**Original Research Article**

# Nigam's scoring system for acute appendicitis with high accuracy surpassing Alvarado scoring system

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## ABSTRACT

**Background:** Acute appendicitis is one of the most common surgical emergencies. Delay in the treatment of acute appendicitis can result in complications, may be lethal. That's why the early diagnosis and quick treatment is essential. The diagnosis of acute appendicitis is still a clinical one. Alvarado scoring system is the commonest scoring system but it has many lacunae. Nigam's scoring system (NSS) is invented to deal with drawbacks of Alvarado scoring system and improve accuracy.
**Methods:** NSS has 17 scoring points. This scoring system can be divided into three parts, 6 and below 6, 7 to 10, and 11 and above. This study includes 36 patients of acute abdomen during a period of 8 years from Jan 2012 to Jan 2020. The diagnosis of acute appendicitis by NSS was compared with the ultrasonography findings, operation findings, and histopathological results.
**Results:** Out of 36 patients 2 patients scored 6 and below, 3 patients scored 7 to 10 and 31 patients scored 11 and above. Accuracy of NSS resulted in 100%. No negative appendicectomy was recorded.
**Conclusions:** NSS has better accuracy than Alvarado scoring system in diagnosing acute appendicitis. NSS is an easy, economical, simple, accurate, fast and dependable scoring system. NSS is best suited for small hospitals which lack advance investigative techniques such as ultrasound, CT scan and MRI.

**Keywords**: Accuracy, Acute appendicitis, Alvarado scoring system, Complications, Diagnosis, Negative appendectomy, NSS

## INTRODUCTION

Acute appendicitis is one of the most common surgical diseases. It can turn to be a life-threatening illness if not treated carefully and well. Globally, acute appendicitis is a common surgical emergency with a life risk of 1 in 7, which means that 6% of the individuals suffer an attack during their life time.[1-3] Early diagnosis and prompt operative intervention is the key for success in the management of acute appendicitis. However, the picture of acute appendicitis may not be classical, and in such situation, a policy of early intervention to avoid perforation may lead to high negative appendicectomy rates.[4,5] Negative appendectomy rates of 20% is commonly reported.

The American general surgeon Alfredo Alvarado developed a scoring system to diagnose acute appendicitis in 1986. The score has 6 clinical items and 2 laboratory measurements with a total 10 points. It gives 1 point to abdominal pain that migrates to the right iliac fossa, anorexia, nausea or vomiting, rebound tenderness, fever of 37.3º C or more and neutrophilia >70% and 2 points to tenderness in the right iliac fossa and leucocytosis >10,000. A score of 5 or 6 is compatible with the diagnosis of acute appendicitis. A score of 7 or 8

indicates a probable appendicitis, and a score of 9 or 10 indicates a very probable acute appendicitis.[6]

The Alvarado score has largely been superseded as a clinical prediction tool by the appendicitis inflammatory response (AIR) score.[7] This system according to Andersson, correctly classifies the majority of patients with suspected appendicitis, leaving the need for diagnostic imaging or diagnostic laparoscopy to the smaller group of patients with an intermediate scoring result.[8]

Another scoring system, the Raja Isteri Pengiran Anak Saleha appendicitis (RIPASA) scoring system was established in 2008 specially for Asian populations. RIPASA score is a clinical prediction rule (CPR) for the diagnosis of acute appendicitis. It was developed by William Chong, a cardiothoracic surgeon at RIPAS hospital in Bandar Seri Begawan in Brunei.[9]

Alvarado score gained popularly as it is easy, noninvasive, simple, reliable and repeatable diagnostic method. It carries high significance in the diagnosis of acute appendicitis.[10] Sensitivity and specificity of the Alvarado scoring system were found to be 93.5% and 80.6% respectively. Positive and negative prediction values were 92.3% and 83.3% respectively and accuracy was 89.8%.[11] Timely diagnosis of acute appendicitis is very important in the medical practice to avoid complications such as perforation, abscess formation and peritonitis, and at the same time could reduce the negative appendectomy rate.[12] Studies indicate that the Alvarado score has moderate to high sensitivity (all studies 82%, men 86%, women 88%, and children 87%) and a moderate specificity (all studies 81% men 57% women 76% and children 76%) suggesting it is not sufficient accurate to rule in or out surgery.[13]

The modified Alvarado score is presently in use for establishing diagnosis of acute appendicitis. The scoring includes elements from the patient history, the physical examination and laboratory tests. Abdominal and pain migrating to RIF, anorexia or ketone bodies in urine, nausea or vomiting, tenderness in the RIF, rebound tenderness, fever of 37.3° Celsius or more, leucocytosis more than 10,000. Tenderness in RIF and leucocytosis are two most important factors and are given 2 points each and other factors are assigned one point each, for a total of 10 points, score 1-4 indicates very unlikely appendicitis and 8-10 highly probable of appendicitis.[14]

The objective of our study is to find a scoring system having accuracy better than others. The new scoring system should not depend on advanced investigative methods.

**METHODS**

This study is an original study. This study was done between Jan 2012 to Jan 2020 at Max hospital, Gurgaon,

Haryana, India. Total 36 patients of acute abdomen with right iliac fossa pain were included. Most of these patients were seen by medical officer and then referred to us as a suspected case of acute appendicitis. Age of patients varied from 13 years to 46 years. Out of 36 patients 28 (77.8%) patients were male and 8 (22.3%) patients were female. Complete blood count and urine examination was done along with clinical examination. We calculated the score according to our NSS. Our decision to operate was primarily based on NSS score. Later on, we compared our diagnosis with ultrasonography, operative and histopathological findings (Table 1).

We developed the NSS by adding our experience to make it more accurate. NSS improves the outcome of scoring system. NSS is developed to improve diagnostic accuracy to avoid delay in surgical intervention to predict the severity of acute appendicitis, reduce the complications, avoid negative appendectomies and avoid requirement of expensive investigations such as ultrasound, CT scan and MRI. NSS is highly important and helpful in places where specialized investigation technologies are not available. It is useful in our villages or remote areas to diagnose acute appendicitis accurately. NSS helps in early diagnosis of acute appendicitis with confidence without any delay.

True positive, true negative, false positive and false negative factors were considered for statistical analysis.

Patients of acute abdomen with pain in right iliac fossa were included in this study and patients with acute abdomen having pain elsewhere were excluded.

The informed consent was taken from all patients.

**Table 1: NSS, n=36.**

| Variables | Score |
|---|---|
| **Symptoms** | |
| Migratory right iliac fossa | 1 |
| Anorexia | 1 |
| Nausea/ vomiting | 1 |
| Pain precedes vomiting | 1 |
| Vomit precedes pain | -1 |
| **Signs** | |
| Tenderness RIF (Mild) | 2 |
| Tenderness RIF (Moderate) | 3 |
| Tenderness RIF (Severe) | 4 |
| Rebound tenderness in RIF | 2 |
| Guarding in RIF | 2 |
| Elevated temperature | 1 |
| **Laboratory findings** | |
| Leucocytosis 10000-12000 | 2 |
| Leucocytosis 12000-15000 | 3 |
| Leucocytosis more than 15000 | 4 |
| **Maximum score** | 17 |

Informed consent was taken from all patients. All patients were subjected to ultrasound of abdomen. All patients above score 11 (34) were operated for appendicectomy as an emergency operation. All appendices removed by operation were sent for histopathological examination.

**Table 2: Interpretation of NSS, n=36.**

| NSS | Interpretation |
|---|---|
| 6 and below 6 | Probably not acute appendicitis |
| 7 to 10 | Probably acute appendicitis |
| 11 and above | Confirmed diagnosis of acute appendicitis. |

**Table 3: NSS management guidelines, n=36.**

| Score | Management |
|---|---|
| 6 and below | Discharge with treatment |
| 7 to 10 | Admit for observation |
| 11 and above | Admit for appendectomy |

**Table 4: NSS results of our study, n=36.**

| Score | No. of patient | Percentage (%) |
|---|---|---|
| 6 and below | 2 | 5.5 |
| 7 to10 | 3 | 8.3 |
| 11 and above | 31 | 86.2 |

**Table 5: Histopathology results of appendectomy.**

| Results | No. of patient | Percentage (%) |
|---|---|---|
| Negative appendectomy | 0 | 0 |
| Appendicitis confirmed by histopathology | 34 | 100 |

## RESULTS

We have to confirm the diagnosis of acute appendicitis before doing appendectomy otherwise there is chance of negative appendectomy. NSS confirmed the diagnosis of acute appendicitis in all cases before appendectomy. The diagnosis was based on NSS which were compatible to the operative and histopathological finding in all cases. There was not a single case of negative appendectomy among 34 operated cases. The negative appendectomy rate was zero. Out of 34 patients diagnosed as appendicitis by NSS all patients underwent appendectomy and appendicitis was confirmed in all cases by operative and histopathological findings. Four patients were having perforation and these all patients had leucocytosis above 15000 and tenderness in RIF was severe.

If NSS comes 6 or below, probabily we are not dealing with acute appendicitis. If the score is between 7-10 probabily diagnosis of appendicitis cannot be ruled out. If the score is 11 or more, we are dealing with a case of appendicitis Table 2. Higher the score after 11, severe is the inflammation, from acute appendicitis to impending perforation or gangrene. The scoring by NSS decides about the management of case. Patient with score below 6 are advised OPD treatment. Patients with score 7-10 are admitted to the hospital for observation and score 11 or above was operated. Out of 36 patients 2 were having scoreless then 6 and were discharged with symptomatic treatment, 3 patients had score between 7-10, were kept in observation and later were operated for appendectomy as their score become 11 and more, 31 patients had score 11 and above and all were operated for appendectomy (Table 3 and 4).

*Accuracy*

The accuracy of a test is its ability to differentiate the patient and healthy cases correctly. Mathematically, this can be stated as:

Accuracy= TP + TN/ TP + TN + FP + FN

In our study=34+0/34 + 0 + 0 + 0=100%

*Sensitivity*

The sensitivity of a test is ability to determine the patient cases correctly. Mathematically, this can be stated as:

Sensitivity= TP/TP + FN

In our study= 34/34 + 0=100%

(TP=True positive, TN=True negative, FP=False positive, FN=False negative).

It is small study but we feel that NSS gives better diagnostic accuracy than Alvarado and other scoring systems.

## DISCUSSION

Acute appendicitis remained the most common of acute abdomen since Reginald H. Fitz who first described the disease and introduced the term appendicitis in 1886.[15]

Inflammation of the appendix may be self-limiting but may progress and the appendix perforates. If the perforation is successfully walled off, an appendix mass is clinically evident. If the perforation is not successfully isolated, generalized peritonitis occurs, leading to shock and even death. As the omentum is less well developed in the infant, the morbidity and mortality is higher in this group.[16] Mortality associated with acute appendicitis has decreased steadily during the 20th century, and in the United States has been recently reported as 0.2 deaths per 100000 cases.[17] This is due to accurate and early diagnosis probably due to scoring systems and advanced technologies.

Tenderness in RIF and leucocytosis are the most important factors in NSS and that's why more points are given to various stages of these two factors in NSS. If someone has severe tenderness in RIF and leucocytosis more than 15000 then it indicates appendicitis and with other symptoms it will earn sufficient points, fit for urgent appendicectomy. This happened in our series several times and we found highly inflamed, or perforated or gangrenous appendix. Because of these points Alvarado himself modified his scoring system in 2016 and refined the criteria of the MANTRELS mnemonic, giving more importance to tenderness and leucocytosis which was not given such importance earlier.[18] In NSS we gave even more importance to tenderness in RIF and leucocytosis than modified Alvarado system. The Alvarado score has overall accuracy for diagnosing acute appendicitis is approximately 80% with a false-negative appendectomy rate of 20%.[19]

Pain preceding vomiting is an important symptom of acute appendicitis but if vomiting proceed pain, probably you are not dealing with appendicitis. This important feature of acute appendicitis is missed by all scoring systems. We have included this factor also in NSS. In most surgical textbooks it has been stated that pain almost always preceeds vomiting in patients with appendicitis. However, the usefulness of this classic history item, "pain before vomiting", has been investigated in only one study nearly 50 years ago.[20] Vomiting that preceeds pain is suggestive of intestinal obstruction, and diagnosis of appendicitis should be reconsidered. The most common symptom of appendicitis is abdominal pain.[21]

Murphy's triad, pain, vomiting and fever, named after John Benjamin Murphy, an American physician and abdominal surgeon and one of the earliest advocates for the intervention for the removal of the appendix in all cases of appendicitis, is important. According to the British medical journal, Murphy's triad consists of pain in the abdomen followed by nausea or vomiting, and general abdominal sensitiveness on the right side, followed elevated body temperature.[22]

Diagnosis of appendicitis has a considerable rate of negative appendicectomy varying from 20-40%.[23,24] It's by no means an easy diagnosis to make, particularly at an early stage, failure to diagnose acute appendicitis at an early stage leads to progression of disease and with morbidity and occasional mortality. It's complications are more in young children and elderly.[25,26]

In case of acute appendicitis, surgeon has to balance his decision to operate, between negative appendectomy and complications. Therefore, an early and definitive diagnosis is required to reduce chances of both negative appendicectomy and perforation. Here NSS plays a major role. A clinical decision to operate early leads to the removal of normal appendix in 15-30% of cases (although the figure may be higher or lower in certain demographic groups).[27] None the less, if a period of observation culminates in the diagnosis of a ruptured appendix, the patient may have a poor outcome that is avoidable. Reduction in the number of unnecessary or non-therapeutic operation should not be achieved at the expense of an increase in number of perforations.[28] CT scan has become gold standard to diagnose acute appendicitis but there are some problems. However, some studies have shown that the use of CT does not necessarily change the clinical management of a patient, especially in those at high risk.[29,30] and may also delay the time of operation and increase the subsequent risk of perforation.[31] Over utilization of (CT) imaging for the diagnosis of acute appendicitis should be discouraged.

An inflamed appendix in the pelvis may never produce somatic pain involving the anterior abdominal wall, but may cause suprapubic discomfort and tenesmus. In this circumstance, tenderness may be elicited only on rectal examination and is the basis for the recommendation that a rectal examination should be performed on every patient who presents with acute lower abdominal pain.[32] Here leucocytosis, fever, vomiting is helpful to reach the diagnosis by scoring through NSS. Despite it being a common health problem, the diagnosis of acute appendicitis is still difficult to make, especially in young persons, the elderly and in reproductive age women. Various genitourinary or gynaecological inflammatory conditions can present with signs and symptoms similar to those of acute appendicitis.[33] Graded compression ultrasonography is helpful here but is expensive. It is particularly useful in female patients when a differential diagnosis of twisted ovarian cyst, ectopic pregnancy or some other gynaecological pathology is being suspected.[34] NSS can diagnose acute appendicitis accurately by excluding all these pathologies.

Total 36 patients of suspected acute appendicitis were included in this study, 2 patients had score below 6 and 3 patients were between 7-10 points 31 patients had score 11 and above. All patients were divided in two groups, group A (NSS below 6) and group B (NSS between 7 and above). All patients were scored by clinical feature and laboratory values. Accuracy, sensitivity, and specificity were calculated. Two patients (5.5%) below 6 points were kept in group A and 34 patients (94.5%) with points above 11 kept in group B. Emergency appendectomy was performed in 34 patients (94.5%). Diagnosis by histopathology was confirmed in all 34 patients (100%). Negative appendectomy score was zero (Table 5).

This study only includes patients of acute abdomen. We have limitations of not including patients of chronic abdominal pain.

## CONCLUSION

Acute appendicitis is a dangerous disease if diagnosis and treatment are delayed. NSS is a simple, reliable and

accurate method to diagnose acute appendicitis without needing CT scan or MRI. NSS enhances the importance of clinical examination to diagnose accurately acute appendicitis without any delay. If the diagnosis by clinical examinations is dependable and accurate then the delay caused by special investigations such as CT scan and MRI can be avoided and there by the serious complications such as perforation of appendix and peritonitis.

## ACKNOWLEDGEMENTS

## REFERENCES

1. Owen TD, William H, Stiff G, Jenkinson LR, Rees BI. Evaluation of Alvarado scoring in acute appendicitis. JR Soc Med. 1992;85:87-8.
2. Mardan MA, Mufti TS, Khattak IV. Role of ultrasound in acute appendicitis. J Ayub Med Coll Abottabad. 2007;19:72-8.
3. Singh KP, Gupta S, Parga P. Application of Alvarado scoring system in the diagnosis of acute appendicitis. JK Sci. 2008;10:84-6.
4. Paulson E. Clinical Practice: Suspected Appendicitis. NEJM. 2003;248:236-42.
5. Kanumba ES, Mabula JB, Ramabu. Modified Alvarado scoring system as a diagnostic tool for acute appendicitis at Bufando Medical Centre. Moonza, Tanzoma. BMC surg. 2011;11:4.
6. Alvarado A. A practical score for the early diagnosis of acute appendicitis. Ann Emergency Med. 1986;15(5):557-64.
7. Douglas CD. Randomized controlled trial of ultrasonography in diagnosis of acute appendicitis, incorporating the Alvarado score. BMJ. 200;321(7206):919-22.
8. Andersson M, Andersson RE. The Appendicitis inflammatory response score, a tool for the diagnosis of acute appendicitis that outperforms the Alvarado score. World J Emergency. 2008;32(8):1843-9.
9. Adi MIW, Thien A, Suyol A, Mackie AJ, Astin S, Tripathi S et al. Development of the RIPASA score a new appendicitis scoring system for the diagnosis of acute appendicitis. Singapore Med J. 2010;51(3):220-5.
10. Chan MY, MG BL. The Alvarado score in acute appendicitis. Ann Academy Med Sing. 2001;30(5):510-2.
11. Memon ZA, Sami W. Acute appendicitis. Diagnostic accuracy of Alvarado scoring system. Asian J Sur. 2013;36(4):144-9.
12. Alvarado A. Improved Alvarado score (MANTRELS) for the early diagnosis of Acute Appendicitis. Int J Surg Res Practice. Alvarado Int J Surg Res Pract. 2019;6:098:1-6.
13. Ohle R, O' Reilly F, Dinitrov BD. The Alvarado score for predicting acute appendicitis. A systematic review. BMC Med. 2011;9:139.
14. Rajshekhar J, Uday MM, Naveen N. Modified Alvarado score and its Application in the Diagnosis of Acute Appendicitis. IJCMR. 2013;3(5):1398-400.
15. Abbas ARM, Safaa AM, Ashwag HAQ, El Syed AA, Al Shigiti NA. Accuracy of Alvarado Scoring System and Selective Computed Tomogarphy in Diagnosis of Suspected Cases of Acute Appendicitis. J Clin Res Rep. 2020;1(2):1-11.
16. Lumley JSP. Acute appendicitis The Acute Abdomen. Hamilton Bailey Physical signs, Butter Worth-Heineman. 18th Editions International Editors.. 1997;304.
17. Lowry SF, Hong J. Appendicitis and appendicial absess. Mastery Surg. 2007;5(2):1430.
18. Alvarado A. How to improve the clinical diagnosis of acute appendicitis in resource limited settings. World J Emrg Surg. 2016;26:11-6.
19. Alvarado A. Clinical Approach in the Diagnosis of Acute Appendicitis. Intech Open. 2018.
20. Takada T, Inokuchi R, Kim H, Sasavi S, Terada K, Yokota H et al. Is "pain before vomiting" useful? Diagnostic performance of the classic patient history item in acute appendicitis. Am J Emrg Med. 2021;41:84-9.
21. Craig S. Appendicitis Clinical Presentation. Drug and Disease. Emergency Med. 2018.
22. Robert SL. Murphy's Triad. BMJ. 1971;1(5745):401-2.
23. Rajshekhar J, Uday MM, Naveen N. Modified Alvarado score and its Application in the Diagnosis of Acute Appendicitis. IJCMR. 2013;3(5):1398-400.
24. Teacher I, Landa B, Cohen M. Scoring system to and in diagnosis of appendicitis. Am Surg. 1983;198:753-9.
25. Queshi H, Burud L. Modified Alvarado scoring system in the diagnosis of acute Appendicitis. J Young Mid Rcs. 2014;1(2):1-6.
26. Kozar RA, Roslyn JJ. The Appendix. Principles of Surgery. Mc Graw Hill. 7th Edn. 1999;1383-93.
27. Hoffman J, Rasmussen OO. Aids in the diagnosis of acute appendicitis. Br J Surg. 1989; 76: 774-779.
28. Velanovich V, Savata R. Balancing the normal appendectomy rate with the perforated appendicitis rate: implication for quality assurance. Am Surg. 1992;58:26-9.
29. Petrosyan M, Estrada J, Chan S, Somers S, Yacoule WN. CT scan in patient with suspected appendicitis. Clinical implications for the acute care surgeon. Eur Surg Res. 2008;40:211-9.

30. Santos DA, Manunga JJr, Hohman D, Avik E, Taylor EW. How often does computed tomography change the management of Acute Appendicitis? Am Surg. 2009;75(10):918-21.
31. Evans SRT. Appendicitis 2006. Ann Surg. 2006;244(5):661-2.
32. Williams NS, O' Connell PR, Mc Caskie AW. Bailey and Love's. Short Practice of Surg. 2018;27(2):1303.
33. Yalmanchili N, Mortala VR, Medasani R, Gade RKR. Study of modified Alvarado score and ultrasound imaging with post-operative histopathology in diagnosis of acute appendicitis. IJSS. 2021;5(4):91-6.
34. Connor TJ, Garcha IS, Ramshaw BJ. Diagnostic laparoscopy for suspected appendicitis. Am Surg. 1955;61:187-92.