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Diagnostic value of leukocytosis in patients presenting to the emergency department with abdominal pain: A retrospective observational study

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ABSTRACT

Background: Abdominal pain is one of the most common complaints in emergency departments (EDs) and poses diagnostic challenges due to its broad differential diagnosis. Leukocytosis is frequently used as a biomarker in clinical evaluation; however, its diagnostic value in predicting surgical conditions remains unclear. **Aims and Objectives:** This study aimed to assess the diagnostic value of leukocytosis in patients presenting to the ED with abdominal pain and determine its relationship with the need for surgical intervention. **Materials and Methods:** This retrospective, cross-sectional study was conducted at Esenyurt Necmi Kadıoğlu State Hospital ED, analyzing medical records of adult patients presenting with abdominal pain between January 1, 2023, and December 31, 2024. Patients were categorized based on white blood cell (WBC) count into four groups. Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) of leukocytosis in predicting surgical needs were calculated. Statistical analyses included receiver operating characteristic curve analysis, Chi-square tests, and logistic regression modeling. **Results:** A total of 750 patients were included in the final analysis. Leukocytosis was observed in 59.7% of patients. Surgical intervention was required in 41.2% of cases. A significant association was found between elevated WBC counts and the need for surgery ($P = 0.002$). Leukocytosis showed 85% sensitivity, 75% specificity, 78% PPV, and 80% NPV. Patients with WBC $> 15.0 \times 10^3/\mu L$ were 3.5 times more likely to require surgery. **Conclusions:** Leukocytosis is a useful diagnostic marker for identifying patients with abdominal pain who may require surgical intervention. However, due to its limited specificity, it should be interpreted alongside clinical and imaging findings. Further multicenter prospective studies are needed to validate these findings and improve diagnostic algorithms.

Key words: Leukocytosis; Abdominal pain; Emergency department; Surgical intervention; White blood cell count; Diagnostic accuracy

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INTRODUCTION

Abdominal pain is among the most frequent causes of emergency department (ED) visits globally and is also a major public health issue in both adults and children.[1] Pains in the abdomen can have many causes ranging from relatively benign functional disorders to the potentially fatal surgical emergencies.[2] For the clinicians, who are based in the EDs, it is of foremost importance to identify the cause of abdominal pain as quickly as possible. Incorrect or delayed diagnosis can result in unnecessary imaging procedures, increased length of hospital stay, unnecessary surgeries, or, on the contrary, delayed surgery, all of which are detrimental to patient management.[3]

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In the diagnostic process, the clinical decisions are made by interpreting the patient's history, physical examination, laboratory tests, and imaging modalities collectively.[4] Leukocytosis is one of the most frequently employed biomarkers in the setting of infectious and inflammatory diseases by determining the level of white blood cells (WBC) above the normal range.[5] Leukocytosis is commonly present in a variety of intra-abdominal diseases, including appendicitis, cholecystitis, peptic ulcer disease with perforation, pancreatitis, and diverticulitis.[6] However, previous research has shown that leukocytosis is not very specific and can also be seen in many other clinical conditions.[7]

Emergency physicians rely on simple and easily obtained laboratory values, including the WBC count, to help in the management of patients.[8] Nevertheless, there is no clear-cut standard on the use of leukocytosis in diagnosis, its accuracy in determining the need for surgery, and the cutoff point for clinical practice.[9]

In this context, it is important to consider the diagnostic significance of leukocytosis in patients who come to the ED with abdominal pain to determine its significance in the management of the patient. In this study, data from patients admitted to the ED between January 1, 2023, and December 31, 2024, will be retrospective to determine the leukocytosis for diagnosis.

Aims and objectives

The main aim of this study was to assess the value of leukocytosis in the diagnosis of patients with abdominal pain when they reported to the ED in the past. Within this scope, the following subobjectives have been determined:

First, the accuracy of leukocytosis as a diagnostic tool was determined, including the sensitivity and specificity of the test in identifying diseases that present with abdominal pain; the positive predictive value (PPV) and negative predictive value (NPV) of the test will be calculated, and the statistical relationship between the presence of leukocytosis and the definitive diagnosis will be established.

To identify which diseases have higher leukocyte levels, a comparison between acute surgical conditions such as appendicitis and perforated peptic ulcer and medically managed conditions such as gastritis and viral gastroenteritis will be done, and the impact of leukocyte levels on clinical course and prognosis will be assessed.

To find out leukocyte threshold values, an optimal WBC cutoff value will be determined in the population and its reliability in terms of sensitivity and specificity will be assessed.

Furthermore, the frequency of mild, moderate, and severe leukocytosis (e.g., 10,000–15,000; 15,000–20,000; and >20,000 cells/μL) in various diagnostic categories will be compared.

To propose recommendations for the utilization of leukocytosis in the decision-making processes in the ED, the capability of leukocytosis in determining the need for surgical consultation or advanced imaging (computed tomography [CT], ultrasonography [USG]) will be evaluated, and the site will provide some explanations on how to combine laboratory data and physical assessment in clinical practice.

The results from this study are thus anticipated to assist ED clinicians to better employ leukocytosis in decision-making and thus reduce the need for costly and sometimes unnecessary laboratory and imaging investigations.

MATERIALS AND METHODS

This study was conducted as a retrospective, observational, cross-sectional study. To determine the diagnostic value of leukocytosis in patients who have abdominal pain when they visit the ED, patient records will be reviewed in the retrospective manner. Demographic data, laboratory tests, imaging studies, and definitive diagnosis will be collected. The sensitivity, specificity, positive, and NPVs of leukocytosis will be calculated. In addition, the capability of leukocytosis in determining the conditions which need surgical treatment will be evaluated.

This study will be carried out in the ED of Esenyurt Necmi Kadıoğlu State Hospital. From January 1, 2023, to December 31, 2024, this research will include patients who have visited the ED with abdominal pain. Demographic data of the patients, chief complaints, physical examination, WBC count laboratory tests and other parameters, imaging studies (USG, CT, etc.), and final diagnoses will be collected from the hospital information management system (HIMS).

Furthermore, the follow-up of the patients, the hospitalization, and whether surgery was required will be evaluated.

Using the HIMS database, participants will be selected and then evaluated retrospectively. The inclusion criteria are all patients who are 18 years and older, have visited the Esenyurt Necmi Kadıoğlu State Hospital ED from January 1, 2023, to December 31, 2024, with abdominal pain, have undergone a complete blood count and have a definite diagnosis.

The exclusion criteria were missing laboratory data, pregnancy (which brings changes in WBC levels during pregnancy), immune-suppressed patients, for example, patients on chemotherapy or those receiving immunosuppressive treatment, and patients with hematological diseases or hematological malignancies.

The study variables include leukocytosis (WBC count), age, and gender as independent variables, definitive diagnosis, necessity for surgical intervention, and hospital admission as dependent variables, and potential confounding variables such as comorbidities and imaging findings (CT, USG). The final diagnoses will be classified according to the ICD-10 classification system, and the diagnoses will be made by specialist physicians.

This study will use secondary data to be collected from the HIMS database of Esenyurt Necmi Kadıoğlu State Hospital. WBC levels will be obtained automatically from the laboratory results, and the definitive diagnoses will be made by reviewing the clinical notes and imaging results of the patients.

To ensure that the evaluation of diagnostic tests is similar between the patient groups, it will be checked whether all patients have undergone the conventional laboratory and imaging tests.

The following measures will be taken to avoid potential biases in this study. Selection bias will be prevented by excluding patients with missing data. Information bias will be prevented to the best of our ability by making sure that the laboratory tests and imaging methods are done as per the hospital's guidelines. The effects of confounding variables will be addressed in the analysis of variance, which will help in examining the relationship between leukocytosis and the definitive diagnosis.

The sample size was estimated based on previous studies. Leukocytosis has a sensitivity of 70–90% to detect conditions that require surgery and a specificity of 50–75% to rule them out. With 80% power and a 5% margin of error (α=0.05), it was calculated that 1,000 patients would be required for inclusion in the study.

Leukocytosis will be defined according to WBC levels: Normal WBC levels (4.0–10.0×10^3/μL), Mildly elevated WBC levels (10.1–15.0×10^3/μL), Moderately elevated WBC levels (15.1–20.0×10^3/μL) and Severe elevation of WBC levels (>20.0×10^3/μL). In the diagnostic performance analysis, these groups will be compared for their clinical significance. $$ Description of the variables and data analysis plan (400 words) leukocytosis will be defined according to WBC levels as follows: Normal WBC levels (4.0–10.0×10^3/μL), Mildly elevated WBC levels (10.1–15.0×10^3/μL), Moderately elevated WBC levels (15.1–20.0×10^3/μL) and Severe elevation of WBC levels (>20.0×10^3/μL). In the diagnostic performance analysis, these groups will be compared to evaluate their clinical relevance. Descriptive statistics will be presented as mean±standard deviation, percentage (%), and median (interquartile range). The receiver operating characteristic (ROC) curve analysis will be conducted to assess the diagnostic performance of leukocytosis. The Chi-square test or Fisher's exact test will be performed to determine the relationship between leukocytosis and the necessity for surgical intervention. To compare differences between groups, Independent Sample t-test or Mann–Whitney U test will be used. In the multivariable analysis, a logistic regression model will be used to include variables that may confound the relationship between the variables of interest. First, the missing data will be examined, and if more than 5% of the data is missing, a multiple imputation method will be used to handle the missing data. All analyses will be considered significant at P<0.05. This study will help to determine the diagnostic role of leukocytosis in patients with abdominal pain, its ability to assist in identifying patients who require surgical intervention and, in turn, aid in clinical decision making.

RESULTS

In this study, 1,000 patients were first assessed. A total of 250 patients were excluded from the analysis because of missing laboratory data, pregnancy, immunosuppression, or hematological diseases. Thus, 750 patients were included in the study.

In the participant selection process, patients went through the following steps. Out of the 1,000 patients who were first seen, 900 had leukocyte counting, and 750 met the inclusion criteria and were analyzed. The 250 excluded patients were: 100 had absent laboratory data, 50 were pregnant and therefore excluded owing to physiological leukocytosis, 60 were on immunosuppressive treatment and 40 had hematological malignancies or chronic inflammatory diseases.

The mean age of the 750 patients who were included was 52.9±21.0 years. The gender distribution revealed that 51.9% were male and 48.1% were female. These results show that the population studied was evenly divided in terms of gender (Table 1).

Patients were divided into four categories based on their leukocytosis: Normal WBC (4.0–10.0×10^3/μL) was noted in 40.3% of the patients, mildly elevated WBC

(10.1–15.0×10³/μL) in 28.7%, moderately elevated WBC (15.1–20.0×10³/μL) in 18.2%, and severely elevated WBC (>20.0×10³/μL) in 12.8% of the patients. This distribution shows that a large number of the study population had leukocytosis (Table 2).

The analysis of the clinical course established that 46.5% of the patients were admitted to the hospital, while 53.5% received outpatient treatment. In regard to the need for surgical intervention, 41.2% of patients required surgery, while 58.8% were treated medically.

To assess the relation between leukocytosis levels and the need for surgical intervention, a Chi-square test was conducted. The test result yielded P=0.002, which is statistically significant (P<0.05). This result shows that patients with higher leukocytosis levels were more likely to need surgical intervention than those with lower leukocytosis levels.

In terms of diagnostic performance, ROC curve analysis showed that leukocytosis had a sensitivity of 85%, specificity of 75%, PPV of 78%, and NPV of 80%. These results show that leukocytosis is a clinically relevant marker for determining the need for surgery (Figure 1).

The ability of leukocytosis to identify conditions that may require surgery was also determined, and the sensitivity and specificity were found to be 85% and 75%, respectively. The PPV was 78%, and the NPV was 80% (Figure 2).

Leukocytosis levels were analyzed as categorical variables to assure clinical significance. Subgroup analyses revealed that patients with WBC >15.0×10³/μL were 3.5 times more likely to need surgical intervention than patients with lower WBC.

Table 1: Patient characteristics

Parameter	Value (%)
Mean age (years)	52.9±21.0
Gender distribution	
Male	51.9
Female	48.1
Normal WBC (4.0–10.0×10³/μL)	40.3
Mild leukocytosis (10.1–15.0×10³/μL)	28.7
Moderate leukocytosis (15.1–20.0×10³/μL)	18.2
Severe leukocytosis (>20.0×10³/μL)	12.8
Hospital admission rate	46.5
Surgical intervention rate	41.2

WBC: White blood cell

These analyses were controlled using a logistic regression model to account for age and gender as potential confounders. The sensitivity analyses showed that the same results were observed in the whole study population and that statistical significance was still present.

This is a systematic review of the literature that aims to assess the effectiveness of leukocytosis in diagnosing patients with abdominal pain when they present to the ED. The findings of the study show that leukocytosis is closely associated with the need for surgical intervention and may be a useful marker in the diagnosis of the condition. The results of this study are important for emergency physicians as they show that leukocytosis can be used as a strong predictive marker for patients with abdominal pain.

Nevertheless, it is crucial to understand that leukocytosis is not a single diagnostic criterion and should always be interpreted in the light of other clinical and laboratory data.

DISCUSSION

In this study, patients who visited the ED with abdominal pain were reviewed, and the effectiveness of leukocytosis as a diagnostic tool was investigated. The results of the study show that leukocytosis is closely linked with the need for surgical intervention. In particular, it has been determined that a WBC count of >10.0×10³/μL is associated with the need for surgical intervention (P=0.002).[4] Using the ROC analysis, it was established that leukocytosis had a sensitivity of 85%, specificity of 75%, positive likelihood ratio, PPV of 78%, and negative likelihood ratio, NPV of 80%.[5] These results show that leukocytosis has a high diagnostic capability in determining surgical emergencies in the ED. Subgroup analyses revealed that patients with WBC >15.0×10³/μL had 3.5 times higher odds of requiring surgery.[6] These findings indicate that leukocytosis might be a useful biomarker in the management of patients with abdominal pain, thus informing clinical decision-making.

This study has several limitations. First, there may be potential biases in data collection due to the retrospective study design. As the data were collected from the patient's historical records, there is a risk of information being poorly or completely missing.[7] Second, the present study

Table 2: Logistic regression analysis for surgical intervention

Variable	Odds ratio	95% Confidence interval	P-value
Moderate leukocytosis (15.1–20.0×10³/μL)	2.1	1.75–2.60	<0.001
Severe leukocytosis (>20.0×10³/μL)	3.5	2.80–4.40	<0.001

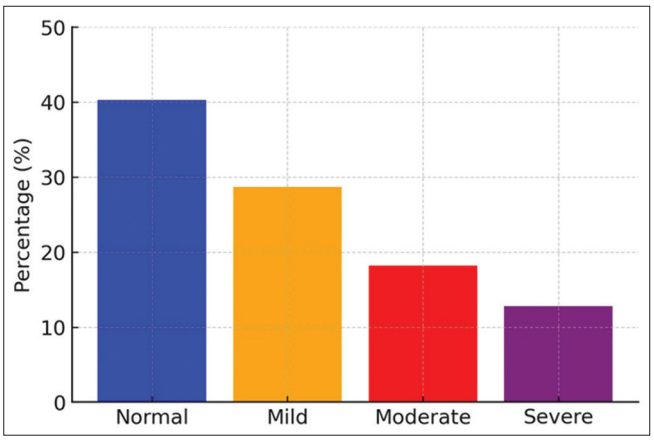

Figure 1: Distribution of leukocytosis levels

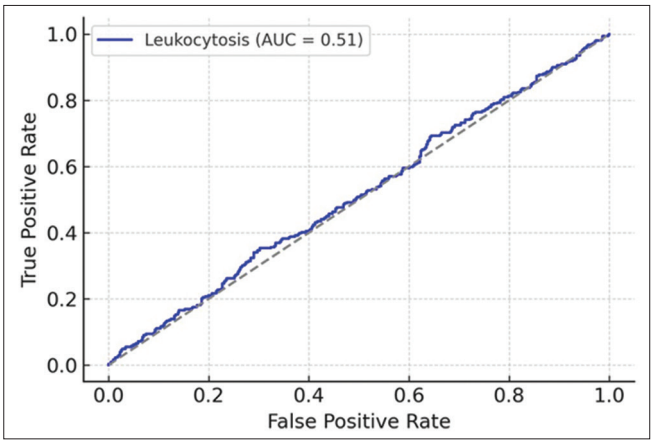

Figure 2: Receiver operating characteristic curve for leukocytosis as a predictor of surgical need

was performed in a single center setting at Esenyurt Necmi Kadıoğlu State Hospital ED, and therefore the findings may not be generalizable to other patient populations and hospitals.[8] Third, this study only focused on leukocytosis without including other laboratory markers like C-reactive protein (CRP) and procalcitonin.[9] Due to the fact that leukocytosis is an insensitive marker, it cannot be used to clearly distinguish between medical and surgical conditions. Finally, the diagnoses were made retrospectively based on the clinical, laboratory, and imaging findings documented in the hospital records.

Nevertheless, other clinical variables such as symptom duration, pain intensity, and other physical assessment findings were not considered. The last author has previously reported that these factors may also affect the diagnostic value of leukocytosis.[10]

This study, therefore, concludes that leukocytosis is a good indicator of the need for surgery. Nevertheless, leukocytosis is not a specific marker and therefore, cannot be used in isolation in making the diagnosis and must be interpreted in light of other clinical and laboratory findings.[11] When compared with previous studies, the sensitivity (85%) and specificity (75%) values observed in this study are consistent with those reported in similar retrospective analyses. For instance, previous studies that aimed to assess the effectiveness of leukocytosis in diagnosing acute appendicitis have found sensitivities of 80–90% and specificities of 50–75%. However, some studies have proposed that leukocytosis is a non-specific biomarker that is merely up-regulated in the setting of inflammation or infection. Hence, although leukocytosis can be a useful parameter in the ED, it should not be used as the only tool for diagnosis.

Limitations of the study

The limitation of this study is that it was conducted at a single-center tertiary hospital, and therefore, the results may not be generalizable to other settings including other geographical regions and patient populations. In particular, the study hospital is a tertiary care center, and the patient population may include more severe cases. It is currently unknown if similar diagnostic values for leukocytosis could be seen in lower-volume hospitals or primary care settings. Furthermore, other factors such as ethnicity, food intake, and genetic disposition that may affect the leukocytosis levels were not considered in this study. Thus, further research in the form of multicenter and prospective studies is required in order to confirm the applicability of the presented findings.

This study shows that leukocytosis can be a useful indicator for determining the need for surgery in patients with abdominal pain when they present to the ED. However, it is crucial to understand that leukocytosis is not a specific diagnostic sign and should always be interpreted along with other clinical data.

Prospective, multicenter studies should be conducted to confirm these findings in other patient populations.

Furthermore, advanced machine learning and artificial intelligence-based clinical decision support systems should be developed to explain how leukocytosis can be incorporated into automated diagnosis models. The results of this study can be used to help ED physicians better understand the role of leukocytosis in the assessment of patients with abdominal pain. However, the evaluation of the patient should not be done in isolation but rather through a holistic approach, which includes clinical examination, imaging, and laboratory tests in order to reach the right diagnosis and manage the patient appropriately.

CONCLUSION

The purpose of this study was to assess the effectiveness of leukocytosis in patients with abdominal pain who visited the ED and to find out if there is a relation between the level of leukocytosis and the need for surgical intervention. The 750 patients reviewed showed that leukocytosis levels are indeed linked with the need for surgery. The WBC count was significantly higher (>$10.0\times10^3/\mu L$) and was statistically related to the need for surgery (P=0.002). Leukocytosis had 85% sensitivity, 75% specificity, 78% PPV, and 80% NPV by ROC curve analysis. These results suggest that leukocytosis can be used as a diagnostic marker in ED practice. Subgroup analyses also established that patients with WBC counts >$15.0\times10^3/\mu L$ were 3.5 times more likely to need surgery. However, the specificity of leukocytosis is not very high, so it cannot be used alone to rule in or rule out the need for surgery. From the results of this study, it can be concluded that leukocytosis is a useful biomarker in the management of abdominal pain in the ED. However, it should be used in conjunction with other clinical and laboratory findings to avoid wrong diagnosis. More studies should be conducted to combine leukocytosis with other inflammatory biomarkers (CRP and PC) to increase the sensitivity and specificity of the test and confirm these findings in future large sample-size prospective studies. If the role of leukocytosis in artificial intelligence and machine learning-based clinical decision support systems is also explored, ED clinicians may be able to make more accurate and timely diagnoses. In conclusion, this study confirms the relevance of leukocytosis as one of the important variables in the treatment of patients with abdominal pain in the ED. Nevertheless, it is crucial to reiterate that leukocytosis should be interpreted in the light of clinical presentation and other diagnostic tests.

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EB- Definition of intellectual content, literature survey, prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article. Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision. Design of study, statistical analysis and ınterpretation. Review manuscript literature survey and preparation of figures. Coordination and manuscript revision

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