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ORIGINAL ARTICLE

Diagnostic accuracy of elevated pro-calcitonin for predicting mortality in patients undergoing surgery for mechanical small bowel obstruction keeping actual mortality as gold standard.

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ABSTRACT… Objective: To assess the diagnostic accuracy of high procalcitonin levels in predicting death among patients having surgery for mechanical small intestinal obstruction, using actual mortality as the gold standard. **Study Design:** Cross-sectional Validation study. **Setting:** Departments of Medicine and Surgery at KRL Hospital, Islamabad. **Period:** October 2023 to June 2024. **Methods:** After receiving approval from the institutional ethical review committee. Patients who provided consent and met the inclusion criteria were included from the medical and surgical units of KRL Hospital, Islamabad. Patients were evaluated upon admission by a researcher under the supervision of a specialist. Blood samples (5–10 mL) were obtained for PCT assessment. Patients were monitored for 14 days, with any fatalities recorded as mortality. **Results:** In this study of 203 participants, the mean age was 47.44±10.56 years, with a mean hospital stay of 13.51±2.13 days and a mean PCT level of 11.09±0.75 ng/mL. PCT levels ≥0.65 ng/mL were found in 88.7% of participants, while 11.3% had levels <0.65 ng/mL. The in-hospital mortality rate was 2.0%. The PCT threshold of 0.65 ng/mL had a sensitivity of 25%, specificity of 89%, PPV of 4.35%, and NPV of 98.33%. **Conclusion:** Elevated PCT levels are a useful biomarker for predicting mortality in mechanical SBO surgery due to high specificity. However, low sensitivity mean PCT should be combined with other diagnostic methods.

Key words: Diagnostic Accuracy, Elevated Procalcitonin, In-hospital Mortality, Small Bowel Obstruction.

INTRODUCTION

Intestinal obstruction (IO) refers to the blockage preventing the passage of intestinal contents, and it is a potentially dangerous surgical emergency linked to high morbidity and mortality[1] IO can be classified into dynamic (mechanical) obstruction, where the bowel is physically blocked, and adynamic (non-mechanical) obstruction, where there is no true peristalsis.[2,3] Key symptoms include abdominal pain, vomiting, constipation, abdominal distension, and failure to pass flatus.[4] The causes of bowel obstruction vary across countries and have evolved over time.[5]

About 80% of IO cases involve the small intestine, while 20% affect the large intestine, with symptom presentation influenced by the obstruction's location and type.[6] Bowel obstruction can be treated using two main approaches: conservative management or surgical intervention. For many patients, both options are viable, and the decision on which to pursue largely depends on the clinician's evaluation, making it a common clinical dilemma. Conservative treatment might effectively manage the obstruction but could result in adhesions that may lead to recurrence. Conversely, surgery, while addressing the obstruction, carries the risk of creating new adhesions, similar to other abdominal procedures.[7]

If patients do not show improvement within 48–72 hours with conservative treatment, they require surgical intervention, as bowel ischemia

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and necrosis may worsen.[8] Procalcitonin (PCT), normally released from the thyroid's C cells in healthy individuals, is elevated in response to bacterial infections due to its production by neuroendocrine cells in the lungs, liver, intestines, and pancreas.[9] PCT has a half-life of 18 to 24 hours, with plasma levels above 0.5 ng/mL considered abnormal.[10]

Elevated PCT levels can help predict mortality risk, with higher levels indicating a greater risk of poor outcomes. For instance, a PCT level ≥0.65 ng/mL has been associated with high sensitivity and specificity in predicting mortality in certain conditions. Sahin et al.[11] reported an in-hospital mortality rate of 35.2% for patients undergoing surgery for mechanical small bowel obstruction. Additionally, procalcitonin levels ≥0.65 ng/mL were found to predict mortality with a sensitivity of 92.9% and specificity of 78.1%.[11]

Due to limited health resources in our country and an increase in the cost of healthcare, determining disease prognosis is vital. Early detection and classification of conditions can enable timely management of critically ill patients. This study aims to provide surgeons with new insights that could shape clinical practice, support the development of management guidelines, and improve surgical outcomes.

METHODS

The objective is to evaluate the diagnostic precision of elevated procalcitonin levels in forecasting mortality in patients undergoing surgery for mechanical small intestine obstruction, using actual mortality as the benchmark standard.

The used research design is a cross-sectional validation study. This study was conducted at the Departments of Medicine and Surgery at KRL Hospital, Islamabad. The study lasted 8 months, from October 2023 to June 2024. (KRL-HI-PUB-ERC/OCT23/27)

The sample size was calculated based on a sensitivity of 92.9%, specificity of 78.1%, and a mortality rate of 35.2% , including a margin of error of d=7.1% for sensitivity and d=10% for specificity, within a 95% confidence interval. The sample size was established as 203 patients.[11]

The used sampling method is non-probability sequential sampling. The inclusion criteria for this research are patients receiving surgical intervention for mechanical small intestinal blockage, as defined operationally, including both male and female individuals aged 20 to 70 years. The criteria exclude patients who will be intubated and transported from other healthcare facilities; Patients having a history of hospitalization in the last three months; patients with a history of surgery in the past three months. Individuals having a history of cancer, Pregnant individuals evaluated via medical history and verified by date scan, as well as patients with a history of renal impairment, chronic obstructive lung disease, asthma, congestive heart failure, myocardial infarction, and chronic liver disease.

Cases that met the operational definition and inclusion criteria were recruited in the research from the medical and surgical units at KRL Hospital, Islamabad. Approval from the institutional ethical review committee was obtained before initiating the research.

Informed permission was obtained from all patients for their participation and the use of their data in the study. A concise history was obtained for demographic data. Patients were evaluated upon admission by the researcher, supervised by a specialist with over a decade of expertise in treating mechanical small intestinal blockage. Blood samples were obtained upon admission, with 5–10 mL taken for procalcitonin (PCT) analysis. All patients were monitored for 14 days, and any fatalities occurring during this timeframe were documented as mortality. The research variables were recorded in a proforma included as an annexe. A predesign questionnaire was used to gather data. Statistical analysis was conducted using SPSS Version 26.

RESULTS

In this study, a total of 203 participants were analyzed with mean age of 47.44±10.56 years. The mean length of hospital stay was

13.51±2.13 days. The mean procalcitonin level was 11.09±0.75 ng/mL. The gender distribution comprised 111 males (54.7%) and 92 females (45.3%). The age groups were categorized as follows: 52 participants (25.6%) were aged 18-40 years, 47 participants (23.2%) were aged 41-50 years, 98 participants (48.3%) were aged 51-60 years, and 6 participants (3.0%) were over 60 years old. Regarding procalcitonin levels, 180 participants (88.7%) had procalcitonin levels ≥0.65 ng/mL, while 23 participants (11.3%) had levels <0.65 ng/mL. The in-hospital mortality rate was 4 participants (2.0%).

The relationship between procalcitonin (PCT) levels and in-hospital mortality was examined using a threshold of 0.65 ng/mL. Among the participants, 1 individual with PCT levels ≥0.65 ng/mL (True Positive, TP) experienced mortality, while 22 individuals with PCT levels ≥0.65 ng/mL (False Positive, FP) did not experience mortality. Conversely, 3 individuals with PCT levels <0.65 ng/mL (False Negative, FN) experienced mortality, and 177 individuals with PCT levels <0.65 ng/mL (True Negative, TN) did not experience mortality. The sensitivity of using a PCT threshold of 0.65 ng/mL to predict in-hospital mortality was 25%, with a specificity of 89%. The positive predictive value (PPV) was 4.35%, and the negative predictive value (NPV) was 98.33%.

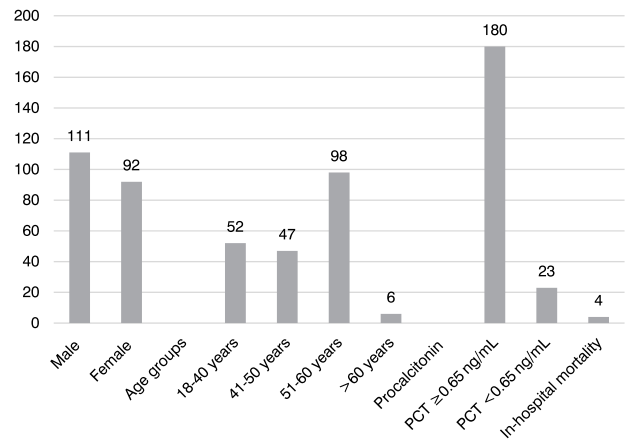

Figure-1. Characteristics of all the enrolled patients (n=203)

Gender	Frequency	Percentage
Male	111	54.7
Female	92	45.3
Age groups		
18-40 years	52	25.6
41-50 years	47	23.2
51-60 years	98	48.3
>60 years	6	3.0
Procalcitonin		
PCT ≥0.65 ng/mL	180	88.7
PCT <0.65 ng/mL	23	11.3
In-hospital mortality	4	2.0
	Mean±SD	
Age (Years)	47.44±10.56	
Length of hospital stay (Days)	13.51±2.13	
Procalcitonin (ng/mL)	1.09±0.75	

Table-I. Characteristics of all the enrolled patients (n=203)

	Mortality (Yes)	Mortality (No)
PCT ≥0.65 ng/mL	1 (TP)	22 (FP)
PCT <0.65 ng/mL	3(FN)	177(TN)
Sensitivity		25%
Specificity		89%
PPV (Positive Predictive Value)		4.35%
NPV (Negative Predictive Value)		98.33%

Table-II. 2x2 Contingency Table with Sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) (n=203)

DISCUSSION

Timely and appropriate surgical intervention for small bowel obstruction (SBO) is anticipated to improve both morbidity and mortality rates. Nonetheless, determining which patients should receive surgical treatment during their hospital stay can be challenging.[12,13] The use of procalcitonin (PCT) as a biomarker to predict mortality in patients undergoing surgery for mechanical small bowel obstruction (SBO) has

been a subject of interest due to its potential to guide clinical decision-making.

In this study, elevated PCT levels were evaluated for their diagnostic accuracy in predicting mortality, with actual mortality serving as the gold standard. In the present study it was stated that a PCT threshold of 0.65 ng/mL had a sensitivity of 25% and a specificity of 89%. This sensitivity means that only 25% of those who eventually died were accurately identified by high PCT levels. This limited sensitivity indicates that while PCT can detect some at-risk patients, it misses a significant number of individuals who will not survive, revealing a limitation in relying exclusively on PCT for early mortality prediction. Conversely, the high specificity of 89% demonstrates that PCT levels below the threshold are strongly associated with a lower risk of mortality. This high specificity suggests that the test is effective at identifying patients who are less likely to die, which can help reduce unnecessary concern and interventions for those with low PCT levels. The present study was supported by GK Sahin et al. in which they stated that in-hospital mortality of patients undergoing surgery for mechanical small bowel obstruction to be 35.2%, sensitivity of 92.9% and specificity of 78.1%.[11]

Another study by Assicot et al.[14], also supported our study finding, who demonstrated that low PCT levels effectively ruled out severe bacterial infections, thereby reducing unnecessary interventions. The PPV in our study was 4.35%, indicating that only a small percentage of patients with elevated PCT levels actually experienced mortality. This low PPV suggests that while elevated PCT can signal risk, it should not be used alone to predict mortality.

This is corroborated by Uzzan et al.[15], who noted that PCT's PPV may be limited and should be part of a comprehensive diagnostic approach. On the other hand, the NPV was 98.33%, showing that low PCT levels are very effective in predicting survival. This high NPV is advantageous for clinical practice, as it confirms PCT's reliability as a rule-out test.

This finding aligns with Meisner[16] who demonstrated that PCT is useful for excluding severe infections and guiding appropriate treatments. The present study highlight the necessity of incorporating PCT into a broader diagnostic framework rather than relying on it alone.

Although elevated PCT levels can indicate a higher risk of mortality, their moderate sensitivity and PPV mean that other diagnostic tools and clinical judgment are also needed.[17] However, the high specificity and NPV of PCT make it a valuable marker for identifying patients with a lower risk of mortality, which can be beneficial for patient management and resource allocation.

CONCLUSION

Elevated PCT levels can serve as a useful biomarker for predicting mortality in patients undergoing surgery for mechanical SBO, especially due to its high specificity and NPV. However, the limited sensitivity and PPV of PCT suggest that it should be combined with other diagnostic methods for more accurate predictions. By using a multifaceted diagnostic approach, clinicians can more effectively identify high-risk patients and adjust their management strategies to improve outcomes.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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AUTHORSHIP AND CONTRIBUTION DECLARATION	
1	**Muhammad Arsalan Ali:** Data collection, analysis, paper writing.
2	**Syed Fahad Ali Zaidi:** Literature review, paper writing.
3	**Muhammad Asim Mehmood:** Data collection, review of manuscript.
4	**Haroon-ur-Rasheed:** Review of manuscript.
5	**Syed Hamad Ali Shah:** Data collection, analysis.
6	**Mubashar Abrar:** Discussion writing, literature review.