one episode of fecal 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 fecal mass in the rectum 6. History of large diameter stools which may obstruct the toilet

Figure 2: Reasons for Obtaining Plain Abdominal Radiographs in the Evaluation of Suspected Pediatric Constipation