Improving Quality and Efficiency for Intussusception Management After Successful Enema Reduction

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OBJECTIVES: The purpose of this project was to implement a protocol facilitating discharge from the emergency department (ED) after successful radiologic ileocolic intussusception reduction in a pediatric referral center.

METHODS: A multidisciplinary team identified drivers for successful quality improvement including educational brochures, a standardized radiologic report, an observation period in the ER with oral hydration challenges, and follow-up phone calls the day after discharge. Patient outcomes were tracked, and quarterly feedback was provided.

RESULTS: Of 80 patients identified over a 24-month period, 34 (42.5%) did not qualify for discharge home due to need for surgical intervention \( n = 9 \), specific radiologic findings \( n = 11 \), need for additional intravenous hydration \( n = 4 \), or other reasons \( n = 7 \). Of 46 patients who qualified for discharge, 30 (65.2%) were successfully sent home from the ED. One patient returned with recurrent symptoms that required repeat enema reduction. Sixteen patients were observed and discharged within 23 hours. Adherence with discharge from the ED improved over time. Discharge from the ED was associated with cost savings and improved net margins at the hospital level for each encounter.

CONCLUSIONS: A sustainable multidisciplinary quality improvement project to discharge intussusception patients from the ED after air-contrast enema reduction was successfully integrated in a high-volume referral center through education, standardized radiologic reporting, and protocolized follow-up.

Intussusception remains one of the most common causes of intestinal obstruction in young children and infants. Treatment of intussusception has evolved over time from a predominantly operative disease to one managed nonoperatively most of the time with high success with radiologically guided enema reduction.1 Traditional practice after successful enema reduction of intussusception includes surgical admission for observation to ensure toleration of enteral diet advancement and to monitor for recurrence of intussusception, which occurs in <10% of patients.2 Absolute indications for admission in the setting of intussusception include perforation, failed enema reduction, and successful enema reduction with identification of a lead point that would merit semiurgent resection to prevent recurrent obstruction. Relative indications for admission after successful enema reduction of intussusception are poorly defined but include a prolonged prorome of symptoms, presence of bloody stools, and dehydration. Several institutions...
have reported success with early discharge from the emergency department (ED) for intussusception patients successfully reduced with enema.2–6 Wide practice variation exists across major children’s hospitals in the United States, resulting in inconsistent costs and resource utilization.7 Traditional practice at our center, a high-volume, tertiary, free-standing, pediatric referral center, was to admit all patients with intussusception for observation. We instituted a quality improvement (QI) initiative to increase the proportion of patients discharged from the hospital from the ED after successful enema reduction. The purpose of this article is to describe the implementation tools used and lessons learned from this QI project.

METHODS
Setting
This QI effort took place at Nationwide Children’s Hospital (Columbus, OH). The hospital is a quaternary care pediatric referral and research center with >450 inpatient beds. There are >83 000 ED visits and nearly 26 000 surgical procedures performed at Nationwide Children’s Hospital annually. The general pediatric surgical service maintains a daily census that averages 60 to 90 patients cared for by 15 attending surgeons.

Planning the Intervention
To increase the number of patients discharged from the ED after successful enema reduction of ileocolic intussusception, a multidisciplinary team was created with representation from surgical, radiologic, and ED services. An aim to discharge 50% of patients from the ED who met clinical grounds for discharge was established after review of available literature and comparison with ED discharge rates at comparison children’s hospitals. A time frame for measurement within 6 months of project initiation with sustainability beyond 1 year was outlined. Key drivers focused on education and standardization were identified, and specific interventions were designed (Fig 1). Education began with a presentation to all 15 surgical faculty members to review protocols in place at various children’s hospitals. National practice variation was explored, and practice habits and indications for admission were discussed. In addition, all ED attending staff members were briefed at the start of the project at a section meeting, and e-mails were sent to all providers including surgical and ED attending staff and fellows.

On the basis of consensus among the multidisciplinary faculty, absolute and relative criteria for admission were developed. Patients excluded from consideration for discharge were those who failed enema reduction, required operative intervention, or had evidence of pathologic lead points or residual obstruction on imaging studies. Absolute criteria for admission included 3 failed reduction attempts by radiologist, family unable to return to the ED if the patient had recurrent symptoms, or the patient remained symptomatic in the ED after successful reduction. Symptoms were defined as vomiting, lethargy, pain, and intolerance of oral liquids. Relative criteria for admission included fevers, bloody stools, and prolonged duration of symptoms before presentation (>12 hours). These criteria were printed onto laminated, pocket-sized cards that were distributed to ED staff and surgical house staff.

Standardization began with creation of a uniform radiology dictation template and report that included clinically relevant data points about the enema reduction of the intussusception. Figure 2 shows a screen shot of the standardized report. The report was completed by the radiologist who performed the enema reduction. The clinical data elements of the template were provided in conversation with the ED provider ordering the study or direct interview with the family. The report summary was intended to influence disposition. The report delineates several items from the history and clinical work-up such as the presence of bloody stools and the duration of symptoms prior to presentation. Additional details such as the maximum pressure required for pneumatic air contrast enema

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**Aim & Key Drivers**

**Key Drivers (WHAT)**

- **Education**
- **Standardization**

**Design Changes or Interventions (HOW)**

- Educate staff on rate and timing of recurrences
- Create Helpful Hands or section for AVS that is geared toward knowing when to bring the child back to the ED
- Create a standardized radiologic report that communicates the ease of reduction, concern over lead points, and completeness of reduction
- Standardized care plan to be used in ED (e.g., observe for 3 hours after reduction, check liquids, no pain, parent educator)
- Follow up on all intussusception patients with a post-ED visit phone call by a nurse

**Specific Aim**

Increase the number of intussusception patients discharged from the ED by 50% by June 2013 and maintain until December 2013

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**FIGURE 1**

Aim and key drivers diagram for instituting a QI project to increase the number intussusception patients discharged from the ED at a high-volume pediatric center after successful air enema reduction. AVS, after visit summary.
reduction and the number of reduction attempts are also reported. With input from radiology staff, it was decided that maximum insufflation pressure of 120 mm Hg for reduction as well as >2 attempts at reduction within the initial session were criteria for admission. Of note, all air contrast enemas were performed by either attending radiologists or pediatric radiology fellows with attending radiologist present at the table side.

There was also a concerted effort to standardize postreduction management in the ED. An agreement was made with ED staff that a 3- to 4-hour postreduction observation period would be the standard. Care within the ED was facilitated with an intussusception pathway order set that enabled nurses to provide clear liquids and move patients along recovery postreduction. At the end of the observation period, if the ED staff determined the patient needed more time for recovery, a surgical admission was indicated. Other variables considered in the decision-making process for discharge from the ED included an assessment of the family’s ability to return to ED if the patient had recurrent symptoms that included emesis, pain, and failure to tolerate liquids.

Any surgical, radiology, or ED staff member could request surgical admission based on clinical judgment related to relative criteria for admission including fevers, bloody stools, and prolonged prodrome of symptoms before reduction. Thus, any ethical dilemma or concern over patient safety defaulted to surgical admission. Furthermore, all patients were evaluated by a pediatric surgical attending or fellow before discharge home from ED. Another educational tool that was incorporated into practice was an ED intussusception discharge instruction brochure tailored to families for discharge from the ED. Patients who were discharged from the ED received a follow-up phone call from an ED nurse the day after discharge to ensure safety and to answer questions.

**Study of the Intervention**

Data collection was performed prospectively, and quarterly reports were provided to the entire multidisciplinary team and highlighted during ED and surgical division meetings. Providers with a propensity to admit patients were approached regarding admission patterns and for further clarification regarding grounds for admission and to provide clinical outcome follow-up from the admissions. Specific feedback was provided to ED staff from the ED liaison on the project, and feedback was provided to surgical staff by the rounding surgeon the day after admission. Reasons that precluded consideration of discharge from the ED were collected. For patients deemed appropriate candidates for discharge from the ED, the number actually discharged from the ED was reported back to project team members.

**Analysis**

An exact Cochran-Armitage test was performed to evaluate whether there was a statistically significant trend over time in the proportion of patients meeting criteria for going
home who in fact went home. A geometric chart (g-chart) was used to demonstrate rarely occurring events while monitoring a process over time. Time spent in the ED was tracked for patients discharged and admitted, and median times were compared using Student’s t test. Financial projections on cost savings were determined using a combination of local data and estimates from the published literature.7 Local data included charges, direct and indirect costs, average payments, contribution margin (difference between what was charged and patient care costs), and net margins (difference between patient care cost and what the hospital was paid). For all statistical analyses a P value <.05 was considered significant. This project was considered exempt from full internal review board review under the auspices of a QI project.

**RESULTS**

Of the 80 patients with ileocolic intussusception between January 1, 2013, and December 31, 2014, 34 (42.5%) did not qualify for discharge home. Table 1 shows the reasons for exclusion from consideration for discharge from the ED. The most common reasons included need for surgical intervention (n = 9), need for >2 reduction attempts or a challenging reduction (n = 6), radiologic findings such as an edematous terminal ileum or possible lead point on imaging (n = 5), hemodynamic instability requiring additional intravenous hydration (n = 4), and travel distance to the hospital precluding prompt return if needed (n = 4). Other reasons for exclusion were history of bloody bowel movements (n = 2) and exceedingly young age of the patient (n = 1).

Of 46 patients who qualified for discharge, 30 (65.2%) were sent home from the ED. Seven patients returned to the hospital with only 1 having recurrent intussusception that required repeat enema reduction. The other 6 returned to the hospital 2 to 10 days postdischarge for management of their viral symptoms with no radiologic or surgical interventions. Of the 16 patients who qualified for discharge but were admitted and then discharged within 23 hours, none required further intervention, and 1 returned after discharge with no interventions performed. An exact Cochrane-Armitage test for trend yielded a P value of 0.004, indicating the proportion of patients meeting criteria for going home who in fact went home increased significantly over time (Fig 3). A geometric chart (g-chart) is used to demonstrate rarely occurring events while monitoring a process over time. Figure 4 depicts a g-chart where the number of admissions between discharges from the ED is shown along the y-axis. After the start of the project, there were 4 patients admitted before a patient was discharged. Thus the first data point graphed is a value of 5 (meaning the fifth patient was discharged). This was followed by an admission and then another discharge (thus the next point graphed was a 2 representing 2 patients until the event of discharge was again encountered). This was followed by 2 admissions and a discharge (thus the next point graphed was a 3). This pattern continued until August 2014 when there was a string of patients discharged from the ED without an admission (thus a series of points graphed at 1, which represents the baseline for the chart and reflects the desired outcome). Although time is represented on the x-axis, the axis is not to scale.

Patients admitted from the ED had a median ED length of stay of 5.4 hours compared with patients who were discharged from the ED who had a median ED length of stay of 6.8 hours (P = .014). Thus, the discharge practice resulted in ~1.4 hours of additional ED occupancy per patient but avoided an admission. Time of day or day of the week was not associated with admission patterns. Compared with patients discharged from the ED, patients who were admitted had higher average charges ($6066 vs $2937) and generated higher average payments ($3379 vs $1764) but incurred higher average direct costs ($1690 vs $666) and average indirect costs ($1588 vs $619). Thus, patients admitted from the ED had an average contribution

**TABLE 1** Quarterly Breakdown of Details Regarding Intussusception Patients Who Were Excluded and Included for Consideration for Discharge Home From the ED from January 2013 to December 2014

<table>
<thead>
<tr>
<th></th>
<th>2013</th>
<th>2014</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>Number of patients deemed not to meet criteria for going home</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Operative intervention required</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Edema of terminal ileum or possible lead point noted on imaging</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Required &gt;2 attempts at reduction of difficult reduction</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Bloody bowel movement</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Distance from hospital/family issues</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Hemodynamic instability requiring additional resuscitation (eg, dehydration)</td>
<td></td>
<td>3</td>
</tr>
<tr>
<td>Young age</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Number of patients who met criteria for going home</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Number of patients who actually went home</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
margin (difference between charges and costs) of $1689 compared with $1098 for patients discharged from the ED. Ultimately, the average net margin per patient (difference between costs and payment) was $101 for admission from the ED and $480 for discharge from the ED. Using local average net margin figures, the hospital made an additional $11,370 by introducing this QI project.
DISCUSSION

This multidisciplinary QI project to discharge intussusception patients meeting protocol criteria from the ED after enema reduction was successfully integrated into a high-volume pediatric referral center, with more than half of eligible patients being discharged from the ED. Results demonstrated increasing staff participation over time with the potential for reduced resource utilization, significant cost savings, and improved patient satisfaction.

The success of this QI project was facilitated by the use of the Institute for Healthcare Improvement (IHI) Model for Improvement, which focuses on design and implementation.8 This model outlines strategies such as forming a team that includes a clinical leader, content experts, and those responsible for the day-to-day execution of the project. Under the leadership of our director of surgical quality improvement, a multidisciplinary team was assembled that also included stakeholders from emergency medicine and radiology. Nurse practitioners in the ED and from the surgical service were involved in vetting the patient information brochures. The day-to-day execution of the project was facilitated by clinical fellows on the pediatric surgical service along with the on-call surgical staff members. The IHI model also outlines the importance of clearly setting aims that have a defined timeline and achievable goal. The aim outlined in this project was determined after performing a retrospective analysis of intussusception admissions over the 2 years preceding project initiation and identifying the number of patients who would have met theoretical grounds for discharge home from the ED. The IHI model outlines selecting and implementing specific interventions. In this project, the changes made to our system included development of educational brochures for patients and families, creation of a standardized radiology reporting template for enema reductions, and standardization of postreduction care in the ED and postdischarge.

The second component of successful QI as described by the IHI model involves implementation and monitoring. We used a plan-do-study-act cycle to provide feedback to health care providers on a quarterly basis.9 Once in place, the project benefitted from rapid feedback because the first quarter of implementation had no patients discharged from the ED despite extensive groundwork that was in place before initiation. Staff from surgery and the ED were who were directly involved in the care of patients admitted to the hospital were queried as to the indications for admission and for sources of disagreement with the protocol. Additional education and discussion resulted in improved compliance with the project. Continuous QI is closely tied to behavioral change at the individual level, which can be fostered by close observation for trends and consistent feedback.

Using these methods, 65% of patients who met criteria for discharge from the ED were, in fact, discharged. Over time, the proportion of patients being discharged from the hospital increased during the project in the setting of a practice that historically admitted all patients. Reservation with discharging patients from the ED after successful enema reduction comes from the concern over missing early recurrences. Timing of intussusception recurrence can range from hours to years, and reliable predictors of recurrence have not been identified.5,10,11 The management of recurrent intussusception has been repeat enema reduction with excellent outcome, even after multiple recurrences. It remains a challenge to identify patients at high risk for recurrence. Previous reports have suggested that duration of symptoms for >24 hours before evaluation may be a risk factor for recurrence or need for surgical intervention, but other studies challenge this assumption.12,13 Regardless, return to the hospital for evaluation of recurrent intussusception typically occurs promptly with shorter duration of symptoms and fewer symptoms on evaluation for recurrences.13 This may be due to increased caregiver vigilance and early recognition of clinical symptoms. We found that only 1 of the 30 patients discharged from the ED had recurrent intussusception, which was successfully managed with a repeat air contrast enema facilitated through the ED. Of the 16 patients who met criteria for discharge home from the ED but were admitted for observation, 1 developed recurrent intussusception and returned to the system.

Similar results have been demonstrated at several other major children’s centers. Bajaj et al shared results of 78 children managed at the Children’s Hospital of Colorado and found that all intussusception recurrences occurred after discharge for both the 35% of patients admitted for 23 hour admission and for the 65% of patients discharged after a 7-hour observation period.6 A comparison of practice patterns at 2 Canadian institutions demonstrated similar recurrence rates and numbers of patients ultimately requiring surgical intervention between patients admitted for observation and those discharged after successful enema reduction.14 Chien et al reviewed a 7-year experience at Phoenix Children’s Hospital encompassing 98 patients and determined that a 6-hour observation period was a safe alternative to mandatory admission for patients with successfully reduced ileocolic intussusception.2 This study provides
a QI roadmap used at a center interested in emulating these outcomes to improve hospital efficiency.

Cost reduction associated with QI and standardized pathways and protocols has been well demonstrated for many pediatric populations and diseases. With intussusception, cost savings have been demonstrated at hospitals that have initiated protocols to discharge from the ED. According to the Healthcare Utilization Project Kids’ Inpatient Database, nearly 3600 patients were admitted for intussusception in the United States in 2012. Using the online Healthcare Utilization Project query system, the median cost of an admitted intussusception patient was $3719. Annual aggregate charges and costs are estimated at $78 million and $24 million for these admissions. Using the Pediatric Health Information System, patients treated at hospitals amenable to discharge from the ED demonstrated 41% lower median cumulative hospital costs compared with hospitals that favored admission ($1540, interquartile range: $881–$2524 vs $2612, interquartile range: $2013–$3735; \(P < .0001\)). These figures include readmission encounters. Data from this study and subsequent work were used to create estimates for cost savings for our QI project. The estimated cost savings of \(\sim$1000\) per patient for discharge from the ED compared with admission used in this study is consistent with data published from France and Canada. Using conservative costs estimates, discharge from the ED confers an estimated cost savings of \$1072 per patient, which translates to a cost savings of \>$32 100\) during the course of this project. If all eligible patients had been discharged from the ED, potential savings would have exceeded \$49 300. Even more interesting is the fact that local financials demonstrate a higher net margin for patients discharged from the ED as opposed to those admitted ($480 for each patient discharged vs \$101 for each admitted). Thus, even though admitting a patient generates higher charges and payments, overall cost-efficiency improved with discharge from the ED, yielding better margins for the hospital.

Cultural obstacles were encountered during this process. Although almost all ED staff were supportive of discharge from the onset, several surgical attending staff with a tendency for admission during the initial phases of the project slowly changed their practice and favored discharge during the end of the 2-year period. One of the 15 surgical attending staff members refused to discharge patients throughout the project and accounted for a significant portion of admitted patients who qualified for discharge. Education and data feedback thus facilitated change for many but not all care providers. Garnering widespread adoption of optimal care pathways and QI efforts remains a critical obstacle facing centers in the United States. Key lessons learned from this project were to keep the conversation at the forefront at division meetings and to understand where reservations and concerns are rooted. Despite a lack of uniform compliance, significant change was observed.

Implementing a standardized protocol and clearly identifying the grounds for admission is the key to learning more about intussusception and delineating the risk factors for recurrence or risk factors indicating a need for surgical intervention. Our data clearly demonstrate that some variables serve as grounds for admission that are difficult to alter, such as the ability of a patient to return to the ED if recurrent symptoms develop. Other exclusions may be open to further investigation. For example, based on health care provider preferences, we allowed for exclusion of patients from our protocol that had specific clinical findings such as presentation with bloody bowel movements or prolonged symptom duration before presentation. Some studies have suggested that duration of symptoms for \(>24\) hours before evaluation may be a risk factor for recurrence or surgical intervention, but other studies challenge this assumption. Multicenter collaborative efforts are needed to elucidate the influence of these variables on outcomes and to determine the nuances of optimal care of patients with intussusception. Standardized data collection will facilitate open discussion regarding criteria for discharge, admission, and operative intervention.

Limitations to this work include small sample size and the limited duration of the QI project. Sustainability is a key hallmark of a successful QI project, and entrenched practice patterns are difficult to modify. Nonetheless, over time our success with discharge of intussusception patients from the ED improved from 0% in the first quarter to a sustained rate exceeding 70% in the last 3 quarters. Another limitation is the generalizability of the QI project to hospitals that may have different resources, size, and scope of care. Success was contingent on the collaborative efforts of frontline care providers from various disciplines and included physicians, trainees, and nurses. This experience adds to the growing body of literature endorsing discharge of successfully reduced intussusception patients from the ED and provides a guide to implement similar protocol and procedures.

**CONCLUSIONS**

For this QI project, we used a multidisciplinary team to identify several key drivers of care for management of patients with intussusception. These included primary caregiver and health care provider education, standardization...
of radiology reports, postreduction observation in the ED, and establishing formal phone call follow-up for patients. With these interventions, quarterly reports, and individualized feedback, we were able to discharge the majority of patients home from the ED. The interventions described in this study may be informative to other hospitals interested in implementing similar quality improvement projects. Standardized care protocols and data collection will allow for larger multicenter collaborations that can evaluate the clinical significance of a variety factors that may influence treatment and discharge decisions.

**REFERENCES**


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**ABBREVIATIONS**

ED: emergency department
IHI: Institute of Healthcare Improvement
QI: quality improvement
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