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Accuracy of lintula score versus alvarado score in diagnosis of acute appendicitis in Al-yarmouk teaching hospital

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Abstract

Background: Acute appendicitis is a common and urgent surgical illness with different manifestations, generous overlap with other clinical symptoms. Alvarado score uses mainly clinical findings and laboratory values to assess the presence of acute appendicitis. Lintula scoring system has the inherent advantage in that it does not require laboratory parameters.

Aim of study: To compare between two applied scoring systems (Alvarado and Lintula) in the diagnosis of acute appendicitis.

Methods: A prospective observational study that was conducted in the Department of General Surgery at Al-Yarmouk Teaching Hospital/Baghdad during the period of 10 months from 1st of April 2019 till 1st of February 2020. It included 160 patients attended the outpatient clinic or the emergency department with signs and symptoms suggestive of acute appendicitis.

Results: In this study, most of the patients (88.8%) were underwent open appendectomy and follow up after discharge. More than half of the operated cases (95.8%) were diagnosed as acute appendicitis. Cut-off point of lintula scoring system was (21), so lintula score > 21 is predictive for diagnosis of appendicitis. Lintula scoring system was 67% sensitive, 58.3% specific, and 63.1% accurate. Cut-off point of Alvarado scoring system was (7), so Alvarado score > 7 is predictive for diagnosis of appendicitis. Alvarado scoring system was 82.7% sensitive, 55% specific, and 77.9% accurate.

Conclusion: Lintula score is comparable to Alvarado score in sensitivity, specificity, and accuracy for the diagnosis of acute appendicitis. Lintula score is simple, non-invasive way to be used in resource limited conditions, but Alvarado score is still more statistically better than Lintula score.

Keywords: Alvarado score, Lintula score, appendicitis

Introduction

Acute Appendicitis is defined as an inflammation of the inner lining of the vermiform appendix that spreads to its other parts. It is a common and urgent surgical illness with protean manifestations, generous overlap with other clinical syndromes, and significant morbidity, which increases with diagnostic delay. In fact, despite diagnostic and therapeutic advancement in medicine, appendicitis remains a clinical emergency and is one of the more common causes of acute abdominal pain ^[1]. Appendicitis may occur for several reasons, such as an infection of the appendix, but the most important factor is the obstruction of the appendicular lumen ^[2].

No single sign, symptom, or diagnostic test accurately confirms the diagnosis of appendiceal inflammation in all cases, and the classic history of anorexia and periumbilical pain followed by nausea, right lower quadrant (RLQ) pain, and vomiting occurs in only 50% of cases ^[3].

Incidence

Appendicitis is most common between the ages of 5 and 40; the median age is 28 ^[4]. Risk factors include being male, higher household income and living in a rural area. In 2013, it resulted in 72,000 deaths globally, down from 88,000 in 1990 ^[5]. In the United States, there were nearly 293,000 hospitalizations involving appendicitis in 2010 ^[6]. Appendicitis is one of the most frequent diagnoses for emergency department visits resulting in hospitalization among children ages 5–17 years in the United States ^[7]. In the UK, around 42,000 to 47,000 operations for appendicitis were performed yearly between 2007 and 2012. Large studies from the UK and US have shown that complicated appendicitis is found at surgery in around 16.5% to 24.4% of cases ^[8].

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In Asian and African countries, the incidence of acute appendicitis is probably lower because of the dietary habits of the inhabitants of these geographic areas. The incidence of appendicitis is lower in cultures with a higher intake of dietary fiber. The incidence of appendicitis gradually rises from birth, peaks in the late teen years, and gradually declines in the geriatric years^[1]. Lymphoid hyperplasia is observed more often among infants and adults and is responsible for the increased incidence of appendicitis in these age groups. Younger children have a higher rate of perforation, with reported rates of 50-85%. The median age at appendectomy is 22 years. Although rare, neonatal and even prenatal appendicitis have been reported. Clinicians must maintain a high index of suspicion in all age groups^[1].

Etiology

Often, the exact etiology of acute appendicitis is unknown. When the appendiceal lumen gets obstructed, bacteria will build up in the appendix and cause acute inflammation with perforation and abscess formation^[9].

The cause of appendicitis is usually from an obstruction of the appendiceal lumen. This can be from an appendicolith (stone of the appendix), or from some other mechanical etiologies. Appendiceal tumors such as carcinoid tumors, intestinal parasites, and hypertrophied lymphatic tissue are all known causes of appendiceal obstruction and appendicitis^[10].

Pathophysiology

The pathophysiology of appendicitis likely result from obstruction of the appendiceal lumen, which results in inflammation, localized ischemia, perforation, and the development of a contained abscess or frank perforation with resultant peritonitis. This obstruction may be caused by lymphoid hyperplasia, infections (parasitic), fecaliths, or benign or malignant tumors^[11]. If appendiceal obstruction persists, intraluminal pressure rises ultimately above that of the appendiceal veins, leading to venous outflow obstruction. As a consequence, appendiceal wall ischemia begins, resulting in a loss of epithelial integrity and allowing bacterial invasion of the appendiceal wall. Within a few hours, this localized condition may worsen because of thrombosis of the appendicular artery and veins, leading to perforation and gangrene of the appendix. As this process continues, a peri-appendicular abscess or [peritonitis](#) may occur^[11]. Bacterial overgrowth occurred at the time of obstruction, with aerobic organisms predominating in early appendicitis and mixed aerobes and anaerobes later in the course. Common organisms include *Escherichia coli*, *Peptostreptococcus*, *Bacteroides*, and *Pseudomonas*^[12].

The scoring system for predicting acute appendicitis

They have the potential to reduce diagnostic error, increase quality and enhance appropriate patient care^[13].

◆ The Alvarado score

Alvarado score is the first and most widely known scoring method, the accuracy of which has been clinically approved^[14]. It uses mainly clinical findings and laboratory values to assess the presence of acute appendicitis^[15]. It has been shown that Alvarado score prevents the delay in therapy and reduced the negative appendectomy rate. Although Alvarado score has a high accuracy rate^[16].

The original Alvarado score describes a possible total of 10 points, but those medical facilities that are unable to perform a differential white blood cell count, are using a Modified

Alvarado Score with a total of 9 points which is not as accurate as the original score^[17].

Further investigations, such as ultrasound and computed tomography (CT) scanning, are recommended when probability of appendicitis is in the intermediate range^[18].

◆ The Lintula score

The Lintula scoring tools were developed in an attempt to assist clinicians in distinguishing acute appendicitis from other causes of abdominal pain, with the aim of reducing the negative appendectomy rate^[19]. Acute abdominal pain patients with a total score of ≤ 15 on the Lintula scales have a lower probability of acute appendicitis and thus do not require hospitalization. Patients with scores of ≥ 21 , have a higher probability of acute appendicitis requiring emergency appendectomy. Patients with Lintula scores between 16 and 20 are suspected cases for acute appendicitis; close inpatient follow-up is recommended for this group^[20].

The Lintula scoring system is a simple, non-invasive and cost effective way of narrowing down the diagnosis of acute appendicitis with potential utility in resource limited settings^[21].

Aim of the study

To compare between two applied scoring systems (Alvarado and Lintula) in the diagnosis of acute appendicitis.

Patients and method

This is a prospective observational study that was conducted in the Department of General Surgery at Al-Yarmouk Teaching Hospital / Baghdad during the period of 10 months from 1st of April 2019 till 1st of February 2020. The study included 160 patients attended the outpatient clinic or the emergency department with signs and symptoms suggestive of acute appendicitis (lower abdominal and/or right iliac fossa pain).

Exclusion criteria

- Age < 5 years.
- Pregnant ladies.
- Patients with features of generalized peritonitis.
- Previous history of intra-abdominal surgery.

Data collection tools

A questionnaire applied to all enrolled participants to collect the needed information. It includes questions to gather the following information:

- Age, gender, and occupation.
- Past medical and surgical history.
- Symptoms:

Anorexia.

Vomiting.

Pain (Site, shifting, rebound, and severity).

Examination (General and vital signs, temperature, abdominal examination and bowel sound).

Investigation results (Complete blood count).

Ethical considerations and official approvals

Verbal permission was obtained from each patient prior to collecting data, and information were anonymous. Names were removed and replaced by identification codes. All information kept confidential in a password secured laptop and data used exclusively for the research purposes.

Statistical analysis

The data analyzed using Statistical Package for Social Sciences

(SPSS) version 25. The data presented as mean, standard deviation and ranges. Categorical data presented by frequencies and percentages. Chi square test was used to assess the association between provisional diagnosis and certain parameters of both scores. Receiver operating characteristic (ROC) curve analysis was used for prediction of Alvarado and lintula scores as diagnostic of acute appendicitis. Pearson's correlation test (r) was used to assess correlation between Alvarado and lintula scores. A level of P – value less than 0.05 was considered significant.

Results

Figure 1 shows the distribution of study patients by decision of appendectomy. Most of the patients (142 patients, 88.8%) had appendectomy.

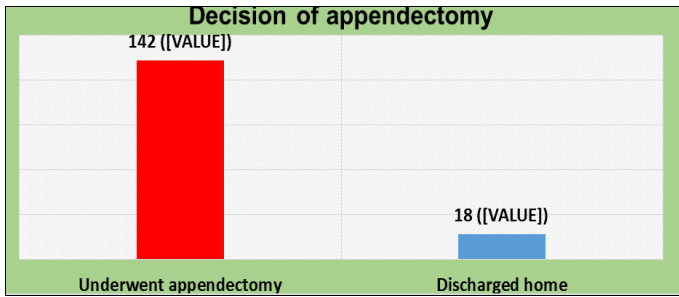


Fig 1: Distribution of study patients by decision of appendectomy

Diagnosis

Table 1 shows the final diagnosis regarding those who underwent appendectomy. We noticed that majorities of the operated cases (95.8%) diagnosed as acute appendicitis (simple+ acute+ gangrenous+ catarrhal appendicitis), while the rest (4.2%) were not appendix (ovarian and pelvic collection)

Table 1: Final diagnosis regarding those who underwent appendectomy

Final Diagnosis	No. (n= 142)	Percentage (%)	
Simple acute appendicitis	72	50.7	
Acute suppurative appendicitis	38	26.8	
Gangrenous appendicitis	9	6.3	
Catarrhal appendix	17	12.0	
Not appendicitis	Ovarian cyst	4	2.8
	Pelvic collection	2	1.4
Total	142	100.0	

Alvarado scoring system

The distribution of Alvarado scoring system is shown in figure (2). In this study the highest proportion of study patients were scored between 7 - 8 by Alvarado scoring system (41.3%).

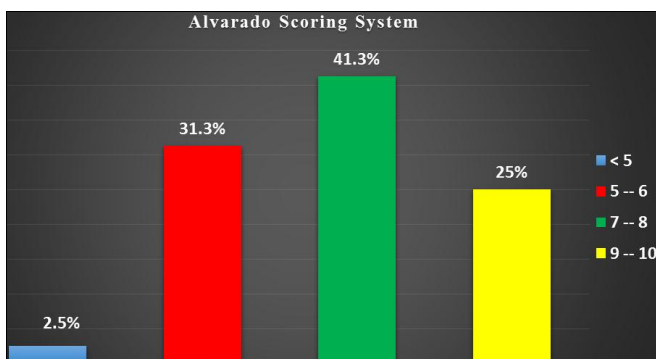


Fig 2: Distribution of Alvarado scoring system

Lintula scoring system

The distribution of lintula scoring system is shown in figure (3). The highest proportion of study patients scored between 21 – 25 was (48.8%), (18.1%) more than 25, (48.8+18.1=66.9%) and less than 21 = (11.2%) less than 15% and (21.9%) between 15-20 this sum was (33.1%).

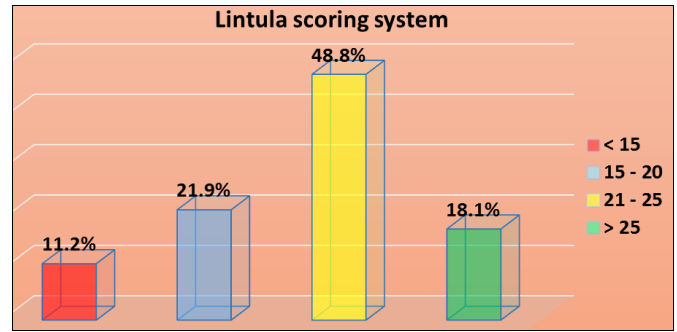


Fig 3: Distribution of lintula scoring system

The association between lintula scoring system parameters and the final diagnosis is shown in table (2). We noticed that 85.9% of patients who had body temperature ≥ 37.5 °C, 78.9% of those who experienced guarding during examination, and 80.7% of those who showed rebound tenderness during examination were diagnosed with appendicitis with significant associations between final diagnosis and all of body temperature (P= 0.001), guarding (P= 0.017), and rebound tenderness (P= 0.04). No statistical significant associations between final diagnosis and all other parameters (P \geq 0.05).

Table 2: Association between final diagnosis and lintula scoring system parameters

Lintula Parameter	Final diagnosis		Total (%) n= 160	P – Value
	Appendicitis (%) n= 119	Normal appendix (%) n= 41		
1. Gender				
Male	61 (81.3)	14 (18.7)	75 (46.9)	0.058
Female	58 (68.2)	27 (31.8)	85 (53.1)	
2. Pain intensity				
Severe	89 (73)	33 (27)	122 (76.3)	0.459
Mild/Moderate	30 (78.9)	8 (21.1)	38 (23.8)	
3. Pain relocation				
Relocated	72 (80.0)	18 (20.0)	90 (56.3)	0.064
Not	47 (67.1)	23 (32.9)	70 (43.8)	
4. Pain at lower quadrant				
Yes	106 (75.7)	34 (24.3)	140 (87.5)	0.304
No	13 (65.0)	7 (35.0)	20 (12.5)	
5. Vomiting				
Yes	82 (78.1)	23 (21.9)	105 (65.6)	0.13
No	37 (67.3)	18 (32.7)	55 (34.4)	
6. Temperature				
≥ 37.5	79 (85.9)	13 (14.1)	92 (57.5)	0.001
< 37.5	40 (58.8)	28 (41.2)	68 (42.5)	
7. Guarding				
Yes	97 (78.9)	26 (21.1)	123 (76.9)	0.017
No	22 (59.5)	15 (40.5)	37 (23.1)	
8. Bowel sound				
Absent	31 (79.5)	8 (20.5)	39 (24.4)	0.4
Normal	88 (72.7)	33 (27.3)	121 (75.6)	
9. Rebound tenderness				
Yes	71 (80.7)	17 (19.3)	88 (55.0)	0.04
No	48 (66.7)	24 (33.3)	72 (45.0)	

The cut-off point of lintula scoring system was (21), so lintula score > 21 is predictive for diagnosis of appendicitis as a large

significant area under the curve (AUC= 64.5%) indicating significant association between higher score of lintula score and diagnosis of appendicitis. Lintula scoring system was 67% sensitive, 58.3% specific, and 63.1% accurate as a predictor for diagnosis of appendicitis.

Table 3: Diagnostic accuracy of lintula scoring system for diagnosis of appendicitis

Lintula scoring system	Cut-off value	Sensitivity	Specificity	PPV	NPV	Accuracy
	21	67%	58.3%	66.3%	59.2%	63.1%

In table 4, the cut-off point of Alvarado scoring system was (7), so Alvarado score > 7 is predictive for diagnosis of appendicitis as a large significant area under the curve (AUC= 85.7%) indicating significant association between higher score of Alvarado score and diagnosis of appendicitis. Alvarado scoring system was 82.7% sensitive, 55% specific, and 77.9% accurate as a predictor for diagnosis of appendicitis.

Table 4: Diagnostic accuracy of Alvarado scoring system for diagnosis of appendicitis

Alvarado scoring system	Cut-off value	Sensitivity	Specificity	PPV	NPV	Accuracy
	7	82.7%	55%	74.2%	52.2%	77.9%

The correlation between Alvarado and lintula scoring systems is shown in table (5) and figure (4). Statistically significant moderate positive correlation was detected between Alvarado and lintula scoring systems (r= 0.562, P= 0.001).

Table 5: Correlation between Alvarado and lintula scoring systems

Lintula scoring system	Alvarado scoring system	
	r	P - Value
	0.562	0.001

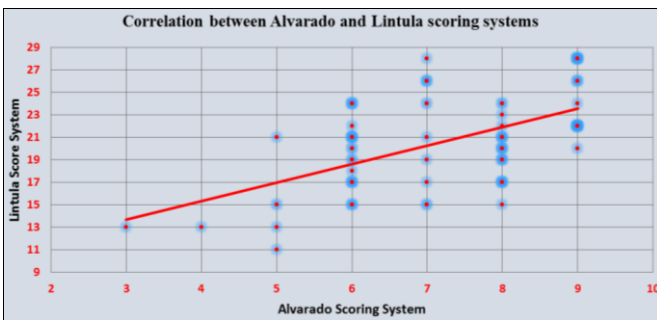


Fig 4: Correlation between Alvarado and lintula scoring systems

Discussion

In the present study. Most of the patients underwent appendectomy (88.8%). Also, majorities of them were diagnosed as acute appendicitis (95.8%) and normal appendix found in 4.2% of the participants.

In comparison to other studies, a comparable result observed in Ojuka *et al.* study in 2017, in which they found that majority of their respondents underwent appendectomy (85.9%); 9.9% were discharged while 4.2% underwent formal laparotomy, also noticed that 42.6% of the patients who underwent appendectomy had uncomplicated acute appendicitis, while 16.4% were found to have a normal appendix [21]. Differently, Kirkil and colleagues in their study in 2013, reported a lower result, as noticed that appendectomy was performed in 64 of the 114 patients included in their study (56.1%). Histopathological examination was

negative for acute appendicitis in 11 of these 64 patients (17%) [22]. Furthermore, a different results observed in Kanumba *et al.* study in 2011, in which all the participants (127 patients) underwent appendectomy. Histopathological examination yielded a higher results, as confirmed appendicitis in 85 patients (66.9%) and the remaining 42 patients had normal appendix giving a negative appendectomy rate of 33.1% [23].

In this study, the highest proportion of study patients were scored between 21 – 25 by Lintula scoring system (48.8%). By comparison to other studies, a lower results observed in Ojuka *et al.* study in 2017, in which found that minority of the respondents (19.72%) had a Lintula index of between 26 and 28 [21].

In this study, association between Lintula scoring and final diagnosis showed that 85.9% are febrile patients (≥ 37.5 °C), 78.9% of those who experienced guarding, and 80.7% of those had rebound tenderness were diagnosed with appendicitis with significant associations with body temperature (P= 0.001), guarding (P= 0.017), and rebound tenderness (P= 0.04), while no statistical significant associations between final diagnosis and all other parameters (P \geq 0.05).

Ojuka and colleagues in their study in 2017, observed a comparable result, when noticed that no association between gender and whether or not the respondents had appendicitis (p = 0.155). Also observed a non-significant association between pain intensity and final diagnosis (p= 0.245) and pain relocation was not related to final diagnosis (p = 0.711) [21].

In this study, ROC curve analysis showed that cut-off point of lintula scoring system was (21), so Lintula score > 21 is predictive for diagnosis of appendicitis. Lintula scoring system was 67% sensitive, 58.3% specific, and 63.1% accurate. In comparison to other studies, current results were slightly sensitive than results observed in Ojuka *et al.* study in 2017, as found at a cut-off score of 21 for the Lintula scoring system, 9.8% of patients would have been falsely positive. At this cut-off point, the sensitivity, specificity and PPV of the Lintula scoring systems were 60.8%, 60% and 79.5% respectively [21].

A more specific findings observed in Kanumba E *et al.*, studies in 2011, in which the PPV for a score of 21 was 100%, with an accuracy of 78%. The cut-off limit of 15 had a PPV of 88.5% and a NPV of 77.8%. Finally found the optimal cut-off point to be 12 points, with a PPV of 87.2% and a NPV of 87.8% [23]. On the other hand, Khanafer and colleagues in ROC curve analysis included in their study in 2016, observed at cut-off point of Lintula score 16, sensitivity, specificity and PPV were 59.3%, 80.1% and 57.1% respectively, which were more specific despite a lower score value [21].

A different results observed in Özsoy *et al.* study in 2017, in which the highest proportion of the participates had an Alvarado score between 5-7 which constituted 55.1% [25].

In the present study, association between Alvarado scoring and the final diagnosis showed that 85.9% of febrile patients (≥ 37.5 °C), and 80.7% of those had rebound tenderness were diagnosed with appendicitis with significant associations between final diagnosis and body temperature (P= 0.001), and rebound tenderness (P= 0.04), but no statistical significant associations between final diagnosis and all other parameters (P \geq 0.05).

In the present study, ROC curve analysis showed that cut-off point of Alvarado scoring system was (7), so Alvarado score > 7 is predictive for diagnosis of appendicitis. Alvarado scoring system was 82.7% sensitive, 55% specific, and 77.9% accurate as a predictor for diagnosis of appendicitis. In comparison to other studies, current results were more specific in diagnosis of appendicitis when compared to results observed in Ojuka *et al.*

study in 2017, as found at a cut-off score of 7 for the Alvarado scoring system, 14.8% of patients would have been falsely positive. At this cut-off point, the sensitivity, specificity and PPV of the Alvarado scoring systems were 84.3%, 35% and 76.8% respectively [21].

In Özsoy *et al.* study in 2017, ROC curve indicated that cut-off value of Alvarado score for correct diagnosis of appendicitis is 7, in accordance to the current study, but was less sensitive but more specific in determining the diagnosis of appendicitis, as found that sensitivity, specificity and PPV were 59.2%, 83.9% and 93.7% respectively [25]. A less sensitive, more specific results observed in Mandeville *et al.*, study in 2011, in which 287 patients found that an Alvarado cutoff score of 7 or higher would give 118 correct diagnoses (41%); sensitivity, 76%; specificity, 72%; and PPV, 76% [26]. Finally, more specific and sensitive results observed in Pogorelic *et al.* study in 2015, in which a total of 311 patients were included in the study. Based on the ROC curve analysis, a cutoff value for Alvarado scoring systems was 7. In patients with acute appendicitis and Alvarado score of 7 or higher, the correct diagnosis would have been set in 75% of patients (sensitivity, 89%; specificity, 59%; positive predictive value, 93.1%) [27].

The differences in the above mentioned studies may be explained by the different populations of patients enrolled, difference in age of participants, because of age-related changes seen in the gastrointestinal tract. As the number and function of the myenteric enteric nervous system decrease with age, there is a decrease in the motility of the gastrointestinal system, and constipation is seen in one-fourth of the individuals over 65 years of age [28], difference in gender as female patients with tenderness in the right lower quadrant can potentially have a variety of conditions, including pelvic infectious disease and other gynecological pathologies [29], the experience of surgeon in determining the disease through clinical examination, investigation done and the experience of the operator of such investigation.

In the current results also, the correlation between Alvarado and Lintula scoring, showed a statistically significant moderate positive correlation between Alvarado and Lintula scoring systems ($r=0.562$, $P=0.001$). Ojuka and colleagues in their study in 2017, agreed to the current results in that a strong positive correlation between Lintula score and Alvarado score ($p=0.001$). they observed that a high value of Lintula score was associated with a high value of Alvarado score [21]. Another agreement observed in Kirkil *et al.* study in 2013, in which observed that Alvarado and Lintula scores correlated highly with the histopathological diagnosis of acute appendicitis ($p=0.001$ and $p=0.000$, respectively) [22].

Conclusion: This study approved that Lintula score is comparable to Alvarado score in sensitivity, specificity, and accuracy for the diagnosis of acute appendicitis. Lintula score is simple, non-invasive way to be used in resource limited conditions.

No conflicts of interest

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References

1. Craig S, Brenner BE. Appendicitis: Practice essentials, backgrounds, anatomy. Medscape 2017,19.
2. Karamanakos SN, Sdralis E, Panagiotopoulos S, Kehagias

- IJSLE, Techniques P. Laparoscopy in the emergency setting: a retrospective review of 540 patients with acute abdominal pain 2010;20(2):119-24.
3. Place RCJT Joem. Acute urinary retention in a 9-year-old child: an atypical presentation of acute appendicitis 2006;31(2):173-5.
4. Ellis HJBjohm. Acute appendicitis 2012;73(3):C46-C8.
5. Abubakar I, Tillmann T, Banerjee AJL. Global, regional, and national age-sex specific all-cause and cause-specific mortality for 240 causes of death, 1990-2013: a systematic analysis for the Global Burden of Disease Study 2013-15;385(9963):117-71.
6. Barrett ML, Hines AL, Andrews RM. Trends in rates of perforated appendix, 2001–2010: statistical brief# 2006,159.
7. Wier L, Yu H, Owens P, Washington R. Overview of Children in the Emergency Department, 2010. Healthcare Cost and Utilization Project, Agency for Healthcare Research and Quality 2013.
8. D'Souza N, Nugent K. Appendicitis. BMJ Clin Evid 2014;2014:0408.
9. Stringer MDJ Jop, health c. Acute appendicitis 2017;53(11):1071-6.
10. Khan MS, Chaudhry MBH, Shahzad N, Tariq M, Memon WA, Alvi ARJJoSR. Risk of appendicitis in patients with incidentally discovered appendicoliths 2018;221:84-7.
11. Jones MW LR, Deppen JG. Appendicitis: StatPearls [Internet]. Treasure Island (FL): tatPearls Publishing 2019. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK493193/>.
12. Hamilton AL, Kamm MA, Ng SC, Morrison M. Proteus spp. as Putative Gastrointestinal Pathogens. Clinical microbiology reviews 2018;31(3).
13. Reilly BM, Evans ATJ Aoim. Translating clinical research into clinical practice: impact of using prediction rules to make decisions 2006;144(3):201-9.
14. Andersson M, Andersson REJW Jos. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score 2008;32(8):1843-9.
15. Yildirim E, Karagülle E, Kirbas I, Türk E, Hasdogan B, Teksam M *et al.* Alvarado scores and pain onset in relation to multislice CT findings in acute appendicitis 2008;14(1):14.
16. Khan I, ur Rehman AJJoAMCA. Application of Alvarado scoring system in diagnosis of acute appendicitis 2005;17(3).
17. Bundy DG, Byerley JS, Liles EA, Perrin EM, Katznelson J, Rice HEJJ. Does this child have appendicitis? 2007;298(4):438-51.
18. Terasawa T, Blackmore CC, Bent S, Kohlwes RJJ Aoim. Systematic review: computed tomography and ultrasonography to detect acute appendicitis in adults and adolescents 2004;141(7):537-46.
19. Lintula H, Kokki H, Kettunen R, Eskelinen MJLSaos. Appendicitis score for children with suspected appendicitis. A randomized clinical trial 2009;394(6):999-1004.
20. Lintula H, Kokki H, Pulkkinen J, Kettunen R, Gröhn O, Eskelinen MJLSaos. Diagnostic score in acute appendicitis. Validation of a diagnostic score (Lintula score) for adults with suspected appendicitis 2010;395(5):495-500.
21. Ojuka D, Sangoro MJ AoAS. Alvarado vs Lintula Scoring Systems in Acute Appendicitis 2017,14(1).
22. Kirkil C, Karabulut K, Aygen E, İlhan YS, Yur M, Binnetoglu K *et al.* Appendicitis scores may be useful in

- reducing the costs of treatment for right lower quadrant pain. *Ulus Travma Acil Cerrahi Derg* 2013;19(1):13-9.
23. Kanumba ES, Mabula JB, Rambau P, Chalya PL. Modified Alvarado Scoring System as a diagnostic tool for Acute Appendicitis at Bugando Medical Centre, Mwanza, Tanzania. *BMC Surgery* 2011;11(1):4.
 24. Khanafer I, Martin D-A, Mitra TP, Eccles R, Brindle ME, Nettel-Aguirre A *et al.* Test characteristics of common appendicitis scores with and without laboratory investigations: a prospective observational study. *BMC Pediatr* 2016;16(1):147.
 25. Özsoy Z, Yenidoğan E. Evaluation of the Alvarado scoring system in the management of acute appendicitis. *Turk J Surg* 2017;33(3):200-4.
 26. Mandeville K, Pottker T, Bulloch B, Liu J. Using appendicitis scores in the pediatric ED. *The American journal of emergency medicine* 2011;29(9):972-7.
 27. Pogorelic Z, Rak S, Mrklic I, Juric I. Prospective validation of Alvarado score and Pediatric Appendicitis Score for the diagnosis of acute appendicitis in children. *Pediatric emergency care* 2015;31(3):164-8.
 28. Saffrey MJ. Ageing of the enteric nervous system. *Mechanisms of ageing and development* 2004;125(12):899-906.
 29. Xingye W, Yuqiang L, Rong W, Hongyu Z. Evaluation of diagnostic scores for acute appendicitis. *J Coll Physicians Surg Pak* 2018;28(2):110-4.