

## **Effectiveness of Appendicitis Inflammatory Response Score in Diagnosis of Acute Appendicitis**

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**ABSTRACT**

**OBJECTIVE:** To determine the diagnostic accuracy of appendicitis inflammatory response (AIR) scores in the diagnosis of acute appendicitis.

**METHODOLOGY:** This cross-sectional observational study was conducted at Liaquat University of Medical and Health Sciences Jamshoro from June to October 2019. Total 500 suspected patients of acute appendicitis according to AIR score were included by consecutive sampling technique, whereas patients without right iliac fossa pain, pregnant mothers, and patients with previous abdominal surgery or known cases of abdominal malignancy were excluded. The histopathological report was obtained for each patient for confirmation of acute appendicitis and diagnostic accuracy of the AIR scoring system. Using SPSS, data was interpreted.

**RESULTS:** From 500 patients, mean age  $21.25 \pm 9.12$  years with 310 (62%) males. AIR scoring was done as a total score between 0-4 as low-risk, 5-8 intermediate-risk, and 9-12 as high risk for appendicitis. 305 (61%) patients complained of vomiting, 480 (96%) pain, 370 (74%) patients had a total leucocyte count (TLC) between  $10-14/9 \text{ mm}^3$ , 270 (54%) reported fever and CRP level  $>50 \text{ ng/ml}$  in 275 (55%) of patients. A significant difference of  $<0.001$  between the clinical and laboratory findings were reported between each category of AIR. Rate of negative appendectomies was 08 % while the sensitivity of AIR scoring acute appendicitis patients was 92%.

**CONCLUSION:** AIR scores were successful in determining the suspected patients with acute appendicitis on a clinical and laboratory basis only without the need for imaging, where intra-operative as well as histopathological diagnosis of acute appendicitis confirming highest sensitivities and minimum of negative appendectomies.

**KEYWORDS:** Appendicitis, diagnostic accuracy, appendicitis inflammatory response, pain, surgery.

**INTRODUCTION**

One of the most commonly observed surgical emergencies observed in both developed as well as developing worlds is acute appendicitis<sup>1</sup>. Even though increases in the usage of inflammatory mediators and diagnostic interventions have been reported yet missed and delay in diagnosing appendicitis and the rate of negative appendectomies remain high<sup>2</sup>. In addition, the risk of complications, perforation of the appendix leading to sepsis and death are also fairly common<sup>2</sup>.

Acute appendicitis is a common gastrointestinal disease affecting 5.7–57 /per 100.000 individuals each year with the highest incidence in children and adolescents. The variation of incidence is due to variations in ethnicity, gender, age, obesity, and season of the year<sup>3</sup>. The ultimate diagnostic modality in acute appendicitis is regarded as the routine imaging technique<sup>4</sup>. Nonetheless, using selected imaging modalities is recommended, since indiscriminate usage of imaging techniques is related to a high frequency of false-positive and false-negative resulting in the patient having low or high probabilities of appendicitis, respectively<sup>5</sup>. Computer tomography helps detect acute appendicitis but can expose patients to ionizing radiations that can be managed with or without treatment, leading to higher rates of appendicitis<sup>6</sup>.

Diagnosing acute appendicitis in clinic emergencies is pivotal since it sets the base for a further selection of diagnostic workup. Particularly, variables demonstrating inflammation have been reported to have vital diagnostic value<sup>7</sup>. Presently, efforts have been put into place for finding newer inflammatory markers which can help in improving the laboratory diagnosis of acute appendicitis. Nevertheless, few studies have compared the diagnostic property of such newer variables to the conventional diagnostic variable that we routinely used<sup>8</sup>.

Clinical signs and symptoms in addition to routinely measured markers of inflammation have limitations with their values as a diagnostic tool when solely used; however, these can help in achieving a greater discriminatory role in combination with a clinical score, such as Alvarado or the Appendicitis Inflammatory Response (AIR) score<sup>9</sup>. Such scorings could aid in classifying patients of acute appendicitis having low or high probabilities of acute appendicitis and also help in serving as a decision-making clinical diagnostic modality for selecting patients for further workup of appendicitis<sup>10</sup>. Therefore it can serve as a tool for sorting outpatients and so reduce the number of negative appendicitis patients or those that can be safely and be conservatively managed<sup>11</sup>.

Scoring systems are a valid and valuable diagnostic tool to discriminate in-between acute appendicitis and abdominal pain of non-specific variety. The AIR scoring has been formulated recently to serve diagnosis which makes use of seven score variables for stratifying patients into Low, Intermediate, and High-risk groups<sup>12</sup>. AIR scores have been reported to be both valid and also out-perform the previously used Alvarado score. This might be possible because the AIR score relies on fewer subjective symptoms like nausea or anorexia and has the incorporation of C-reactive protein<sup>13</sup>.

The objectives of this study were to determine the diagnostic accuracy of appendicitis inflammatory response (AIR) score in the diagnosis of acute appendicitis.

## **METHODOLOGY**

This cross-sectional observational study was designed to be conducted at the Department of Surgery, Liaquat University of Medical and Health Sciences Jamshoro from June-October 2019. Five hundred patients of either age presented with sudden-onset, non-traumatic Right Iliac Fossa (RIF) pain, suspected to be acute appendicitis were included in the study by consecutive sampling technique, whereas patients without RIF pain, pregnant women, patients with previous abdominal surgery or known case of abdominal malignancy were excluded from the study. Patients were selected by consecutive sampling techniques from August 2019 to January 2021. Detailed medical history of each patient was obtained. The AIR score sheet was filled for each patient. The histopathological report was obtained for each patient for confirmation of acute appendicitis and diagnostic accuracy of the AIR scoring system. Using the AIR score for acute appendicitis proforma, the scoring of the patients was recorded. The total score was calculated at 12. A total score between 0-4 was regarded as a low risk for acute appendicitis, while a score in-between 5-8 was termed as intermediate risk for acute appendicitis while a score in-between 9-12 was classified as a high risk for acute appendicitis.

All the information was analyzed by using a statistical package for social science (SPSS) version 22. Qualitative data were represented as the frequency in percentages while quantitative data as mean and standard deviation. Chi-square test was applied to test for significance keeping a p-value of <0.05 as statistically significant.

## RESULTS

A total of 500 patients suspected of acute appendicitis were included in the study during the study period. The mean age of patients was  $21.25 \pm 9.12$  years with 310 (62%) males and 190 (38%) females. Diagnosis of acute appendicitis was made on a clinical and laboratory basis. Scoring was done according to the AIR scores with a total score between 0-4 classified as low-risk for appendicitis, 5-8 intermediate-risk, and 9-12 as high risk. 305 (61%) of patients complained of vomiting, 480 (96%) complained of pain, 195 (39%) patients were observed to have light rebound tenderness while 280 (56%) medium and 25 (5%) strong rebound tenderness. 270 (54%) were found to have a fever. 370 (74%) patients had a total leucocyte count (TLC) between 10-14.9  $\text{mm}^3$ , TLC of  $>15 \text{ mm}^3$  in 100 (20%) and TLC of  $<10 \text{ mm}^3$  in 30 (6%) of patients. A CRP level in-between 10-49 ng/ml was reported in 225 (45%) patients while  $>50$  ng/ml in 275 (55%) of patients **Table I**.

After applying AIR scorings, 05 patients were classified into the low-risk category, 375 patients in the intermediate category, and 120 patients in the high-risk category **Figure I**.

Among the low-risk patients according to AIR score, the findings among the patients recorded were vomiting, pain, light rebound tenderness, a TLC  $<10 \text{ mm}^3$ , leucocytes below  $<70 \%$ , and CRP in-between 10-49. Amongst the intermediate-risk patients according to AIR score, 180 patients experienced vomiting, 355 pain, in 170 patients light, in 195 patients medium and 10 patients, a strong rebound tenderness, fever in 165 patients, TLC in-between 10-14.9  $\text{mm}^3$  in 285 patients, TLC  $>15 \text{ mm}^3$  in 65 patients and TLC  $<10 \text{ mm}^3$  in 25 patients, leucocytes in-between 70-84 % in 275 patients,  $>85 \%$  in 70 patients and  $<70$  in 30 patients and CRP in-between 10-49 in 205 patients and 170 patients,  $>50$ . Among the 120 high-risk patients, all patients had vomiting, pain, 20 had light, 85 had medium and 15 had strong rebound tenderness, 105 were observed to have a fever. In 85 patients, TLC was in-between 10-14.9  $\text{mm}^3$ ,  $>15 \text{ mm}^3$  in 35 patients, 70-84 % leucocytes in 70 patients and  $>85 \%$  in 50 patients. CRP in-between 10-49 ng/ml was reported in 15 patients while 105 patients had a CRP  $>50$  ng/ml. A significant difference of  $<0.001$  between the clinical and laboratory findings was reported between each category of AIR scoring **Table II**.

An intra-operative diagnosis of appendicitis was made in 479 (95.8%) patients while 21 (4.2%) of cases were intra-operatively reported to be negative for appendicitis. Similarly, histopathologically, 460 (92%) cases were reported to be of acute appendicitis while 40 (8%) were negative for appendicitis. All negative appendicitis cases were from the intermediate air risk group. Therefore, the rate of negative appendectomies in the study was 08% while the sensitivity of AIR scoring in cases of acute appendicitis was 92 % **Figure II**.

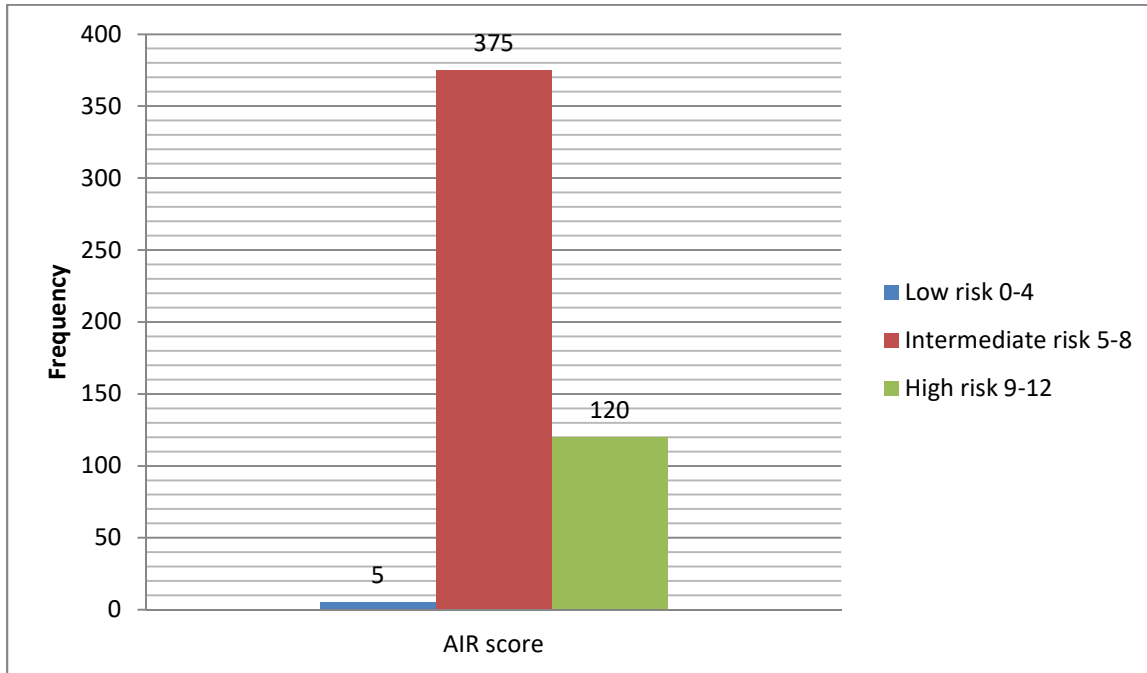
**TABLE I: BASELINE DEMOGRAPHICS OF STUDY PATIENTS**

Mean ± SD		
Age (years)		21.25 ± 9.12
Frequency (%)		
Gender	Male	310 (62)
	Female	190 (38)
Vomiting	Yes	305 (61)
	No	195 (39)
Pain	Yes	480 (96)
	No	20 (04)
Rebound Tenderness	Light	195 (39)
	Medium	280 (56)
	Strong	25 (05)
Temperature	Yes	270 (54)
	No	230 (46)
Total Leucocyte Count mm <sup>3</sup>	10-14.9	370 (74)
	>15	100 (20)
	<10	30 (06)
Leucocytes %	70-84	345 (69)
	>85	120 (25)
	<70	35 (07)
CRP ng/ml	10-49	225 (45)
	>50	275 (55)

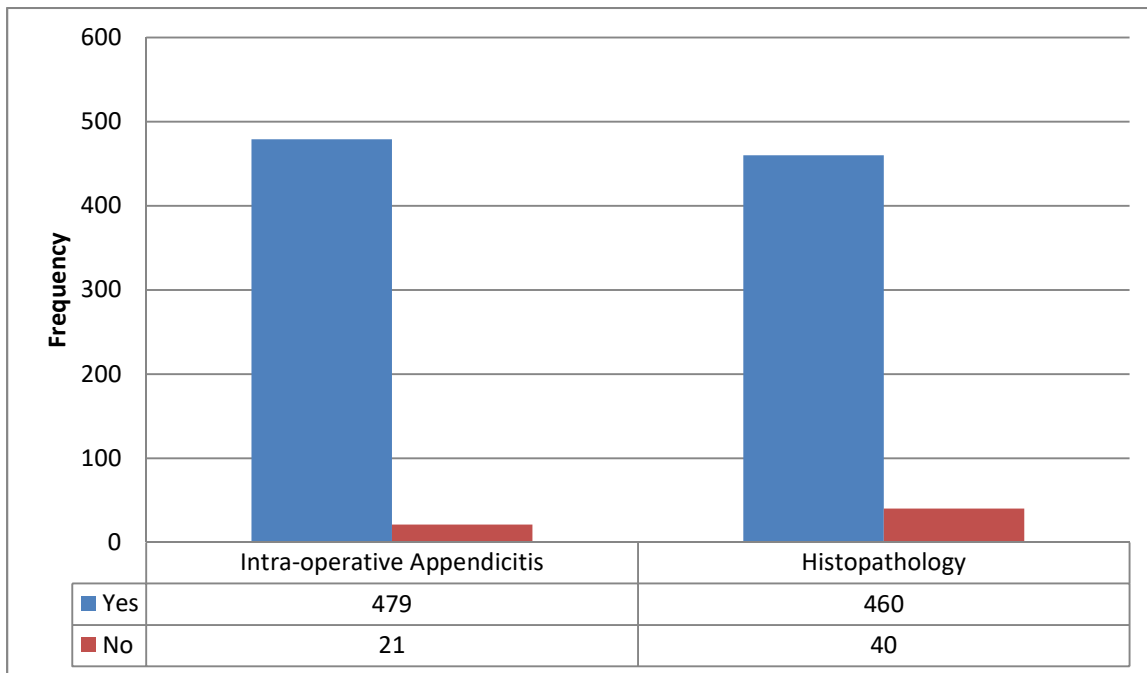
**TABLE II: AIR SCORING ACCORDING TO SYMPTOMS**

<b>AIR scoring</b>					
<b>Variables</b>		<b>Low-Risk n=05</b>	<b>Intermediate- Risk n= 375</b>	<b>High-Risk n=120</b>	<b>p-value</b>
Vomiting		05	180	120	<0.001
Pain		05	355	120	0.031
Rebound Tenderness	Light	05	170	20	<0.001
	Medium	00	195	85	
	Strong	00	10	15	
Temperature		00	165	105	<0.001
Total Leucocyte Count mm <sup>3</sup>	10-14.9	00	285	85	<0.001
	>15	00	65	35	
	<10	05	25	00	
Leucocytes %	70-84	00	275	70	<0.001
	>85	00	70	50	
	<70	05	30	00	
CRP ng/ml	10-49	05	205	15	<0.001
	>50	00	170	105	

**FIGURE I: GRAPHICAL REPRESENTATION OF AIR SCORES OF PATIENTS**



**FIGURE II: GRAPHICAL REPRESENTATION OF APPENDICITIS DIAGNOSED ON INTRA-OPERATIVE AND HISTOPATHOLOGICAL BASIS**





## DISCUSSION

For the evaluation of patients complaining of abdominal pain and for identifying the patients having suspected acute appendicitis, the diagnostic strategies ought, to begin with, a complete history along with a physical examination<sup>14</sup>. The Infectious Diseases Society of America (IDSA) and Surgical Infection Society (SIS) recommend the following pathways to be established in diagnosing and managing acute appendicitis<sup>15</sup>. The recommendations include both clinical as well laboratory findings which include pain in the abdomen, localized and rebound tenderness, and evident inflammatory changes on laboratory investigation<sup>16</sup>, these shall help in the identification of most acute appendicitis suspected patients. Some other diagnostic pathways might add radiological imaging with or without other computer support systems<sup>17</sup>.

Most importantly, a gold standard criterion for suspected acute appendicitis is the histopathological confirmation of appendicitis, even though the pre-operative diagnostic criteria are lacking in standardization. Confirmation of negative appendectomy is either done as an intra-operative finding or at the histopathological confirmation<sup>18</sup>. In diagnosing acute appendicitis, the most commonly used scoring system is the Alvarado score. Nonetheless, it can over-predict acute appendicitis especially in children and so contribute to higher rates of negative appendectomies, thereby leading to an increase in morbidity<sup>19</sup>. The Appendicitis Inflammatory Response (AIR) score is reported to out-perform Alvarado score among the adult population<sup>20</sup>.

According to the results of this study, incidences of acute appendicitis were reported more frequently in males (62%) in comparison to females (38%). The finding is seen to be consistent with other studies done by **Saha DA et al** as well as by **Barlas SU et al** where appendicitis was more commonly observed among males (68.5% and 53.5%) in comparison to females (31.5% and 46.5%) respectively<sup>21,22</sup>. The mean age reported in our study was  $21.25 \pm 9.12$  years which is again in line with other studies where the maximum ages of patients were below 30 years (78.6%).<sup>21</sup> In another study, the mean age of appendicitis patients reported was 27 years<sup>23</sup>.

Other than pain, which was observed in 96% of patients, the next most common symptom was vomiting, reported in 61% of patients in this study. Similarly, a study reported a maximum of 62 % of patients presented with vomiting<sup>24</sup>. In line with our study, another study reported a higher frequency of vomiting among the patients, i.e. 77.5%<sup>21</sup>, in our study, 54 % of patients were found to have a fever. Likewise, other studies also reported the same high rate of fever among appendicitis patients<sup>25</sup>. In line with other studies, it was observed in our study that in all of the patients, rebound tenderness was reported, however, it was classified as light, medium and strong whereas the majority of the patients reported medium rebound tenderness<sup>26</sup>. Leukocytosis was reported in 69 % of patients in our study, similar to which other studies also reported the same<sup>27</sup>. A high CRP was seen in 55 % of patients, while a study reported higher CRP levels as compared to our study<sup>28</sup>.

Sensitivity of AIR score was reported as in 9 % of patients in our study while the rate of negative appendectomy on histopathological diagnosis was 08% ( $p < 0.001$ ). Diagnostic accuracy of AIR score has been observed between 71 and 97 % while the rate of negative appendectomies between 14 and 75%<sup>29,30</sup> AIR scoring has been given validation by studies indicating it as accurate for screening of patients for suspecting acute appendicitis. It is ideal for a scoring system to be clinically effective for increasing diagnostic accuracy for making decisive actions for suspected acute appendicitis, also helping to reduce the unnecessary need for patients to be exposed to radiation imaging and/or increasing the precious time before undergoing surgical

intervention for preventing perforation of the appendix. AIR scores have been concluded to be superior in terms of being easy to use in clinical setup, especially in under-resourced areas.<sup>31</sup> Even though the study covered all the bases of AIR scoring for suspected appendicitis, the study might not be immune from selection or observer bias. Similarly, since the study was conducted at a single center with a limited sample size. Overlapping of symptoms might also have taken place. Therefore in stratifying patients of acute appendicitis especially among the high-risk category, where even the need for imaging modality or further workup should not be necessary must be treated as acute appendicitis surgically until proven otherwise. Further, multi-centered studies with larger surgical expertise and sample size would be enlightening in determining further diagnostic accuracy of AIR score as well as compared AIR scoring with other scoring systems used for acute appendicitis.

## **CONCLUSION**

According to the results of the study, AIR scores were successful in determining the suspected patients with acute appendicitis on a clinical and laboratory basis only without the need for imaging, where intra-operative as well as histopathological diagnosis of acute appendicitis confirming highest sensitivities and minimum of negative appendectomies.

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**DATA SHARING STATEMENT:** The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions

## **AUTHOR CONTRIBUTIONS**

Nazir S: Concept, manuscript writing

Sehrish R: Abstract writing

Kumari A: Discussion writing

Sulman S: Reference collection

Munir A: Proof reading and final approval

Tariq AB: Discussion writing

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