

CURRENT GUIDELINES ON EVIDENCED-BASED DIAGNOSIS AND MANAGEMENT OF ACUTE APPENDICITIS

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Article Info: Received 17 August 2021; Accepted 28 October 2021

DOI: <https://doi.org/10.32553/ijmbs.v5i10.2273>

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Conflict of interest: No conflict of interest.

Abstract

Introduction: Appendicitis is the inflammation of the vermiform appendix. Appendicitis can be considered the most commonly interpretive cause of acute and severe abdominal pain. Acute Appendicitis (AA) is mainly caused by luminal obstruction obstructed by numerous etiologies. This causes an increase in the rate of bacterial overgrowth and mucus production thereby causing necrosis, wall tension and potential perforation.

Materials and Methods: The study is a Retrospective cohort and was conducted during the periods of 11 months. The study included 97 patients with appendicitis and divided them based on the protocol by which they receive diagnosis and management. Out of 97 patients, 49 patients were assigned to group 1 and the other 48 patients were assigned to group 2. Group 1 includes those patients who were treated symptomatically and diagnosis and management were given to them according to the wish of the consulting physician. For the determination of outcomes of treatments given to Group 1 and Group 2 patients, the study considered complications found in the patients. These complications are recorded for each of the groups. Also, the study recorded the complication in each of the treatment methods of Group 1 patients. This allowed the authors of this study to find out how outcomes vary when treatment is given differently from that of Alvarado Scoring criteria.

Results: The complications that were found in the study participants are fever, generalized peritonitis, perforation, abscess, a mild respiratory infection. The study found that the complications among the patients in Group 1 and Group 2 separately. In Group 1, 8 patients had a fever, while 3 patients had a fever in Group 2. Group 1 patients had all the listed complications including perforation (n=7), abscess (n=4), mild respiratory infection (n=3) and peritonitis (n=2). In Group 2, only 4 patients showed complications including fever in 3 patients and perforation in 1 patient.

Conclusion: The study has concluded that following Alvarado criteria in diagnosis and management of acute appendicitis results in the least possible complications. The study suggests the clinicians follow Alvarado criteria for proper management of acute appendicitis.

Keywords: Acute appendicitis, Alvarado criteria, appendicitis complications, appendicitis diagnosis, appendicitis treatment

Introduction

Appendicitis is regarded as an inflammation of the vermiform appendix, which is a finger-shaped vestigial pouch that protrudes out from the colon at the bottom right side of the abdomen. As per its location in humans, it intensifies the pain in the right side of the lower abdomen. Usually, the beginning of inflammation pain begins from naval and then later becomes very acute or known as Acute Appendicitis or AA. For many years, Appendicitis can be considered as the most commonly interpretive cause of acute and severe abdominal pain [1]. This acute abdominal condition takes the shape of an emergency with an account of 7-10% of the total emergencies [2]. It has taken the place of most occurred non-obstetric surgical treatment done in pregnant ladies. The number of cases is increased with the toll of 6.3 to 9.9 per 10,000 pregnant ladies [3]. A blockage in the appendix lining infects it and cause appendicitis. Later, the rapid multiplication of infectious bacteria results in the swollen, inflamed and pus-filled appendix. Acute Appendicitis (AA) is mainly caused by luminal obstruction obstructed by numerous etiologies. This causes an increase

in the rate of bacterial overgrowth and mucus production thereby causing necrosis, wall tension and potential perforation [4]. Despite the adult population, acute appendicitis (AA) is also very common in young patients and is characterized by acute abdominal agony. Acute appendicitis diagnoses have numerous clinical presentations. Moreover, the treatment becomes more complicated due to numerous differential diagnoses. Therefore, the surgeries of Acute appendicitis are referred to as "the chameleon of surgery" [5].

Moreover, the accurate timing to perform an appendectomy on a patient is also a cause of concern for the surgeons. Appendectomy, being a sensitive surgery, requires minute detailing like age of the patient, conditions (pregnant or morbid ladies) etc. That's why it is important to study every age group regarding the choice of management strategy before performing non-surgical treatments or appendectomy from case to case. In addition to this, the appropriate management should be chosen in acute appendicitis. The limitations which can occur in patients

suffering acute appendicitis are the presence of complex co-morbid diseases or irregular populaces of patients. The major goal for drafting the intervention guidelines for treating Acute Appendicitis was to determine the key role of antibiotics in treating the disease. Approximately half of all total cases in children are present accompanied by non-specific symptoms. The differential diagnoses of Appendicitis depend upon age. In children and teenagers, the physical examination and medical history should be done by keeping in mind the age factor. An experienced examiner plays a key role while examining children and adolescents [6]. As stated earlier, appendicitis in children is not accompanied by any specific or stated symptoms. Moreover, the absence of abdominal tenderness, leukocytosis, nausea and vomiting lowers down the probability of interpreting appendicitis [7]. Researches and meta-analysis revealed that 92% of children and adolescents suffering uncomplicated appendicitis became symptom-free with conservative treatment [8]. In contrast, some studies also showed that appendicitis when managed conservatively in children results in hospital readmission [9]. Thus, these studies conclude that children and adolescents who are less ill can be conservatively managed. Acute appendicitis includes appendicolith. This appendicolith can be proved vulnerable to complicated appendicitis. Approximately, 10% of appendicitis patients also have appendicolith. This kind of appendicitis with appendicolith can obstruct the appendiceal lumen and cannot be diagnosed effectively with antibiotic therapy only. Moreover, meta-analysis reports reveal probabilities of non-surgical treatment failure in patients having appendicitis along with appendicolith. At last, this group of children requires appendectomy only. Thus, it can be concluded that non-surgical management can be inefficient and may result in fatal outcomes like in children and adolescents diagnosed with appendicolith along with acute appendicitis [10]. Thus, acute Appendicitis can be managed intelligently with appendectomy which is done with less invasive technique and minimum anaesthetic and surgical risk in children.

In adulthood, the probabilities of AA decrease with the increasing age of patients [11,12]. However, the epidemiology, diagnoses and outcomes of cases of appendicitis in the elderly are different from that in the younger population. The elder population suffering appendicitis has a higher mortality rate than younger ones [13,14]. Research and a clinical trial were conducted in which it was studied that to whom non-surgical intervention must be provided at priority [15, 16]. While treating patients having co-morbidities, the physician should be vigilant. Another study recorded that a successful number of pregnant ladies who are diagnosed with appendicitis was effectively treated with non-surgical methods [17]. However, some pregnant ladies also suffered septic shock after non-surgical treatment [18]. Therefore,

non-surgical interventions in pregnant ladies are riskier than the performance of surgery or appendectomy. In the case of antibiotic treatment, there are reports of discontinuation of the antibiotics upon the improvement of the symptoms without proper completion. This discontinued medication sometimes decreases the reliability of antibiotic intervention thereby worsening the severity of the disorder [19]. There are some reasons which make it necessary to perform appendectomy after non-surgical medical intervention. First is the reoccurrence of the disease and second is the occurrence of appendicular neoplasm. The risk of reoccurrence of acute appendicitis is far less than that of occurrence of appendicular neoplasm. Moreover, the risk of the occurrence of appendicular neoplasm takes an edge with the growing age of patients [20,21]. This risk is higher in complicated appendicitis [22]. Therefore, we can say that if the signs of reoccurrence of appendicitis and appendicular neoplasm are less, then it is better to avoid appendectomy in non-complicated appendicitis. However, in acute appendicitis, it is the best option because it mitigates every possible after-effect of the disorder in a critically ill patient and relieves him.

Literature Review

Though acute appendicitis is a challenge since previous centuries yet the accurate diagnostic workup is still challenging. The need of the hour is a two-step diagnosis [23]. Firstly, Acute Appendicitis should be separated from other abdominal comorbidities. Secondly, differentiation must be conducted between complicated and uncomplicated Acute Appendicitis. In patients suffering acute appendicitis, perforation becomes the most dangerous complication. It results in sepsis, fertility issues, peritonitis, bowel obstruction and abscesses [24]. Perforation can be prone to many complications of postoperative nature. Moreover, it can also increase hospital stay as well as increase antibiotic dosages. The rate of perforation in adults lies between 17%-32% [25]. Observational study on children with Acute Appendicitis reveals that more than 48 hours duration after the onset of symptoms results in increased perforation risks. In contrast, it is quite low in children operated within 24 hours [25].

The very common and the most basic symptom of Acute Appendicitis is abdominal pain. Occasionally, 50% of patients complain of colicky central abdominal pain along with vomiting. Later this pain migrates to the right iliac fossa [26].

However, most of the patients bear peri-umbilical colicky pain which gets very severe within 24 hrs and later on shifts to the right iliac fossa [27]. A low-grade fever is also a symptom of Acute Appendicitis. Perforation or rupture becomes a major problem. As soon as the temperature of the body exceeds 38.3 C, this condition should be checked. The complicacy of this condition further complicates its diagnosis. To avoid any unnecessary complications,

physical exams and history taking play a major role [28]. Furthermore, the clinical setting, age factor, as well as symptoms, also play a major role in the acuteness of the condition. For the diagnosis of acute appendicitis, some determinants can be used in the efficient diagnosis and devising management strategies. The questionnaires like Pediatric appendicitis score, Appendicitis Inflammatory Response or the Alvarado Score can categorize the patients as low risk, moderate risk or high risk based on their laboratory findings. This act provides better assistance in diagnosis [29]. The accurate and efficient diagnosis of Acute Appendicitis prevents the morbidity rate and mortality. Moreover, on-time diagnoses reduce the risks of perforation. The study of individual signs and symptoms is also important. Skilled sonographers must perform first-line imaging or formal ultrasonography in vulnerable patients, especially in pregnant women and children. Acetaminophen or non-steroidal anti-inflammatory drugs and opioids should be given [30]. The most effective treatment for dealing with Acute Appendicitis is laparoscopic appendectomies. However, intravenous antibiotics must be a priority while treating children and adults suspected of acute appendicitis [31]. As far as physical examination of a patient with Acute Appendicitis is considered, abdominal tenderness occurs in maximum patients [26]. The abdomen region near or at McBurney's point is tender. This tenderness produces intense agony and rigidity in muscles in the right iliac fossa [27]. Usually, muscle guarding before Percussion tenderness of the abdominal region as well as rebound tenderness is the most authentic features of Acute Appendicitis. However, the absence of these reliable symptoms cannot minimize the probability of the condition. Laboratory findings and examinations show raised leukocytosis. Neutrophilia more than occurs in maximum cases. The urinalysis value becomes abnormal along with haematuria, bacteriuria and pyuria in 19% to 40% of patients [32]. Immunological examination of Acute Appendicitis of the patient shows appendiceal faecalith along with gas, terminal ileum distension and localized paralytic ileum, absent caecal shadow; blur right psoas muscle; free intraperitoneal [33]. As stated earlier, we cannot clearly say that some treatment is accurate for treating acute appendicitis. We also cannot say that there is any standard treatment for acute appendicitis. It is so because there is no standard evidence-based approach for treating the condition. The treatment of this inflammatory disease varies from case to case and person to person. Medical sciences cannot proclaim that Acute Appendicitis is managed only by surgery or by a conservative method. Moreover, the treatment or diagnosis also depends upon the risk factors and clinical condition of the suspected patient [34]. Moreover, the adoption of a conservative method treatment is followed by associated risks [35]. Although the World Society of Emergency Surgery (WSES) and The European Association of Endoscopic Surgery (EAES) give priority to the

conservative diagnosis, they also emphasize defining appendectomy at inflammation-free intervals [36].

The demand for conservative treatment of Acute Appendicitis is increasing universally. However, the chances of reoccurrence occur in this option. In contrast, laparoscopic appendectomy is an achievable alternative. It is so because laparoscopic surgery has a higher unproblematic recovery rate with a shorter hospital stay. It can be suggested that symptomatic patients who are vulnerable to severe complications must opt for laparoscopic appendectomy surgery [37]. Earlier, the operation for acute appendicitis was performed as early as feasible to avoid perforation and other related complications [38]. No clear evidence is found on this point also. As stated earlier, appendectomy is very commonly performed in many countries (eg. Germany). The lifetime risk of acute appendicitis is more in men than in women [39]. Nowadays, laparoscopic appendectomy, surgery for Acute Appendicitis is very common and easily available. Near about 25% of the appendectomies on children are done with the laparoscopic method. Appendectomy, with time, has become a safer method and has less surgical risk [40]. In addition to this, the comorbidities and mortality of patients who have undergone appendectomy is the result of their earlier medical history and complicity of the condition [41]. Vermiform appendix acts as a reservoir for the intestinal microbiome. As soon as Acute Appendicitis is suspected, the clinician should perform a physical examination at priority along with blood tests [42]. Nowadays, laparoscopic appendectomy surgery has been accepted universally by Acute Appendicitis patients. This open cholecystectomy is safe and ensures short duration hospitalization and speedy recovery [43].

Developed by Semme in 1996, it results in minimal morbidity. Moreover, both oral and parenteral medication dosages were short in laparoscopic appendectomy as compared to open appendectomies. This oral medication diminishes pain in this kind of surgery and makes it advantageous [44]. Moreover, postoperatively, the patients who opted for laparoscopic appendectomy recovered fast as compared to open appendectomies. Studies show that these patients returned to work after 2 weeks of surgery whereas open appendectomy patients resumed their work in approx a month. Studies provide an evidence-based efficient analysis of this technique. It could also be performed on Acute Appendicitis patients with higher perforation rates [45].

Therefore, as far as diagnosis of Acute Appendicitis is concerned, laparoscopic appendectomy is also a leading intervention for typical complicated conditions. Based on a meta-analysis, we can say that a very short delay does not complicate the condition of the patient. However, the period between the onset of the condition to the complicity of appendicitis decides appendectomy. Therefore, on

observing free intraperitoneal air, children and adults with severe comorbidities should be operated.

Centuries ago, severe pain in the right side abdomen was recognized as the core symptom of Acute Appendicitis. Despite being immensely researched presumably evident in pathophysiology, the accurate diagnosis of acute appendicitis is still mysterious. Though millions of researches, to date, are performed on this condition yet absolutely correct pathophysiology of the appendix and its related diseases is unknown. We can conclude that the diagnosis of inflammatory diseases or conditions is always prone to controversies. Despite relevant theories and evidence, the decision regarding diagnosis and management at the appropriate time is important for the desirable outcome [46].

Materials and Methods

The study is a Retrospective cohort. The study was conducted during the periods of 11 months. The study considered 97 patients with appendicitis and divided them based on the protocol by which they receive diagnosis and management. Out of 97 patients, 49 patients were assigned to group 1 and the other 48 patients were assigned to group 2. Group 1 includes those patients who were treated symptomatically and diagnosis and management were given to them according to the wish of the consulting physician. While Group 2 includes those patients for whom the ALVARADO scoring system was followed. Then both the groups were given appropriate management and outcomes were measured.

Although there are several scoring systems developed to diagnosis acute appendicitis properly, the present study has used the Alvarado Scoring system which is used in diagnosing acute appendicitis popularly. Diagnosis by scoring implies the efficient determination of the condition using parameters that should be easier for the clinicians. The Alvarado system is comprehensive, effective and suitable for use in the clinical setting. This scoring system is reproducible, reflects Murphy's triad and can be used by clinicians with less experience. Thus, employing Alvarado Scoring system will significantly decrease the time to definite diagnosis and thereby reduce the probability of onset of complications [47].

For Group 2 patients, the Alvarado criteria were strictly followed for diagnosis while for Group 1 patients, it was simply a few clinical features based on which acute appendicitis was diagnosed. Therefore, for Group 1 patients, the time to diagnose them was more and proper management was not provided to them. This study retrospectively applied the Alvarado score on Group 1 patients and accounted for their management which was given for each of the patients. To determine the efficacy of Alvarado scoring including its diagnostic value and its corresponding recommended management, this study has used complications of appendicitis (mainly perforation), as it can lead to peritonitis, bowel obstruction, abscess, sepsis.

Alvarado Scoring

This study has employed the following table as part of the Alvarado criteria (Table 1).

Table 1: Alvarado Criteria for diagnosis of acute appendicitis

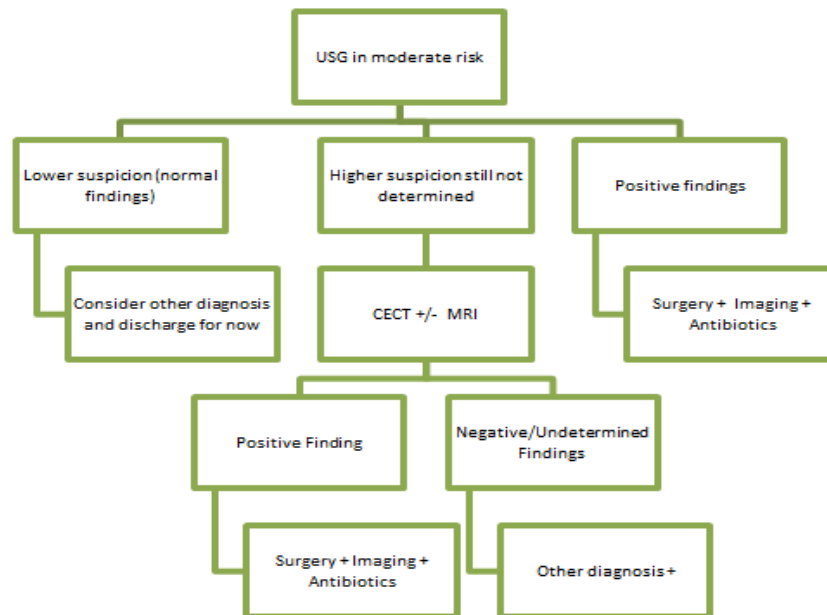
Criteria	Score
Migration of pain	1
Anorexia	1
Nausea/vomiting	1
Right lower quadrant Tenderness	2
Rebound tenderness	1
Temperature $\geq 37.3^{\circ}\text{C}$ (99.1°F)	1
Leukocytosis $\geq 10,000$ per μL (10.0×10^9 per L)	2
PMN $\geq 75\%$	1
Total possible score	10

As Group 2 patients were diagnosed and managed according to the Alvarado scoring system, so, this study has determined the Alvarado scoring for the patients of Group 1 retrospectively. The following table shows the required management profiles based on the above Alvarado scoring (Table 2).

Table 2: Alvarado Criteria and its clinical management strategy

Management strategy based on Alvarado Scoring		
Alvarado score < 4 (Low Risk)	Alvarado score: 4-6 (Moderate Risk)	Alvarado score ≥ 7 (High Risk)
Conservative management	USG of abdomen (Right Lower Quadrant) + Pelvic USG (females only) ↓ Refer to Figure 1	Surgical Management \pm Imaging studies \pm antibiotics

If Alvarado scoring comes to be 4 to 6, then, ultrasound of the Right Lower Quadrant has to be done and based on the results, we can divide the outcomes into 3 categories, namely lower suspicion, higher suspicion and positive finding. Thereafter, the management strategy has to be followed (Figure 1).

**Figure 1: Clinical management strategy in Moderate risk based on Alvarado Score**

Summarizing Group 1 patients

This study has retrospectively attached Alvarado Scoring on the patients of Group 1. But during their treatment, Group 1 patients were not treated according to Alvarado Criteria, instead, they received treatment according to the wish of the consulting doctors. So, we retrospectively determined their received treatment and found the following. 12 patients had much lesser clinical features and were given conservative treatment. However, their Alvarado score came to be less than 4. This was according to the Alvarado criteria. There are 15 patients whose Alvarado score was found to be 4 to 6 but Ultrasound was not done. According to Alvarado score, ultrasound needs to be done in patients with a score of 4-6. But 15 patients of

Group 1 were not given ultrasound whose Alvarado score was later found to be 4 to 6. However, 12 patients in Group 1 were given ultrasound whose Alvarado score was later found to be 4 to 6. These 12 patients received an ultrasound which was according to the Alvarado scoring criteria. But among these 12 patients, only 4 patients received treatment according to Alvarado scoring criteria while 8 patients did not receive it. These 8 patients' treatments were significantly different from Alvarado criteria. 10 patients were found to have Alvarado scores of more than 7 who can be regarded as at high risk. Out of these 10 patients, 3 were given treatments similar to Alvarado criteria while 7 received treatments that were significantly different from Alvarado criteria. Refer to Table 3.

Table 3: Alvarado Scoring for Group 1 patients done retrospectively

Alvarado score < 4(Low Risk)	Alvarado score: 4-6 (Moderate Risk)		Alvarado score ≥7 (High Risk)		
	N = 12	N = 15	N = 12		
Received conservative management (similar to Alvarado Criteria)	USG not done	USG done		Treatment is given similar to Alvarado Criteria (N = 3)	Treatment is given much different from Alvarado Criteria (N = 7)
		Treatment is given similar to Alvarado Criteria (N = 4)	Treatment is given much different from Alvarado Criteria (N = 8)		

Determination of outcomes

The efficient management of appendectomy should result in the disappearance of pain and complete resolution. But if the management is not efficient enough, may result in complications. It may complicate into the most concerning condition, that is, perforation which may result in 17% to 32% of cases in adults. Perforation, in turn, may lead to peritonitis, bowel obstruction, abscess and sepsis [48,49]. Timing of the surgical management is also important to bring the desired outcome. If surgical management is required, it should not be delayed more than 48 hours as it may lead to other complications like surgical site infection (SSI) [50].

For the determination of outcomes of treatments given to Group 1 and Group 2 patients, the study considered complications found in the patients. These complications are recorded for each of the groups. Also, the study

recorded the complication in each of the treatment methods of Group 1 patients. This allowed the authors of this study to find out how outcomes vary when treatment is given differently from that of Alvarado Scoring criteria.

Result

The complications that were found in the study participants are fever, generalized peritonitis, perforation, abscess, a mild respiratory infection. The study found that the complications among the patients in Group 1 and Group 2 separately (Table 4 and Figure 2). In Group 1, 8 patients had a fever while 3 patients had a fever in Group 2. Group 1 patients had all the listed complications including perforation (n=7), abscess (n=4), mild respiratory infection (n=3) and peritonitis (n=2). In Group 2, only 4 patients showed complications including fever in 3 patients and perforation in 1 patient.

Table 4: The complication after the treatment given to Group 1 and 2

Complications	Group 1	Group 2
Fever	8	3
Generalised peritonitis	2	0
Perforation	7	1
Abscess	4	0
Mild respiratory infection	3	0

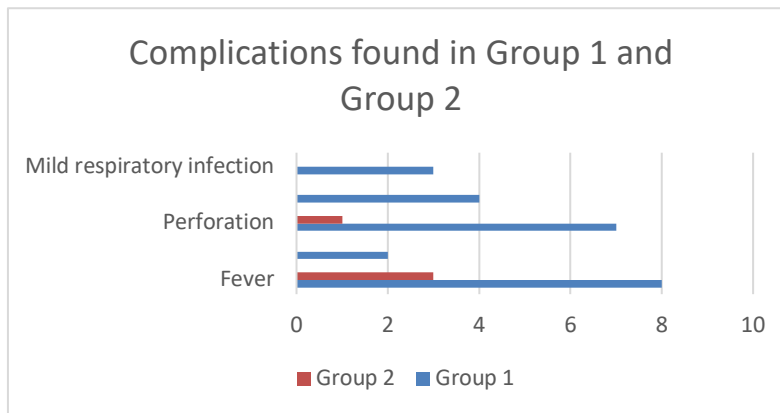


Figure 2: Complications found in the patients of Group 1 and 2

The table below shows the number of patients found after the treatment with each of the complications mentioned above (Table 5).

Table 5: Specific complications found in Group 1 patients

Alvarado Score	Number of patients	Description	Complications				
			Fever	Generalised peritonitis	Perforation	Abscess	Mild respiratory infection
< 4	12	Received conservative management (similar to Alvarado Criteria)	1	0	0	0	0
4-6	15	USG not done	6	0	4	2	1
	4	USG done and Treatment given similar to Alvarado Criteria (N = 4)	0	0	0	0	0
	8	USG done but Treatment given much different from Alvarado Criteria (N = 8)	0	0	1	1	2
≥ 7	3	Treatment is given similar to Alvarado Criteria (N = 3)	0	0	0	0	0
	7	Treatment is given much different from Alvarado Criteria (N = 7)	1	2	2	1	0

Discussion

The result of the study has shown that the patients who were given diagnosis and treatment according to Alvarado Score (Group 2 patients), were found to be the least possible complications. In Group 1 patients, although the diagnosis and treatments were given according to the wish of the consulting doctors, the treatments which were given similar to Alvarado criteria had resulted in lesser complications. While treatments that differed significantly from the Alvarado criteria had resulted in various complications.

Alvarado scoring system and its clinical management strategy enable the clinicians to do risk stratification in patients who are presented with acute abdominal pain and provide efficient management to bring desired outcome (complete resolution) with the least complication [51].

Conclusion

The study found that patients with suspected acute appendicitis should be diagnosed and managed according to the Alvarado Score and its clinical management strategy respectively. The study has concluded that following Alvarado criteria in diagnosis and management of acute appendicitis results in the least possible complications which is evidenced by the finding that 24 patients from much more complications significantly did not get treatment according to Alvarado management strategy. While only 4 patients from Group 2 had complications who received management according to Alvarado criteria. Hence, the study suggests the clinicians follow Alvarado criteria for proper management of acute appendicitis and also recommends conducting larger studies in the future to keep Alvarado criteria updated.

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