

## Original Research Article

# Appendicitis inflammatory response score: a novel scoring system for acute appendicitis

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## ABSTRACT

**Background:** Acute appendicitis is one of the most common surgical emergencies encountered by doctors on call with emergency appendicectomy being a very common outcome of emergency laparotomies. There's been a marked decline in mortality over the past 50 years, but the rates of perforation and negative laparotomy have not changed much as they're influenced by factors untouched by technological advances.

**Methods:** A prospective comparative study to compare appendicitis inflammatory response score (AIR) and Alvarado scoring systems in evaluating suspected cases of acute appendicitis. 100 patients presenting with pain in the right lower quadrant of abdomen at the surgical clinics at Basaveshwar Teaching and General Hospital, Kalaburagi, Karnataka, India, who after clinical examination and relevant investigations were provisionally diagnosed to have acute appendicitis and warranted surgery for the same were evaluated using the scoring systems - Alvarado Score and Appendicitis Inflammatory Response Score. The scores were tallied and compared with final histopathology report. The study was conducted for a period of one and a half year.

**Results:** The results revealed that AIR (at score >4) demonstrated a higher sensitivity and specificity compared to Alvarado score (89.9 versus 78.6%) and (63.6 versus 54.5) respectively. Alvarado showed a slightly better sensitivity at score >8 (21.3 versus 12.3%).

**Conclusions:** The Appendicitis Inflammatory Response Score outperformed the Alvarado score. It holds promise to be incorporated into the clinician's daily inventory in efficiently diagnosing Appendicitis.

**Keywords:** AIR score, Scoring acute appendicitis

## INTRODUCTION

Reginald Fitz from Boston first identified inflammation of the appendix as a cause of right lower quadrant pain. He coined the term appendicitis and recommended early surgery intervention. Robert Lawson performed first appendectomy in England.<sup>1</sup> Now 130 years later, acute appendicitis still remains one of the most common abdominal emergency, demanding surgery. Mortality rate has improved since advent of antibiotics in 1940. No perfect diagnostic evaluation tool exists to detect appendicitis if symptoms are ambiguous. If symptoms are vague diagnostic process takes longer, thus delaying

surgery increasing the possibility of complications. On the other hand, hasty operation without accurate diagnosis will lead to negative appendectomy, increasing the morbidity and cost of treatment.<sup>2,3</sup>

Even with the advent of modern diagnostic tools, misdiagnosis of appendicitis has remained more or less constant. The percentage of misdiagnosis is higher among women than men. Diagnostic approaches include symptomatology, physical examinations, laboratory findings and imaging modalities like ultrasonography and computerized tomography (CT) of abdomen. Although the advent of ultrasound has improved the diagnosis of

appendicitis, it is highly operator dependent. Abdominal CT carries risk of radiation exposure and also increases the cost.<sup>4</sup> Many surgeons tend to rely on abdominal ultrasound or CT examination for objective diagnosis.

Many scoring systems have been designed for diagnosis of acute appendicitis. Among those systems, Alvarado system being simple to apply and efficacious.<sup>5,6</sup> The Alvarado score - a scoring system for diagnosing appendicitis uses eight variables with total of 10 points. Alvarado scoring system has the following drawbacks though;

Its construction was based on a review of patients who had been operated with suspicion of appendicitis - retrospective analysis.

- Whether each variable is statistically and independently relevant to acute appendicitis and valid as an inflammatory reaction variable is not accounted for
- The score does not incorporate C-reactive protein(CRP) as a variable, though many studies have showed its importance in assessment of patients with appendicitis.<sup>7</sup>

The recently introduced Appendicitis Inflammatory Response Score incorporating CRP was designed with a view to overcome these drawbacks.<sup>8</sup>

The objectives of this study were to compare appendicitis inflammatory response score and Alvarado scoring systems in evaluating suspected cases of acute appendicitis.

## METHODS

The period of the study was one-and-a-half-year December 2014 to May 2016. A prospective comparative study was design.

100 patients presenting with pain in the right lower quadrant of abdomen, who after clinical examination were provisionally diagnosed to have acute appendicitis and warranted surgery for the same.

### Inclusion criteria

Patients with provisional clinical diagnosis of acute appendicitis.

### Exclusion criteria

Patients presenting with non-right iliac fossa pain and those who had been admitted by other specialties for other complaints but subsequently developed right iliac fossa pain.

A total of 100 cases of suspected acute appendicitis who were admitted, investigated and treated were taken for the study. After detailed examination and investigations Alvarado score and appendicitis inflammatory response score was applied to each case and the scores were tallied accordingly.

Every year an average of 300 patients of acute appendicitis get admitted and operated on. By stratified random sampling every 3rd patient was selected for the study.

### Alvarado score

This system consists of 4-symptoms, 1-sign, 3-laboratory findings scored as follows.

**Table 1: Alvarado score.**

Nausea or vomiting	1
Anorexia	1
Pain in right lower quadrant	2
Migration of pain to right lower quadrant	1
Rebound tenderness	1
Body temperature >37.5 °C	1
Leukocytosis shift	1
WBC count >10000/cumm	2

### Appendicitis inflammatory response score

This system consists of 2-symptoms, 1-sign and 4-laboratory values scored as follows.

**Table 2: AIR score.**

AIR score	
Vomiting	1
Pain in right lower quadrant	1
Muscular defence	
Light	1
Medium	2
Strong	3
Body temperature >38.5 °C	1
Polymorphonuclear leucocytes	
70-84%	1
Equal or more than 85%	2
WBC	
10000-14999 cells/cumm	1
Equal or more than 15000/cumm	2
CRP estimation	
10-49 mg/l	1
Equal or more than 50 mg/l	2

### Following decisions were taken

- Cases with score of 1-4 were observed for development of acute appendicitis

- Cases with score of 5-8 were observed for next 24 hours, reevaluated. If their clinical condition was highly suspicious of acute appendicitis as decided by treating surgeon, they were subjected for appendicectomy
- If at any point, the surgeons decided that on examination, clinical features were convincing enough to warrant surgery, then irrespective of the scores appendectomy were performed
- All patients who were considered for appendectomy underwent ultrasonography of abdomen to rule out other conditions mimicking acute appendicitis
- Both scoring systems were compared with final Histopathology analysis report. Sensitivity, specificity, positive predictive value and negative predictive value were determined.

## RESULTS

Statistical analysis of observations and results of the study was presented in tabular form.

**Table 3: Age and sex characteristics.**

Age	Female	Male	Total
<18 years	3	8	11
≥18 years	32	57	89
<b>Total</b>	<b>35</b>	<b>65</b>	<b>100</b>

In this study male patients (65) were more than female patients (35).

**Table 4: Mean age.**

Sex	Mean age±SD	Range
Female	27.2±10.29	9 - 56 years
Male	29.8±14.09	11 - 72 years
Both	28.9±12.89	9 - 72 years

Mean age in females being 27.2±10.29 and in males 29.8±14.09, with range in both sexes being 9 to 72 years.

**Table 5: Ultrasonography findings.**

Ultrasonography findings	
Acute appendicitis	80
Normal or probe tenderness	20

Ultrasound could diagnose appendicitis in 80 patients.

In this study, anorexia was the most common symptom, presenting in 99 individuals. Vomiting was present in 74 patients, pain in the right lower quadrant present in 96 patients. Guarding was present in 40 patients and leucocytosis present in 61 individuals.

**Table 6: Frequency of signs and symptoms.**

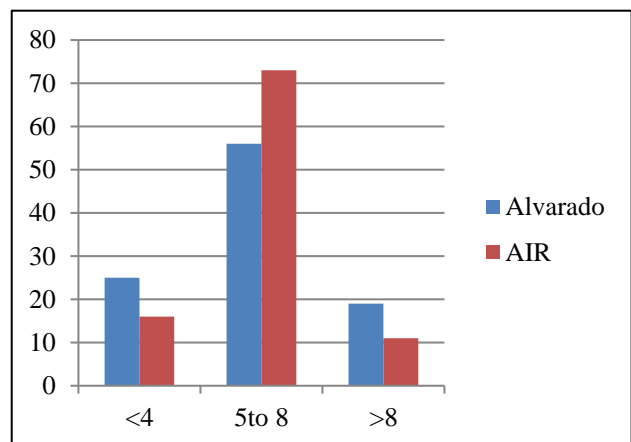
Signs and symptoms	Frequency
Anorexia	99
Vomiting	74
Pain rlq	96
Migrating pain	17
Rebound tenderness	75
Guarding	40
Leucocytosis	61

**Table 7: Distribution of patients as per score.**

Score	Alvarado	Air	Histopathology
≤4	25	16	Aa - 89
5-8	56	73	Ca - 11
>8	19	11	
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>

Maximum number of patients were present in score range of 5-8, with 56 patients being grouped by Alvarado score and 73 patients grouped by AIR score.

Histopathology which was the gold standard used in this study reported 89 cases as acute appendicitis and 11 cases as chronic appendicitis.



**Figure 1: Graphical representation of score distribution (y-axis: number of patients).**

**Table 8: Correlation of Alvarado score with histopathology.**

Score	AA	CA	Total
>4	70	5	75
≤4	19	6	25
<b>Total</b>	<b>89</b>	<b>11</b>	<b>100</b>

Alvarado diagnosed 75 patients as acute appendicitis (at score>4) of which 5 cases were false positive ones. Alvarado ruled out acute appendicitis (at score≤4) in 25 individuals of which 19 were false negative ones.

**Table 9: Correlation of Alvarado score with histopathology.**

Score	AA	CA	Total
>8	19	0	19
≤8	70	11	81
<b>Total</b>	<b>89</b>	<b>11</b>	<b>100</b>

Alvarado score (at score >8) correctly diagnosed in 19 individuals with zero false positive cases.

**Table 10: Correlation of air score with histopathology.**

Score	AA	CA	Total
>4	80	4	84
≤4	9	7	16
<b>Total</b>	<b>89</b>	<b>11</b>	<b>100</b>

AIR diagnosed 84 patients as acute appendicitis (at score >4) of which 4 were false positive cases. It ruled out acute appendicitis (at score <4) in 16 individuals of which 9 were false negative ones.

**Table 11: Correlation of air score with histopathology.**

Score	AA	CA	Total
>8	11	0	11
≤8	78	11	89
<b>Total</b>	<b>89</b>	<b>11</b>	<b>100</b>

AIR could diagnose 11 cases of acute appendicitis (at score >8) with no false positive cases.

**Table 12: Correlation of CRP level with histopathology.**

Value	AA	CA	Total
≥10	82	6	88
<10	7	5	12
<b>Total</b>	<b>89</b>	<b>11</b>	<b>100</b>

CRP was high (> 10 mg/L) in 88 individuals with falsely raised in 6 patients.

## DISCUSSION

Acute appendicitis is one of the commonest surgical emergencies with an 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.<sup>9</sup> Surgeon's good clinical assessment is considered to be most important requisite in diagnosis of appendicitis. Several other conditions can mimics this clinical condition.

Management strategy in patients of suspected appendicitis still remains a challenge even after introduction of USG, CT and diagnostic laparoscopy. The

use of USG or CT in suspected patients of appendicitis is common. CT should be used selectively to minimize exposure to ionizing radiation. False negative results may delay surgery and increase morbidity.

Decisions to operate based solely on physical examination, result in a higher rate of negative appendectomies. A negative appendectomy can lead to severe morbidity and even mortality.<sup>10,11</sup> Even without complications it is associated with unnecessary disability and costs.

Appendicitis inflammatory response score can be used to prevent negative appendectomy.<sup>12</sup> 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.

A scoring system should be of simple design in order to aid in decision making process for treatment. The goal of scoring system should be to discriminate when there is uncertainty rather than making a diagnosis.

In this prospective study, an attempt was made to evaluate the efficiency of appendicitis inflammatory response score and compare it with Alvarado score.

**Table 13: Comparison of AIR score and Alvarado score.**

	Present study		Castro et al	
	AIR	Alvarado	AIR	Alvarado
Score	>4 >8	>4 >8	>4 >8	>4 >8
Sensitivity	89.9 12.3	78.6 21.3	93 10	90 29
Specificity	63.6 100	54.5 100	85 100	55 95

- Sensitivity of AIR of 89.9% (at score >4) in the present study correlates well with studies of Castro et al (93%)
- Both AIR and Alvarado (at score >8) demonstrated specificity of 12.3% and 21.3% respectively which were comparable with results obtained by Castro et al - 10% and 29% respectively
- Specificity of Alvarado (at score >4) in the present study 54.5% was comparable with studies of Castro et al - (55%).<sup>12</sup>

The Alvarado was first reported in 1986. It was based on several variables found in 305 patients with acute appendicitis. Other variations exist but do not differ much.<sup>13,14</sup>

Use of Alvarado like scoring system was evaluated in large German study. The scoring system consisted of eight variables. The scoring system also did not include

C-reactive protein and it found no significant difference in negative appendectomy rates.<sup>15</sup> More recently AIR - like scoring system was developed by Sammalkorpi et al.<sup>16</sup> The scoring system also included C-reactive protein was evaluated. It demonstrated a sensitivity of 95% and specificity of 54% respectively.

Anorexia was the most common symptom in the present study. It is said that the sequence of appendicitis that is anorexia, followed by pain, in turn followed by vomiting in present in more than 95% individuals. If vomiting precedes the onset of pain the diagnosis of acute appendicitis should be questioned.

**Table 14: Percentage of patients with acute appendicitis exhibiting Leucocytosis and Rebound tenderness.**

	Present study	Kim BS et al
Leucocytosis	61%	72%
Rebound tenderness	75%	68%

Rebound tenderness was demonstrated in 75% individuals in the present study which was comparable with the studies of Kim BS et al - (68%).<sup>17</sup> It is a simple test that does not need lot of experience to perform or interpret. Lawrie considers it a “popular and somewhat unkind way of emphasizing what is already obvious”.

C-reactive protein demonstrated a sensitivity of 92% and specificity of 45.5 % in the present study. A recent meta-analysis has shown that there is fivefold increase in the positive likelihood ratio for acute appendicitis when both WBC count and C-reactive protein are elevated.<sup>18,19</sup>

Ultrasound is a safe, radiation-free method. In a review of graded compression US in the diagnostics of acute appendicitis the mean respective sensitivities and specificities of ultrasound were 78% and 83%.

Ultrasound demonstrated a sensitivity of 86.5% and specificity of 72.7% which was comparable with study conducted by Al-Ajerami, which demonstrated a sensitivity of 84.8% but a higher specificity of 83.3%.<sup>20</sup>

## CONCLUSION

Although acute appendicitis is one of the commonest surgical emergency, its management is still challenging. Appendicitis inflammatory response score outperformed Alvarado score displaying higher sensitivity and specificity. Such a scoring system is important for better outcome. Scoring systems should aid in correct diagnosis in order to avoid negative appendectomies. Ultrasound is a useful tool in diagnosing patients of acute appendicitis. The results of the present study were comparable with the studies of Castro et al.

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