Original Article

Accuracy Evaluation of Pediatric Appendicitis Scoring (PAS) Method in Differentiating Nonspecific Abdominal Pain from Appendicitis

Roya Raeisi, Mona Azizi, Jalaleddin Amiri, Manouchehr Ghorbanpour[1], Farzaneh Esna-Ashari[2,3]

Department of Pediatrics, Hamadan University of Medical Sciences, Hamadan, [1]Hamadan University of Medical Sciences, Besat Hospital, Hamadan, [2]Community Medicine, Faculty of Medicine, Hamadan University of Medical Sciences, Hamadan, [3]School of Public Health and Research Center for Health Sciences, Hamadan University of Medical Sciences, Hamadan, Iran

Abstract

Background: This study aimed at evaluating the accuracy of the pediatric appendicitis scoring method in differentiating nonspecific abdominal pain (NSAP) from appendicitis. **Methods**: This cross-sectional study was conducted on 391 children who were hospitalized in the emergency ward due to acute abdominal pain suspected of appendicitis . Pediatric Appendicitis Score (PAS), C-reactive protein (CRP), and appendicitis pathology results of patients undergoing surgery were recorded. **Results:** The results showed that the no significant difference was found among patients in the three experimental groups (appendicitis, specific abdominal pain except appendicitis, and NSAP) with respect to temperature (p = 0.212), but the other variables were significantly different. Findings showed that high CRP frequency, pain migration to right lower quadrant (RLQ), tenderness in right iliac fossa (RIF), anorexia, leukocytosis, high neutrophil, and mean tenderness in RLQ in the appendicitis group were higher than those in the other two groups (p = 0.001). The PAS questionnaire can also be used as a reliable questionnaire with appropriate sensitivity (0.929) and specificity (0.993), and this questionnaire along with detailed clinical examinations could reduce the rate of negative appendectomy to less than 1%. **Conclusions:** This study showed high accuracy of PAS in diagnosing children with appendicitis and differentiating appendicitis from cases of NSAP and specific abdominal pain other than appendicitis. The PAS system could also significantly reduce cases of negative appendicitis. Although high CRP had an excellent ability to diagnose appendicitis, its accuracy was lower than PAS.

Keywords: *Abdominal pain, appendicitis, nonspecific, pediatrics, scoring*

Introduction

Acute appendicitis often emerges with subtle symptoms and may be confused with other diseases. However, acute appendicitis is one of the most common causes of acute abdominal pain.[1,2] The highest incidence of appendicitis is in the second decade of life with a rate of 86 per 100,000 cases per year.[3-5]

Despite the application of new techniques and routine imaging tests, such as ultrasound and CT scan, 5% to 10% of appendectomies are still negative.[6-9] The rate of negative appendectomy and complicated appendectomy in children is higher than that in adults. Based on the research literature, negative appendectomy in children is 8.4%, and in those under 6 years old is 56.7%. The appendicitis perforation rate in children under 6 years old is over 50%. This is likely related to the thinness of the appendix in these children and the associated diagnostic problems.[10,11]

Appendicitis symptoms overlap with other diagnoses of acute abdomen, cases where there are no typical symptoms, and complications associated with the delayed diagnosis. Consequently, this has led to the persistence of the challenges associated with diagnosis of appendicitis.[12]

The term "nonspecific abdominal pain" (NSAP) refers to abdominal pain that, despite thorough clinical and Para-clinical examinations by a specialist, does not lead to a clear and accurate diagnosis.[13] NSAP is one of the most common diagnoses following hospitalization of children due to abdominal pain.[14] There are numerous diagnostic criteria for early and accurate diagnosis of appendicitis and reducing negative appendectomy due to specific abdominal pain except for appendicitis, and NSAP.

They also can reduce frequent visits to emergencies. These criteria include scoring

How to cite this article: Raeisi R, Azizi M, Amiri J, Ghorbanpour M, Esna-Ashari F. Accuracy evaluation of pediatric appendicitis scoring (PAS) method in differentiating nonspecific abdominal pain from appendicitis. Int J Prev Med 2023;14:40.

Address for correspondence:
Dr. Jalaleddin Amiri, Department of Pediatrics, Hamadan University of Medical Sciences, Hamadan, Iran.
E-mail: r_reisi2@yahoo.com

Access this article online

Website: www.ijpvmjournal.net/www.ijpm.ir

DOI: 10.4103/ijpvm.ijpvm_539_21

Quick Response Code:

systems, the help of inflammatory factors, imaging, and/or combination of such techniques. These criteria often include clinical evidence (signs and symptoms), laboratory markers, and imaging.[15-17]

Significant progress has been made recently in the assessment of children with suspected appendicitis. For instance, using ultrasound as front-line imaging without much error in diagnoses or the negative results of appendectomy in acute abdominal pain has reduced CT scan application in the diagnosis of appendicitis. However, the perforated appendicitis rate has remained unchanged, and changes in care are still needed.[18]

In meta-analysis studies, the usefulness of standard scoring systems in children was assessed according to the history of the disease, laboratory criteria, and criteria in pediatric emergencies. As a result, three scoring systems, including AIR, Alvarado, and Pediatric Appendicitis Score (PAS), were evaluated and compared. The results showed that the use of scoring systems as a tool could help in the subsequent decision-making of patients and physicians. Among them, PAS was the most helpful in differentiating cases of appendicitis.[19] Some studies show that the PAS minimizes the risks of radiation and the use of ultrasound.[20,21]

Using observational methods with aid of PAS, is highly useful in children and adolescents.[22] PAS is based on clinical examination (anorexia, nausea, and vomiting, tenderness in the lower right abdomen, pain migration, tenderness during percussion or coughing, fever) and laboratory findings (neutrophils above 7,500 and leukocytosis above 10,000).[23,24]

One of the important consequences of NSAP is the frequent visits to pediatric emergencies and the high prevalence of negative appendectomy in children with NSAP, which imposes costs on the health system. This leads to severe concern in families. Therefore, this study was aimed at evaluating the accuracy of pediatric appendicitis scoring method in differentiating NSAP from appendicitis.

Materials and Methods

A cross-sectional study was conducted on children aged 5–15 years who, were admitted to the emergency ward of Besat Medical Center of Hamadan, Iran, due to acute abdominal pain suspected of appendicitis during 2019–2021. The participants were selected based on total sampling and inclusion criteria (5- to 15-year-old children with acute abdominal pain suspected of appendicitis, and no underlying disease). According to the sample size, 391 patients were selected. Patients who met the following criteria were excluded from the study: a duration of abdominal pain more than 72 h (differentiation of appendicitis from NSAP is rarely required in these cases, and usually another diagnosis is required), having pain less than 6 h (diagnostic tests are not usually performed at this time), a history of blood disorders, malignancy, liver disease or inflammatory diseases (currently either diagnosed within one month before the onset of symptoms), antibiotic or antiinflammatory therapy within one month after diagnosis and patients who did not wish to continue to participate in the study due to any reason.

After explaining the process and objectives of the study and ensuring that records of individuals are preserved, all patients' parents were asked to sign the informed consent form. Next, with the cooperation of the patient, their demographic information and history (age, sex, length of hospital stay, the time interval from onset of pain to hospitalization, the time of the test, etc.) were recorded by the treating physician or pediatric resident. The second part of the questionnaire related to the PAS variables (pain in the right iliac fossa by RIF touching pain, tenderness in RIF with cough or percussion, pain migration to RIF, anorexia, nausea and vomiting, body temperature, leukocyte number, and neutrophil rate) with clinical examination and CRP results,

The results of pathology and abdominal ultrasonography were recorded by reviewing the patients' files and Para-clinical results.

Diagnosis of NSAP has been considered if a specific cause such as appendicitis, mesenteric adenitis, gastroenteritis, urinary tract infection, etc. Is not considered as the cause of abdominal pain with nonspecific findings on ultrasound and no antibiotic treatment in a month after discharge (to prevent cases of appendicitis or undiagnosed infectious disease). Diagnosis of appendicitis was also based on confirmation of postoperative pathology.

All patients with nonspecific pain up to one month after discharge were followed up by telephone to check for exclusion criteria. No antibiotic treatment within one month of discharge to prevent appendicitis cases of undiagnosed infectious disease.

Categorization in evaluating patients with suspected appendicitis:

A. Low risk (PAS <4): Low risk of acute appendicitis with no imaging required. A score with a higher negative predictive value (95%) in the absence of right lower quadrant (RLQ) pain is considered other causes of acute abdominal pain if the pain intensifies with walking, jumping, or coughing.
B. Moderate probability (PAS = 6–4): Imaging can be helpful in this subset of patients, preferably ultrasound. Surgical advice is essential for patients with double scores and imaging in which appendicitis cannot be visualized.
C. High risk (6 PAS>): Surgical advice is essential for these patients. Patients should have an ultrasound before having surgical counseling.

All tests and imaging were performed at Besat Hospital, and no intervention was performed in the routine procedure

for acute abdomen based on the Alvarado system. CBC/UA tests and ultrasound were routinely performed for all patients with acute abdominal pain referred to the emergency ward and needed surgery counseling. Quantitative CRP was measured separately for patients, the results were recorded in a checklist, and the researcher performed all examinations and completed the information of the questionnaire. The decision to transfer to the operating room or discharge from the emergency room was coordinated with the pediatrician and surgeon. Finally, the results of each PAS scoring criteria were evaluated according to the final diagnosis, ultrasound, and pathology results in differentiating appendicitis from NSAP.

Statistical analysis was performed using SPSS version 16. Descriptive statistics were used to achieve the objectives of the study. A *P* value less than 0.05 was considered statistically significant. Uniformity analysis of quantitative variables was performed through a *t*-test; qualitative variables were assessed using a multivariate logical regression of Chi-square test to identify variables most associated with appendicitis and NSAP. Finally, the area below the ROC curve and the cut-off point was determined for quantitative variables to differentiate appendicitis from NSAP.

Results

A total of 391 patients aged 5–15 years who were suspected of having acute appendicitis were included in the study. The mean age of these patients was 9.46 ± 2.62 years, and the age range of patients was between 5 and 15 years. Of the 391 included patients, 160 (40.9%) were male, and 231 (59.1%) were female. Table 1 shows frequency of final diagnosis results for patients.

Comparison of PAS variables frequency in the three groups of appendicitis, specific abdominal pain except for appendicitis, and NSAP is shown in Table 2.

Table 3 shows ROC curve information, cut-off point and sensitivity and specificity of PAS, CRP, and PAS+CRP variables.

ROC curve, PAS, CRP, and PAS+CRP variables are presented in Figure 1.

Taking the cut-off point (7.5 for PAS) into consideration, 92.9% of appendicitis patients were located above that point and, only 2.7% of patients with NSAP had a PAS score above 7.5. None of the patients with specific abdominal pain had a PAS score above 7.5 except for the appendicitis group. Comparison of patients with PAS score above 7.5, CRP above 25.5, and PAS+CRP above 7.5 showed a significant difference between the three groups ($p = 0.001$). With the use of the PAS questionnaire and through determining the cut-off point of 7.5, the rate of negative appendectomies was reduced from 9.1 to 0.38%. By setting a cut-off point equal to 25.5 for CRP, the rate of negative appendectomies was reduced to 4.92%. Furthermore, using the 7.5 cut-off point for PAS+CRP, the rate of negative appendectomies was reduced to 3.41%.

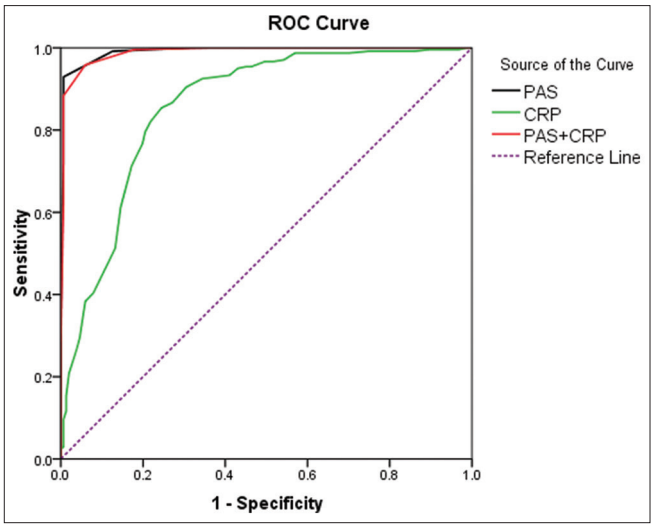

Figure 1: ROC curve, PAS, CRP, and PAS+CRP variables

If the cut-off point (CRP) of CRP is 25.5, 76.7% of appendicitis patients were located above the cut-off point, and 35.1% of patients had a CRP more than 25.5 for NSAP. However, only 14.9% of patients with the specific abdominal pain without appendicitis group had a CRP of more than 25.5.

If we consider patients with a CRP score greater than 25.5 or equivalent to one with other patients scoring zero and add these numbers to the PAS score, the cut-off point value of PAS+CRP is 7.5. 95.8% of appendicitis patients were located above the cut-off point. PAS+CRP score of 24.3% of patients with NSAP was above 7.5. However, PAS+CRP score of the patients with the specific abdominal pain without the appendicitis group was lower than 7.5.

One-month follow-up results showed that 7 patients (2.65%) who underwent an operation developed postoperative complications. In addition, among the patients in the specific abdominal pain without appendicitis group, 21 patients needed to take antibiotics for up to one month after discharge.

Discussion

NSAP is defined as an acute abdominal pain process without a suspected organic cause, which is self-limiting and does not recur. In pediatric emergency departments, this is the most common discharge diagnosis in patients with acute abdominal pain and often requires a differential diagnosis with appendicitis in clinical practice.[25,26]

Marcos Prada *et al*. (2018)[27] examined the usefulness of PAS and CRP in differentiating appendicitis from NSAP. The results showed no difference in temperature and RLQ

Table 1: Frequency of final diagnosis results for patients

Variable	Frequency	Frequency percentage
Final diagnosis		
Transfer to surgical service	15	3.8
Transfer to surgical service and performing appendectomy	264	67.5
Discharge from the emergency room or ward without surgery	40	10.2
Diagnosis of pneumonia	1	0.3
Diagnosis of urinary tract infection	9	2.3
Diagnosis of gastroenteritis	32	8.2
Diagnosis of mesenteric adenitis	15	3.8
Pharyngitis	2	0.5
Discharge without a particular diagnosis	13	3.3
Total	391	100%
Outcomes of surgical appendicitis pathology		
Normal appendicitis	131	49.6
Gangrene appendicitis	86	32.6
Perforated appendicitis	23	8.7
Typical appendicitis (healthy)	24	9.1
Total	264	100%

Table 2: Comparison of PAS variables frequency in the three groups of appendicitis, specific abdominal pain except for appendicitis, and nonspecific abdominal pain

Variable	Status						*P*
	Appendicitis		specific abdominal pain except appendicitis		Nonspecific abdominal pain		
	No	%	No	%	No	%	
Fever	38	15.8	23	20.2	3	8.1	0.212
High CRP	784	76.7	17	14.9	13	35.1	0.001
Pain migration to RLQ	205	85.4	63	55.3	21	56.8	0.001
Tenderness in RIF	231	96.2	14	12.3	20	54.1	0.001
Anorexia	201	83.8	59	51.8	18	71.1	0.001
Leukocytosis more than 10,000	234	97.5	35	30.7	25	67.6	0.001
Neutrophils over 75%	237	98.8	27	23.7	23	62.2	0.001

Table 3: ROC curve information, cut-off point and sensitivity and specificity of PAS, CRP, and PAS + CRP variables.

Variable	The area under the curve (AUC)	Confidence interval (CI 95%)	Cut-off point	Sensitivity	Specificity	*P*
PAS	0.991	0.984-0.999	7.5	0.929	0.993	0.001
CRP	0.858	0.817-8980	25.5	0.767	0.801	0.001
PAS + CRP	0.989	0.980-0.998	7.5	0.958	0.940	0.001

tenderness between patients with appendicitis and patients with NSAP. While the pains exacerbated by coughing, jumping, or percussion in the RLQ of the abdomen, were variables more closely related to appendicitis. Leukocytosis, CRP, and neutrophils were significantly different. PAS correctly classified patients into low-risk and a high-risk group for appendicitis, and also the CRP was effective in increasing the diagnostic accuracy.[27] Our results showed that no significant difference was found between patients with appendicitis and patients with NSAP with respect to temperature, but the tenderness in touching RLQ in the appendicitis group was higher than that in the NSAP groups. The difference between the two studies may be due to different perceptions of pain intensity in different cultures. In other parameters our study was consistent with previous studies.

Khaasteh *et al*. (2020)[28] showed that WBC more than 11,000 and PMN more than 65% have a remarkable ability to diagnose appendicitis and its complications. Kharbanda *et al*. (2017)[29] showed that the intensity of tenderness in RLQ and tenderness in RIF and coughing and percussion are among the main symptoms of appendicitis. Various studies have reported different numbers on the sensitivity and specificity of leukocyte and PMNs counts, ranging from 55% to 89% and from 43 to 66%, respectively.[30-32] The elevation of these counts in many other manifestations with RIF pain causes their low specificity. Given that inflammatory and infectious processes are associated with the activation of neutrophils in the first 3–6 h of onset, they are more useful in the first 24 h of onset. In the present study, the cut-off points with the discriminatory power and

the sensitivity and specificity found were consistent with the previous studies.

Samuel (2002) conducted a study to examine the pediatric appendicitis scale. The results showed that pain indicators in the RLQ of the abdomen were sensitive to cough and percussion, anorexia, nausea, RIF's tenderness, leukocytosis, PMN, and pain migration were sufficiently sensitive in the diagnosis of appendicitis. The pediatric appendicitis scale had a sensitivity of 1, specificity of 0.82, a positive predictive value of 0.96, and a negative predictive value of 0.99. Pediatric appendicitis score was a simple and relatively accurate diagnostic tool for diagnosing appendicitis in children.[33] The negative appendectomy rate in the study was 9.1%, and there was no patient with undiagnosed appendicitis. The results of studies and published statistics related to the rate of appendectomy indicate a prevalence of 5% to 10% negative appendectomy,[6-7] which is consistent with our study

Marcos Prada *et al*. (2018)[27] showed that CRP was effective in increasing the diagnostic accuracy, which is not consistent with our study. According to their proposal, in addition to using PAS to differentiate NSAP from appendicitis, CRP can be used alongside PAS indicators for diagnosis. Also, Khaasteh *et al*. (2020)[28] showed that if the CRP level is within the normal range, it will have a negative predictive value of about 100% for appendicitis. For diagnosis of appendicitis, especially in the early stages, the discriminatory power of CRP is not high because its value is in the range that is compatible with other processes. However, to differentiate between uncomplicated and complex appendicitis, CRP levels are helpful.

Given the results of most studies on the influential role of CRP and the inconsistency with our study, the accuracy of the laboratory used can be somewhat questioned, which requires further investigation

Although PAS+CRP have reduced the rate of negative appendectomies, this reduction has been less than that of PAS, making its use a little questionable.

MarcosPrada *et al*. (2018)[27] demonstrated the ability of the PAS to correctly classify patients into low-risk and high-risk groups for appendicitis. Attia *et al*. (2009)[34] demonstrated the usefulness of PAS scoring in differentiating appendicitis from other causes of abdominal pain. Thus, the score of six and above showed a high-rate probability of appendicitis with 100% sensitivity and 92% specificity. In another study, Bhatt *et al*. (2009)[35] showed the usefulness of the PAS for diagnosing appendicitis in children; the use of PAS reduced 41% of unnecessary imaging, and the rate of negative appendectomy was less than 8%.

Recently, systematic studies of various appendicitis prediction rules used in children have demonstrated the high methodological quality of validation studies for PAS, which offers superior diagnostic performance (sensitivity of 93% and negative predictive value of 10%[12]

Studies also show that it can help classify patients into low-risk and high-risk groups and that there is no need for further diagnostic tests[35-39]

PAS can be very useful in guiding clinical decision-making and improving resources use. It can also be used as a valuable tool to predict the severity of appendicitis and the risk of complications and guide the decision to repeat a structured physical examination during the observation time.

Given that PAS classifies patients by risk of appendicitis; it may be helpful in the differential diagnosis of appendicitis and NSAP. The variable associated with appendicitis is Tenderness in the RIF on coughing, hopping, and percussion, which in the PAS justifies its greater weight

Conclusions

The results showed a high accuracy of PAS in early diagnosis of appendicitis, differentiation of appendicitis from nonspecific cases of abdominal pain, and specific abdominal pain without appendicitis. The PAS could also significantly reduce cases of negative appendicitis. Although CRP had an excellent ability to diagnose appendicitis, its accuracy was lower than PAS. CRP can be used as an alternative to PAS in the diagnosis of appendicitis.

Acknowledgements

This study was approved in Hamadan University of Medical Sciences, as a research project.

Ethical considerations

The research followed the tents of the Declaration of Helsinki. The Ethics Committee of Hamadan University of Medical Sciences approved this study. The institutional ethical committee at Hamadan University of Medical Sciences approved all study protocols (IR.UMSHA.REC.1398.312). Accordingly, written informed consent taken from all participants before any intervention. This study was extracted from M.D thesis of Hamadan at this university (Thesis COD: 9904102233)

Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors. The patient gave the consent to publish as a case report

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

Received: 26 Dec 21 **Accepted:** 27 Oct 22
Published: 21 Mar 23

References

1. Eryigit V, Mahsanlar Y, Demirtas Y, Parlak I. The value of ultrasonography, leukocyte count and clinical results in diagnosis of acute appendicitis and the duration of stay of the patients in emergency department. Turk J Emerg Med 2014;14:20-4.
2. Maita S, Andersson B, Svensson JF, Wester T. Nonoperative treatment for nonperforated appendicitis in children: A systematic review and meta-analysis. Pediatr Surg Int 2020;36:261-9.
3. Bachur RG, Callahan MJ, Monuteaux MC, Rangel SJ. Integration of ultrasound findings and a clinical score in the diagnostic evaluation of pediatric appendicitis. J Pediatr 2015;166:1134-9.
4. Kvasnovsky CL, Shi Y, Rich BS, Glick RD, Soffer SZ, Lipskar AM, *et al*. Limiting hospital resources for acute appendicitis in children: Lessons learned from the U.S. epicenter of the COVID-19 pandemic. J Pediatr Surg 2021;56:900-4.
5. Gorter RR, van den Boom AL, Heij HA, Kneepkens CF, Hulsker CC, Tenhagen M, *et al*. A scoring system to predict the severity of appendicitis in children. J Surg Res 2016;200:452-9.
6. Sivitz AB, Cohen SG, Tejani C. Evaluation of acute appendicitis by pediatric emergency physician sonography. Ann Emerg Med 2014;64:358-64.e4.
7. Sousa-Rodrigues CF, Rocha AC, Rodrigues AK, Barbosa FT, Ramos FW, Valões SH. Correlation between the Alvarado Scale and the macroscopic aspect of the appendix in patients with appendicitis. Rev Col Bras Cir 2014;41:336-9.
8. Von-Muehlen B, Franzon O, Beduschi MG, Kruel N, Lupselo D. AIR score assessment for acute appendicitis. Arq Bras Cir Dig 2015;28:171-3.
9. Sammalkorpi HE, Mentula P, Leppäniemi A. A new adult appendicitis score improves diagnostic accuracy of acute appendicitis-a prospective study. BMC Gastroenterol 2014;14:114.
10. Fallon SC, Orth RC, Guillerman RP, Munden MM, Zhang W, Elder SC, *et al*. Development and validation of an ultrasound scoring system for children with suspected acute appendicitis. Pediatr Radiol 2015;45:1945-52.
11. Mán E, Simonka Z, Varga Á, Rárosi F, Lázár G. Impact of the Alvarado score on the diagnosis of acute appendicitis: Comparing clinical judgment, Alvarado score, and a new modified score in suspected appendicitis: A prospective, randomized clinical trial. Surg Endosc 2014;28:2398-405.
12. Kulik DM, Uleryk EM, Maguire JL. Does this child have appendicitis? A systematic review of clinical prediction rules for children with acute abdominal pain. J Clin Epidemiol 2013;66:95-104.
13. Pennel DJ, Goergen N, Driver CP. Nonspecific abdominal pain is a safe diagnosis. J Pediat Surg 2014;49:1602-4.
14. Thornton GC, Goldacre MJ, Goldacre R, Howarth LJ. Diagnostic outcomes following childhood non-specific abdominal pain: A record-linkage study. Arch Dis Child 2016;101:305-9.
15. Buyukbese Sarsu S, Sarac F. Diagnostic value of white blood cell and C-reactive protein in pediatric appendicitis. BioMed Res Int 2016;2016:6508619.
16. Delgado-Miguel C, Muñoz-Serrano AJ, Barrena Delfa S, Núñez Cerezo V, Estefanía K, Velayos M, *et al*. Índice neutrófilo-linfocito como predictor de peritonitis en apendicitis aguda en niños [Neutrophil-to-lymphocyte ratio as a predictor of peritonitis in acute appendicitis in children]. Cir Pediatr 2019;32:185-9. Spanish.
17. Zviedre A, Engelis A, Tretjakovs P, Jurka A, Zile I, Petersons A. Role of serum cytokines in acute appendicitis and acute mesenteric lymphadenitis among children. Medicina (Kaunas) 2016;52:291-7.
18. Cornudella MP, Almiñana NP, Ruiz AD, Espuny XB, Monne MR, Mir ES. Utilidad del Pediatric Appendicitis Score y la ecografía abdominal en el proceso diagnóstico de apendicitis aguda [Utility of Pediatric Appendicitis Score and abdominal ultrasound in the diagnostic process of acute appendicitis]. Cir Pediatr 2019;32:128-34. Spanish.
19. Newton E, Mandavia S. Surgical complications of selected gastrointestinal emergencies: Pitfalls in management of the acute abdomen. Emerg Med Clin North Am 2003;21:873-907, viii.
20. Sayed AO, Zeidan NS, Fahmy DM, Ibrahim HA. Diagnostic reliability of pediatric appendicitis score, ultrasound and low-dose computed tomography scan in children with suspected acute appendicitis. Ther Clin Risk Manag 2017;13:847-54.
21. Kim DY, Shim DH, Cho KY. Use of the pediatric appendicitis score in a community hospital. Indian Pediatr 2016;53:217-20.
22. Gudjonsdottir J, Marklund E, Hagander L, Salö M. clinical prediction scores for pediatric appendicitis. Eur J Pediatr Surg 2021;31:252-60.
23. Fuhrer AE, Sukhotnik I, Ben-Shahar Y, Weinberg M, Koppelmann T. Predictive value of alvarado score and pediatric appendicitis score in the success of nonoperative management for simple acute appendicitis in children. Eur J Pediatr Surg 2021;31:95-101.
24. Mills AM, Dean AJ, Hollander JE, Chen EH. Abdominal pain: A survey of clinically important outcomes for future research. Canadian J Emerg Med 2010;12:485-90.
25. Fagerström A, Paajanen P, Saarelainen H, Ahonen-Siirtola M, Ukkonen M, Miettinen P, *et al*. Non-specific abdominal pain remains as the most common reason for acute abdomen: 26-year retrospective audit in one emergency unit. Scand J Gastroenterol 2017;52:1072-7.
26. Boendermaker AE, Coolsma CW, Emous M, Ter Avest E. Efficacy of scheduled return visits for emergency department patients with non-specific abdominal pain. Emerg Med J 2018;35:499-506.
27. Prada Arias M, Salgado Barreira A, Montero Sanchez M, Fernandez Eire P, Garcia Saavedra S, Gomez Veiras J, *et al*. [Appendicitis versus non-specific acute abdominal pain: Paediatric Appendicitis Score evaluation]. An Pediatr (Engl Ed) 2018;88:32-8. Spanish.
28. Khaasteh M, Heidari F, Motamedi A, Aslani K, Jamshidi M, Amini H. Evaluation of children's appendicitis score compared with pediatric appendicitis score in diagnosis of pediatric appendicitis. JSSU 2020;28:3110-20.
29. Kharbanda AB, Monuteaux MC, Bachur RG, Dudley NC, Bajaj L, Stevenson MD, *et al*. A clinical score to predict appendicitis in older male children. Acad Pediatr 2017;17:261-6.
30. Paajanen H, Somppi E. Early childhood appendicitis is still a difficult diagnosis. Acta Paediatr 1996;85:459-62.
31. Stefanutti G, Ghirardo V, Gamba P. Inflammatory markers for acute appendicitis in children: Are they helpful? J Pediatr Surg 2007;42:773-6.
32. van Leeuwen HJ, Van Der Tol M, Van Strijp JA, Verhoef J, van Kessel KP. The role of tumour necrosis factor in the kinetics of lipopolysaccharide-mediated neutrophil priming in whole blood. Clin Exp Immunol 2005;140:65-72.
33. Samuel M. Pediatric appendicitis score. J Pediatr Surg 2002;37:877-81.
34. Attia MW. The Paediatric Appendicitis Score (PAS) was useful in children with acute abdominal pain. Evid-Based Med 2009;14:26.
35. Bhatt M, Joseph L, Ducharme FM, Dougherty G, McGillivray D. Prospective validation of the pediatric appendicitis score in a Canadian pediatric emergency department. Acad Emerg Med 2009;16:591-6.

36. Goldman RD, Carter S, Stephens D, Antoon R, Mounstephen W, Langer JC. Prospective validation of the pediatric appendicitis score. J Pediatr 2008;153:278-82.
37. Hatcher-Ross K. Sensitivity and specificity of the pediatric appendicitis score. J Pediatr 2009;154:308.
38. Zúñiga RV, Arribas JL, Montes SP, Fernandez MN, Abad CG, Martin LG, *et al*. Application of Pediatric Appendicitis Score on the emergency department of a secondary level hospital. Pediatr Emerg Care 2012;28:489-92.
39. Mandeville K, Pottker T, Bulloch B, Liu J. Using appendicitis scores in the pediatric ED. Am J Emerg Med 2011;29:972-7.