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Research Article

Role of the Appendicitis Inflammatory Response (Air) Score in the Early Diagnosis of Acute Appendicitis

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ABSTRACT

Background: Acute appendicitis is one of the most common surgical emergencies worldwide and remains a significant diagnostic challenge because of its variable clinical presentation. Delayed diagnosis may result in complications such as perforation and peritonitis, whereas overdiagnosis can lead to unnecessary appendectomies. The Appendicitis Inflammatory Response (AIR) score is a clinical scoring system that combines symptoms, signs, and inflammatory markers to improve diagnostic accuracy and assist in clinical decision-making.

Aim: To evaluate the role of the Appendicitis Inflammatory Response (AIR) score in the early diagnosis of acute appendicitis and assess its impact on imaging utilization and emergency department management.

Materials and Methods: This prospective observational study was conducted in the Institute of General Surgery, Rajiv Gandhi Government General Hospital, Chennai, over a period of one year. A total of 120 patients aged 16 years and above presenting with suspected acute appendicitis were included. AIR scores were calculated using clinical parameters and laboratory investigations, including white blood cell count, neutrophil percentage, and C-reactive protein levels. Patients were categorized into low-risk (0–4), intermediate-risk (5–8), and high-risk (≥9) groups. Final diagnosis was established by histopathological examination in operated patients and clinical follow-up in non-operated patients. Diagnostic performance parameters including sensitivity, specificity, positive predictive value, and negative predictive value were analyzed.

Results: The study included 64 females (53.3%) and 56 males (46.7%), with a mean age of 42.3 ± 18.7 years. The mean AIR score was 6.2 ± 2.1. Based on risk stratification, 27 patients (22.5%) were classified as low risk, 80 (66.7%) as intermediate risk, and 13 (10.8%) as high risk. Acute appendicitis was confirmed in 95 patients (79.2%), including 55 cases (45.8%) of uncomplicated appendicitis and 40 cases (33.3%) of complicated appendicitis. At a cutoff score of ≥5, the AIR score demonstrated a sensitivity of 96% and specificity of 76% for diagnosing acute appendicitis. Computed tomography was required in only 35 patients (29.2%), and the negative appendectomy rate was 4.2%. The mean emergency department length of stay was 5.8 ± 2.4 hours, with a significant association between AIR score category and duration of stay ($p < 0.001$).

Conclusion: The Appendicitis Inflammatory Response score is an effective and reliable tool for the early diagnosis of acute appendicitis. It provides excellent diagnostic accuracy, facilitates risk stratification, reduces unnecessary CT imaging, improves emergency department efficiency, and minimizes negative appendectomy rates. Routine incorporation of the AIR score into clinical practice may enhance patient outcomes and optimize healthcare resource utilization.

Keywords: Acute Appendicitis, Appendicitis Inflammatory Response Score, AIR Score, Diagnostic Accuracy, Risk Stratification, Emergency Department, Computed Tomography.

INTRODUCTION

Acute appendicitis is the most common cause of acute surgical abdomen and one of the most frequently encountered surgical emergencies worldwide. It affects approximately 7–8% of the population during their lifetime, with the highest incidence occurring in adolescents and young adults. Despite advances in diagnostic techniques, acute appendicitis continues to pose a diagnostic challenge because of its variable clinical presentation and overlap with numerous gastrointestinal, urological, and gynecological conditions. Delayed diagnosis may lead to serious complications such as perforation, abscess formation, generalized peritonitis, and sepsis, whereas overdiagnosis can result in unnecessary surgical intervention and increased healthcare costs (1,2).

The diagnosis of acute appendicitis traditionally relies on a combination of clinical history, physical examination, laboratory investigations, and imaging modalities. Although

ultrasonography and computed tomography (CT) have improved diagnostic accuracy, their routine use may be limited by availability, cost, operator dependency, and concerns regarding radiation exposure, particularly in younger patients (2). Therefore, the development of reliable clinical scoring systems has become increasingly important for facilitating early diagnosis and guiding management decisions.

Several clinical scoring systems have been proposed to improve the diagnostic accuracy of acute appendicitis. Among these, the Alvarado score has been widely utilized because of its simplicity and ease of application. However, studies have demonstrated variable performance of the Alvarado score across different patient populations, prompting the development of more accurate and objective diagnostic tools (3). The Appendicitis Inflammatory Response (AIR) score was introduced by Andersson and Andersson as a clinical prediction model that combines symptoms, signs, and inflammatory laboratory parameters to enhance diagnostic precision (4). The AIR score incorporates variables including vomiting, right lower quadrant pain, rebound tenderness or muscular defense, body temperature, leukocyte count, proportion of neutrophils, and serum C-reactive protein (CRP) concentration. Unlike earlier scoring systems, the AIR score places greater emphasis on the inflammatory response associated with appendiceal pathology, thereby improving its ability to discriminate between patients with and without acute appendicitis. Based on the total score, patients are classified into low-, intermediate-, and high-risk categories, allowing clinicians to determine the need for observation, additional imaging, or immediate surgical intervention (4).

Several studies have demonstrated that the AIR score possesses superior diagnostic accuracy compared with conventional clinical scoring systems. The incorporation of CRP as an inflammatory marker contributes significantly to its predictive value and may assist in distinguishing uncomplicated from complicated appendicitis. Furthermore, the AIR score has been shown to reduce negative appendectomy rates while maintaining a high sensitivity for detecting clinically significant disease (4,5). Owing to its simplicity, reproducibility, and cost-effectiveness, the AIR score may be particularly useful in resource-limited settings where access to advanced imaging techniques is restricted.

Given the ongoing challenges associated with the diagnosis of acute appendicitis and the need for prompt and appropriate management, assessment of the diagnostic utility of the AIR score remains clinically relevant. Therefore, the present study was undertaken to evaluate the importance of the Appendicitis Inflammatory Response (AIR) score in the early diagnosis of acute appendicitis and to determine its effectiveness as a diagnostic aid in patients presenting with suspected appendicitis.

Aim and Objectives

Aim: To evaluate the role of the Appendicitis Inflammatory Response (AIR) score in the early diagnosis of acute appendicitis and to assess its diagnostic accuracy in patients presenting with suspected acute appendicitis.

Objectives

1. To determine the AIR score in patients presenting with clinical suspicion of acute appendicitis.
2. To evaluate the association between AIR score categories (low, intermediate, and high risk) and the final diagnosis of acute appendicitis.
3. To assess the sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and overall diagnostic accuracy of the AIR score.
4. To correlate AIR score findings with operative and/or histopathological findings wherever applicable.
5. To assess the utility of the AIR score in facilitating early diagnosis and clinical decision-making in patients with suspected acute appendicitis.
6. To evaluate the effectiveness of the AIR score in reducing unnecessary imaging investigations and negative appendectomy rates.

MATERIALS AND METHODS

Study Design

This was a prospective observational study conducted to evaluate the diagnostic utility of the Appendicitis Inflammatory Response (AIR) score in the early diagnosis of acute appendicitis.

Study Setting

The study was carried out in the Department of General Surgery at [Institution Name], a tertiary care teaching hospital, over a period of [duration of study] from [month, year] to [month, year].

Study Population

All patients presenting to the emergency department or surgical outpatient department with clinical suspicion of acute appendicitis during the study period were considered for inclusion.

Sample Size

A total of [sample size] consecutive patients fulfilling the eligibility criteria were enrolled in the study after obtaining informed written consent.

Inclusion Criteria

- Patients aged ≥18 years presenting with right iliac fossa pain suggestive of acute appendicitis.
- Patients willing to participate in the study and provide informed consent.
- Patients undergoing clinical evaluation, laboratory investigations, and further management for suspected acute appendicitis.

Exclusion Criteria

- Patients with a previous history of appendectomy.
- Pregnant women.
- Patients with generalized peritonitis requiring immediate surgical intervention.
- Patients with chronic inflammatory diseases or malignancies that could alter inflammatory markers.
- Patients receiving immunosuppressive therapy.
- Patients with incomplete clinical or laboratory data.

Data Collection

Detailed demographic data, clinical history, physical examination findings, laboratory investigations, imaging findings, operative findings, and histopathological reports were recorded using a structured data collection form.

The following parameters required for calculation of the AIR score were documented at presentation:

- Vomiting
- Right lower quadrant pain
- Rebound tenderness or muscular defense
- Body temperature
- Total leukocyte count
- Percentage of neutrophils
- Serum C-reactive protein (CRP) level

AIR Score Assessment

The Appendicitis Inflammatory Response (AIR) score was calculated for each patient based on the criteria proposed by Andersson and Andersson (2008). The total score ranged from 0 to 12 points.

Patients were stratified into three risk categories:

- **Low-risk group**: AIR score 0–4
- **Intermediate-risk group:** AIR score 5–8
- **High-risk group**: AIR score 9–12

Clinical management decisions were made according to standard institutional protocols and were independent of study participation.

Reference Standard for Diagnosis

The final diagnosis of acute appendicitis was established based on operative findings and histopathological examination in patients undergoing appendectomy. In patients managed conservatively, the diagnosis was confirmed or excluded through clinical follow-up, imaging findings, and treatment outcomes.

Outcome Measures

The primary outcome was the diagnostic performance of the AIR score in identifying acute appendicitis.

The following parameters were assessed:

- Sensitivity
- Specificity
- Positive predictive value (PPV)
- Negative predictive value (NPV)
- Diagnostic accuracy

Secondary outcomes included the correlation of AIR score categories with operative and histopathological findings and the ability of the AIR score to predict complicated appendicitis.

Statistical Analysis

Data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version [XX.0] (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD), while categorical variables were presented as frequencies and percentages. The Chi-square test or Fisher's exact test was used for comparison of categorical variables, and Student's t-test or Mann–Whitney U test was used for continuous variables where appropriate. Receiver operating characteristic (ROC) curve analysis was performed to evaluate the diagnostic performance of the AIR score. A p-value <0.05 was considered statistically significant.

Ethical Considerations

The study protocol was reviewed and approved by the Institutional Ethics Committee of [Institution Name] (Approval No. _____). Written informed consent was obtained from all participants before enrollment. The study was conducted in accordance with the ethical principles outlined in the Declaration of Helsinki.

RESULTS

A total of 120 patients presenting with suspected acute appendicitis were included in the study. The study population comprised 56 males (46.7%) and 64 females (53.3%), with a mean age of 42.3 ± 18.7 years. The highest proportion of patients belonged to the 30–39 years age group (19.2%), followed by the 60–69 years age group (17.5%).

Table 1. Demographic Characteristics of the Study Population (N = 120)

Variable	Number (%)
Male	56 (46.7)
Female	64 (53.3)
Mean Age (years)	42.3 ± 18.7

The female population slightly outnumbered males, and the mean age indicated that acute appendicitis affected a broad spectrum of adult patients.

Among the presenting clinical features, vomiting was observed in 59 patients (49.2%), while right iliac fossa pain was present in 76 patients (63.3%). Abdominal tenderness was absent in 17 patients (14.2%), mild in 29 patients (24.2%), moderate in 41 patients (34.2%), and severe in 33 patients (27.5%). Fever ≥38.5°C was documented in only 10 patients (8.3%).

Table 2. Clinical Characteristics of Study Participants

Variable	Number (%)
Vomiting Present	59 (49.2)
Right Iliac Fossa Pain Present	76 (63.3)
No Tenderness	17 (14.2)
Mild Tenderness	29 (24.2)
Moderate Tenderness	41 (34.2)
Severe Tenderness	33 (27.5)
Fever ≥38.5°C	10 (8.3)

Moderate and severe tenderness together accounted for 61.7% of cases, indicating that localized abdominal tenderness remained an important clinical finding. However, classical symptoms such as fever and right iliac fossa pain were absent in a considerable proportion of patients.

Laboratory investigations demonstrated leukocyte counts between 10–15 $\times 10^9$/L in 52 patients (43.3%), while 31 patients (25.8%) had leukocyte counts exceeding 15 $\times 10^9$/L. Neutrophil percentages of 70–84% and ≥85% were observed in 35 (29.2%) and 30 patients (25.0%), respectively. CRP levels were elevated in most patients, with 55 patients (45.8%) demonstrating CRP concentrations ≥50 mg/L.

Table 3. Laboratory Parameters

Parameter	Number (%)
WBC <10 $\times 10^9$/L	37 (30.8)
WBC 10–15 $\times 10^9$/L	52 (43.3)
WBC >15 $\times 10^9$/L	31 (25.8)
Neutrophils 70–84%	35 (29.2)
Neutrophils ≥85%	30 (25.0)
CRP <10 mg/L	25 (20.8)
CRP 10–49 mg/L	40 (33.3)
CRP ≥50 mg/L	55 (45.8)

Elevated inflammatory markers were common among study participants, supporting the diagnostic utility of combining clinical and laboratory parameters within the AIR scoring system. The mean AIR score was 6.2 ± 2.1, ranging from 1 to 11. Based on AIR score categorization, 27 patients (22.5%) were classified as low risk, 80 patients (66.7%) as intermediate risk, and 13 patients (10.8%) as high risk.

Table 4. Air Score Risk Stratification

AIR Risk Category	Number (%)
Low Risk (0–4)	27 (22.5)
Intermediate Risk (5–8)	80 (66.7)
High Risk (≥9)	13 (10.8)
Mean AIR Score	6.2 ± 2.1

Most patients belonged to the intermediate-risk category, indicating that a substantial proportion required further evaluation and risk-based management. All patients underwent ultrasonography as the primary imaging modality. Computed tomography was required in only 35 patients (29.2%), while 85 patients (70.8%) were managed without CT imaging.

Table 5. Imaging Utilization

Imaging Modality	Number (%)
Ultrasonography	120 (100)
CT Scan	35 (29.2)
No CT Scan	85 (70.8)

The low utilization of CT imaging demonstrates the potential role of AIR score-guided assessment in reducing radiation exposure and unnecessary imaging investigations.

The mean emergency department length of stay was 5.8 ± 2.4 hours. Low-risk patients had a mean stay of 3.8 hours, whereas high-risk patients had a mean stay of 8.2 hours. A statistically significant association was observed between AIR score category and length of stay ($p < 0.001$).

Table 6. Emergency Department Length of Stay

Parameter	Value
Mean Length of Stay	5.8 ± 2.4 hours
Low-Risk Patients	3.8 hours
High-Risk Patients	8.2 hours
p-value	<0.001

Higher AIR scores were associated with longer emergency department stays, reflecting increased diagnostic complexity and resource utilization.

Final diagnosis confirmed acute appendicitis in 95 patients (79.2%), including 55 cases (45.8%) of uncomplicated appendicitis and 40 cases (33.3%) of complicated appendicitis. Alternative diagnoses were identified in 25 patients (20.8%). The negative appendectomy rate was 4.2%.

Table 7. Final Diagnostic Outcomes

Outcome	Number (%)
Uncomplicated Appendicitis	55 (45.8)
Complicated Appendicitis	40 (33.3)
Total Appendicitis	95 (79.2)
Other Diagnoses	25 (20.8)
Negative Appendectomy Rate	4.2%

Most patients were ultimately diagnosed with acute appendicitis, and the low negative appendectomy rate suggests improved diagnostic precision.

The AIR score demonstrated excellent diagnostic performance. At a cutoff value of ≥5, the score achieved a sensitivity of 96% and specificity of 76% for diagnosing acute appendicitis.

Table 8. Diagnostic Performance of AIR Score

Parameter	Value (%)
Sensitivity	96
Specificity	76
Negative Appendectomy Rate	4.2

Summary of Major Findings

The AIR score effectively stratified patients with suspected acute appendicitis into clinically meaningful risk categories. A sensitivity of 96% and specificity of 76% demonstrated high diagnostic accuracy. The score was associated with a substantial reduction in CT scan utilization, while maintaining a low negative appendectomy rate of 4.2%. Furthermore, AIR score categories significantly correlated with emergency department length of stay, supporting its utility as both a diagnostic and patient-management tool in the evaluation of acute appendicitis.

DISCUSSION

Acute appendicitis remains one of the most common surgical emergencies worldwide, and timely diagnosis is essential to prevent complications while minimizing unnecessary surgical interventions. The present study evaluated the utility of the Appendicitis Inflammatory Response (AIR) score in the early diagnosis of acute appendicitis and demonstrated that the score provides effective risk stratification with high diagnostic accuracy. The AIR score also contributed to reducing imaging utilization and improving emergency department efficiency.

In the present study, the mean age of patients was 42.3 ± 18.7 years, with a slight female predominance (53.3%). Although appendicitis is traditionally reported to occur more frequently in younger males, recent studies from tertiary care centers have demonstrated a more balanced gender distribution, particularly in adult populations. The wider age distribution observed in the present cohort suggests that acute appendicitis should remain an important differential diagnosis across all adult age groups.

Right iliac fossa pain was present in 63.3% of patients, while vomiting occurred in 49.2%. Notably, more than one-third of patients did not exhibit the classical symptom of right iliac fossa pain. Similar observations have been reported by Bhangu et al., who emphasized the variability in clinical presentation and the limitations of relying solely on classical symptoms for diagnosis. Such findings reinforce the importance of objective scoring systems that integrate clinical and laboratory parameters to improve diagnostic precision.

The laboratory findings in the present study demonstrated that elevated inflammatory markers were common among patients with suspected appendicitis. Leukocytosis was observed in 69.1% of patients, while CRP levels ≥50 mg/L were present in 45.8% of cases. These findings support the rationale behind the AIR score, which incorporates both leukocyte count and CRP levels as objective indicators of inflammation. Andersson and Andersson reported that inclusion of CRP significantly enhanced diagnostic performance compared with earlier scoring systems such as the Alvarado score. The substantial proportion of patients with elevated CRP in the present study further validates the importance of inflammatory markers in appendicitis diagnosis.

The mean AIR score in the present study was 6.2 ± 2.1, with the majority of patients (66.7%) classified in the intermediate-risk category. Similar distributions have been reported by De Castro et al. and Sammalkorpi et al., who found that most patients with suspected appendicitis fall within the intermediate-risk range. This group often presents the greatest diagnostic challenge and typically benefits from selective imaging and close clinical observation. The AIR score therefore serves as an effective tool for guiding management decisions in this important subgroup.

One of the most significant findings of the present study was the excellent diagnostic performance of the AIR score. At a cutoff value of ≥5, the AIR score demonstrated a sensitivity of 96% and specificity of 76%. These findings are consistent with the original validation study by Andersson and Andersson, who reported superior diagnostic accuracy of the AIR score compared with the Alvarado score. Similarly, Kularatna et al., in a meta-analysis comparing appendicitis scoring systems, demonstrated

that the AIR score achieved higher sensitivity and specificity than several alternative clinical prediction models. The high sensitivity observed in the present study indicates that the AIR score is particularly effective in identifying patients with true appendicitis, thereby reducing the likelihood of missed diagnoses.

Another important outcome of the study was the reduction in imaging utilization. Only 35 patients (29.2%) required CT scanning, whereas the majority were managed without advanced imaging. This finding is clinically relevant because routine CT utilization increases healthcare costs and exposes patients to unnecessary radiation. Previous studies by Andersson et al. and Sammalkorpi et al. have demonstrated that AIR score-guided management can substantially reduce imaging requirements while maintaining diagnostic safety. The present findings support these observations and highlight the potential value of AIR score implementation in resource-limited settings.

Emergency department efficiency also improved with AIR score-based risk stratification. The mean emergency department stay was 5.8 ± 2.4 hours, and a significant association was observed between AIR score category and duration of stay ($p < 0.001$). Low-risk patients had shorter stays, whereas high-risk patients required longer observation and intervention periods. Similar findings have been reported by Eko et al. and Coleman et al., who demonstrated that structured clinical pathways incorporating appendicitis scoring systems can improve patient flow and reduce emergency department overcrowding. The AIR score therefore provides benefits extending beyond diagnosis by facilitating more efficient resource allocation and patient management.

The final diagnostic outcomes further support the effectiveness of the AIR score. Acute appendicitis was confirmed in 79.2% of patients, and the negative appendectomy rate was only 4.2%. This rate is substantially lower than the historically reported rates of 15–20%. Similar reductions in negative appendectomy rates have been documented in studies evaluating AIR score-guided management protocols. A low negative appendectomy rate reflects improved diagnostic precision and minimizes unnecessary surgical procedures and their associated morbidity.

The strengths of the present study include its prospective design, standardized assessment of AIR score components, and evaluation within a high-volume tertiary care center. However, certain limitations should be acknowledged. The study was conducted at a single institution, which may limit generalizability. In addition, the relatively modest sample size may affect the precision of some subgroup analyses. Multicenter studies involving larger populations would be useful to further validate these findings and assess the applicability of the AIR score across different healthcare settings.

The findings of the present study demonstrate that the AIR score is a reliable and practical clinical tool for the early diagnosis of acute appendicitis. The score provides excellent sensitivity, acceptable specificity, effective risk stratification, reduced CT utilization, shorter emergency department stays, and a low negative appendectomy rate. These advantages support the routine incorporation of the AIR score into the diagnostic evaluation of patients presenting with suspected acute appendicitis, particularly in resource-constrained environments where optimization of healthcare resources is essential.

CONCLUSION

The present study demonstrates that the Appendicitis Inflammatory Response (AIR) score is a reliable, practical, and accurate tool for the early diagnosis of acute appendicitis. The AIR score showed excellent diagnostic performance with a sensitivity of 96% and specificity of 76%, enabling effective risk stratification of patients into low-, intermediate-, and high-risk categories. Its application facilitated a substantial reduction in CT scan utilization, improved emergency department efficiency, and was associated with a low negative appendectomy rate of 4.2%. By integrating clinical findings with objective inflammatory markers, the AIR score enhances diagnostic confidence and supports timely clinical decision-making. Therefore, routine use of the AIR score may improve patient outcomes, optimize resource utilization, and serve as a valuable adjunct in the evaluation of patients presenting with suspected acute appendicitis, particularly in resource-limited healthcare settings.

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