

**Comparison of Appendicitis Inflammatory Response Score and Alvarado Score in Predicting Acute Appendicitis: A Study in Tertiary Care Hospital**Aaquib Pervaiz Butt<sup>1</sup>, Priyanka Koushal<sup>2</sup>, Kailash Singh<sup>3</sup>, Harpreet Singh<sup>4</sup>, Ankita Sharma<sup>5</sup>, Ayushi Bhushan<sup>6</sup><sup>1</sup>Senior Resident, Department of Surgery SKIMS and researcher<sup>2</sup>Senior Resident, Department of Surgery, GMC Jammu<sup>3</sup>Associate Professor, Department of Surgery, GMC Jammu.<sup>4,5,6</sup>Post Graduate Student, Department of Surgery, GMC Jammu

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Corresponding Author: Dr. Kailash Singh

Conflict of interest: Nil

**Abstract:**

**Background:** Appendix is a finger shaped pouch that projects from the colon on the lower right side of abdomen. The term appendicitis was first coined by "Reginald Fitz" in 1886 from Boston and identified as the common cause of right lower quadrant pain. To increase the diagnostic accuracy and to decrease the negative appendectomy rate, a variety of different approaches have been described, including the development of predictive scoring systems, computer-aided diagnosis, performance of diagnostic laparoscopy, ultrasonography, computed tomography, and magnetic resonance imaging. The most common and widely applied score in acute Appendicitis is Alvarado score but has been observed with few drawbacks. The scoring doesn't include CRP, a widely accepted laboratory marker in assessment of cases of acute appendicitis. A recently introduced appendicitis inflammatory response score (AIR) is designed to overcome the drawbacks associated with the implementation of Alvarado scoring system. This scoring system incorporates CRP as one of the variable in scoring the cases of suspicious appendicitis. The objective of this study is to evaluate the AIR score in cases of suspicious appendicitis and to compare it with Alvarado scorings system. Acute appendicitis accounts for a good number of cases presenting to emergency and therefore the study was conducted with the objectives of 1) To Assess and evaluate the patients having signs and symptoms of acute Appendicitis; 2) To establish the role of scoring system in evaluation of outcome of patients suffering from acute appendicitis; 3) Comparison of scoring system, Alvarado and Appendicitis Inflammatory Response score in acute appendicitis.

**Materials and Methods:** The study Comparison of Appendicitis inflammatory response score (AIR) and Alvarado score in predicting acute appendicitis was carried out prospectively on 118 patients presenting to the emergency of the Post Graduate Department of General Surgery Government Medical College, Jammu over a period of 12 months w.e.f. November 2021 to October 2022. The study subject consisted of all the patients who presented with pain abdomen in right lower quadrant and umbilical region with history of sudden onset and being non-traumatic. All the patients were treated as in-patients. After proper history, examination and basic laboratory tests patients were subjected to AIR scoring and Alvarado scoring.

**Results:** This study was conducted on 118 patients with clinical diagnosis of acute appendicitis, in the Post Graduate Department of Surgery, Government Medical College Jammu. This was established by general and systemic examination and baseline investigations of patients as per Performa. 8 patients were histopathologically and intra operatively proven negative for appendicitis and were excluded from the study. Patients of all age groups and either sex were included in the study. The maximum number of patients was in the age group of 18 to 45 years (51.8%) with a mean age of 20.66 years. The youngest patient was 06 years old whereas oldest patient was 66 years old. There were 68 males and 42 females in our study. The male to female ratio is 1.6:1. All patients were put on intravenous fluids, antibiotics and nil per oral, patients were kept under observation in emergency ward. The preoperative Appendicitis Inflammatory Response score and Alvarado score were recorded in each patient at the time of admission. Three diagnostic zones were defined with score > 8 as high probability, 5-8 as medium probability and less than 5 as low probability of appendicitis. Exploration was done on the decision of senior surgeon in emergency operation theatre. Specimens were sent for histopathology postoperatively. Out of 110 patients, 50 had advanced appendicitis, 60 had phlegmonous appendicitis as shown by histopathology. Out of 8 patients with negative appendicectomies, 03 patients had mesenteric lymphadenitis, 01 had meckel's diverticulitis, 01 patient had epiploic appendagitis and 03 patients had complicated right ovarian cyst. Head to head comparison between AIR SCORE and Alvarado score was done at two cut off points, 4 & 8. The sensitivity and specificity of AIR score were 0.96 and 0.79 as compared to Alvarado score having sensitivity and specificity of 0.80 and 0.71 at 4 cut off point for all appendicitis. This was accompanied by positive predictive value of 0.84 for AIR score and 0.65 for Alvarado score. At 8 cut off

point the sensitivity and specificity of AIR Score were 0.18 and 1.00 as compared to Alvarado score having sensitivity and specificity of 0.28 and 0.95. This was accompanied by positive predictive value of 0.99 for AIR Score and 0.84 for Alvarado score. Both scores were compared on age and gender distribution. The area under receiver operating characteristic curves (ROC) was compared. The AIR score outperforms Alvarado in both males and females and also in all age groups, particularly in paediatric and geriatric patients with  $p < 0.001$  which is highly significant.

**Conclusion:** The AIR score outperforms the ALVARADO score in predicting the acute appendicitis. AIR score displays higher specificity and higher positive predictive value thereby preventing negative appendicectomies. Avoiding subjective parameters and introduction of CRP as a parameter makes it an attractive clinical prediction for diagnosing acute appendicitis with higher specificity. The AIR score can be used in resource limited setting as it also prevents costly radiological investigations thereby reducing the cost of treatment as well.

**Keywords:** Acute appendicitis, Appendicitis inflammatory Score, Alvarado Score, Comparison.

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## Introduction

The term appendicitis was first coined by "Reginald Fitz" in 1886 from Boston and identified as the common cause of right lower quadrant pain. Appendicitis may occur for several reasons, such as an infection of the appendix, but the most important is the obstruction of the appendiceal lumen due to lymphoid hyperplasia, inspissated stools, etc., leading to bacterial overgrowth. The continued mucus secretion causes distension of the lumen leading to lymphatic and then venous obstruction, ensuing acute inflammatory response and ultimately acute appendicitis, gangrene and perforation of appendix [1]. The essential features of appendicitis are gradual onset of central abdominal pain with migration and localisation of pain to right iliac fossa, followed by nausea and vomiting. Localised tenderness and evidence of peritoneal inflammation [guarding and percussion tenderness] make the diagnosis probable. The usual picture of appendicitis is often not classical, leaving in many cases a diagnostic problem. The negative laparotomy was associated with definite morbidity but the mortality rate was minimal compared to the lethal potential of appendicular perforation and peritonitis [2]. Among young male patients, the negative appendectomy rate is relatively low (5-22%), while for women of childbearing age, the figure may be as high as 30-50%. In young children, the diagnosis may be wrong in 30-46% of the patients. The difficulty in diagnosing acute appendicitis in old age is reflected by the high incidence of perforation, i.e., 60-90% in many reports, rather than by a high rate of negative appendectomy. Diagnosis is also difficult during pregnancy and may result in both maternal and fetal mortality [3].

Negative appendectomy rates (finding a normal appendix in laparotomy) have still remained as a cause of concern despite adoption of imaging studies like sonography and tomography widely. To increase the diagnostic accuracy and to decrease the negative appendectomy rate, a variety of

different approaches have been described, including the development of predictive scoring systems, computer-aided diagnosis, performance of diagnostic laparoscopy, ultrasonography, computed tomography, and magnetic resonance imaging. Diagnostic scoring systems have been developed in an attempt to improve the diagnostic accuracy of acute appendicitis. An ideal scoring system would work as a tool that speeds up and increases the accuracy of decision-making and at the same time reduces the need of potentially harmful and expensive imaging the most prominent of those scores is that developed by Alvarado [4]. In his original paper, Alvarado recommended an operation for all patients with a score of 7 or more and observation for patients with scores of 5 or 6 [3]. The Alvarado score has been observed doesn't include CRP, a widely accepted laboratory marker in assessment of cases of acute appendicitis. A recently introduced appendicitis inflammatory response score (AIR) is designed to overcome the drawbacks associated with the implementation of Alvarado scoring system. This scoring system incorporates CRP as one of the variables in scoring the cases of suspicious appendicitis [5].

The AIR score has a good statistical discrimination for patients with acute appendicitis and outperforms the Alvarado score. The discriminatory property of the AIR score to diagnose acute appendicitis remains high in the more difficult patients e.g. women, children and elderly patients [6]. CRP as a variable is included in AIR score. An elevated level of C-reactive protein (CRP), an acute phase protein, is one of many downstream indicators of inflammation. In most, though not all diseases, the circulating value of CRP reflects ongoing inflammation and/or tissue damage much more accurately than do other laboratory parameters of the acute-phase response. The CRP concentration is thus a very useful but a nonspecific biochemical marker of inflammation, measurement of which contributes importantly to

(a) screening for organic disease, (b) monitoring of the response to treatment of inflammation and infection, and (c) detection of intercurrent infection in immune compromised individuals [7]. The AIR score is useful for diagnosing acute appendicitis. The serum CRP and assessment of percentage of segmented neutrophils in WBC are important in the diagnosis and stratification of evolutionary stage of acute appendicitis [8]. The present study will evaluate the sensitivity and specificity of appendicitis inflammatory response (AIR) score in diagnosing acute appendicitis and compare the AIR score with Alvarado Score in diagnosing acute appendicitis.

### Aims and Objectives

**Aim:** To evaluate and compare the Alvarado and AIR (appendicitis inflammatory Response) score as a tool for diagnosis and severity of acute appendicitis.

### Objectives:

1. To Assess and evaluate the patients having signs and symptoms of acute appendicitis.
2. To establish role of scoring system in evaluation of outcome of patients suffering from acute appendicitis.
3. Comparison of scoring systems, Alvarado and Appendicitis Inflammatory Response score in acute appendicitis.

### Materials and Methods

**Study Design:** This is a prospective study.

**Study Design:** This study was conducted at Government Medical College Jammu, a tertiary care hospital.

**Study Duration:** This study was conducted over a period of one year between November 2021 to October 2022.

**Patient Enrollment:** A total of 118 patients presenting with sudden onset and non-traumatic pain in right lower quadrant and umbilical region of abdomen admitted to emergency of Government Medical College and hospital Jammu were included in the study and were subjected to AIR scoring and Alvarado scoring. After obtaining informed written consent. 8 patients were histopathologically and intra operatively proven negative for appendicitis and were excluded from the study. All the patients were treated as inpatients.

**Inclusion Criteria:** All the patients admitted in Postgraduate Department of Surgery, Government Medical College, Jammu, diagnosed as a case of appendicitis clinically and radiologically.

**Exclusion Criteria:**

- Patients having been diagnosed to have appendicular lump /appendicular perforation on admission.
- Patients not consenting to be a part of study.

### Data Collection

A total of 118 patients presenting with sudden onset and non-traumatic pain in right lower quadrant and umbilical region of abdomen admitted to emergency of Government Medical College and hospital Jammu were included in the study and were subjected to AIR scoring and Alvarado scoring. After obtaining informed written consent from patients or the parents if the patient was a minor. 8 patients were histopathologically and intra operatively proven negative for appendicitis and were excluded from the study. All the patients were treated as in-patients. A detailed history regarding time of onset of pain, duration of pain, type of pain, site of pain, any shift in the site of pain, radiation of pain, relation of pain to any food intake or postural variation/ history of vomiting, its frequency, colour, amount, presence of blood in the vomitus/ history of fever with its duration and intensity, gastrointestinal symptoms such as constipation/ diarrhoea, presence of blood in stools, any history of jaundice/any history of respiratory distress; urinary symptoms as frequency, retention of urine and hematuria were noted. Any previous history of any surgical intervention; type of surgery, duration since surgery at presentation was recorded. Detailed history of dietary habits like consuming excessive junk food, packed foods, were taken into consideration. All the patients underwent a detailed general physical examination and a thorough systemic examination including Central nervous system, cardiovascular system, respiratory system and musculoskeletal system. Local examination included the examination of the abdomen, groin and genitalia by following the standard protocol of examination including inspection, palpation, percussion and auscultation and noting the findings of the examination. Per rectal examination was done in all the patients.

All the patients were subjected to routine investigations including hemogram, Coagulogram, renal function tests, liver function tests, blood sugar, blood grouping, serology for HIV and Hepatitis, urine routine examination, serum amylase and serum lipase. X ray chest and erect abdominal radiograph was done in all the cases. Ultrasonography of the abdomen was done in all the cases. IV fluid supplementation, IV antibiotics, analgesics were instituted along with nasogastric tube insertion for decompression and urinary catheterization for monitoring urinary output were done wherever required.

The current recommended score is

**ALVARDO Score**

- Nausea or vomiting 1
- Anorexia 1
- Pain RLQ 2
- Migration of pain 1
- Rebound Tenderness 1
- Body Temp > 37.5 °C 1
- Leucocytosis shift 1
- WBC count TLC > 10,000 2
- Total score 10
- Score Inference Management
- 0-4 not likely appendicitis Discharge and followup
- 5-8 probably appendicitis Diagnostic work up
- 9-10 highly likely appendicitis operate without further investigations

**Acute Inflammatory Response (AIR) Score**

- Vomiting 1
- Pain RLQ 1
- Rebound Tenderness – light 1
- Medium 2
- Strong 3
- Body temp
- 3 8.5°C 1
- PMN
- 70%-84% 1
- >85% 2
- WBC count
- 10,000—14,999 1
- >15,000 2
- CRP
- 10—49mg/l 1
- >50mg/l 2
- Total score 12

After scoring, three diagnostic test zones are defined: one with high sensitivity for appendicitis to identify patients who can be safely discharged on OPD follow up, another with high specificity for appendicitis to identify patients who can be

operated upon without further examination! Investigation and an intermediate group of a patients who need additional diagnostic work up.

**Score Diagnosis Zone Management**

0-4 Low possibility DISCHARGE and follow-up 5-8 intermediate group diagnosis work up 9-12 High probability operate without further Investigations After grading the patients, a senior surgical resident examined the patients and the decision to operate was subsequently confirmed by senior surgical staff member. Imaging by means of trans abdominal ultrasonography (USG) was done in all the patients. The surgical procedure consisted of emergency appendectomy (open). The diagnosis of appendicitis was confirmed by histopathological examination of all appendectomy specimens. Appendicitis pathologically diagnosed when infiltration of muscularis propria by neutrophils has been seen. Patients will be classified into two groups:

1. Phlegmonous Appendicitis
2. Advanced appendicitis defined as macroscopic gangrenous appendicitis with or without perforation.

After collecting the data, the sensitivity and specificity of the AIR and Alvarado scoring was compared by appropriate statistical methods.

**Statistical Analysis**

Statistical analysis was performed with SPSS statistical software. A p value < 0.05 was considered statistically significant. The area under the receiver operating characteristic (ROC) curves was used to examine the performance Characteristics of two scoring systems. Data was represented in the tables represented below.

**Ethical consideration:** Ethical clearance was obtained from Institutional Ethical Committee of Government Medical College Jammu.

**Table 1: showing comparison of AIR score and Alvarado score based on percentage of patients in different age groups and Mean Age years**

Age	No. of Patients	Percentage of Patients	Mean Age(years)	AIR score	Alvarado Score	P-value
<18	48	43.6%	11.14	0.89	<b>0.80</b>	<0.001
18-45	57	51.8%	20.66	0.88	<b>0.81</b>	<0.001
>45	05	4.5%	55.2	0.86	<b>0.70</b>	<0.001
<b>Total</b>	<b>110</b>	<b>100%</b>				

The total number of patients in our study were 118. Among these 08 patients were proven negative appendectomies. The rest of the study was conducted on 110 patients.

The maximum number of patients was in the age group of 18 to 45 years (51.8%) with a mean age of 20.66 years. The age of youngest patient was 6

years and the age of most elderly patient was 66 years. There were 68 males and 42 females. The male to female ratio is 1.6:1. 51.8 % patients lie in the age group of 18-45 years in which AIR score (0.88) outperforms the Alvarado score (0.81).

43.6 % of patients lie in the age group of less than 18 years, in which AIR score (0.89) outperforms the

Alvarado score (0.80).4.5% of patients who lie in the age group of above 45 years of age again scored

high AIR (0.86) as compared to Alvarado score (0.70).

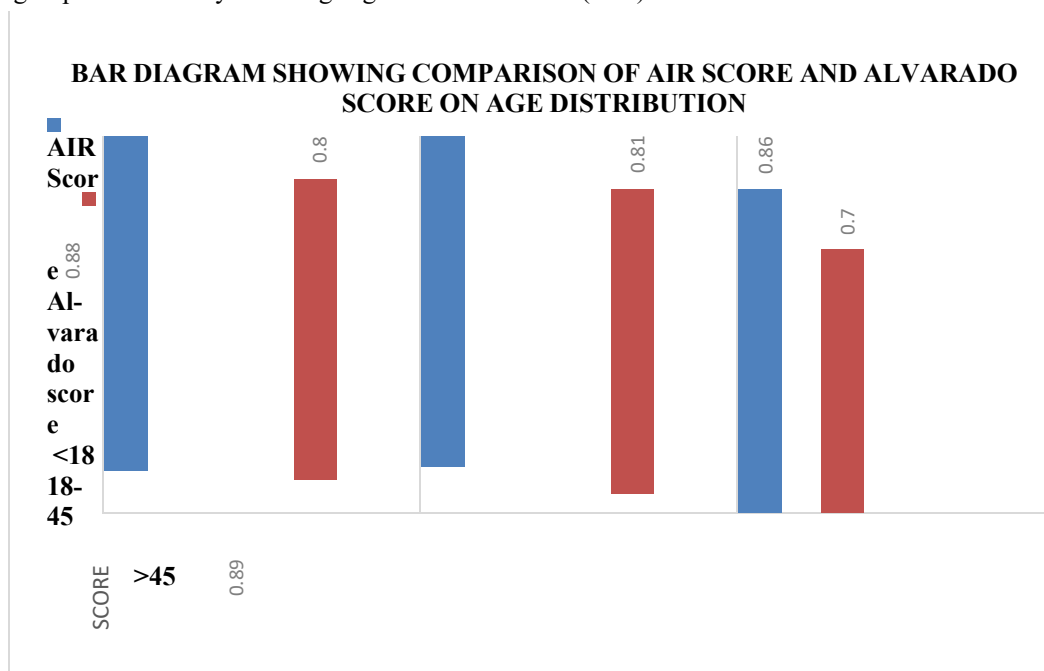


Figure 1:

Table 2: Showing comparison of AIR score and Alvarado score on gender distribution.

Groups	No. of Patients	AIR Score	Alvarado score	p-value
Male	68	0.85	0.70	<0.001
Female	42	0.90	0.71	<0.001

In our study there were 60 males and 40 females. The performance of AIR score is more in both males and females. The area under ROC curve is 0.87 for males in AIR score and 0.64 in Alvarado score. In case of females, the area is 0.89 for females in Air score and 0.69 in Alvarado score. The AIR score performs well in both males and females with p value <0.001 which is statistically significant

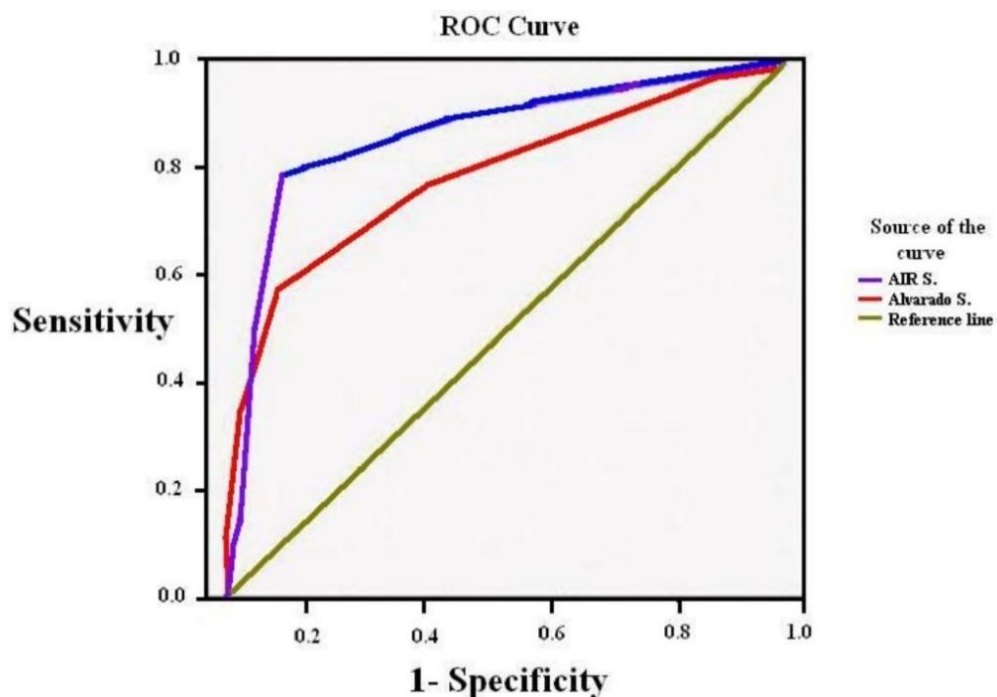


Figure 2: ROC Curve showing comparison of AIR and Alvarado in Male

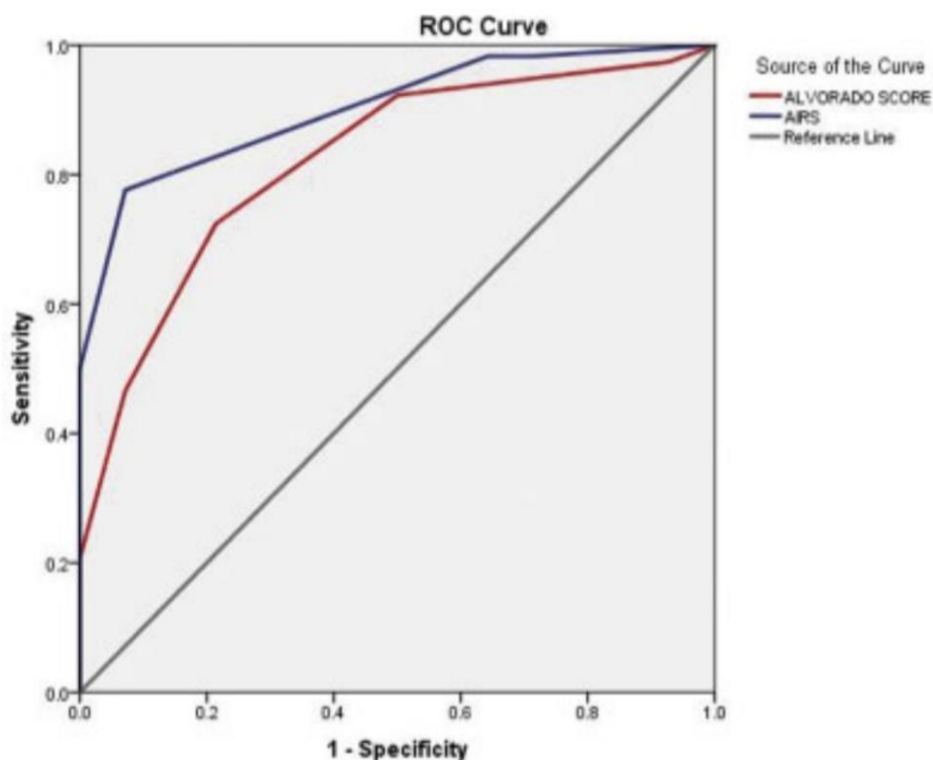


Figure 3: ROC Curve showing comparison of AIR and Alvarado in Female

Table 3: Showing Distribution of patients according to the diagnostic test zone

Diagnostic test zone	NO. of patients (AIR Score)	No of patients (Alvarado Score)
Scale >8	12	20
Advances appendicitis	7	07
Phlegmonous appendicitis	5	13
Scale 5-8	68	48
Advanced appendicitis	27	18
Phlegmonous appendicitis	41	30
Scale <5	30	42
Advanced appendicitis	16	25
Phlegmonous appendicitis	14	17
Total	110	110

Score more than 8 was noted in 12 patients (with 7 showing advanced appendicitis and 5 showing phlegmonous appendicitis) and 20 patients (with 7 showing advanced appendicitis and 13 showing phlegmonous appendicitis) in AIR and Alvarado score respectively.

Score on a scale of 5-8, was noted in 68 patients (with 27 showing advanced appendicitis and 41 showing phlegmonous appendicitis) and 48 patients

(with 18 showing advanced appendicitis and 30 showing phlegmonous appendicitis) in AIR and Alvarado score respectively

Score on a scale of less than 5, was noted in 30 patients (with 16 showing advanced appendicitis and 14 showing phlegmonous appendicitis) and 42 patients (with 25 showing advanced appendicitis and 17 showing phlegmonous appendicitis) in AIR and Alvarado score respectively.

Table 4: showing Comparison of patients on the basis of histopathology

Diagnosis	Advanced appendicitis	Phlegmonous appendicitis	Negative appendicitis
AIR Score	6.75	6.80	5.2
Alvarado Score	6.24	6.04	5.8
Number of patients	50	60	8

Among 110 patients, 50 patients were histopathologically proven advanced appendicitis. The average AIR score was 6.75 and average Alvarado score was 6.24. 60 patients were having phlegmonous appendicitis proven by histopathology. The average AIR score in this subgroup was 6.80 and average Alvarado score was 6.04. Only 8

patients had undergone negative appendectomy. The AIR score in this subgroup was 5.2, which was significantly less than average Alvarado score 5.8.

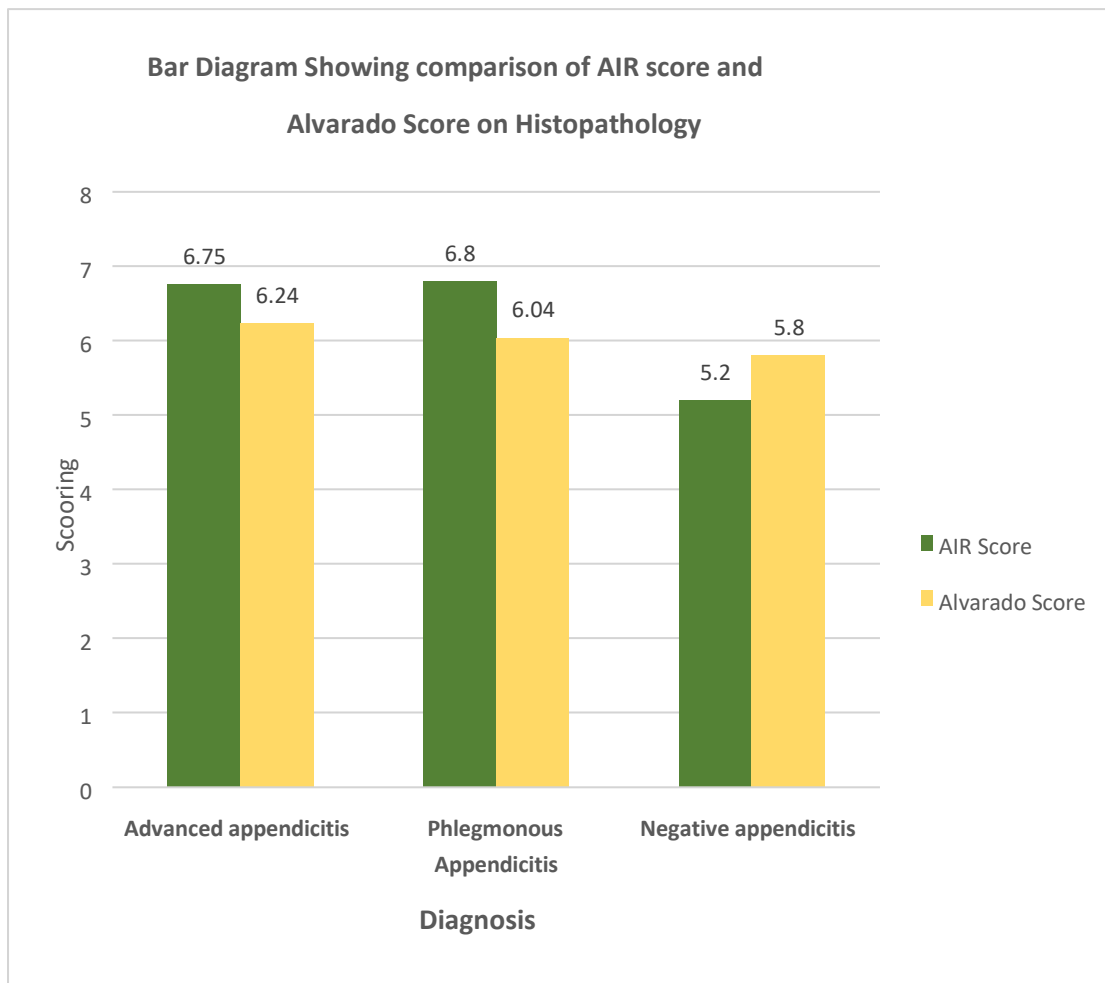


Figure 4: Bar diagram showing comparison of AIR score and Alvarado Score on Histopathology

Table 5: Showing comparison of AIR score and Alvarado score at cut off points 4 and 8 for all appendicitis

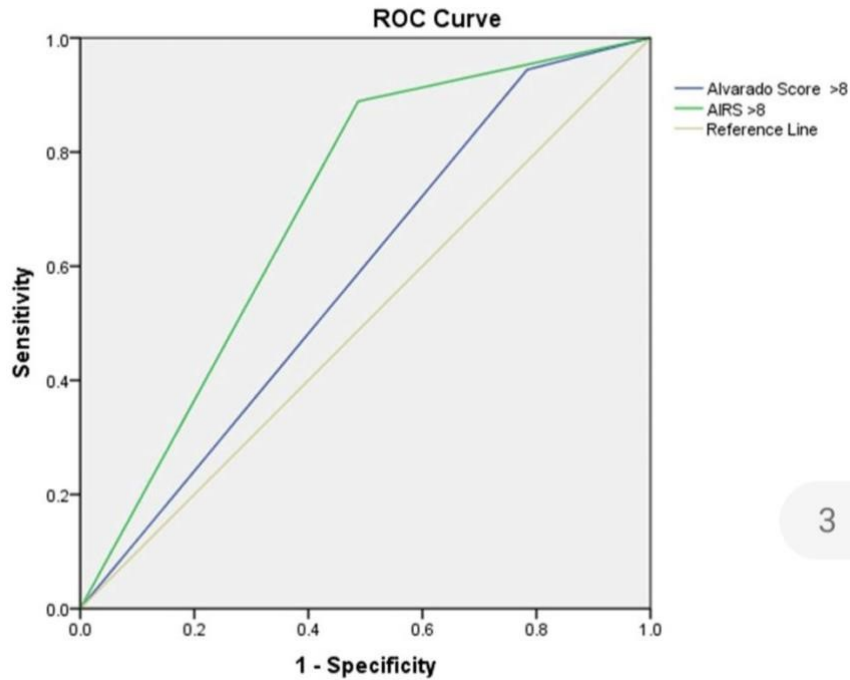
Diagnostic value	AIR Score		Alvarado Score	
	>4 points	>8points	>4 points	>8points
Sensitivity	0.96	0.18	0.80	0.28
Specificity	0.79	1.00	0.71	0.95
PV+	0.84	0.99	0.65	0.84
PV-	0.90	0.57	0.84	0.66

Two cut off points were defined to obtain three diagnostic test zones; one with a high Sensitivity for appendicitis that could be used to rule out appendicitis and one with a high specificity for appendicitis that could be used to rule in appendicitis.

The results were compared with the corresponding test zones for Alvarado score as shown in table: A score of greater than 4 points gave a higher sensitivity (0.96 VS 0.80 respectively) and specificity (0.79 vs .071 respectively) for AIR score compared to Alvarado score. This corresponds to higher positive predictive value (0.84 vs 0.65) and

higher negative predictive value (0.90 vs 0.84) for Air score compared to Alvarado score.

A score of greater than 8 points had a lower sensitivity for AIR score in Diagnosing acute appendicitis compared with Alvarado score (0.18 vs 0.28), however this was associated with higher specificity (1.00 vs 0.95 respectively). These scores translate higher positive predictive value for AIR score than Alvarado score (0.99 vs 0.84), but lower negative predictive value (0.57 vs 0.66). Similar results are found for both phlegmonous and advanced appendicitis.



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Figure 5: ROC Curve showing comparison of Alvarado and AIR score at cut off point 8

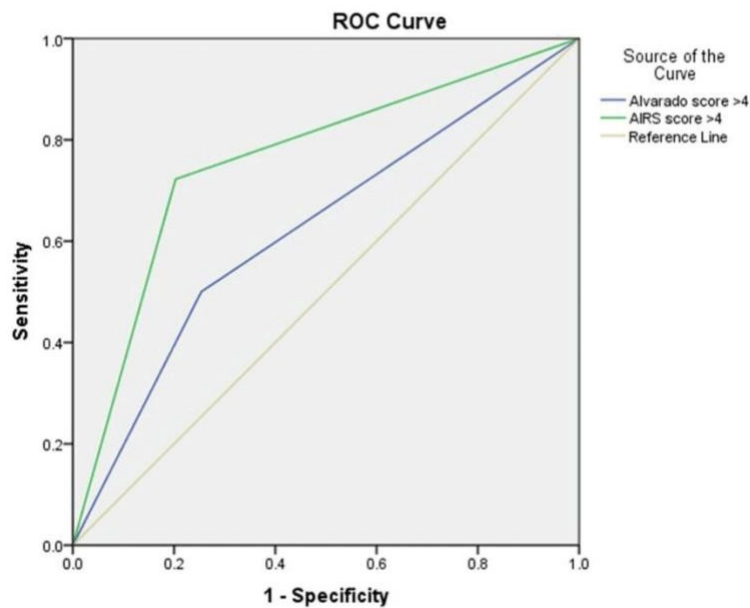


Figure 6: ROC Curve showing comparison of Alvarado and AIR score at cut off point 4

The study is to establish the role of scoring system in evaluation of outcome of patients suffering from acute appendicitis and to compare the Alvarado score and AIR score in predicting acute appendicitis.

**Discussion**

The term appendicitis was first coined by “Reginald Fitz” in 1886 from Boston and identified as the common cause of right lower quadrant pain. The essential features of appendicitis are gradual onset of central abdominal pain with migration and

localisation of pain to right iliac fossa, followed by nausea and vomiting. Localised tenderness and evidence of peritoneal inflammation [guarding and percussion tenderness] make the diagnosis probable. The usual picture of appendicitis is often not classical, leaving in many cases a diagnostic problem. Negative appendectomy rates (finding a normal appendix in laparotomy) have still remained as a cause of concern despite adoption of imaging studies like sonography and tomography widely. To increase the diagnostic accuracy and to decrease the negative appendectomy rate, scoring systems have



been developed in an attempt to improve the diagnostic accuracy of acute appendicitis the most prominent of those scores is that developed by Alvarado. In his original paper, Alvarado recommended an operation for all patients with a score of 7 or more and observation for patients with scores of 5 or 6. The Alvarado score has been observed doesn't include CRP, a widely accepted laboratory marker in assessment of cases of acute appendicitis. A recently introduced appendicitis inflammatory response score (AIR) is designed to overcome the drawbacks associated with the implementation of Alvarado scoring system. This scoring system incorporates CRP as one of the variables in scoring the cases of suspicious appendicitis.

The AIR score has a good statistical discrimination for patients with acute appendicitis and outperforms the Alvarado score. The discriminatory property of the AIR score to diagnose acute appendicitis remains high in the more difficult patients e.g. women, children and elderly patients. The serum CRP and assessment of percentage of segmented neutrophils in WBC are important in the diagnosis and stratification of evolutionary stage of acute appendicitis. The present study was undertaken to evaluate the sensitivity and specificity of appendicitis inflammatory response (AIR) score in diagnosing acute appendicitis and compare the AIR score with Alvarado Score in diagnosing acute appendicitis.

The total number of patients in the study was 118. 8 patients were histopathologically and intra operatively proven negative for appendicitis and were excluded from the study; thereby comparing the outcome of Alvarado and AIR scores in 110 patients. The maximum number of patients was in the age group of 18 to 45 years (51.8%) with a mean age of 20.66 years. The youngest patient was 06 years old whereas oldest patient was 66 years old. There were 68 males and 42 females in our study.

The male to female ratio is 1.6:1. Gopalam PR et al., in their study titled Comparison of acute inflammatory score and Alvarado score in diagnosis of acute appendicitis at a tertiary care hospital noted that among 300 patients with suspicion of appendicitis, there were 164 (54.67%) males and 136 (45.33%) of females with male preponderance in the study. The mean age of the male was 34 years with a range of 7-84 years and female was 31 years with a range of 12-74 years.

The most common age group in the study was 16-25 years (34%) followed by 26-35 years (28%) [9]. Jose T et al., in their study of Appendicitis Inflammatory Response Score in Comparison to Alvarado Score in Acute Appendicitis, included 130 patients (77 males and 53 females) with a male

female ratio of 1.5:1 [10]. Karki O Bet al., conducted study titled Evaluation of the Appendicitis Inflammatory Response Score against Alvarado Score in Diagnosis of Acute Appendicitis The study included 217 patients with 109 (50.2%) males and 108 (49.8%) females. The mean age of patients was  $25.77 \pm 15.54$  [11].

In Our study, it is observed that both the AIR score and Alvarado score are accurate in ruling out appendicitis in those stratified as low risk with high negative predictive value. The scoring systems are well placed to be used as a decision support tool for junior surgeons or emergency room doctors when evaluating patients with low risk of appendicitis, who could be safely selected for observation on an outpatient basis. Important differences do exist between AIR score and ALVARADO score when it comes to selecting those at high probability of acute appendicitis. A high AIR score has excellent specificity and positive predictive value that exceeds those of ALVARADO score.

In our study, it has been found that a score of greater than 4 points gave a higher sensitivity (0.96 VS 0.80 respectively) and specificity (0.79 vs .071 respectively) for AIR score compared to Alvarado score. This corresponds to higher positive predictive value (0.84 vs 0.65) and higher negative predictive value (0.90 vs 0.84) for Air score compared to Alvarado score. A score of greater than 8 points had a lower sensitivity for AIR score in Diagnosing acute appendicitis compared with Alvarado score (0.18 vs 0.28), however this was associated with higher specificity for AIR score (1.00 vs 0.95 respectively). These scores translate higher positive predictive value for AIR score than Alvarado score (0.99 vs 0.84), but lower negative predictive value (0.57 vs 0.66). Gope Det et al., in their study titled, Comparison between AIR score and Alvarado score in cases of non-perforated and perforated acute appendicitis observed that for scores >4, AIR score has higher sensitivity and specificity.

The negative predictive value (NPV) of AIR score was higher and the positive predictive value (PPV) of AIR score was also high. For scores >8, Alvarado score has higher sensitivity as compared to AIR score whereas AIR score has higher specificity as compared to Alvarado score. NPV of Alvarado score was higher while PPV of AIR score was higher [12]. Sudhir Setal., in their study reported that in cases of phlegmonous appendicitis with scores >4, Alvarado score has high sensitivity (97.06) compared to AIR score (78.43), whereas AIR score has high specificity (89.8 vs. 10.02) which translates to negative predictive value of 80% and 6.92% for AIR score and Alvarado score, respectively. For scores >8, Alvarado score has high sensitivity and specificity compared to AIR

score, 33.33 versus 20.59 and 97.96 versus 96.94 respectively.

This translates to negative predictive value of 58.54 and 53.98 for Alvarado score and AIR score, respectively [13]. KollarD et al., in their study titled Predicting Acute Appendicitis, A comparison of the Alvarado Score, the Appendicitis Inflammatory Response Score and Clinical Assessment concluded that AIR score assigned a smaller proportion of patients to the high probability zone than the Alvarado score (14 vs. 45 %) but it did so with a substantially higher specificity (97 %) and positive predictive value (88 %) than the Alvarado score (76 and 65 %, respectively) [14]. Yeşiltaş M in their study Can Alvarado and Appendicitis Inflammatory Response scores evaluate the severity of acute appendicitis stated that Both the AS and the AIRS can evaluate pathological severity, but only the AIRS can evaluate complicated or uncomplicated appendicitis and the diameter of the appendix. These tools can be used to reduce the number of unnecessary radiological or surgical interventions [15]. Dnyanmote AS et al., in their study of comparison between AIR score and Alvarado score in cases of appendicitis noted that Appendicitis inflammatory response score is better than Alvarado score displaying higher sensitivity and specificity. AIR scoring performed well almost equally with Alvarado system with high specificity and high negative predictive value preventing unnecessary negative appendectomies. Follow up of these cases will help in deciding surgical intervention in unnecessary cases. This scoring system also prevents unnecessary and costly radiological investigations thereby reducing the financial burden to the patients.

In our study, we observed that among 118 patients, 50 patients were histopathologically proven advanced appendicitis. The average AIR score was 6.75 and average Alvarado score was 6.24. 60 patients were having phlegmonous appendicitis proven by histopathology. The average AIR score in this subgroup was 6.80 and average Alvarado score was 6.04. Only 8 patients had undergone negative appendectomy, accounting 6.7% of total cases operated. The AIR score in this subgroup was 5.2, which was significantly less than average Alvarado score 5.8. Memon AA et al., in their study, Diagnostic accuracy of Alvarado score in diagnosis of acute appendicitis noted that those who had score <7 but proceeded to surgery purely on the basis of surgeon's decision have evidence of acute appendicitis on histopathology in 82% with negative appendectomy rate of 17%.

Most of these patients fall at score >5 while all those at score 3 or 4 have normal appendix [17]. Flum et al analyzed the data from the Washington State Database and identified 63,707 patients who

underwent appendectomy and they have noted a negative appendectomy rate of 15.5% [18]. Sharma et al., noted a negative appendectomy rate of 23.72%, which was 13.43% in males and 37.25% in females [19]? Guller et al., in an analysis based on the prospective database of the Swiss Association of Laparoscopic and Thoracoscopic Surgery (SALTS) which included patients aged 12 years and over undergoing emergency laparoscopic appendectomy between 1995 and 2006 noted a negative appendectomy rate of 6.4% and a perforation rate of 16.5% [20].

In our study, in the distribution of patient according to diagnostic test zone, it has been found that score more than 8 was noted in 12 patients (with 7 showing advanced appendicitis and 5 showing phlegmonous appendicitis) and 20 patients (with 7 showing advanced appendicitis and 13 showing phlegmonous appendicitis) in AIR and Alvarado score respectively. Score on a scale of 5-8, was noted in 68 patients (with 27 showing advanced appendicitis and 41 showing phlegmonous appendicitis) and 48 patients (with 18 showing advanced appendicitis and 30 showing phlegmonous appendicitis) in AIR and Alvarado score respectively.

Score on a scale of less than 5, was noted in 30 patients (with 16 showing advanced appendicitis and 14 showing phlegmonous appendicitis) and 42 patients (with 25 showing advanced appendicitis and 17 showing phlegmonous appendicitis) in AIR and Alvarado score respectively. GopalamPR et al., in a cross sectional prospective study reported that 116 cases out of 300 (38.7%) were diagnosed pathologically as appendicitis, with 88 cases as phlegmonous appendicitis and 28 as cases of advanced appendicitis.

In the remaining 184 cases which were negative pathologically for appendicitis, other alternate causes of diagnosis were found in 116 cases [9]. Sudhir S et al., in their study reported that overall 109 patients out of 200 had pathologically proven appendicitis. 53(26.5%) patients had phlegmonous appendicitis, 49(24.5%) had advanced appendicitis, whereas 07 patients had chronic appendicitis (3.5%). 91 patients out of 200 had no pathologically proven appendicitis [13].

In our study, it has been observed that there was no significant past surgical history, previous hospitalization, ATT intake, any comorbidity and any other medical history in 84 patients. Out of rest 26 patients 8 had episodes of recurrent pain right lower abdomen, 10 patients were known hypertensive, 5 patients had history of jaundice, 1 patient had history of previous cholecystectomy, 1 patient had history of repair of duodenal perforation and 1 patient had anti-tubercular drug

history. No comparative study has been found in this regard.

### Conclusion

The AIR score outperforms the ALVARADO score in predicting the acute appendicitis. AIR score displays higher specificity and higher positive predictive value thereby preventing negative appendectomies. Avoiding subjective parameters and introduction of CRP as a parameter makes it an attractive clinical prediction for diagnosing acute appendicitis with higher specificity. The AIR score can be used in resource limited setting as it also prevents costly radiological investigations thereby reducing the cost of treatment as well.

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