

Decreasing Radiation Exposure to the Abdomen in Children with Chronic Constipation

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Abstract

Background: Bowel management for children with chronic constipation may include repeated single-view abdomen radiographs (AXR) to monitor treatment success. Only one image of the abdomen is needed to include most of the colon, but technologists often make a second (or even third) exposure to be sure they have imaged the entire abdomen. Our quality improvement project aimed to reduce radiation exposure by decreasing the frequency of >1 exposure performed for AXR orders in children with chronic constipation from 27% to <10% by December 2022 and sustain. **Methods:** We counted baseline (01/2020–11/2020) and intervention (12/2020–5/2023) examinations with >1 exposure. Initial interventions were a structured communication to technologists and an article in the monthly department newsletter and later, a technologist education module. Additional interventions included communication to radiologists, project updates and encouragement to all technologists, and individual technologist feedback. A statistical process control chart tracked data to study process changes over time. **Results:** During the baseline and intervention periods, 525/1944 and 1329/8334 examinations, respectively, had >1 exposure performed for AXR orders. Interventions created 2 centerline shifts. Overall, examinations with >1 exposure decreased from 27% to 13.5%. **Conclusions:** Frequency of >1 exposure performed for AXR orders in children with chronic constipation decreased from 27% to 13.5% through education and communication. This was sustained. We plan to assign training modules for all new technologists, policy reminders (annual training in odd years) for all technologists, and continue individualized learning opportunities. (*Pediatr Qual Saf* 2023;8:e681; doi: 10.1097/pq9.000000000000681; Published online September 28, 2023.)

INTRODUCTION

Constipation is a common gastrointestinal disorder that affects people of all ages and genders, with an estimated prevalence of 16% in adults and 12% in children.¹

In children, the diagnosis of functional constipation is based on medical history, physical examination, and assessment of bowel habits, as outlined in the widely-accepted Rome IV criteria.² Evidence-based guidelines do not

support using radiography, including single-view abdominal radiography (AXR), as a routine diagnostic tool for functional constipation in children.^{3,4} Despite these guidelines,

AXRs are still frequently obtained to aid in diagnosing functional constipation in children.⁵ Previous quality improvement (QI) work to decrease the use of AXRs has focused on changing the examination ordering habits of emergency room providers, pediatricians, and pediatric gastroenterology clinicians for diagnosis of constipation.^{6–8}

There is a role for AXR in monitoring treatment success in children with chronic constipation. For example, at our institution, an international referral center for patients with refractory constipation, children undergo a structured bowel management program. This program includes repeated AXRs assessing ongoing treatment and has been successful. It is also cost-effective by reducing hospital admissions in children with chronic constipation, fecal incontinence due to anorectal malformations, and/or severe functional constipation.^{9–11} For these patients, the AXR field of view can be limited to the course of the colon and rectum to assess stool burden. This approach limits the number of exposures to the pediatric abdomen as is desired by the ALARA (As Low As Reasonably Achievable) concept and the Image Gently Alliance campaign to use the minimum level of radiation needed in imaging examinations to achieve the necessary results.^{12,13}

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To cite: Chun BC, Chmil M, Ruess L. Decreasing Radiation Exposure to the Abdomen in Children with Chronic Constipation. *Pediatr Qual Saf* 2023;8:e681.

Received for publication March 30, 2023; Accepted July 14, 2023.

Published online September 28, 2023

DOI: 10.1097/pq9.000000000000681



We note that the option for a technologist to use the one exposure imaging protocol was limited to patients referred from outpatient clinics or those undergoing an inpatient bowel program, excluding acute care patients and those whose imaging requests included the word “pain.” This was based on historical precedence at our institution, where radiologists and providers expected an AXR to include lung bases to exclude lower lobe pneumonia as a cause of abdominal symptoms in younger children.

Specific Aim

Using quality improvement (QI) methodology, our project aimed to reduce radiation exposure by decreasing the frequency of >1 exposure performed for AXR orders in children with chronic constipation from 27% to <10% by December 2022 and sustain.

METHODS

Context

Our institution is a large urban pediatric tertiary care hospital with high-volume Colorectal, Gastroenterology (GI), and Urology specialty clinics that manage referral patients with chronic constipation. This QI work was exempt from IRB review per institutional policy. Article preparation followed the SQUIRE 2.0 guidelines.¹⁴

Clinical Care

The Colorectal clinic’s organized bowel management program is a structured approach to managing patients with chronic constipation.¹⁰ Patients participate in an outpatient week of daily assessment and adjustments of medical therapy, with results often confirmed by daily AXR. Patients treated in GI and Urology clinics are also assessed with AXR during the treatment of severe functional constipation and/or fecal incontinence. Final radiology reports, typically available within 30 minutes, include an assessment of the right abdomen, upper abdomen, left abdomen, and lower abdomen and pelvis with a comment regarding stool volume in each location as (1) none, (2) stool in non-dilated bowel, or (3) stool distending bowel.

Data Collection

We identified AXR examinations via electronic medical records (EPIC Systems, Corp., Verona, Wis.). Baseline period (1/2020 thru 11/2020) examinations were included if they were ordered by Colorectal, GI, or Urology clinics and the patient history indicated chronic constipation or included other relevant terms indicating the patient is a child with a history of constipation undergoing treatment (Table 1).

We excluded patients over 17 years of age, examinations missing the number of exposures in the search results, and if the reason for the examination stated “pain.” We also excluded examinations if the ordering department was one of our emergency departments or urgent care centers.

Table 1. List of Common Indications, Diagnoses, and/or Symptoms for Children with that Qualify for Single Limited Abdominal Radiograph per Protocol

Chronic Constipation	
Anorectal malformation/constipation	
Impaction	
Encopresis	
Incontinence of feces, overflow, fecal soiling	
Post cleanout	
Sitz marker count	
Large stool burden	
Limited stool output/alternating stool pattern	
Evaluate stool burden/fecal load	
Fecal retention	
This includes children from Colorectal, GI, or Urology clinics and/or patients with orders that clearly state that the study is performed to assess stool burden only.	

Interventions

The interventions are outlined in the key driver diagram (Fig. 1). In November 2020, we implemented the first intervention with structured SBAR (Situation, Background, Assessment, and Recommendation) communication and technologist education in the November Issue of our department newsletter.¹⁵ These interventions addressed the false impression that the pubic symphysis and diaphragm need to be included in every AXR order, despite an exception rule for patients with chronic constipation or imaging request for stool burden assessment only, as stated in the preexisting radiology department procedure manual. We also used our department’s electronic comment tool to give technologists feedback.¹⁶

In November 2021, all technologists completed a required 25 slide self-paced module added to our institution’s electronic Learning Center (Fig. 2). This intervention provided clear protocols and image guidelines, with examples, for patients with repeated AXR orders for constipation. Technologists were directed to do one view only (ie, acceptable to exclude the diaphragms/lungs and symphysis) if the majority of the large bowel is visible for stool burden assessment.

In February 2022, radiologists who read AXR examinations were reminded of the existing protocol for patients with chronic constipation, such that an AXR without the upper abdomen and/or excluding the lung bases should be considered adequate in these patients. This discouraged radiologists from contacting technologists and requesting an additional view of diaphragms if not otherwise necessary.

In April 2022, new technologists and those not previously notified completed the teaching module with examples. An email update was sent to all technologists in May 2022 with encouragement and reminders about the protocol. The education module was also added as part of new hire orientation. Managers provide individual technologist feedback when appropriate. A project update was communicated in the March 2023 issue of the department newsletter.

Decreasing frequency of >1 exposure in abdominal x-rays in children with chronic constipation

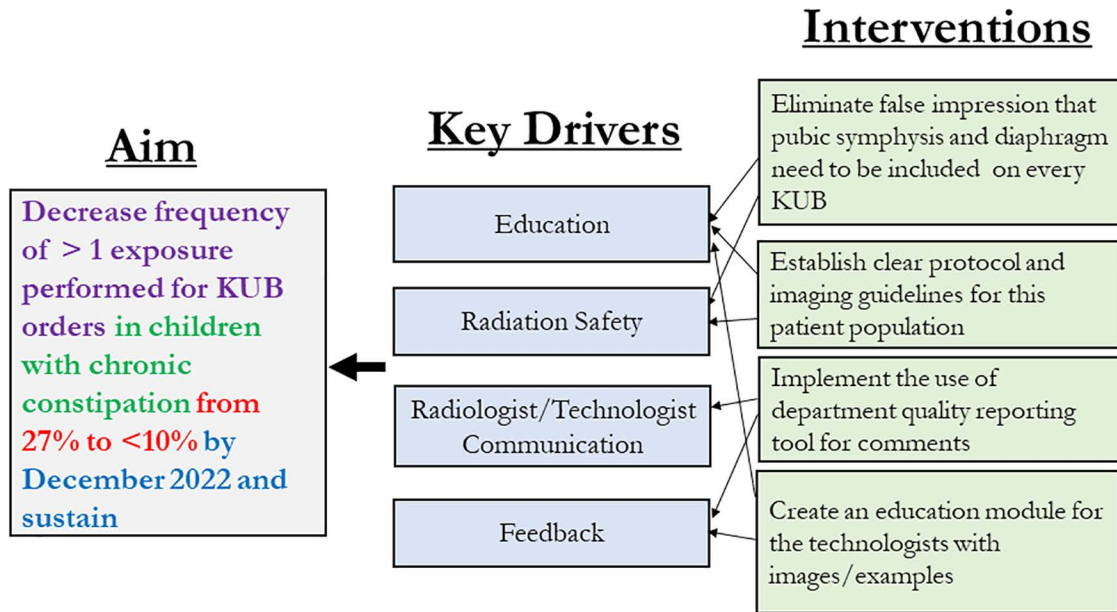


Fig. 1. Key driver diagram outlines the aim, key drivers, and interventions for decreasing radiation exposure to the abdomen in children with chronic constipation.

“Follow-up constipation”

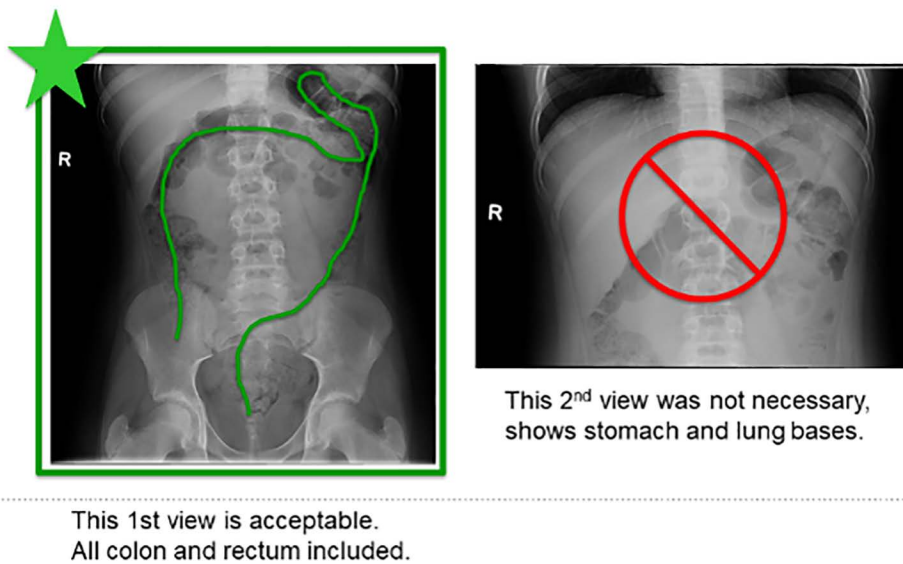


Fig. 2. Image of a single slide from the technologist training module. The slide illustrates acceptable imaging for a single-view abdomen radiograph ordered to follow up constipation in a teenager participating in a bowel management program. The highlighted image on the left with a green star shows that all the colon and rectum are imaged. The second image on the right, added by the technologist to display the reminder that the upper abdomen and lung bases were not necessary. This is emphasized with an overlying red symbol.

Analysis

The frequency of examinations with >1 exposure performed for AXR orders in children with chronic constipation was determined by dividing the number of examinations with >1 exposure exams (numerator) by the total number of examinations (denominator). We reviewed data monthly through May 2023.

A radiology quality coordinator (M.C.) loaded data into a proprietary statistical process control chart template, allowing the team to study process changes over time.¹⁷ We utilized the American Society for Quality criteria for adjusting the centerline and control limits for the statistical process control chart. In addition, we reviewed the process stages for variations.¹⁸ Annotated charts indicate the timing of interventions.

RESULTS

Study Population

During the 11-month baseline period (01/2020 to 11/2020), 1944 AXR examinations were performed in children with a clinical history of chronic constipation. The mean age of the patients in the baseline group was 7.57 years (range 0–17 years, median 7 years). Colorectal clinic examinations accounted for 36.1% (702/1944), GI clinic examinations accounted for 39.2% (761/1944), and Urology clinic exams accounted for 24.7% (481/1944).

During the 30-month intervention period (12/2020 to 5/2023), 8334 AXRs were performed. The mean age in the intervention group was 7.56 years (range 0–17 years, median 7 years). Among the 8334 total AXR examinations, Colorectal clinic examinations accounted for 42.7% (3556/8334), GI clinic examinations accounted for 39.2% (3268/8334), and Urology clinic examinations accounted for 18.1% (1510/8334).

Frequency of >1 Exposure per AXR Order

During the 11-month baseline period, 27% (525/1944) of examinations had >1 exposure performed for AXR orders in children with provided clinical history of chronic constipation. Figure 3 shows a decrease in the frequency of >1 exposure performed for children with chronic constipation with two process shifts during the intervention period. With structured communication (SBAR) and topic discussion in the departmental newsletter as the first intervention in November 2020, the frequency of >1 exposure during the next 12-month period that followed significantly decreased to 20.5% (591/2886) of examinations. In November 2021, after implementing a required technologist education module, the centerline shifted a second time to 13.5% (738/5448). This lower frequency of >1 exposure has been sustained with low-performance variability using radiologist education, education for new technologists, encouragement, and reminders to all technologists, and individual technologist feedback when needed (Fig. 3).

DISCUSSION

Prior reports aiming to reduce unnecessary radiation exposure in children with constipation have focused on decreasing the use of AXR as a diagnostic tool.^{6–8} These efforts rely on local provider training and education to change ordering behavior in the acute care setting or initial GI clinic visit, citing clinical guidelines that advocate using history and physical examination for diagnosis without the need for AXR.^{2,6–8} However, surveys indicate many providers who care for children with chronic constipation may not be aware of the guidelines, and there is still a role for using AXR in the management of chronic constipation.^{5,9,10}

Our approach to reducing radiation exposures in children with chronic constipation recognizes that while AXRs are still often requested, a dedicated radiology department protocol can lead to a decrease in the number of exposures for each examination by limiting the required exposure area. For these patients, only the area of the colon and rectum need to be imaged to assess for stool burden. We called this project, “Just the Colon, Please,” to stress a different approach to these patients, unlike the standard imaging procedure for a supine AXR in a child, which directs precise collimation such that the diaphragm, symphysis pubis, and outer edges of the abdomen are all included.¹⁹ In the standard imaging scenario, the AXR examination may require more than one exposure to include the entire area. For example, a child may be uncooperative and move, or may be too large or tall, or the technologist may over-collimate. With targeted education and data-driven feedback to all those involved in the care process while reinforcing the underlying reasons for any changes implemented, we decreased the frequency of >1 exposure for AXR orders in children with chronic constipation to nearly our goal level. And, in each child that had a one exposure examination rather than a 2 or 3 exposure examination, the dose to the individual patient was reduced, meeting ALARA and Image Gently guidelines.^{12,13}

We demonstrated sustained improvement for >1 year and near our goal level, without additional interventions. We recognize that we relied on education and communication to approach our project goal and that such low-reliability improvement interventions alone are rarely sufficient for long-term sustained improvement.²⁰ To address this, we have planned for continued education using a “count-twice” approach as suggested by Burke and Marang-van de Mheen and have aligned the tools with existing online training sets and clinical workflows. Further, we have engaged managers to provide individualized examination-specific feedback.²¹ All new technologists are required to complete the original training module during orientation. For current staff, a shorter refresher module has been added to the annual Radiology skills day requirements assigned to each technologist on odd number years. We also have expanded the use of our department quality reporting tool that is embedded in the

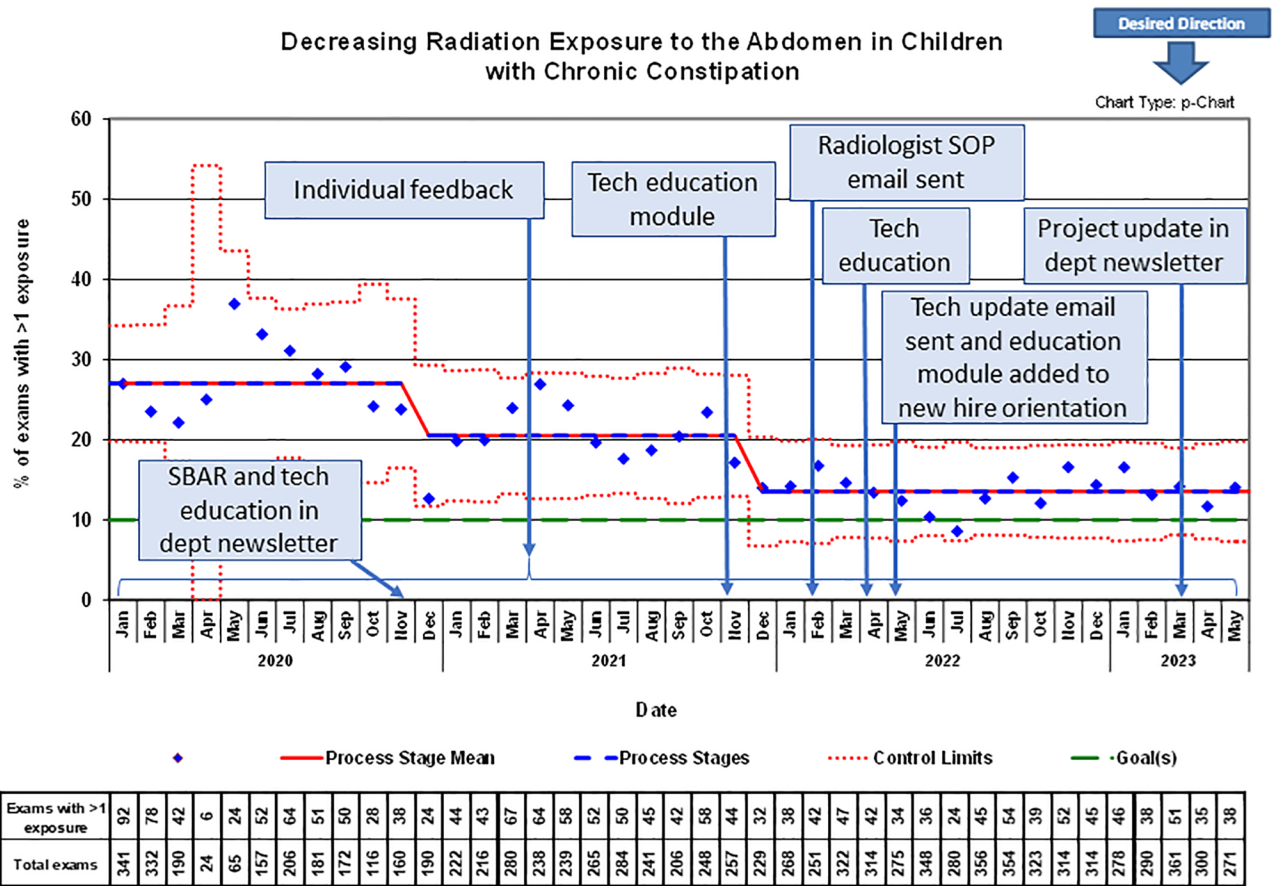


Fig. 3. P-chart percentage of single-view abdomen examinations with >1 exposure over time. Interventions are indicated in blue text boxes.

clinical workflow and allows radiologists to quickly tag an exam with multiple exposures that does not follow the protocol.¹⁶ Encounter-specific information is reported to a manager, who then forwards and discusses it with the technologist for ongoing training.

Limitations

The baseline period includes the 2020 pandemic period when bowel management clinics were canceled, and patient volume was low. Although we did not reach the threshold goal of 10%, we believe this was a reasonable goal in our practice. The overall number of children eligible for a limited AXR may have increased if we had provided more specific instructions to the referring providers in the GI and Urology clinics. While we did communicate with providers that an AXR request stating “assess stool burden” was likely to reduce radiation exposure in their patients, we did not specifically indicate that including the word “pain” would disqualify them. Still, our institution has an extensive practice dedicated to the care of patients with chronic constipation, and the reduced exposure protocol, as we suggest, may not impact a significant number of patients in other practices. Also, our institution has a robust focus on QI with leadership support, a strong culture of patient safety, and abundant resources for QI

work, which may not exist for other institutions to duplicate our work.

CONCLUDING SUMMARY

A QI initiative decreased the frequency of >1 exposure performed for single-view abdomen radiograph orders in children with chronic constipation from 27% to 13.5% through education and training, establishing clear protocols and guidelines, and feedback.

ACKNOWLEDGMENTS

The authors thank the Department of Radiology Quality Improvement team for suggestions and feedback.

DISCLOSURE

The authors have no financial interest to declare in relation to the content of this article.

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