

# Predicting Role of the Appendicitis Inflammatory Response Score in Diagnosis and Risk Stratification of Acute Appendicitis among Adult Patients

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## ABSTRACT

**Background:** Appendicitis is a global disease. Understanding the global evolution of appendicitis in highly industrialized countries and in newly industrialized countries is necessary for planning healthcare resource utilization. Scoring systems have been designed to aid in the clinical assessment of patients with acute appendicitis. The recently introduced Appendicitis Inflammatory Response (AIR) score was designed to overcome these drawbacks. This simple clinical score can correctly classify the majority of patients with suspected appendicitis. To evaluate the AIR score on patients with suspicion of acute appendicitis and its risk stratification and assess the sensitivity and specificity of the AIR score.

**Materials and methods:** This descriptive of observational study was carried out in the Department of Surgery, Chittagong Medical College Hospital, Chattogram from 21<sup>st</sup> March to 20<sup>th</sup> September 2017. Total 100 cases of appendicitis patients were selected after careful history taking, thorough general and local examination and appropriate investigations fulfilling inclusion and exclusion criteria.

**Results:** The present study of 100 selected cases reveals that maximum number of patients (54.0%) were between 15-25 years age group, mean age of appendicitis was 24.5±8.9 years. The sensitivity and Specificity of the Appendicitis Inflammatory Response Score (AIR score) in diagnosis and risk stratification of acute appendicitis was 85.2% and 96.9% respectively. Similarly, the positive predictive value and accuracy rate for the same is 93.5 % and 93.0% respectively.

**Conclusion:** Through associating easily applicable clinical criteria and two simple laboratory tests AIR score help in diagnosis and risk stratification of suspected appendicitis and could guide decision-making to reduce admissions, optimize utility of diagnostic imaging and prevent negative explorations.

**Key words:** Acute appendicitis; AIR score; Inflammatory response.

## Introduction

Data from newly industrialized countries is sparse, but suggests that appendicitis is rising rapidly.<sup>1</sup> The lifetime risk of developing an Acute Appendicitis (AA) is approximately 7% with an estimated incidence of 90-10 cases /100,000 inhabitants / year. It can occur in any decade of life.<sup>2,3</sup> Appendectomy is the only treatment of acute appendicitis aiming preventing its complication and AIR score contribute to diagnosis and its risk stratification.<sup>4,5</sup>

Fecalith, lymphoid hyperplasia, or impacted stool, cecal tumor (Rare) are the most common cause of acute appendicitis.<sup>6</sup> Although several infectious agents, genetic and environmental factors are also responsible.<sup>7-10</sup> Highest rates of appendicitis cases were found in the winter and summer season, whereas the lowest rates were found in the spring and fall.<sup>11</sup> The appendix could serve as a microbial reservoir and Fusobacteria (Mainly Fusobacterium nucleatum and necrophorum) were a specific component of these epithelial and submucosal infiltrate in 62% of patients with proven appendicitis.<sup>12,13</sup> Role of immune balance comes from epidemiological studies showing a reduced risk of developing ulcerative colitis after appendectomy, with a slightly increased risk of Crohn's disease.<sup>14,15</sup>

Appendicitis patient were classified into two groups: (1) phlegmonous appendicitis and (2) advanced appendicitis, defined as a macroscopic gangrenous appendix with or without perforation and the optimal management strategy is still challenging, even after the introduction of US, CT and diagnostic laparoscopy.<sup>16</sup> Computed Tomography (CT) seems to have had an even greater effect on the declining the negative laparotomy rate.<sup>17-18</sup>

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Scoring systems have been designed to aid clinical assessment and The Alvarado score is the most well-known but has some drawbacks.<sup>19-21</sup>

The Appendicitis Inflammatory Response (AIR) score was designed to overcome these drawbacks and this simple clinical score can correctly classify the majority of patients with suspected appendicitis, leaving the need for diagnostic imaging or diagnostic laparoscopy.<sup>22,23</sup> Appendicitis inflammatory response score can be used to prevent negative appendectomy. It was developed in 2008 in Sweden based on prospectively collected data of variables with independent prognostic value using a mathematically more appropriate method for the construction.<sup>24</sup> Aim of the study is to evaluate the AIR score on patients with suspicion of acute appendicitis and its risk stratification and assess the sensitivity and specificity of the AIR score.

#### Materials and methods

This is a descriptive observational study. Patient with acute abdomen attended in the General Surgery Department of Chittagong Medical College Hospital. Total 100 cases of appendicitis patients were selected. Information was collected from the study population by questionnaire and case record form. Variables were found among all the patients. Prior permission was taken from the Ethical Review Committee (ERC) of Chittagong Medical College Hospital. The objectives of the study, risk and benefits to be derived from the study was explained to the patients in easily understandable local language and then informed consent was sought from them. All patients were evaluated by detail history, examination, investigation reports recorded in predetermined case record form, then AIR score of the individual patient was calculated and stratified in to 3 groups as per scoring system. Peroperative findings and after operation histopathology report were collected and compared to the AIR score. Informed written consent was obtained from all patients.

Data for socio- demographic and clinical variables were obtained from all subjects by the use of a pre- designed and comprehensible questionnaire. After collection of all information, these data were checked, verified for consistency and edited for finalized result. After editing and coding, the coded data were directly entered into the computer by using SPSS version 20. Quantitative data expressed as mean and standard deviation and qualitative data as frequency and percentage. Comparison was done by tabulation and graphical presentation in the form of tables, pie chart, graphs, bar diagrams, histogram and charts etc. The result was presented in tables. A “p” value <0.05 considered as significant.

## Results

**Table I** Physical Examination findings (n=100)

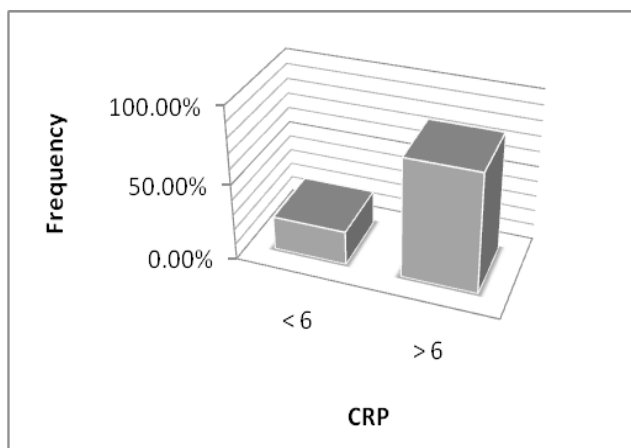
Physical sign	Number of patients	Percentage (%)
Tenderness in right iliac fossa	100	100.0
Rebound tenderness	83	83.0
Elevated temperature (>38.5° C)	62	62.0
Rovsings sign	76	76.0
Positive cough sign	86	86.0
Obturator sign	67	67.0
Muscle guard		
Low	22	22.0
Mild	47	47.0
Severe	14	14.0

Table I demonstrated that tenderness in right lower quadrant was the most common physical sign of appendicitis pathology, present in 100% cases; followed by positive cough sign and rebound tenderness, 86% and 83.0% of patients respectively, obturator test were positive in 67 patients and elevated temperature (>38.5°C) in 62 cases.

**Table II** Laboratory profile of the patients (n=100)

Laboratory features	Number of patients	Percentage (%)
Leukocyte count (mm <sup>3</sup> )		
● <10,000		
● 10,000–14,900		
● >15,000	18	18.0
	54	54.0
	28	28.0
Neutrophil count		
● <70%	12	12.0
● 70-84%	69	69.0
● >84%	19	19.0
ESR		
● Elevated	67	67.0
● Normal	33	33.0

Laboratory features of the patients reveals, abnormal leukocyte count, differential counts, and ESR are usually present at diagnosis, reflecting the degree of the disease. The presenting leukocyte counts range widely, from 0.1 to 1500 x 10<sup>9</sup>/L (Median 15 x 10<sup>9</sup>/L) and are increased (>10x10<sup>9</sup>/L) in slightly over one half of the patients. The degree of leukocyte count elevation at diagnosis is a very strong predictor for complication of disease and prognosis. Increased ESR are usually present at inflammatory condition, present in 67.0% cases (Table II).



**Figure 1** Distribution of patients according to Serum C-reactive protein findings (n=100)

Figure 1 shows that 78% of septic patients have had raised CRP (>6mg/L) and 22% of patients have had normal CRP (<6mg/L).

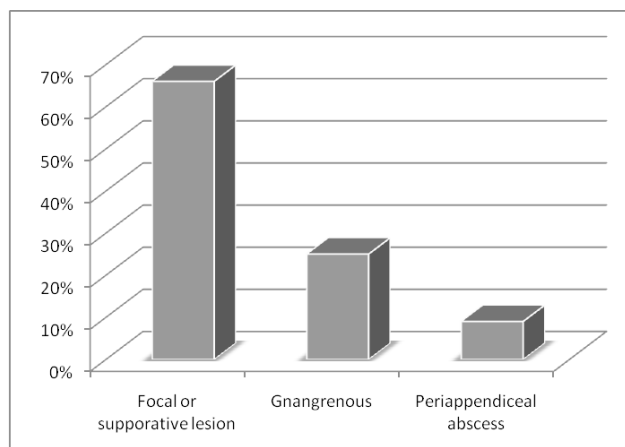
**Table III** Correlation of AIR Score with histopathological findings (n=100)

Score	AIR prediction	Histopathological finding		p-value
		Complicated (n=34)	Uncomplicated (n=66)	
0-4	Low probability	3	23	0.919 <sup>ns</sup>
5-8	Mild probability	2	41	
9-12	High probability	29	2	

	Summary of Data			
	Low	Mild	High	Total
X	26	43	31	100
Mean	13	21.5	15.5	16.6667
X <sup>2</sup>	538	1685	845	3068
Std. Dev.	14.1421	27.5772	19.0919	16.7412

One-Way ANOVA test was used to compare between groups. Result shows that, 23(88.4%) patients of low probability and 41(95.3%) patients of mild probability correlates with histopathological finding as uncomplicated. Among 31 cases of high probability appendicitis, 29(93.5%) cases correlate with histopathological finding as complicated. The f-ratio value is 0.08642. The p-value is .919415. The result is not significant at p< .05 (Table III).



**Figure 2** Post-operative diagnosis (According to per-operative and histopathology findings) of appendicitis (n=100)

Post operatively, diagnosis is based on per operative findings plus histopathological findings. Appendicitis divided into either complicated appendicitis or uncomplicated appendicitis. Simple, focal or suppurative appendicitis regarded as uncomplicated appendicitis and gangrenous, perforated and periappendiceal abscess formation regarded as complicated appendicitis. Findings revealed that, 66.0% of appendicitis diagnosed as suppurative or uncomplicated appendicitis and 34.0% regarded as complicated appendicitis (Figure 2).

**Table IV** Predictive value of the AIR score in diagnosis and risk stratification of acute appendicitis (n=100)

AIR prediction	Per-operative and histopathological finding		p value
	Gangrene/ peri appendiceal abscess (n=34)	Focal or suppurative (n=66)	
Gangrene/ peri appendiceal abscess (n=31)	29	2	0.000001
Focal or suppurative (n=69)	5	64	

Result in Table IV shows that amongst diagnosed case of appendicitis, 29 patients of Gangrene/ peri appendiceal abscess consistent with AIR prediction. Among 66 cases of focal or suppurative appendicitis, 64 cases consistent with AIR prediction. The chi-square statistic is 23.6051. The p-value is 0.000001. This result is significant at p< .05. So validity of AIR finding is significant in diagnosis and risk stratification of acute appendicitis.

### Discussion

Acute appendicitis is the most common cause of acute abdomen. It continues to be an important cause of morbidity in the population when its diagnosis is late or only known in developed stages of diffuse peritonitis. In a study there was predominance of males (65.3%) over females (34.7). The age varied from 16 to 85, with an average of 34.3.<sup>4</sup>

Present study shows that abdominal pain was the commonest presentation in acute appendicitis 50(100%), followed by nausea, vomiting, 42(84%), fever 39(78%), anorexia 38(76%) were the most common presentation. on physical examination. Tenderness in right lower quadrant was the most common physical sign of appendicitis pathology, present in 100% cases, followed by positive cough sign and rebound tenderness, 86% and 83.0% of patients respectively, obturator test were positive in 67 patients and elevated temperature (>38.5 C) in 62 cases. Abnormal leukocyte count, differential counts, and ESR are usually present at diagnosis, reflecting the degree of the disease. Study shows that 78% of septic patients have had raised CRP (>6mg/L) and 22% of patients have had normal CRP (<6mg/L).

The inflammation of the vermiform appendix happens mainly due to the obstruction of its lumen. From the pathological point of view, the acute appendicitis is classified as: catarrhal, phlegmonous, gangrenous and perforated. These categories represent the evolutionary stages of the disease. Pain in the abdomen is the main and most frequent symptom of acute appendicitis, with classic migration from periumbilical or epigastric to location in the right iliac fossa in 75% of patients. It may occasionally be reported in other places depending on the position occupied by the cecal appendix.<sup>4</sup>

These symptoms generally aggravate as the disease progresses. The diagnosis is eminently clinical, being associated with laboratory and image exams in case of diagnostic uncertainty. The development of AIR score contributes to diagnosis because through associating easily applicable clinical criteria and two simple laboratory tests, it is attributed the score which classifies the patients regarding the probability of diagnosis.<sup>4</sup>

The severity of acute appendicitis is assessed based on the Appendicitis Inflammatory Response Score (AIR). AIR score revealed that in maximum cases (43.0%) the score was 5 to 8 (Mild probability) in 31.0% of patients were the score was 9 to 12 (High probability) and 26 cases revealed low probability. Appendicitis Inflammatory Response Score (AIR) evaluation of clinical findings and investigation evidence suggested that most of the appendicitis were uncomplicated or simple, suppurative appendicitis (69.0%) and complicated appendicitis were (31.0%) of patients.

On per-operative evaluation, it is found that, among 100 patients 67.0% were inflamed appendicitis, 33.0% were acute appendicitis with perforation. Generalized peritonitis due to purulent peritoneal collection observed in 38.0% of cases. On gross examination it was found that 77.0% cases obstruction of lumen due to fecalith, 25.0% were gangrenous, and 18.0% of cases pelvic abscess.

Post-operatively diagnosis based on per operative findings plus histopathological findings. Appendicitis divided into either complicated appendicitis or uncomplicated appendicitis. Simple, focal or suppurative appendicitis regarded as uncomplicated appendicitis and gangrenous, perforated and peri appendiceal abscess formation regarded as complicated appendicitis. Findings revealed that, 66.0% of appendicitis diagnosed as suppurative or uncomplicated appendicitis and 34.0% regarded as complicated appendicitis.

In a prospective observational study total 464 patients were included, of whom 210 (45.2%) with non-appendicitis pain were correctly classified as low risk. However, 13 low-risk patients had appendicitis. Low-risk patients accounted for 48.1% per cent of admissions (223 of 464), 57% of negative explorations (48 of 84) and 50.7% of imaging requests (149 of 294). An AIR score of 5 or more (Intermediate and high risk) had high sensitivity for all severities of appendicitis (90%) and also for advanced appendicitis (98%).

In another study all patients who underwent appendectomy were stratified by the AIR criteria as mild (65,3%) and high probability (34,3%) for acute appendicitis, which made possible to infer that the patients assessed in the emergency suffering from abdominal pain and that had been stratified as low probability, in fact did not need surgical intervention.<sup>4</sup>

In this study correlation was done on Appendicitis Inflammatory Response Score (AIR score) with post operative histopathology report. The Sensitivity and Specificity of the Appendicitis Inflammatory Response Score (AIR score) in diagnosis and risk stratification of acute appendicitis was 85.2% and 96.9% respectively. Similarly the positive predicative value and accuracy rate for the same is 93.5 % and 93.0% respectively.<sup>25</sup>

Patients with score for high probability had statistically significant chance of showing more developed stages of acute appendicitis.<sup>4</sup> When criteria were analyzed in an isolated manner, as previously described by other authors, was noticed that CRP and segmented neutrophils show direct relation with the acute appendicitis stage. CRP was below 50 in patients in stage 1 and segmented neutrophils below 85% in 95% of the cases, and in stage 4, CRP was above 50 and segmented neutrophils above 85% in 60% of patients.<sup>4</sup>

The AIR score quantifies a patient's risk of appendicitis when presenting with acute abdominal pain. This prospective observational study has confirmed the diagnostic accuracy of the AIR score, as reported by other authors and evaluated the potential benefits of using it to guide decision-making with respect to hospital admission, diagnostic imaging and negative surgical explorations.<sup>4,26</sup>

### Limitation

- This is a small study, only patients of acute appendicitis admitted in Chittagong Medical College Hospital (CMCH) were taken for the study. So this will not reflect the overall picture of the country. A large scale study needs to be conducted to reach to a definitive conclusion.
- Majority of the patients were poor and illiterate. Many had no proper treatment, checkup. Patient comes in tertiary center after development of some hazards, complication. So some hazards, risk factors are subsistence before and after treatment.
- Sample were taken by purposive method in which question of personal bias might arise.

### Conclusion

Risk stratification of patients with suspected appendicitis by the AIR score could guide decision-making to reduce admissions, optimize utility of diagnostic imaging and prevent negative explorations. The present study suggests Appendicitis Inflammatory Response Score (AIR) appears to be a promising new clinical-laboratory scoring for diagnosing acute appendicitis. The serum CRP and assessment of percentage of neutrophils in WBC are important in the diagnosis and stratification of evolutionary stage of the disease. The development of AIR score contributes to diagnosis because through associating easily applicable clinical criteria and two simple laboratory tests it is attributed the score which classifies the patients regarding the probability of diagnosis. CBC and CRP, is a simple cheap and easily available test in every laboratory, can be added to the routine investigation list of clinically suspected case of acute appendicitis for the confirmation of diagnosis. Since the rise in neutrophil, CRP level was significantly higher in patients with appendiceal perforation, it has a definite predictive potential in these cases. The Sensitivity and Specificity of the Appendicitis Inflammatory Response Score (AIR score) in diagnosis and risk stratification of acute appendicitis was 85.2% and 96.9% respectively. Therefore, obtaining AIR values upon admission can be used to help determine the presence of complication and thus aid in prompt clinical management

### Recommendations

- Early detection, laboratory facility and management for acute appendicitis and complication should be available at primary health care level.
- Appendicitis Inflammatory Response (AIR) Score should be implemented in all suspected cases of acute appendicitis as a fast and first diagnostic tool.
- Prioritizing the routine hematological test adopted for Risk Stratification, follow up and management of appendicitis patients.

### Disclosure

All the authors declared no competing interest.

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