



# The Efficacy of Appendicitis Inflammatory Response Score in Diagnosis of Acute Appendicitis

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## Key words:

Acute appendicitis,  
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## Abstract:

**Background:** Acute appendicitis is one of the most common cause of acute abdominal pain. The management of suspected appendicitis represents a prime target for improved decision-making in emergency surgical care (OPD, Emergency room). The aim of the work is to evaluate the appendicitis inflammatory response (AIR) score and compare its performance in predicting the risk of appendicitis to the Alvarado score.

**Objective:** To evaluate the diagnostic performance of the AIR score and potential benefits of risk stratification to guide clinical decision making.

**Methods:** This prospective observational study was conducted in the OPD and Emergency department, Sir Salimullah Medical College & Mitford Hospital, Dhaka. From June'2021 to May'2022. A total 240 patients with right lower abdominal pain. History, clinical examination, hematological, radiological investigations were done. AIR score was calculated. Considering histopathology report as gold standard the score was compared. Histopathology report was done in Pathology Department of SSMC, Dhaka.

**Results:** Right iliac fossa pain (100%) was the most common symptom, followed by vomiting (58.3%), temperature (29.5%), and rebound tenderness. After applying AIR scorings, 44(18.3%) patients in low-risk group (0-4), 112(46.7%) patients in the intermediate risk group (5-8) and 84(35.0%) patients in the high-risk category (9-12). Amongst the 240 applying the AIR score, Sensitivity of inflammatory response score vs histopathology findings was 97.9%, specificity 78.4%, accuracy 93.8%, positive and negative predictive values were 94.4% and 90.9% respectively.

**Conclusion:** Risk stratification of patients with suspected appendicitis by the AIR score could guide decision-making to reduce admissions, length of hospital stay, cost and case fatality rate, optimize utility of diagnostic imaging and to decrease negative exploration.

## Introduction:

Acute appendicitis is the most common indication for emergency abdominal surgery with incidence of 1.17 per 1000 and lifetime risk of 8.6% in men

and 6.7% in women. The incidence is highest in adolescents and young adults, but the incidence of complicated appendicitis shows little variation between different age groups.<sup>1</sup> A clinical diagnosis

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alone leads to a negative appendectomy rate of 15 to 30%.<sup>2</sup> The diagnosis is especially difficult for women of reproductive age and with gynecological disease. The use of ultrasound and CT scans, in addition to clinical assessment and blood tests, has reduced the rate of negative appendectomy to less than 10%.<sup>1,3</sup>

Appendicitis is the inflammation of the vermiform appendix and is caused by a blockage of the hollow portion of the appendix, most commonly by faecolith. However, the blockage could also be caused by inflamed lymphoid tissue caused by a viral infection, parasites, gallstones, or tumors.<sup>4-6</sup> Robert Lewson Tail in 1880 first performed appendectomy in England.<sup>5</sup>

The diagnosis of appendicitis is largely based on clinical symptoms and signs. Appendicitis commonly presents with right iliac fossa pain, nausea, vomiting, and decreased appetite. Several scoring systems for diagnosis of appendicitis already exist. The most known is the Alvarado score.<sup>1</sup> The Appendicitis Inflammatory Response (AIR) Score is a developed diagnostic tool that uses seven variables (vomiting, right iliac fossa pain, rebound tenderness, temperature, WBC count, neutrophil count and CRP) to stratify patients into low, intermediate, and high-risk groups.<sup>2</sup> That has been validated and found to perform the Alvarado Score.<sup>7-9</sup>

The AIR score demonstrated higher sensitivity and specificity compared to the Alvarado score. It is appropriate for both pediatric and adult patients

with suspected appendicitis. The AIR score diagnoses appendicitis based on some clinical and laboratory findings. AIR score.<sup>2</sup>

The aim of this study is to see the potential benefits of risk stratification by the AIR score to guide clinical decision-making.

### Material and Methods:

This prospective observational study was conducted from June' 2021 to May' 2022; at the Department of Surgery, Sir Salimullah Medical College and Mitford Hospital, Dhaka, Bangladesh. The study enrolled a total of 240 patients who met the eligibility criteria.

**Inclusion criteria:** 1. Patient age 12 years and above. 2. Patients admitted for general surgery with suspected appendicitis during the study period were included for observation.

**Exclusion criteria:** 1. patients with appendicular lump formation on presentation, 2. patients with generalized peritonitis due to a perforated appendix or other cause of gut perforation, 4. Patient with Co-morbid disease (DM, HTN, COPD, Bronchial Asthma, CKD), 5. Patient with Covid-19 Disease positive.

Patients with right iliac fossa pain who were operated on for suspected acute appendicitis during the study period and consented to participate in the study were included. The AIR score has 4 clinical items (2 symptoms and 2 signs) and 3 laboratory measurements, each given an additive point score, with a maximum of 12 points possible.

AIR Score variables	Component (Present/Absent)	Score
Vomiting		1
Right Iliac Fossa Pain		1
Rebound Tenderness or Guarding	Light (on deep press patient felt pain)	1
	Moderate (on slight press patient felt pain)	2
	Strong (on slight press patient felt severe pain)	3
Temperature	≥38.5 °C	1
White Cell Count	10-14.9 (× 10 <sup>9</sup> /l)	1
	≥15 (× 10 <sup>9</sup> /l)	2
Proportion of PMNs	70-84 (%)	1
	≥85 (%)	2
C-reactive protein	10-49 (mg/l)	1
	≥50 (mg/l)	2

A score of 0-4 was considered low-risk, 5-8 was considered intermediate-risk, needed further imaging or observation, and 9–12 was considered high-risk for appendicitis. The diagnosis was confirmed by histopathology in all resected specimens. Statistical analysis was performed with the help of the computer program SPSS (Statistical Package for Social Sciences), version 26. The comparison of continuous variables was done by independent-samples t-tests. Diagnostic accuracy was analyzed using receiver operating characteristic (ROC) curves. Statistical significance was attributed at the 5% level.

### Result:

The patient's age ranges from 12 to 50 years; the mean (SD) age was 25.7 (10.1); the majority (40%) of patients are between the ages of 12 and 20. Males predominated, with a male-to-female ratio of 1.5:1. The majority of patients (42.5%) were students, with 20.4% being housewives, 20.0% being service members, 11.7% being businessmen, and 5.4% being day laborers. 240 patients (100%) complained of RIF pain, while 140 (58.3%) complained of vomiting, and 98 (40.8%) observed medium and 94 (39.2%) strong rebound tenderness. (Table-I). 170 (70.8%) patients had a total leucocyte count (TLC) between 10-14.9  $\text{mm}^3$ , 135(56.3%) patients had neutrophils between 70-84% and 83 (34.6%) patients had  $\geq 85\%$ . and A CRP level in the range of 10-49 mg/l was reported in 139 (57.9%) patients (table-II). According to AIR scores, 44 patients (18.3%) were classified as low-risk (0-4), 112 patients (46.7%) as intermediate (5-8), and 84 patients (35.0%) as high-risk (9-12), respectively (Table-III). One seventy four (96.1%) of 181 patients with an intra-operative diagnosis of appendicitis were histopathology positive (Table-VII). 196 patients were in the high risk and intermediate risk groups in the inflammatory response score, among them, 185(94.4%) patients were positive on histopathology (Table-VIII).

**Table 1.** Distribution of the study population by clinical features (n=240).

Symptoms and sign	Frequency	Percentage
Vomiting	140	58.3
Right iliac fossa Pain	240	100.0
Temperature ( $\geq 38.5^{\circ}\text{C}$ )	71	29.6
Rebound tenderness		
Light	26	10.8
Medium	98	40.8
Strong	94	39.2

Among 240 patients, right iliac fossa pain was the most common symptom, presenting in all 240 (100%) individuals. Vomiting was present in 140 patients (58.3%), and temperature was present in 71 (29.5%). Only 26 patients (10.8%) had light rebound tenderness, 98 (40.8%) had medium, and 94 (39.2%) had severe rebound tenderness.

**Table II.** Distribution of the study population by laboratory findings (n=240)

	Ranges	Frequency	Percentage
Total Leucocyte count ( $\text{mm}^3$ )	10-14.9	170	70.8
	$\geq 15$	70	29.2
Neutrophilia	<70%	22	9.2
	70-84%	135	56.3
	$\geq 85\%$	83	34.6
C-reactive protein	<10 mg/l	44	18.3
	10-49 mg/l	139	57.9
	$\geq 50$ mg/l	57	23.8

Among 240 patients, 170 (70.8%) had a total leucocyte count (TLC) between 10-14.9  $\text{mm}^3$ , and a TLC of  $>15$   $\text{mm}^3$  in 70 (29.2%) of patients. 135 patients (56.3%) had neutrophilia ranging from 70-84%, with 83(34.6%) having more than 85%. CRP levels of  $<10$  mg/l were reported in 44 (18.3%) patients, 10-49 mg/l in 139 (57.9%) patients, and  $>50$  mg/l in 57 (23.8%) patients.

**Table-III :** Distribution of the study population according to inflammatory response score (n=240)

AIR scoring	Frequency	Percentage
Low Risk (0-4 score)	44	18.3
Intermediate (5-8 score)	112	46.7
High risk (9-12 score)	84	35.0

Maximum (46.7%) number of patients in the intermediate category (5-8) and 84 (35.0%) patients in the high-risk category (9–12).

**Table-IV.** AIR scoring according to symptoms, signs & Laboratory findings (n=240)

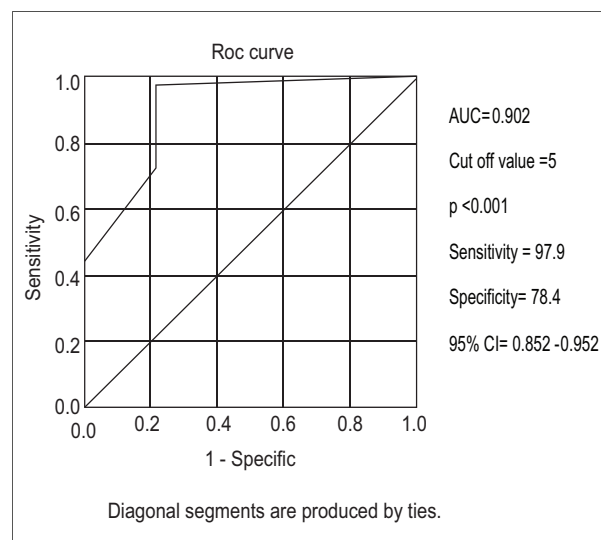
Variables		AIR scoring		
		Low risk (0-4 score)	Intermediate (5-8 score)	High risk (9-12 score)
Vomiting	Yes	0(0.0%)	48(42.9%)	52(61.9%)
	No	44(100.0%)	64(57.1%)	32(38.1%)
Pain in RIF	Yes	44(100.0%)	112(100.0%)	84(100.0%)
Temperature	≥38.5 <sup>o</sup> C	0(0.0%)	25(22.3%)	31(36.9%)
	< 38.5 <sup>o</sup> C	44(100.0%)	87(77.7%)	53(63.1%)
Rebound tenderness	Light	22(50.0%)	3(2.7%)	0(0.0%)
	Medium	0(0.0%)	74(66.1%)	24(28.6%)
	Strong	0(0.0%)	35(31.3%)	60(71.4%)
TLC	10-14.9	0(0.0%)	94(83.9%)	32(38.1%)
	≥15	0(0.0%)	18(16.1%)	52(61.9%)
	<10	44(100.0%)	0(0.0%)	0(0.0%)
Neutrophilia	70-84%	22(50.0%)	74(66.1%)	39(46.4%)
	≥85%	0(0.0%)	38(33.9%)	45(53.6%)
	<70%	22(50.0%)	0(0.0%)	0(0.0%)
C-reactive protein	10-49 gm/L	0(0.0%)	101(90.2%)	38(45.2%)
	≥50 gm/L	0(0.0%)	11(9.8%)	46(54.8%)
	<10 gm/L	44(100.0%)	0(0.0%)	0(0.0%)

According to the AIR score, 44 of the low-risk patients had RIF pain, 22 had light rebound tenderness, TLC in 10 mm<sup>3</sup> in 44 (100%) patients, and neutrophils were in the range of 70-84% in 22 (50%) patients. Among the 112 intermediate-risk patients, 48(42.9%) had vomiting, 112 (100%) had pain, 25(22.3%) had fever, and 74(66.1%) had medium rebound tenderness, TLC between 10-14.9 mm<sup>3</sup> in 94(83.9%) patients, and CRP between 10-49 in 101(90.2%) patients. Among the 84 high-risk patients, 52(61.9%) had vomiting, 84 (100%) had RIF pain, 31(36.9%) had fever, and 60(71.4%) had strong rebound tenderness. In 52 (61.9%) patients, TLC was >15 mm<sup>3</sup>, and in 45 patients, neutrophilia was >85%. CRP between 10 and 49 g/L was reported in 38 (45.2%) patients, while CRP 50 g/L was reported in 46 (54.8%) patients. A significant difference of <0.001 between the clinical and laboratory findings was reported for each category of AIR scoring (p<0.05).

**Table-V:** Appendicitis diagnosed on intra-operative and histopathological basis (n=240).

Intra-operative Appendicitis	Frequency	Histopathology	
		Positive	Negative
Yes	181	174 (96.1%)	7 (3.9%)
No	59	15 (25.4%)	44 (74.6%)
Total	240	189(78.8%)	51(21.2%)

174 (93.0%) of 181 patients with an intra-operative diagnosis of appendicitis were histopathology positive. Similarly, histopathologically, 15 (25.4%) of the 59 intraoperative negative cases were found to have acute appendicitis.

**Fig.-1:** ROC curve analysis performed to predict best cut off value of AIR score for acute appendicitis.

**Table-VI.** Comparison between inflammatory response score with histopathology findings (n=240).

Inflammatory response score	Frequency	Histopathology		p value
		Positive	Negative	
High + Intermediate risk group	196	185(94.4%)	11(3.6%)	<0.001 <sup>s</sup>
Low risk group	44	4(9.1%)	40(90.9%)	

Parenthesis indicates corresponding percentage, s= significant, p value reached from chi square test

In the high and intermediate risk groups of 196 patients, AIR could diagnose 185 (94.4%) cases of acute appendicitis (at a score >8) with 11 (3.6%) false positives. In the low risk group, only 4 (9.1%) patients were histopathologically positive.

**Table-VII.** Performance of diagnostic test (n=240)

	Inflammatory response score vs histopathology	
	Values	95% CI
Sensitivity	97.9%	94.7% to 99.4%
Specificity	78.4%	64.8% to 88.7%
Positive Predictive Value	94.4%	90.9% to 96.6%
Negative Predictive Value	90.9%	78.9% to 96.4%
Accuracy	93.8%	89.9% to 96.5%

The sensitivity of the inflammatory response score vs histopathology findings was 97.9%, specificity was 78.4%, accuracy was 93.8%, and the positive and negative predictive values were 94.4% and 90.9%, respectively.

### Discussion:

A thorough history and physical examination should be the first step in the diagnostic process for assessing patients complaining of abdominal pain and identifying patients with suspected acute appendicitis.<sup>10</sup> The Infectious Diseases Society of America (IDSA) and Surgical Infection Society (SIS) advise using both clinical and laboratory findings to identify patients who are most likely to have acute appendicitis. These findings include abdominal pain, localized and rebound tenderness, and evident inflammatory changes on laboratory findings.<sup>11</sup> The Alvarado score is the most widely used scoring system for detecting acute appendicitis. According to reports, among adults, the Appendicitis Inflammatory Response (AIR) score performs better than the Alvarado score.<sup>12</sup>

In this study, it was found that, for a cutoff value of 5, the inflammatory response score had a sensitivity of 97.9%, a specificity of 78.4%, an accuracy of 93.8%, and positive and negative predictive values of 94.4% and 90.9%, respectively.

Therefore, Jose et al. observed that the AIR score had a specificity of 36% and a sensitivity of 98% for values below 5. Score 6 revealed a sensitivity decline to 77% and a 97% specificity.<sup>13</sup>

For all acute appendicitis severity levels, Scott et al. found a high sensitivity (90%) for AIR scores of 5 or more (moderate and high risk), which climbed to 98% for advanced appendicitis. A score of 9 or higher (high risk) was reported to have a 97% specificity, with 70% of those patients suffering perforation or gangrene.<sup>14</sup>

According to Kollar et al., the AIR score had an 88% positive predictive value and a 97% specificity.<sup>12</sup>

According to De Castro SM et al., a score of more than 4 points corresponded to a 93% sensitivity and 85% specificity for the AIR score. This corresponds to an AIR score with a 95% negative predictive value.<sup>15</sup>

An ideal scoring system would help reduce the need for patients to undergo unnecessary radiation exposure during imaging procedures and/or lengthen the valuable time before undergoing surgery to prevent appendix perforation. It would also help increase diagnostic accuracy for taking prompt action in cases of suspected acute appendicitis. It has been determined that AIR scores are preferable in terms of being simple to utilize in clinical settings, particularly in places with little resources.

### Conclusion:

Using AIR score to stratify suspected appendicitis cases and reduce hospital admission can reduce negative appendectomy and patients' suffering.

### Recommendation:

It is a standard scoring system, as such scoring system initially try to our OPD and Emergency room by our OPD and emergency medical officer to check their performance to stratify the appendicitis patients for reducing over admission as well as negative appendicectomies.

### Limitations of the study:

The study population was selected from one selected hospital in Dhaka city and was conducted at a very short period of time. so that the results of the study may not be reflect the exact picture of the country.

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