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Effectiveness of the implementation of pediatric intussusception clinical pathway

A pre- and postintervention trial

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Abstract

Intussusception is common among children at the pediatric emergency department (ED) with acute abdomen. Diagnosis and treatment delay remain a challenge. This study aimed to evaluate the impact of intussusception clinical pathways (CPs) implementation, including bedside point-of-care ultrasonography, on patient management in a pediatric ED.

In January 2017, an intussusception management protocol was implemented for children with symptoms of intussusception. We retrospectively examined the charts of patients diagnosed with intussusception during the preprotocol (January 2015 to December 2016) and postprotocol (January 2017 to January 2019) periods and compared their outcomes.

A total of 106 and 108 patients were included in the preprotocol and postprotocol groups, respectively. After CP implementation, the median door-to-ultrasonography time decreased from 66.5 (range: 13, 761) to 54 (20, 191) minutes; meanwhile, door-to-reduction time decreased from 121.5 (37, 1077) to 80.5 (40, 285) minutes; the median ED length of stay decreased from 440 to 303.5 minutes; and finally, admission rate increased from 18.9% to 40.7% ($P < .01$). There was no between-group difference in the rates of complications, readmission, emergency surgery, or reduction failure.

The implementation of an intussusception CP decreased time-to-diagnosis, time-to-treatment, and ED length of stay estimates among children screened using point-of-care ultrasonography. The present findings suggest that the implementation of an intussusception CP may improve the efficiency of time and resource use.

Abbreviations: CP = clinical pathway, ED = emergency department, LOS = length of stay, POCUS = point-of-care ultrasonography, US = ultrasonography.

Keywords: clinical pathway, emergency department, intussusception

1. Introduction

Intussusception is a common diagnosis among children presenting at the pediatric emergency department (ED) with acute abdomen. Efficient interdepartmental cooperation is key to early diagnosis and treatment.[1–3] The classical presentation of intussusception consists of the triad of colicky abdominal pain, bloody stool, and vomiting. Diagnosis of intussusception can be difficult in nonverbal children, where history taking is limited and symptoms are atypical.[1–3] Examination with ultrasonography (US) in patients with suspected intussusception is important for accurate diagnosis; in fact, bedside point-of-care ultrasonography (POCUS) is being increasingly used for intussusception screening in pediatric EDs.[4,5]

Clinical pathway (CP) is a multidisciplinary management tool based on evidence-based practices for improving patient results. CPs tend to be used in time-sensitive situations, such as acute coronary syndrome and acute stroke in adult EDs.[6,7] Many studies have shown meaningful improvements in patient safety and outcomes, such as door-to-needle time, ED length of stay (LOS), and complication rates, owing to multidisciplinary cooperation that involve CPs.[6–9] A handful of studies has previously examined the effectiveness of certain CP programs in pediatric EDs.[10,11] Although intussusception is a time-sensitive disease in pediatric EDs, few previous studies have examined the role of CPs in its diagnosis and treatment, focusing primarily on management.[12,13]

In January 2017, we introduced a quality improvement project at our pediatric ED for rapid identification, and effective and efficient management of intussusception. We compared the outcomes of patients with intussusception before and after the implementation of CPs at our pediatric ED. We hypothesized

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The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

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that this protocol would reduce door-to-US time, door-to-reduction time, ED LOS, and the rate of complications.

2. Methods

This study was a quality improvement project that was performed at a tertiary 315-bed children's hospital affiliated with Seoul National University. Our pediatric ED has an annual average capacity of approximately 18,000 patient visits. When a patient presents at the ED with suspected intussusception, an X-ray is taken, the patient is examined, and a radiologist is requested to perform a US to confirm intussusception. This confirmation process can take >2 hours. An on-call radiology resident remains available for air reduction, as required. If intussusception is likely, the ED physician examines the POCUS, to confirm whether or not to trigger CP activation. If the US examination does not confirm intussusception, the patient is discharged. When CP is activated, another US evaluation by a radiologist or the ED physician is performed before reduction is initiated.

During the 4-year period, a total of 233 patients were diagnosed with intussusception; their charts were retrospectively reviewed. The present study included 214 patients (Fig. 1). An intussusception management protocol was created by a multidisciplinary team, including representatives from pediatric emergency medicine, pediatric radiology, and pediatric surgery; the protocol was implemented in January 2017. Patients presenting with symptoms (abdominal pain, cyclic irritability, vomiting, or currant jelly stool) indicative of intussusception that had not been confirmed with a US were evaluated by the ED physician with a bedside POCUS. All POCUS examinations were performed by residents, fellows, or faculty members that had received US training and performed at least one previous US examination for intussusception. CP activation was triggered when intussusception was suspected based on POCUS or US findings (doughnut or pseudo-kidney sign) or an equivocal findings. CP activation entailed sending a relevant text message through the medical order communication system, and the summoning of a radiologist and pediatric surgeon. Other staff were instructed to simultaneously prepare for immediate reduction. Meanwhile, the radiologist performed another US examination or the ED physician performed a sonographic view check to determine the type of intussusception. If ileocecal intussusception was confirmed, the ED was notified, and a nurse started an intravenous drip, took a blood sample, and requested written consent from the patient's guardian to perform the reduction. The radiologist treated ileocecal intussusception by pneumatic reduction; subsequently, the patient was either admitted or discharged after a 4-hour ED observation. If the reduction failed, the medical team consulted a surgeon to discuss operative management. If small bowel intussusception was confirmed, the patient remained at the ED for a 4-hour observation period and was discharged if self-reduction occurred. Persistent small bowel intussusception required consultation with a surgeon to decide between operation or observation. If the patient's guardian requested admission, we allowed a 1-day admission for observation; the associated cost was similar to that associated with ED stay and mostly covered by the national insurance. If the guardian did not request admission, the patient remained in the ED for a 4-hour observation and was then discharged (Fig. 2).

In the present study, we evaluated data from a 4-year period, including 2 years before (preprotocol period: January 2015 to December 2016) and 2 years after (postprotocol period: February 2017 to January 2019) CP initiation. We incorporated a 1-month break between these periods to allow for adequate provider training and protocol implementation. The results of the study period were confirmed every 3 months (Fig. 3).

2.1. Data collection

The study population included all patients under the age of 15 years diagnosed with intussusception at our pediatric ED. Patient data were retrospectively extracted from medical records. Patients were excluded if they had been diagnosed with intussusception prior to their arrival at our ED, or if they did not receive a US evaluation, did not trigger CP activation, or if

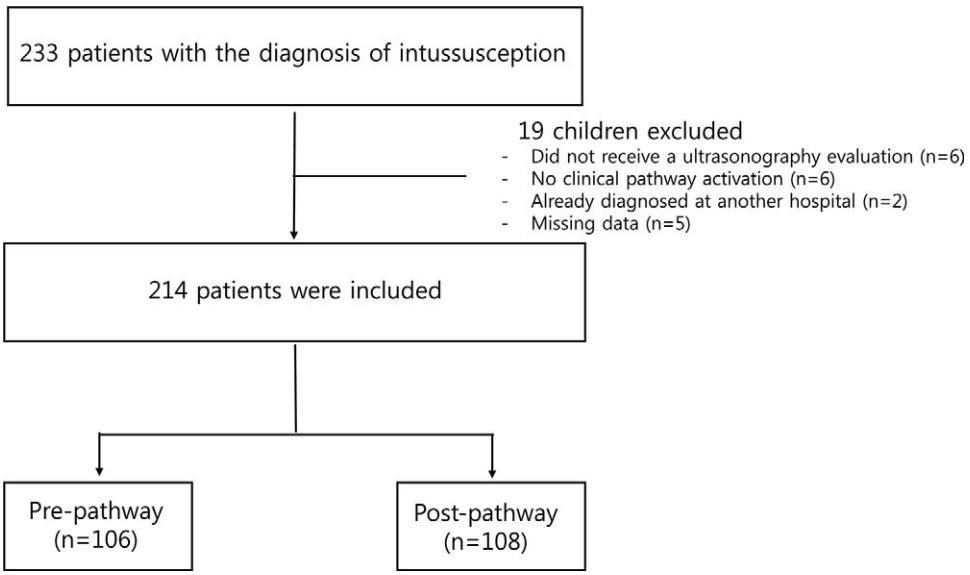

Figure 1. Participant eligibility and study flow chart.

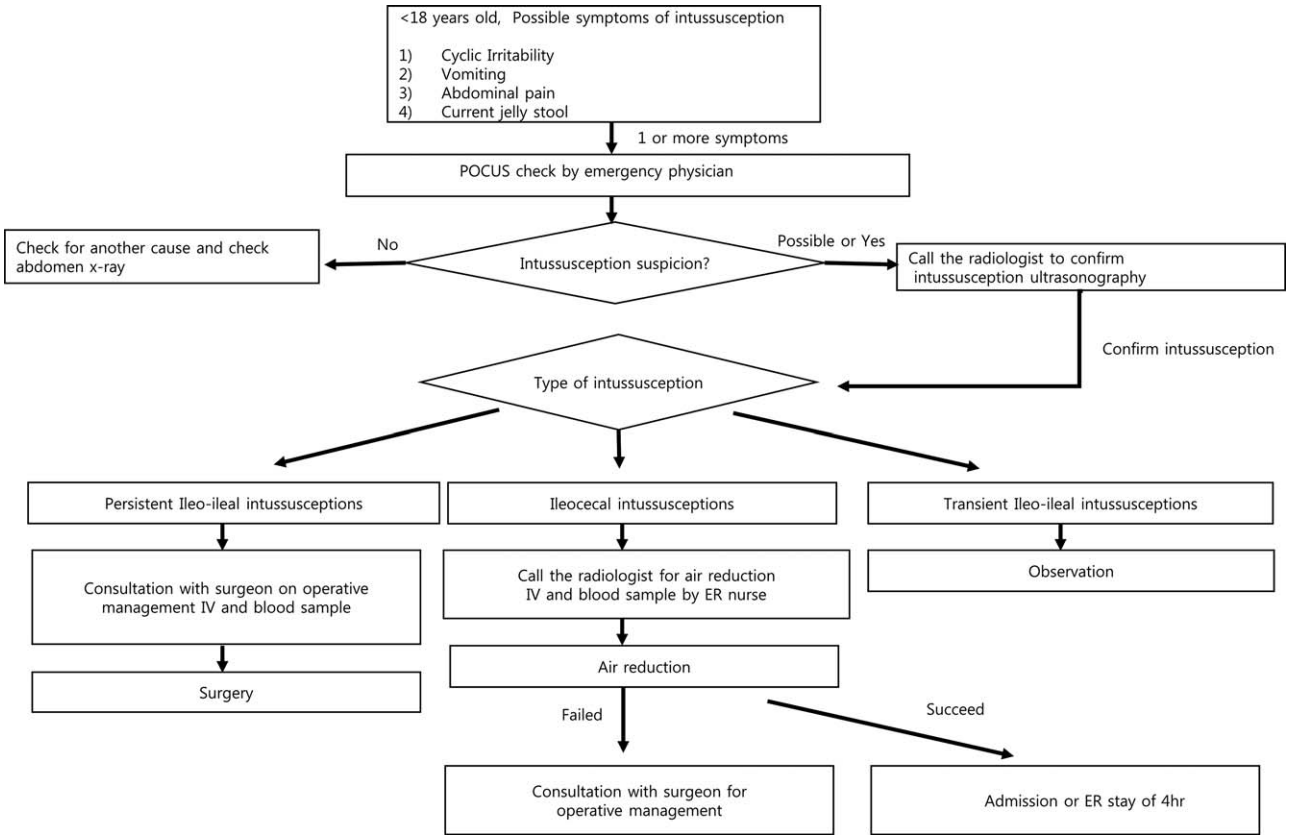

Figure 2. Intussusception clinical pathway protocol. POCUS = point-of-care ultrasonography, ER= emergency department, IV=intravenous.

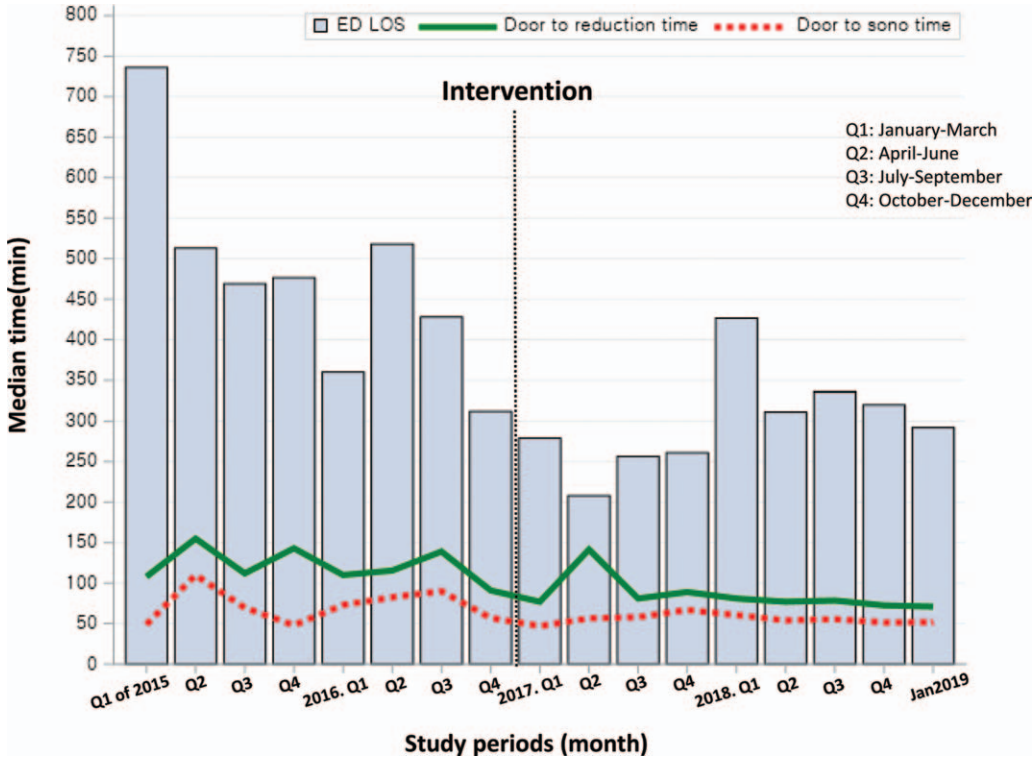

Figure 3. Quarterly median emergency department length of stay, door-to-ultrasonography time, and door-to-reduction time estimates before and after the clinical pathway periods. ED = emergency department; LOS = length of stay.

their data were incomplete (Fig. 1). Patients were also excluded if they had indications for immediate operative management (including peritonitis and hemodynamic instability, among others). A total of 19 patients were excluded.

We extracted data on patient age, sex, level of triage, and symptoms. The timing of patient arrival at the ED, acquisition of US images by a radiologist, timing of pneumatic reduction, departure time from the ED, and hospital discharge outcome were evaluated. Data on door-to-US time (interval from arrival at the ED to a diagnosis confirmed with a US), door-to-reduction time (interval from arrival to pneumatic reduction), and the rates of admission, readmission, reduction failure, emergency surgery, and complications were also collected.

The study was approved by the Institutional Review Board (approval IRB No: H-1802–083–923) of Seoul National University Hospital.

2.2. Statistical analysis

The data were presented as means ± standard deviations for continuous variables with normal distribution. The data were compared using *t* tests for continuous variables. Continuous variables with non-normal distribution were reported as medians (min, max). Comparisons between the pre- and postprotocol groups were performed using the Mann–Whitney *U* test. Categorical variables were compared using the chi-square test or the exact chi-square test, as required. *P* values of $<.05$ were considered indicative of a statistically significant finding. All statistical analyses were performed using Statistical Package for the Social Sciences (SPSS) for Windows version 21.0 (SPSS Inc., Chicago, IL).

3. Results

A total of 233 patients were diagnosed with intussusception. Among them, 19 patients were excluded due to the following reasons. In the pre-protocol period, 5 patients diagnosed with intussusception had incomplete data, while 1 patient was diagnosed with intussusception at another hospital. In the postprotocol period, 6 patients did not receive appropriate care due to high workload in the ED and lack of access to POCUS, resulting in management by a radiologist. In addition, 6 patients were examined with a POCUS before a radiologist confirmed intussusception; however, as the ED physician was not involved, CP was not activated. Finally, 1 patient had a previously confirmed diagnosis from another hospital. The final sample included 214 patients (106 and 108 in the pre- and postprotocol periods). During the 4-year period, a US was conducted in 430 patients with suspected intussusception. Patient characteristics were compared between the periods. There was significant difference between the pre-and postprotocol groups in terms of age, symptom onset-to-ED arrival time and ED triage level, cyclic irritability, and vomiting (Table 1). The median time from symptom onset to ED arrival was 553 min. Over 80% of the patients were classified as ED triage level 3; the most common complaint was abdominal pain. The median door-to-US time was 66.5 minutes and 54.0 minutes during the pre- and postprotocol periods, respectively ($P = .01$). In addition, the median door-to-reduction time was 121.5 minutes and 80.5 minutes during the pre- and postprotocol periods, respectively ($P < .01$). All patients undergoing reduction received an intravenous, and a surgeon was expected to be available within 90 minutes in case of complications (perforation or other concerns with a failed reduction). The median ED LOS decreased by 136.5 minutes in the postprotocol period [440 minutes (48, 1624)] compared to that in the preprotocol period [(303.5 minutes) 66, 1387; $P < .001$]. In addition, after protocol implementation, there was a statistically significant increase in the admission rate (18.9% vs 40.7%, $P < .001$). There was no between-group difference in the rates of complications, readmission, reduction failure, or emergency surgery (Table 2). There were 6 cases in which an emergency physician missed a diagnosis after applying the CP. There were 2 cases in which surgery was performed due to failure of air reduction. In these 2 cases of surgery, the emergency physician confirmed intussusception so a radiologist was called. The radiologist confirmed intussusception and then performed an air reduction, but the air reduction was not successful so emergency surgery was performed.

4. Discussion

The present CP for the early diagnosis and treatment of intussusception was developed by a multidisciplinary team,

Table 1

Patient characteristics.

	Total	Before CP	After CP	*P*-value
No.	214	106	108	
Age (yr), mean (SD)	1.9 (1.3)	2.1 (1.4)	1.6 (1.2)	.011‡
Female, *n* (%)	84 (39.3)	39 (36.8)	45 (41.7)	.465†
Symptom-to-ED visit time, minutes, median (min, max)	553 (6, 5760)	600 (30, 5760)	540 (6, 3240)	.011*
Triage level = 3, *n* (%)	174 (81.3)	91 (85.9)	83 (76.9)	.091†
Symptom				
Fever, *n* (%)	29 (13.6)	12 (11.3)	17 (15.7)	.345†
Abdominal pain, *n* (%)	129 (60.3)	61 (57.6)	68 (63.0)	.418†
Vomiting, *n* (%)	75 (35.1)	43 (40.6)	32 (29.6)	.094†
Currant jelly stool, *n* (%)	24 (11.2)	12 (11.3)	12 (11.1)	.961†
Diarrhea, *n* (%)	31 (14.5)	16 (15.1)	15 (13.9)	.802†
Cyclic irritability, *n* (%)	56 (26.2)	22 (20.8)	34 (31.5)	.074†
Mass, *n* (%)	2 (0.9)	2 (1.9)	0 (0.0)	.244†

CP = clinical pathway; ED = emergency department; SD = standard deviation.

* Mann–Whitney test.

† (exact) chi-square test.

‡ ANOVA.

Table 2

Clinical outcomes before and after clinical pathway implementation.

	Total	Before CP	After CP	*P*-value*	*P*-value†
No.	214	106	108		
Door to US time, min Median (min, max)	58 (13, 761)	66.5 (13, 761)	54 (20, 191)	.0188	.008
Door to reduction time, min Median (min, max)	94 (37, 1077)	121.5 (37, 1077)	80.5 (40, 285)	<.0001	<.0001
ED LOS, min Median (min, max)	356.5 (48, 1624)	440 (48, 1624)	303.5 (66, 1387)	<0.0001	<.0001
Admission duration (day, n=64)	2 (1, 39)	2 (1, 39)	2 (1, 9)	.0164	.004
Complication, *n* (%)	0 (0)	0 (0)	0 (0)	NA	NA
Revisit, *n* (%)	13 (6.1)	7 (6.6)	6 (5.56)	.7482	.7133
Reduction fail, *n* (%)	19 (8.9)	7 (6.6)	12 (11.11)	.2464	.5216
Operation, *n* (%)	7 (3.3)	5 (4.72)	2 (1.85)	.2775	.5356
Admission, *n* %)	64 (29.9)	20 (18.87)	44 (40.74)	.0005	.0005

CP = clinical pathway; ED = emergency department; LOS = length of stay; US = ultrasonography.

* Significance before and after CP.

† Correction of triage level, age, symptom to ED visit time, cyclic irritability, and vomiting.

encompassing specialists in pediatric emergency medicine, pediatric radiology, and pediatric surgery. Screening with POCUS by ED physicians reduced the door-to-US time and door-to-reduction time. All patients who underwent reduction were observed at the ED for 4 hours afterward. After successful reduction, early hospitalization or ED discharge was achieved, reducing the ED LOS.

The usefulness of a CP has been confirmed in diseases requiring rapid diagnosis and treatment in the ED context. Intussusception, which requires efficient interdepartmental cooperation and a timely POCUS examination, is a good candidate for CP application in the pediatric ED. However, few previous studies have examined the impact of CP on intussusception outcomes; in fact, previous studies have mainly focused on treatments or postreduction care.[12,13] The present study is unique in that it outlines all steps involved in intussusception management (from diagnosis to hospitalization) and treatment, depending on intussusception type.

Regarding postreduction management, we applied the principle of early hospitalization or ED discharge after 4 hours of observation. Several studies have evaluated the safety and benefit profile of ED observation and discharge, and reported good outcomes in cases that did not involve complications.[13–15] One previous study developed a postreduction management practice guideline for intussusception in the pediatric ED.[13] This protocol involved feeding patients 2 hours after reduction and discharging them 2 hours thereafter, given successful feeding. The median LOS in the postimplementation period was significantly shorter than that in the preimplementation period in the previous study. Another study has shown that the ED-based observation and discharge after successful air enema reduction in children with ileocolic intussusception was safe, facilitated early discharge, and reduced the burden on hospital resources.[14] Our protocol for postreduction management allowed for either early hospitalization or early discharge, as we aimed to reduce patient time in the ED. Choosing between these options required the assessment of factors such as patient concerns and hospital capacity at a given time; wherever possible, we accounted for guardian preference.

The uptake of bedside POCUS examinations by the ED physicians to screen for conditions that may require urgent treatment is increasing.[16] POCUS tends to be used in the examination of pediatric patients with acute abdomen and to help screen for disorders such as intussusception and acute appendicitis, lowering the radiation risk to patients.[17,18] Kim et al[5] have shown that performing POCUS for intussusception screening reduced the ED LOS and the number of US referrals to radiology departments, while not being associated with poor outcomes in children with clinically nonspecific intussusception. Systematic review and meta-analysis by Margaret et al[19] shows POCUS by ED physicians is highly sensitive and specific for the identification of intussusception for children presenting to the ED. POCUS has the potential to reduce the time to treatment and overall ED LOS. POCUS protocol for intussusception reduced the LOS by over 200 minutes and shortened the door-to-reduction time by 26 minutes. Our study showed the same result as the median ED LOS decreased by 136.5 minutes in the postprotocol period. The reason the ED LOS decreased in our study was because US was performed in the ED as in other studies. It can be seen that the rapid, highly sensitive and specific POCUS diagnosis in the ED ultimately reduced the time spent in the ED.

Consistent with previous studies, the present study demonstrated a significant reduction in door-to-US time and door-to-reduction time (from 66.5 to 54 minutes and from 121.5 to 80.5 minutes, respectively), and in ED LOS (from 440 to 303.5 minutes). In addition, following our protocol, we were able to demonstrate that both postreduction admission and ED stay were safe and effective, and did not increase the rates of complications or readmissions, compared to those observed in the preprotocol period.

This study has several limitations. First, the study enrolled patient was small at 214 patients. However, the present findings were statistically significant, supporting the implementation of the present CP. Second, the data were obtained from a single institution and our experience with CP implementation may not generalize to other hospitals. Future studies should include patients from multiple hospitals to evaluate the impact of a multicenter protocol and to improve the validity of the present findings. Third, the rates of false-negative or false-positive findings in the present study were unknown. Future studies should analyze sensitivity and specificity needed for the accuracy of POCUS for intussusception. Forth, there was no data on patient outcomes or cost of care, and further trials are needed to determine how POCUS influences these factors. Finally, the present study did not include data on patients diagnosed with intussusception at other hospitals after discharge from our ED. However, the number of such cases is likely to be small, as

patients are routinely advised to return to our ED should their symptoms persist or should new symptoms develop.

5. Conclusion

The implementation of an intussusception CP was successful in decreasing the door-to-US time, door-to-reduction time and ED LOS. The CP did not affect the rates of ED revisie or complications.

Author contributions

Conceptualization: So Hyun Paek, Do Kyun Kim.
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Supervision: Do Kyun Kim, Young Ho Kwak.
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Writing – review & editing: So Hyun Paek, Young Ho Kwak, Jae Yun Jung, Se Uk Lee, Joong Wan Park.

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