

# Diagnosis of Acute Appendicitis: A Cross-sectional Study on Alvarado's Score from a Low Income Country

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**Background:** Alvarado score is the most widely used scoring system for diagnosing acute appendicitis, globally. There have been concerns regarding the diagnostic accuracy of this score as it was shown to have lower sensitivity in certain populations like Blacks and Asians. Despite its wide clinical use in the Ethiopian set up, the diagnostic accuracy of this score remained largely unexamined in this population.

**Methodology:** A prospective cross-sectional study was conducted and all adult patients who presented with right lower quadrant abdominal pain and evaluated with a clinical impression of acute appendicitis were enrolled in the study. Data was collected by trained surgical residents over a period of six months (August 2019– January 2020) and analysed using SPSS version 25.

**Results:** A total of 235 patients were enrolled in this study among whom two thirds were males. The majority of the study participants (61.7%) had an Alvarado score of  $\geq 7$  while almost a quarter of them had a score of  $< 4$ . The mean Alvarado score in this study was  $7 \pm 1.8$  whereas the median and the mode were 7 and 9 respectively. The overall sensitivity, specificity, positive predictive value and negative predictive value of Alvarado score were 99.1%, 55.6%, 98.2% and 62.5% respectively. The sensitivity and specificity of this score was superior in males compared to females (99.3% vs 97.6% and 80% vs 25%). A score of  $\geq 5$  was found to have a sensitivity of 98.4%.

**Conclusion:** Alvarado score was found to have good sensitivity and positive predictive value in this study. A score of  $\geq 5$  can be used to “rule in” the diagnosis of acute appendicitis. Hence, the use of Alvarado score's in the Ethiopian setup is to be encouraged.

**Keywords:** Alvarado score, acute appendicitis, sensitivity, specificity

## Background

Acute appendicitis is the most common gastrointestinal pathology requiring urgent surgical intervention.<sup>1–4</sup> Although population-based data is lacking in the Ethiopian setup, acute appendicitis has been shown to be the most common indication for emergency surgical intervention in several facility-based reports.<sup>5–9</sup> Despite its common occurrence, its clinical diagnosis remained challenging.

Clinical evaluation of a patient who is suspected to have acute appendicitis through a meticulous history and physical examination has remained the mainstay of diagnosis.<sup>2,10</sup> Although a number of diagnostic tools, including imaging modalities and biochemical tests, have been developed some reports have shown that, at a population level, the diagnosis of acute appendicitis has not improved with the availability of advanced diagnostic testing.<sup>11</sup>

The ideal evaluation of a patient with acute appendicitis aims to make an accurate diagnosis once the patient comes to the emergency department. The reported negative appendectomy rates vary between 11–40% in literature.<sup>12–18</sup> A rate of 15–20% has been accepted as appropriate to reduce the incidence of perforation in the past but this figure is being challenged these days due to the high post-operative morbidity in patients who have undergone a negative appendectomy.<sup>19–24</sup>

This diagnostic difficulty has led to the need for developing objective ways of evaluating patients with suspected acute appendicitis by using scoring systems. More than ten scoring systems for the diagnosis of acute appendicitis have

been described in the literature so far, with variable results in different setups. Among these, Alvarado's score, which uses eight predictive factors with a total score of ten, is the most well described and widely used one.<sup>11,25,26</sup>

In prior studies done about Alvarado's score sensitivity for the diagnosis of acute appendicitis, varied and conflicting results have been reported and racial difference has been mentioned as one factor for this difference. Some of the studies have found out that it has got a high sensitivity and recommended its routine use while the rest of the literature had an opposing report.<sup>27–32</sup>

In a low-income country setup like Ethiopia where imaging modalities such as ultrasound and computed tomography scan are neither widely available nor cost-effective, the diagnosis of acute appendicitis is mainly guided by clinical evaluation. Thus, it is crucial to have an effective clinical scoring system in order to minimize delayed intervention and unnecessary appendectomies as well.

This study will be helpful to provide objective data about the sensitivity of the widely used Alvarado's score in the Ethiopian setup. Since the reliability of this score in our population is not yet tested, this facility-based study will serve as a stepping point to evaluate this scoring system in our context and also serves as a baseline for further population based study.

## Methodology

This study was conducted in Menelik II Referral Hospital which is the first public Hospital in Ethiopia established in 1896 by Emperor Menelik II. The hospital serves many patients from the metropolis and surrounding towns.

A prospective observational study was conducted and all patients who presented to the adult emergency department with right lower quadrant acute abdominal pain and evaluated with a clinical suspicion of acute appendicitis were included in the study. Sample size was calculated by using the single population proportion formula using a P of 0.83 which is taken from a similar Indian study.

Data was collected for a period of six months by trained surgical residents using a questionnaire developed for the purpose of this study. Data coding and analysis was done using SPSS 25 (Statistical Packages for Social Sciences). Alvarado's score was calculated for each patient using the clinical and laboratory parameters (Table 1). Frequencies and percentages were used to describe categorical variables. For continuous variables, mean was calculated. Sensitivity, specificity, positive predictive value and negative predictive value of Alvarado's score were calculated using the respective formulas.

A written consent was taken from each study participant after the objective of this study is clearly explained to them. Ethical clearance was also obtained from the research and ethical board of the College of Health Sciences of Addis Ababa University. All research procedures were done in accordance with the Declaration of Helsinki.

## Result

In the study period, 235 patients with acute abdominal pain were assessed in our institution with a clinical diagnosis of acute appendicitis and Alvarado's score was calculated for each patient. Based on the clinical evaluation, a decision was made whether to proceed with surgical exploration or to follow the patients conservatively.

**Table 1** Components of Alvarado Score

Predictive Factor	Assigned Value
Elevated temperature >37.3°C	1
Rebound tenderness	1
Migration of pain to right lower quadrant	1
Anorexia	1
Nausea or vomiting	1
Right lower quadrant tenderness	2
Leukocytosis >10,000	2
Leukocyte left shift	1
Total score	10

## Socio Demographic Characteristics

Among the 235 patients, 150 (63.8%) were males with a male to female ratio of 1.8:1. The mean age of the study participants was  $27.5 \pm 8.5$  years while the median and mode were 25 years and 27 years respectively. As to the age distribution, the youngest study participants, aged 18–25 years, accounted for 50.2% of the study population while those aged >40 years accounted for only 8.5%. The great majority of patients (88.5%) were residents of Addis Ababa.

## Alvarado's Score

The Alvarado score was calculated for all patients and it was  $\geq 7$  in 145 (61.7%) of the study population while 23 (9.8%) had a score of 4 or less. The mean Alvarado's score of the study population was  $7 \pm 1.8$  with a median of 7 and mode of 9. Among the 235 patients evaluated, 5 were kept in the emergency department for serial examination using the following parameters: worsening or improvement of symptoms, vital signs, abdominal exam and Alvarado's score. They were not given any medications (neither analgesics nor antibiotics) and were just observed conservatively and discharged improved. The Alvarado score of these patients were five and less.

A grossly normal appendix was found intra operatively in 4 (1.7%) patients. As pathology service is not available in our Hospital, these specimens were not subjected to such examination. All of these patients had a score of five or less. All patients with Alvarado score of seven and above were operated on and had acute appendicitis of various stages intra operatively (Table 2).

The overall sensitivity and specificity of Alvarado score was 99.1% and 55.6% respectively. The sensitivity and specificity of this score was found to be lower in females compared to males (97.6% vs 99.3% and 25% vs 80% respectively) (Table 3). The positive predictive value of Alvarado score in this study was 98.2% while the negative predictive value was 62.5%.

The negative predictive value of Alvarado score, while using a score of 4 as a cut-off point, was 60% whereas it was found to be 100% at a cut-off point of 7 (Table 4). Hence, the later cut-off point was found to be reliable to rule out the diagnosis of acute appendicitis in this study.

**Table 2** Alvarado Score versus Intra Operative Finding

Alvarado Score	Acute Appendicitis		Discharged Without Surgery	Total
	Yes	No		
$\leq 4$	16	3	4	23
5–6	65	1	1	67
$\geq 7$	145	0	0	145
Total	226	4	5	235

**Table 3** Alvarado Score in Males vs Females

	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
Male	99.3	80	99.3	80
Female	97.6	25	96.4	33.3
Overall	99.1	55.6	98.2	62.5

**Table 4** Sensitivity, Specificity, Positive Predictive Value and Negative Predictive Value of Alvarado Score at Different Cut off Points

Alvarado Score	Sensitivity	Specificity	Positive Predictive Value	Negative Predictive Value
$\leq 4$	88.2	50	83.3	60
5–6	98.4	66.7	98.4	66.7
$\geq 7$	100	100	100	100

## Discussion

Even though acute appendicitis is the most common cause of an acute surgical abdomen, making an accurate and timely diagnosis of it remained challenging. Several clinical scores have been developed to this end and they have been especially useful in low income countries set up where modern imaging modalities are inaccessible and/or unaffordable to the public.

According to the Jerusalem guideline which was devised by the World Society of Emergency Surgery in 2020, clinical scores alone seem sufficiently sensitive to identify low-risk patients and decrease the need for imaging and negative surgical explorations in patients with suspected acute appendicitis.<sup>33</sup> Another recent review also demonstrated that three scores for acute appendicitis including the Alvarado score, are sensitive enough to exclude appendicitis and decreased the need for imaging and the negative appendectomy rate.<sup>34</sup>

Among others, Alvarado's score is the most well-known and widely used clinical scoring system for the diagnosis of acute appendicitis.<sup>11,22–24</sup> In a recent review done by Alfredo Alvarado himself, Alvarado score was compared to other scoring methods for acute appendicitis and it was found to be associated with the lowest negative appendectomy rate and missed perforation rate.<sup>35</sup>

In the current study, 235 adult patients who presented to our emergency department with acute abdominal pain and evaluated with a clinical suspicion of acute appendicitis were included. The predominance of men seen in this study is also reflected in other reports.<sup>36–42</sup> Our patients were found to be relatively young when compared to other study participants in studies done elsewhere while other scholars reported a comparable mean age with our patients.<sup>38–40,42,43</sup>

The mean Alvarado score in this study was found to be similar with a study from Qatar while it was higher compared to reports from India and Pakistan.<sup>40,42,43</sup> The majority of our study participants (61.7%) had an Alvarado score of seven and above which was much lower than a report from Morocco (91%). On the other hand, this finding is significantly higher when compared to other studies in which less than half of the study participants (36.6–48%) had such a score.<sup>34–37</sup> On the other hand, the percentage of patients who had a score of four and less was smaller in our study compared to other reports.<sup>36–39</sup>

The overall sensitivity of Alvarado score in this study was found to be similar with a result from one systematic review and another report from Morocco but significantly higher when compared to reports from Jordan, Tunisia, and Pakistan.<sup>37,40,44–46</sup> On the other hand, the overall specificity of this score in our study (55.6%) was lower when compared to other reports in which it was in the range of 75–92.3%.<sup>37,40,43</sup> In this study, the positive and negative predictive value of Alvarado's score were comparably higher than other reports.<sup>37,40,43</sup>

In this study, all patients with an Alvarado score of seven and above were operated on and had a confirmed acute appendicitis intraoperatively. Out of patients with a score of 5 or more, only one patient had a negative appendectomy. The sensitivity of Alvarado score at a score of 5 or more was 98.4% which is replicated in one systematic review and even higher than reports from Brazil, Qatar and Samoa.<sup>38,41,42,45</sup> Hence, this cut off point can be recommended for “ruling in” the diagnosis of acute appendicitis based on this result.

A score of 4 or less was reported to be reliable to “rule out” the diagnosis of acute appendicitis in a study from Tunisia.<sup>46</sup> This was contrary to our findings in that two thirds of our patients with such a score had acute appendicitis intraoperatively and also the negative predictive value of Alvarado score at this cut off point in this study was 60%. Therefore, we cannot safely recommend a score of 4 or less as a safe tool to rule out the diagnosis of acute appendicitis based on these findings.

From the results of this study we can conclude that Alvarado score is a good tool to diagnose acute appendicitis. Its use is especially significant in a set up like ours where modern diagnostic imaging modalities are not widely available or not cost-effective. This hospital based study can be used as a stepping stone to do a population based study in Ethiopia in order to get a better picture about the use of this scoring system at a larger scale as its validity has been questioned in the black population by some literatures.

## Disclosure

The authors report no conflicts of interest in this work.

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