EVALUATING THE EFFECTIVENESS OF THE MODIFIED ALVARADO SCORING SYSTEM (MASS) AND APPENDICITIS INFLAMMATORY RESPONSE SCORE (AIRS) IN DIAGNOSING ACUTE APPENDICITIS: A COMPARATIVE ANALYSIS

Dr. Sathish N[1], Dr. M. Ganesan[2]

Post Graduate, Professor
Meenakshi Medical College Hospital And Research Institute,
Kanchipuram, Tamilnadu.

KEYWORDS

Acute appendicitis, Modified Alvarado Score, Appendicitis Inflammatory Response Score, Diagnosis, Sensitivity, Specificity.

ABSTRACT

Background

Acute appendicitis is one of the most common emergency surgical conditions. Despite advancements in medical technology, its diagnosis remains primarily clinical. Delayed or inaccurate diagnosis can lead to complications such as perforation or unnecessary surgery. The Modified Alvarado Scoring System (MASS) and Appendicitis Inflammatory Response Score (AIRS) are widely used scoring systems for preoperative evaluation. This study compares the effectiveness of these two scoring systems in diagnosing acute appendicitis.

Materials & Methods

This prospective study was conducted at Meenakshi Medical College Hospital and Research Institute. A total of 20 patients with suspected acute appendicitis were evaluated using both MASS and AIRS. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy were calculated for each scoring system. The histopathological examination (HPE) served as the gold standard for confirmation.

Results

MASS demonstrated a sensitivity of 60%, specificity of 85%, PPV of 90%, and NPV of 50%, with an overall diagnostic accuracy of 70%. AIRS, with a cutoff score >8, showed superior performance with a sensitivity of 80%, specificity of 95%, PPV of 95%, and NPV of 70%, achieving an overall diagnostic accuracy of 80%. The higher sensitivity and NPV of AIRS suggest that it is a more reliable tool for reducing unnecessary appendectomies.

Conclusion

AIRS proved to be more effective than MASS in diagnosing acute appendicitis due to its higher sensitivity, specificity, and diagnostic accuracy. Its high NPV suggests a reduced risk of negative appendectomy, thereby preventing unnecessary surgeries and avoiding additional financial burden. Further studies with larger sample sizes are needed to validate these findings.

Introduction:

Among the most frequent emergency surgical procedures performed in hospitals is the treatment of acute appendicitis. Although medical technology has advanced, diagnosing appendicitis remains primarily a clinical process. The condition affects 1.5 to 1.9 individuals per 1000 in the general population, with males being more susceptible at a ratio of 1.42. The identification of appendicitis is complicated by its shared symptoms with various other conditions, especially in the early stages of presentation. Diagnosis can be aided by clinical

prediction scores, which quantify the likelihood of a disorder based on key symptoms, signs, and available diagnostic test results. These scores serve as independent tools for diagnostic or prognostic assessment.

The choice to perform an appendectomy is primarily determined by patient history, physical examination, and diagnostic tests. Prompt surgical intervention aims to prevent the rupture of the appendix. Incorrect diagnosis and surgical delays can result in complications such as perforation, potentially leading to peritonitis. To minimize the occurrence of unnecessary appendectomies, researchers have developed various diagnostic scoring systems for acute appendicitis. Among these, the Modified Alvarado Scoring System (MASS) is the most frequently used and widely adopted approach. The diagnosis relies solely on historical data, physical examination findings, and laboratory results. This approach has some limitations. Notably, the evaluation method does not incorporate CRP, a widely recognized laboratory indicator used in assessing cases of acute appendicitis. Researchers have utilized inflammatory markers from laboratory tests, either independently or as components of scoring systems, to enhance the accuracy of diagnosing appendicitis. The Appendicitis Inflammatory Response Score (AIRS), a newly developed tool, aims to address the limitations associated with the Modified Alvarado Scoring System (MASS). The evaluation method resembles the modified Alvarado Scoring System but includes CRP as an additional parameter for assessing potential cases of appendicitis. Incorporating objective clinical indicators and laboratory markers into a clinical scoring system can improve the diagnostic precision of the condition. Therefore, this study was conducted to evaluate the effectiveness of AIRS in comparison to the MASS score for identifying acute appendicitis.

The aim of the study is to do comparative study between Modified Alvarado Scoring System (MASS) and Appendicitis Inflammatory Response Score (AIRS) in diagnosis of acute appendicitis in patients.

Materials and methods:

A Prospective Observational Study was undertaken at Meenakshi Medical College Hospital & Research Institute, focusing on patients admitted between December 2022 and October 2023. The investigation involved a sample size of 20 participants.

Inclusion criteria**:** 1) Patients willing to undergo appendectomy based on clinical assessment 2) Patients willing to participate in the study and give consent for the study. Exclusion criteria: 1) Pregnant women. 2) Patients with right iliac fossa mass. 3) Patients not willing to participate in the study.

Clinically suspected acute appendicitis cases admitted to the surgical wards of Mamata General Hospital were included in the study after obtaining informed consent.

A comprehensive assessment was performed, including detailed history, clinical examination, and relevant investigations such as hematological tests, urinalysis, biochemical markers, and abdominal ultrasound. Both the Appendicitis Inflammatory Response Score (AIRS) and the Modified Alvarado Scoring System (MASS) were applied to each patient. A score of >7 on the Modified Alvarado Scoring System and >8 on the Appendicitis Inflammatory Response Score indicated a high likelihood of acute appendicitis.

The decision to perform an appendectomy was based on the surgeon’s clinical judgment, considering clinical findings, laboratory results, and radiological investigations. Surgical findings were documented, and histopathology results of the excised appendix were recorded for correlation with the pre- and postoperative diagnoses based on the scoring systems.

The data was organized and tabulated for analysis. The following parameters were included in both scoring systems:

Table 1: Modified Alvarado Score

Symptoms	**Score**
Nausea and Vomiting	1
Anorexia	1
Migration of pain to right iliac fossa	1
Signs	
Right iliac fossa tenderness	2
Rebound tenderness or muscular defence	1
Fever	1
Investigation	
Raised WBC	2
Total Score	**9**

Interpretation of Modified Alvarado Score:

- 1–4: Unlikely appendicitis
- 5–6: Possible appendicitis
- 7–9: Likely acute appendicitis

Table 2: Appendicitis Inflammatory Response Score (AIRS)

Diagnosis	**Score**
Vomiting	1
Pain in right lateral quadrant	1
Temperature (PMN%)	
70–84%	1
≥85%	2
Rebound tenderness or muscular defence	1–3
WBC Count (10.0–14.9 x 10^9/L)	1
≥15.0 x 10^9/L	2
CRP concentration (10–40 g/L)	1
≥50 g/L	2
Total Score	**12**

Interpretation of AIRS:

- 0–4: Low probability of appendicitis
- 5–8: Intermediate probability
- 9–12: High probability of appendicitis

Statistical analysis was conducted with IBM SPSS Statistics version 25, using chi-square test, unpaired t-test for continuous data and Pearson's χ^2 test for categorical data. A p-value of <0.05 was considered statistically significant.

Results:

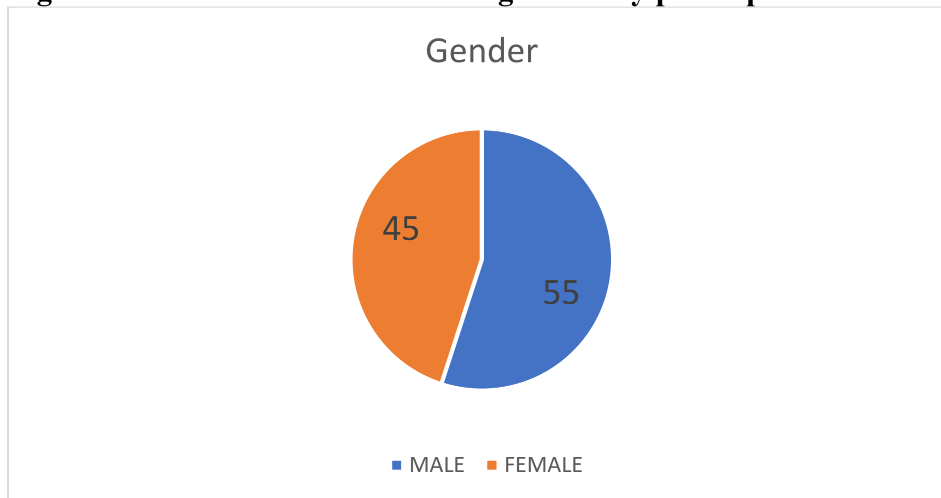
Table 3: Age distrubution

Age	Frequency	Percentage
5-10	1	5
11-20	7	35
21-30	6	30
31-40	3	15

41-50	2	10
51-60	1	5
Total	20	100

The age distribution of 20 patients shows that acute appendicitis is most common in the **11–20 years** (35%) and **21–30 years** (30%) age groups. The occurrence declines with age, with **15%** in **31–40 years**, **10%** in **41–50 years**, and **5%** each in **5–10 years** and **51–60 years**. This suggests that appendicitis is more frequent in adolescents and young adults, with fewer cases in older age groups.

Figure 1: Gender distribution among the study participants



The study included **55% males** and **45% females**, indicating that acute appendicitis is slightly more common in males than females.

Figure 2: USG finding among the study participants

Out of **100** percentage, **75%** were diagnosed with **acute appendicitis**, while **25%** had a **normal appendix**. This indicates that the majority of clinically suspected cases were confirmed, while a quarter had other conditions mimicking appendicitis.

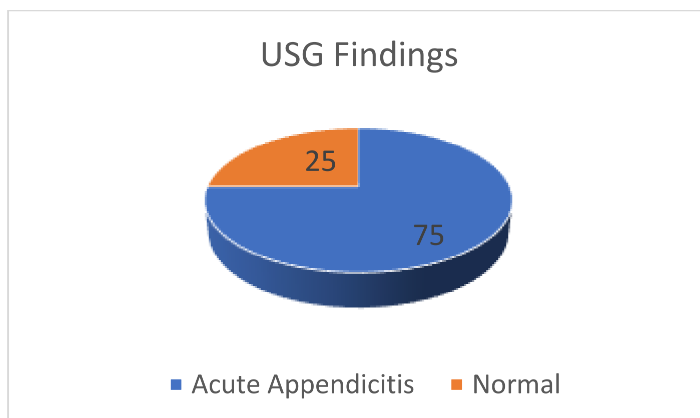


Table 4 : Clinical and Laboratory Findings in Acute Appendicitis Cases

	Frequency (20)	**Percentage (100%)**
Presenting symptoms		
Pain Abdomen	20	100
Vomiting	14	70
Fever	8	40

Anorexia	7	35
P/A Examination		
RIF tenderness	20	100
Guarding	1	5
Rebound Tenderness	12	60
WBC count		
< 10,000	6	30
10000-15000	9	45
> 15,000	5	25
CRP VALUE		
10-40 g/l	6	30
>50 g/l	14	70
Type of surgery		
Open Appendicectomy	15	75
Lap Appendicectomy	5	25
HPE Findings		
Acute Appendicitis	13	65
Acute Appendicitis with perforation	1	5
Acute on chronic Appendicitis	0	0
Normal	6	30

Clinical and Laboratory Findings in Acute Appendicitis Cases

- **Presenting Symptoms:** All 20 patients (100%) had abdominal pain, making it the most consistent symptom. Vomiting was reported in 70%, fever in 40%, and anorexia in 35% of cases.
- **Physical Examination:** Right iliac fossa (RIF) tenderness was present in 100% of patients. Rebound tenderness was observed in 60%, while guarding was noted in only 5%.
- **WBC Count:** 30% had WBC counts <10,000, 45% had 10,000–15,000, and 25% had >15,000, indicating varying degrees of infection and inflammation.
- **CRP Value:** 70% had elevated CRP levels >50 g/L, suggesting significant inflammation, while 30% had moderate elevation (10–40 g/L).
- **Type of Surgery:** 75% underwent open appendicectomy, while 25% had a laparoscopic appendicectomy.

- **Histopathology Findings (HPE):** 65% had acute appendicitis confirmed. 5% had acute appendicitis with perforation. 30% had a normal appendix, suggesting other causes for symptoms. No cases of acute on chronic appendicitis were observed.

Table 5: MODIFIED ALVARADO SCORING

MODIFIED ALVARADO SCORING	Frequency	Percentage
1-4 (Unlikely)	3	15
5-6 (Possible)	7	35
7-8 (present)	7	35
9-10 (Definitive)	3	15
Total	20	100

The Modified Alvarado Scoring system helps assess the likelihood of acute appendicitis based on clinical signs and symptoms. In this study of 20 patients, 15% had a low score (1–4), making appendicitis unlikely, while 35% had a moderate score (5–6), indicating a possible diagnosis. Another 35% scored 7–8, suggesting a strong likelihood, and 15% had a definitive diagnosis with a score of 9–10. The majority (70%) fell within the possible to probable range, emphasizing the need for further evaluation to confirm the diagnosis.

Table 6: AIR SCORING

AIR SCORING	Frequency	Percentage
0 - 4 (Probability of appendicitis is not probably)	4	20
5-8 (Intermediate group)	12	60
9-12 (High Probability)	4	20
Total	20	100

The Appendicitis Inflammatory Response (AIR) Score is used to assess the likelihood of acute appendicitis. In this study of 20 patients, 20% had a low score (0–4), indicating a low probability of appendicitis. The majority, 60%, fell into the intermediate group (5–8), requiring further evaluation. Another 20% had a high score (9–12), suggesting a strong likelihood of appendicitis. These results emphasize the need for additional diagnostic measures, especially for those in the intermediate category.

Table 7: Evaluation of effectiveness

HPE Findings	MODIFIED ALVARADO SCORING > 7	AIR SCORING >8
Sensitivity	60 %	80 %
Specificity	85 %	95 %
Positive predictive value	90 %	95 %
Negative predictive value	50 %	70%
Diagnostic accuracy	70 %	80 %

The diagnostic performance of the Modified Alvarado Score (MAS) and Appendicitis Inflammatory Response (AIR) Score was evaluated using histopathological examination (HPE) findings as the gold standard. The AIR Score demonstrated higher sensitivity (80% vs. 60%), specificity (95% vs. 85%), and diagnostic accuracy (80% vs. 70%) compared to MAS. Additionally, the AIR Score had a better positive predictive value (95% vs. 90%) and negative

predictive value (70% vs. 50%). These findings suggest that the AIR Score is a more reliable tool for diagnosing acute appendicitis with greater accuracy and predictive capability.

Discussion

The accurate diagnosis of acute appendicitis remains a clinical challenge, as misdiagnosis can lead to unnecessary surgeries or delayed treatment with complications. The Modified Alvarado Scoring System (MASS) and Appendicitis Inflammatory Response Score (AIRS) are widely used clinical tools to assess the likelihood of acute appendicitis. This study compared the effectiveness of these scoring systems in preoperative diagnosis, demonstrating that AIRS provides superior diagnostic accuracy.

The findings of this study indicate that AIRS has higher sensitivity (80% vs. 60%) and specificity (95% vs. 85%) compared to MASS. The positive predictive value of AIRS (95%) was also greater than MASS (90%), suggesting that patients identified as high-risk by AIRS are more likely to have true appendicitis. Additionally, AIRS exhibited a higher negative predictive value (70% vs. 50%), meaning it better rules out non-appendicitis cases, thereby reducing unnecessary surgeries. These results align with previous studies that support the higher diagnostic accuracy of AIRS in acute appendicitis diagnosis [1,2].

MASS remains a useful and simple tool, but its lower specificity and negative predictive value suggest that it may lead to more false positives, increasing the risk of negative appendectomies. Previous studies have shown similar limitations of MASS, emphasizing that while it is effective, it may not be as reliable as AIRS for clinical decision-making [3]. On the other hand, AIRS incorporates inflammatory markers, making it a more refined tool that aligns with pathological changes in appendicitis, enhancing its diagnostic performance [4].

Another advantage of AIRS is its potential to reduce the reliance on expensive radiological investigations, which may not be readily available in resource-limited settings. By improving diagnostic certainty, AIRS can help minimize unnecessary imaging, reducing patient costs and hospital burden [5]. However, despite its advantages, AIRS is not infallible, and its accuracy may vary based on population characteristics, warranting further validation in larger and diverse cohorts.

The limitations of this study include a relatively small sample size, which may affect generalizability. Additionally, other diagnostic modalities such as ultrasonography and CT scans were not directly compared, which could have provided a more comprehensive analysis. Future research should focus on larger, multicenter studies to validate the findings and explore the integration of clinical scoring systems with imaging techniques for optimal diagnosis.

In conclusion, this study demonstrates that AIRS is a more effective tool than MASS for the preoperative diagnosis of acute appendicitis, with higher sensitivity, specificity, and diagnostic accuracy. Its high negative predictive value helps reduce unnecessary surgeries, making it a valuable bedside tool for clinicians. Further research is recommended to strengthen its clinical application and confirm its diagnostic utility in varied patient populations.

Conclusion

Based on the findings of this study, the Appendicitis Inflammatory Response (AIR) Score demonstrated superior diagnostic accuracy, sensitivity, and specificity compared to the Modified Alvarado Scoring System (MASS) for the preoperative diagnosis of acute appendicitis. AIRS not only improves diagnostic reliability but also has a higher negative predictive value, reducing unnecessary appendectomies and avoiding unwarranted radiological investigations, thereby minimizing patient burden. Given its simplicity and bedside applicability, AIRS serves as a valuable tool for surgeons in clinical decision-making. However, further studies with larger sample sizes are recommended to confirm its diagnostic utility and generalizability.

References

1. Andersson M. The appendicitis inflammatory response score: a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. *World J Surg*. 2008;32(8):1843-9.
2. Sammalkorpi HE, Mentula P, Leppäniemi A. A new adult appendicitis score improves diagnostic accuracy of acute appendicitis—a prospective study. *BMC Gastroenterol*. 2014;14(1):114.
3. Ohle R, O'Reilly F, O'Brien KK, Fahey T, Dimitrov BD. The Alvarado score for predicting acute appendicitis: a systematic review. *BMC Med*. 2011;9:139.
4. Atema JJ, van Rossem CC, Leeuwenburgh MM, Stoker J, Boermeester MA. Scoring system–based pretest probability stratification of CT scan use in patients with clinically suspected appendicitis. *Acad Radiol*. 2015;22(4):437-44.
5. Kularatna M, Lauti M, Haran C, MacFater W, Sheikh L, Huang Y, et al. Clinical prediction rules for appendicitis in adults: which is best? *World J Surg*. 2017;41(7):1769-81.
6. Kanumba ES, Mabula JB, Rambau PF, Chalya PL. "Modified Alvarado Scoring System as a Diagnostic Tool for Acute Appendicitis at Bugando Medical Centre, Mwanza, Tanzania." *BMC Surgery*, 2011;11:4
7. de Castro SMM, Ünlü Ç, Steller EPH, van Wagensveld BA, Vrouenraets BC. "Evaluation of the Appendicitis Inflammatory Response Score for Patients with Acute Appendicitis." *World Journal of Surgery*, 2012;36(7):1540-1545.
8. Yeşiltaş M, Karakaş DÖ, Gökçek B, Hot S, Eğin S. "Can Alvarado and Appendicitis Inflammatory Response Scores Evaluate the Severity of Acute Appendicitis?" *Ulus Travma Acil Cerrahi Derg*, 2018;24(6):557-562
9. Kollár D, McCartan DP, Bourke M, Cross KS, Dowdall J. "Predicting Acute Appendicitis? A Comparison of the Alvarado Score, the Appendicitis Inflammatory Response Score, and Clinical Assessment." *World Journal of Surgery*, 2015;39(1):104-109.
10. Macco S, Vrouenraets BC, de Castro SM. "Evaluation of Scoring Systems in Predicting Acute Appendicitis in Children." *Surgery*, 2016;160(6):1599-1604.