

Navigating the intussusception scoring system: A journey beyond boundaries

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Abstract: Bowel resection is usually performed in the operative management of pediatric intussusception patients when the strangulation process lasts for a long time, causing intestinal ischemia and necrosis. A combined scoring system of biological markers and clinical conditions of pediatric patients with intussusception can be a tool to help make decisions to perform appropriate and rapid intestinal resection to reduce patient morbidity and mortality. This was a retrospective cross-sectional study of pediatric intussusception patients undergoing laparotomy surgery at Dr. Soetomo Hospital in 2019 – 2024. The data were collected from electronic medical records, with 69 patients meeting the inclusion criteria, multivariate analysis was performed to obtain markers and ratios of inflammatory markers associated with the occurrence of intestinal necrosis in pediatric patients with intussusception. Of the total 69 subjects, 49 (58%) underwent bowel resection and the rest (29 [42%]) resolves without bowel resection, 49 (58%) was male and dominated by age group of < 12 months old (51 [73,9%]), the most common clinical symptoms were abdominal pain (68 of 69 [98,6%]). Using the Backward Stepwise method, 2 clinical factors were obtained in the form of significant vomiting and abdominal mass ($p < 0.05$) and a biological marker in the form of CAR cut off ($p < 0.05$). Conclusion: A scoring system could not be created in this study, but several variables could be used as components of a scoring system in the future study.

Keywords: Bowel resection, Intussusception scoring system, Pediatric intussusception.

1. Introduction

Intussusception is a condition where a proximal segment of the intestine telescopes into a distal segment, making it the most common cause of intestinal obstruction in infants. This pediatric emergency can lead to intestinal ischemia and necrosis, potentially necessitating bowel resection. Prompt diagnosis and treatment are crucial, as delays can be fatal. Management of intussusception typically begins with resuscitation. Non-surgical reduction using liquid or air enemas can be performed in patients without contraindications to this approach [1]. Surgical intervention is indicated when there is intestinal necrosis, perforation, or failure of non-operative reduction [2].

A scoring system can assist pediatric surgeons in making decisions during surgery, thereby reducing morbidity and mortality in pediatric intussusception patients. The classic triad of intussusception includes colicky abdominal pain, vomiting, and bloody stool. Laboratory tests showing elevated levels of C-reactive protein (CRP), neutrophil-lymphocyte ratio (NLR), CRP-lymphocyte ratio (CLR), and CRP-albumin ratio (CAR) can help indicate intestinal necrosis in intussusception cases.

This study aims to obtain a combined scoring system as a sign for the need for bowel resection in cases of pediatric intussusception.

2. Methods

This research is a retrospective cross-sectional study with an observational analytic approach. The population of this study was all pediatric patients (obtained from medical record data) diagnosed with intussusception between January 2019 and July 2024 at Dr. Soetomo General Hospital, Surabaya. The study was approved by the joint committee of ethics of the Dr. Soetomo General Hospital, Surabaya (1056/KEPK/VII/2024). The sample size is determined using the cross-sectional research formula, with total minimum of sample was 69 patients. The inclusion criteria using patients' medical records diagnosed with intussusception and patients aged 0-18 years old. Exclusion criteria was incomplete medical record data, both subjective data and laboratory data that studied according to research variable in this study. Data was processed using the Statistical Package for the Social Sciences (SPSS) version 27.0. The collected data were tested using logistic regression to determine the predictive value (PR) of patient and laboratory factors evaluated against the incidence of bowel resection and non-bowel resection with the Chi-Square test. Receiver operating characteristics (ROC) analysis was used to determine the cut-off value of the independent variables studied. Data from medical records are guaranteed confidentiality by researchers with approval from the ethics committee.

3. Result

3.1. Demographic Data of Research Subjects

The total subjects in this research population were 87 patients, with 69 pediatric patients remaining who had intussusception cases between January 2019 and July 2024. These patients were treated by the Pediatric Surgery Division of the General Surgery Department at Dr. Soetomo Hospital in Surabaya, Indonesia, following the elimination process based on inclusion and exclusion criteria. From the population, 40 (58%) were male, and 29 (42%) were female. The oldest patient was 10 years old, while the youngest was 2 months old. We categorized the subjects into two age groups: <12 months, comprising 51 (73.9%) patients, and ≥12 months, comprising 18 (26.1%) patients. Additionally, the population was predominantly composed of subjects who underwent intestinal resection, totaling 40 (58%) patients Table 1.

Table 1.
Demographic data of research subjects.

Variable		Total [n (%)]
Gender	Boy	40 (58)
	Girl	29 (42)
Age	< 12 months	51 (73,9)
	≥ 12 months	18 (26,1)
Bowel resection	Yes	40 (58)
	No	29 (42)

In this population, it was found that out of 56 patients (81.2%), 38 of them underwent intestinal resection due to vomiting. Additionally, nearly the entire population—68 patients (98.6%)—experienced colicky abdominal pain, with 39 of them undergoing intestinal resection. Furthermore, 64 patients (92.8%) reported passing mucus and blood in their stools, and 38 (55.1%) of them underwent resection. The onset of symptoms to the time of intestinal resection ranged from 2 to 7 days (Table 2).

In the physical examination, it was found that 38 patients (55.1%) had abdominal masses, and pseudoportio was detected in 24.6% (17 patients) of the population. Regarding laboratory tests, patients who underwent intestinal resection showed varying hemoglobin (Hb) levels, with a minimum of 5.5 g/dL and a maximum of 15.4 g/dL, with an average Hb level of 10.16 g/dL. The lowest hematocrit (HCT) level in patients undergoing intestinal resection was 16.6%, while the highest was 48.0%, with an average of 30.50%. The highest platelet count in patients undergoing intestinal resection was 898,000/μL, and the lowest was 127,000/μL, with an average of 464,320/μL. The lowest white blood cell (WBC) count in patients undergoing intestinal resection was 2,860/μL, while the highest was

21,520/ μL , with an average of 11,940/ μL . Lymphocyte levels in patients undergoing intestinal resection ranged from a minimum of 8.40% to a maximum of 57.30%, with an average of 30.02%. Neutrophil levels ranged from a minimum of 19.10% to a maximum of 83.00%, with an average of 55.89% (Table 2).

Table 2.

Characteristic of research subjects.

Variable		Total [n(%)]	Bowel resection [n(%)]
History taking			
Vomit	Present	56 (81.2)	38 (55.1)
	Absent	13 (18.8)	2 (2.9)
Abdominal colic pain	Present	68 (98.6)	39 (56.5)
	Absent	1 (1.4)	1 (1.4)
Red currant jelly stool	Present	64 (92.8)	38 (55.1)
	Absent	5 (7.2)	2 (2.9)
Physical examination			
Abdominal mass	Present	38 (55.1)	31 (44.9)
	Absent	31 (44.9)	9 (13)
Pseudoportio	Present	17 (24.6)	9 (13)
	Absent	52 (75.4)	31 (44.9)
Laboratories examination			
<i>Cut off</i> CAR	≤ 0.96	32 (46.4)	9 (13)
	> 0.96	37 (53.6)	31 (44.9)
<i>Cut off</i> LCR	≥ 7.75	32 (46.4)	11 (15.9)
	< 7.75	37 (53.6)	29 (42)

In Table 3, the researchers also included ratios from several laboratory test results, such as NLR, CAR, and LCR. Among the subjects who underwent intestinal resection, the lowest NLR, CAR, and LCR values were 0.46, 0.11, and 0.65, respectively, while the highest values were 9.48, 7.02, and 89.60, respectively. The average values for these three variables were 2.36, 3.09, and 10.64, respectively. Additionally, 32 (46.4%) patients had a CAR cutoff ≤ 0.96 , while 37 (53.6%) had a CAR cutoff > 0.96 . Regarding LCR, 32 (46.4%) patients had an LCR cutoff ≥ 7.75 , and 37 (53.6%) had an LCR cutoff < 7.75 (Table 2)

Table 3.

Characteristic of research subjects.

Variable	Bowel resection	Lowest value	Highest value	Middle value	Average
Onset (day)	Present	2	7	3.5	4.08
	Absent	1	21	3	2.52
Hb	Present	5.5	15.4	10	10.16
	Absent	7.6	11.7	9.9	9.92
HCT	Present	16.6	48.0	30.40	30.50
	Absent	22.4	35.2	29.90	29.98
Platelet	Present	127	898	433	464.32
	Absent	177	773	479	468.20
WBC	Present	2.86	21.52	11.7	11.94
	Absent	3.38	36.28	10.96	13.17
Lymphocyte	Present	8.40	57.30	29.75	30.02
	Absent	3.92	64.20	32.50	32.67
Neutrophil	Present	19.10	83.00	57.55	55.89
	Absent	21.80	79.30	55.20	54.67
NLR	Present	0.46	9.48	1.90	2.36
	Absent	0.34	12.09	1.83	2.44
CAR	Present	0.11	7.02	3.45	3.09
	Absent	0.05	2.29	0.58	0.70
LCR	Present	0.65	88.60	3.00	10.64

	Absent	2.12	176.47	15.19	27.53
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3.2 The Relationship of the Variables Studied with the Act of Intestinal Resection

In Table 4, the relationship between the variables studied and intestinal resection was examined. Among all the variables studied, only vomiting events ($p = 0.003$, $p < 0.05$), the presence of abdominal masses ($p = 0.000$, $p < 0.05$), and laboratory test results in the form of CAR and LCR cutoffs ($p = 0.000$, $p < 0.005$) showed significant associations with intestinal resection. In the scoring system testing, researchers employed a multivariate test using the Backward Stepwise method. After passing through three elimination stages, it was found that variables such as vomiting, abdominal mass, and the CAR (cutoff point) can be consistently used to determine whether intestinal resection is necessary in cases of pediatric intussusception (Table 5).

Table 4.

Relationship of the variables studied with the action of intestinal resection.

Variable	P value
Gender	0.062
Age	0.809
Vomit	0.003
Abdominal mass	0.000
Abdominal colic pain	1.000
Onset	0.602
Pseudoportio	0.629
Red currant jelly stool	0.408
Hb	0.585
HCT	0.676
Platelet	0.916
WBC	0.415
Lymphocyte	0.387
Neutrophil	0.744
NLR	0.702
CAR Cut Off	0.000
LCR Cut Off	0.000

Table 5.

Multi variate analysis.

Variable	P value
Step 1	0.800
Geder	
Vomit	0.046
Abdominal mass	0.053
CAR cut off	0.041
LCR cut off	0.987
Constanta	0.003
Step 2	0.798
Gender	
Vomit	0.041
Abdominal mass	0.052
CAR cut off	0.008
Constanta	0.003
Step 3	0.039
Vomit	
Abdominal mass	0.037
CAR cut off	0.008
Constanta	0.000

4. Discussion

Intussusception is a condition where a segment of the proximal intestine folds into the distal part of the intestine, which is the most common cause of intestinal obstruction. According to the CMUI scoring

system, four groups of factors—demographics, clinical symptoms, clinical signs (physical examination), and radiological findings are used to determine the risk factors for non-operative reduction failure. Other researchers have modified the CMUI scoring system by adding biomarkers, eliminating the reduction method, and adjusting the patient's weight threshold, resulting in higher sensitivity and specificity for the risk of non-operative reduction failure [3]. The operative procedure performed for intussusception is manual reduction laparotomy, where the decision for intestinal resection depends on the condition of the intestine, which may experience ischemia and progress to necrosis. Factors associated with intestinal necrosis include Albumin and CRP as significant infection markers [4].

4.1. Bowel Resection in Pediatric Intussusception Patients at Dr. Soetomo General Hospital, Surabaya

The group is dominated by male patients, which occurs because boys with good nutrition have a faster growth rate compared to girls of the same age. Well-nourished Children have a higher risk of developing intussusception compared to children with poor nutrition. This is related to the complex immune system that occurs in the intestines [5, 6]. This group is also dominated by patients under 12 months of age, which aligns with Al-Salem, et al., that the incidence of intussusception in children peaks between 4 and 9 months of age [7].

4.2. Gender

In this study, we found that there was no relationship between gender and bowel resection surgery. This is consistent with the research conducted by Ajao, et al. [8] and Ezomike, et al. [9] who stated that there was no relationship between gender and the performance of bowel resection in cases of intussusception [8, 9]. However, study by Yao et al., stated that female patients with intussusception are at higher risk of undergoing bowel resection, while Huang, et al. [10] found that male patients with intussusception have a higher risk of undergoing bowel resection compared to female patients [8, 10, 11].

4.3. Age

Nisar et al. stated that age is not related to bowel resection, which is in line with the study conducted by Yao et al., where no relationship was found between loss of bowel viability and age. Similar results were also shown in the study conducted by Ezomike, et al. [9] In our study, we found results consistent with these three studies, where there was no significant relationship between age and bowel resection in pediatric intussusception cases [12].

4.4. Vomiting

Ravitch and Young, as mentioned in Ein and Daneman, also revealed that vomiting is the most common initial symptom in intussusception cases. Both Toronto series found that vomiting is the second most common symptom after pain in intussusception cases [7, 13]. This aligns with our analytical findings that vomiting is significantly associated with intestinal resection.

4.5. Abdominal Mass

A 'sausage-shaped' mass is often found due to the progression of this disease. More than 90% of patients present with vomiting and bloody stools, while 60% present with a palpable mass [14]. In this study, the emergence of an abdominal mass in children with intussusception was significantly associated with the likelihood of undergoing resection in intussusception cases.

4.6. Abdominal Colic Pain

Wu et al. demonstrated that one of the reasons for deciding on surgical intervention is the presence of peritonitis or the emergence of severe pain caused by intestinal necrosis or ischemia [15]. Abdominal pain is closely associated with an increased risk of bowel resection and independently predicts the need

for surgical intervention. Typically, abdominal pain is characterized by intermittent cries and leg pulling toward the abdomen. However, abdominal pain remains a classic symptom of intussusception and occurs in a significant number of patients where non-operative management is sufficient. Interestingly, abdominal pain may be more pronounced in infants and could indicate a worse prognosis. Often, this pain is less noticeable in infants compared to older children, where abdominal pain is the primary presenting symptom [8].

This is in line with data regarding the most common complaint in this research, which is colicky abdominal pain. Despite statistically insignificant correlations, most patients still undergo bowel resection. This phenomenon may occur due to the wide range of causes of colicky pain. Additionally, it is challenging to obtain an accurate pain history from non-verbal children or parents who may not be aware that their child is in pain. Such conditions pose a significant challenge for healthcare providers [16].

4.7. Onset

Chalya et al., found that clinical delay of more than 24 hours since the onset of symptoms significantly correlates with the decision to perform bowel resection [17]. Some studies also showed that 84.6% of patients who arrived early (≤ 24 hours) successfully underwent intussusception reduction, compared to patients who arrived late (> 24 hours), where only 54.1% achieved reduction, and 45.9% required bowel resection [12, 18]. This contrasts with the data in this study, where there was no significant association between symptom onset and the decision to perform bowel resection. This lack of significance may be due to challenges in obtaining accurate pain history from parents or caregivers who may not fully understand when the patient actually began experiencing symptoms.

4.8. Pseudoportio

Pseudoportio refers to a condition where the portion of the intestine affected by intussusception is exceptionally long, making it palpable during rectal examination. Although this occurrence is relatively rare (only 5% among cases), the discovery of pseudoportio indicates that intussusception has progressed to an advanced stage, implying a worsened prognosis. This progression results from obstruction within the digestive system, which, if left untreated, can lead to ischemia and eventual intestinal necrosis. However, in this study, no significant association was found between pseudoportio and the decision to perform bowel resection. Currently, there are no other studies discussing the between pseudoportio and prognosis or the need for surgical resection in pediatric intussusception patients. Further research is necessary to explore the connection between the emergence of pseudoportio and the decision for bowel resection [19].

4.9. Red Currant Jelly Stool

"Red currant jelly stool" is a sign of impending ischemia in cases of intussusception. This symptom is considered rare or not always present in intussusception cases. A study showed that patients with intussusception who present with red currant jelly stool have a higher risk of experiencing pneumatic reduction failure, which ultimately leads to the need for bowel resection [15, 20].

In this study, we found that bloody mucus stools did not have a significant correlation with bowel resection. This may be due to differing understandings between doctors and patients, leading to errors in data reporting during the anamnesis process.

4.10. Hemoglobin

Anemia can occur in cases of intussusception due to prolonged ischemia, which causes the intestine to become necrotic. Nisar et al. showed that anemia can be considered a determining factor for bowel resection, with pediatric intussusception patients having hemoglobin levels < 10 mg/dL being 2.7 times more likely to undergo bowel resection. This contrasts with the findings of this study, where hemoglobin levels did not have a significant relationship with bowel resection. This discrepancy may be

due to the broad range of causes of anemia. Additionally, this study had fewer samples compared to Nisar et al.'s study, and we did not define the inclusion and exclusion criteria that could be factors for anemia, such as malnutrition, which can also cause anemia [21, 22].

4.11. Hematocrit

Hematocrit can also indicate anemia if HCT levels drop below 30%. Nisar et al., showed that pediatric intussusception patients with HCT levels < 30% had a 2.6 times higher risk of undergoing bowel resection. This contradicts the findings of this study, where HCT levels did not have a significant relationship with bowel resection, which is consistent with the results for hemoglobin levels [12].

4.12. Platelet

Budiananti et al. showed that platelet levels do not have a significant relationship with the occurrence of intestinal necrosis in pediatric intussusception cases. This is consistent with our study, where platelet levels also did not have a significant relationship with the decision to perform bowel resection in pediatric intussusception cases [4].

4.13. White Blood Cell

White blood cells are often used as biomarkers to detect infections. Thuijls et al., found that WBC levels did not have a significant relationship when compared between groups with mesenteric ischemia and non-mesenteric ischemia [23]. This is consistent with the findings of this study, where WBC levels did not have a significant relationship with bowel resection in pediatric intussusception cases. This may be because WBC levels can increase due to infections in other areas and do not specifically indicate infection in a particular region or organ.

4.14. Lymphocyte

Lymphocyte levels decrease as the inflammatory process increases, due to the excessive secretion of cortisol. In this study, the average lymphocyte count in the group that did not undergo bowel resection was indeed lower compared to the group that underwent resection, but statistically, there was no significant relationship between lymphocyte levels and bowel resection in pediatric intussusception patients. This clearly contradicts the existing theory, which may be due to the small sample size in this study [4].

4.15. Neutrophil

Neutrophils, also known as polymorphonuclear leukocytes (PMNs), under homeostatic conditions, enter the circulation, migrate to tissues, and are eventually engulfed by macrophages. Neutrophils are important effector cells in the immune system [24]. A previous study at Dr. Soetomo General Hospital stated that there is no significant relationship between neutrophils and the occurrence of intestinal necrosis [4]. A similar finding was also observed in this study, where neutrophils did not have a significant relationship with the need for bowel resection.

4.16. Neutrophil-Lymphocyte Ratio

The neutrophil-to-lymphocyte ratio plays a role in indicating an inflammatory response resulting from intestinal ischemia. NLR typically increases in bacterial infections, where neutrophils are released to migrate to the site of infection. After 12-20 hours, the bone marrow will increase the production of immature neutrophils into the bloodstream, resulting in a left shift in the white blood cell count [25].

Lymphocyte levels decrease due to excess cortisol during inflammatory reactions, which subsequently affects physiological stress and lowers lymphocyte counts. Lymphocyte suppression also occurs due to the release of inflammatory factors such as TNF- α and IL-6 [19, 26]. In relation to this study, the neutrophil-to-lymphocyte ratio has an insignificant effect on the decision to perform bowel

resection, which aligns with the previous analyses of the relationship between lymphocytes and neutrophils.

4.17. C-Reactive Protein Ratio

An increased ratio of CRP to albumin will influence the decision to perform bowel resection. According to theory, if intestinal necrosis occurs, CRP levels will rise, which can lead to hypoalbuminemia due to systemic inflammation. The researchers chose to use a cut-off for the CAR to simplify the scoring system. The results of this study differ from those of Chen, et al. [27] where the CRP-albumin ratio was found to be insignificant [27].

4.18. Lymphocyte-C-Reactive Protein Ratio

The lymphocyte-C-reactive protein ratio was found to be significantly lower in patients who underwent bowel resection compared to those who did not. This ratio is significant as an indicator for bowel resection in cases of intussusception. Chen et al. concluded that the LCR serves as a high-value indicative marker that is easy to apply using routine examinations without additional costs [27].

Although previous studies indicated that a low LCR was significant for bowel resection, the researchers did not choose LCR as a variable in this study because it is still considered a covariate of CAR. The components of CAR, which include CRP and albumin, are theoretically believed to provide higher accuracy in determining the need for bowel resection [4, 27].

4.19. Combined Scoring System for Bowel Resection in Pediatric Intussusception

This study identified three factors that can be included in a scoring system: the presence of vomiting, abdominal mass findings, and the cut-off CAR from supporting examinations. The results were far from the researchers' expectations, as only a few of the factors studied could contribute to the scoring system.

This research has several limitations: first, the small sample size; second, the absence of CRP data, particularly at the beginning of the study; third, a high level of subjectivity during the anamnesis process, leading to hopes for a standardized anamnesis to reduce examiner bias; and finally, the transition from traditional medical records to digital records during the study, which resulted in some incomplete data in the medical records.

5. Conclusion

While a scoring system could not be developed in this study, the findings can pave the way for creating a scoring system to guide bowel resection decisions in pediatric intussusception cases. This could be achieved by incorporating factors from anamnesis, physical examinations, and supporting diagnostic tests.

Transparency:

The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained. This study followed all ethical practices during writing.

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