# Role of neutrophil-to-lymphocyte ratio in the prediction of early postoperative complications after surgery for intestinal obstruction

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**Background**
Gastrointestinal surgery is associated with significant risk of postoperative complications, reaching up to 50% of cases especially in major operations. These complications have their detrimental effects not only on the patients, physically and psychologically, but also they induce a significant increase in costs, a timely concern while healthcare expenditures need to be controlled.
**Aim**
This study was designed to determine the value of a simple noninvasive parameter – the neutrophil-to-lymphocyte ratio (NLR) – in the first day postoperative in the prediction of early postoperative complications following intestinal obstruction surgery.
**Patients and methods**
This study includes 170 consecutive patients complaining of intestinal obstruction due to different primary causes and not having a previous abdominal surgery. The number of the male patients in the study is 97 (57.1%) patients, while the females are 73 (42.9%). The age of the patients was in the range in between 16 and 70 years with a mean age of 53.16±2.57 years.
**Results**
The NLR value in the preoperative investigation ranges between 2 and 25 with an average value of 6.71±8.7. The NLR that was done in the first postoperative day ranges between 0.6 and 31.3 with an average value of 6.77±4.75. Although the NLR increases postoperatively, it was found that there is insignificant difference between the NLR before and after 24 h postoperatively. The NLR of the complicated patients ranged between 1.61 and 31.3 with an average value of 8.65±4.83, while that of noncomplicated cases have a range of 0.6–7.63 with an average of 3.985±1.47. The difference of the mean of NLR in first postoperative day between complicated and noncomplicated cases is highly significant. Receiver-operating characteristic curve analysis of NLR suggested that a cutoff value of 5.01 was the optimal value for predicting complications, with an area under the curve of 0.873. This cutoff point produced a sensitivity of 84.61% (95% confidence interval=0.7545–0.9133) and a specificity of 78.37% (95% confidence interval=0.6728–0.8711). The overall model quality is good as it is equal to 0.82.
**Conclusion**
NLR is a good, cheap, and easily available investigation that can predict postoperative early complication after operation for intestinal obstruction. It has good sensitivity and specificity in the prediction of early postoperative complications. Further studies that compare other cheap and easily available biomarkers with NLR in predicting postoperative complications are required.

**Keywords:**
early postoperative complications, intestinal obstruction, neutrophil-to-lymphocyte ratio

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## Introduction

Gastrointestinal surgery is associated with significant risk of postoperative complications, reaching up to 50% of cases especially in major operations [1]. These complications have their detrimental effects not only on the patients, physically and psychologically, but also they induce a significant increase in costs, a timely concern while healthcare expenditures need to be controlled [2].

It is important for surgeons to identify preoperatively patients at risk (e.g. patients with preexisting cardiopulmonary pathology or with malnutrition) and to rapidly recognize patients who will develop

postoperative complications. Being the first step to anticipate complications, early identification of patients at risk is a must condition to succeed [3]. To this regard, available biomarkers such as white blood cells count, C-reactive protein (CRP), procalcitonin (PCT), or interleukin-6 are quite disappointing, being poorly accurate, with low sensitivity or specificity, with slow kinetics, relatively late indicators, expensive, or difficultly reproducible [4].

Zahorec and colleagues found that attention should be attracted to the relationship between neutrophil and lymphocyte counts in the peripheral blood of patients after major surgery, systemic inflammatory response syndrome, and sepsis. The physiological immune response of circulating leukocytes to various stressful events is often characterized by an increase in neutrophil counts and a decline in lymphocyte counts. This so-called neutrophil–lymphocyte stress factor was found to correlate well with the severity of disease and outcome, according to Acute Physiology and Chronic Health Evaluation II and Sepsis-related Organ Failure Assessment scores [5].

The causes of lymphocytopenia as the marker of a depressed cell-mediated immunity have been extensively studied. The mechanisms responsible for lymphopenia involve margination and redistribution of lymphocytes within the lymphatic system and marked accelerated apoptosis [6]. Neutrophilia, the opposite phenomenon during systemic inflammation, is caused by demargination of neutrophils, delayed apoptosis of neutrophils, and stimulation of stem cells by growing factors [5].

However, recent studies have shown that the neutrophil-to-lymphocyte ratio (NLR) is a reliable marker of systemic inflammation and a routinely performed test (complete blood counts) because of its rapidity and easy detection, availability, and cost-effectiveness On the basis of the physiological response of circulating leukocytes to precipitating stress factors, with increased numbers of neutrophils and fewer lymphocytes, the ratio between these two subgroups has been evaluated in periods of inflammation in different diseases, such as lung cancer, colorectal cancer, end-stage renal disease, and acute coronary syndrome, among others [7].

## Aim

This study was designed to determine the value of a simple noninvasive parameter – the NLR – in the first day postoperatively in predicting early postoperative complications following intestinal obstruction surgery.

## Patients and methods

### Study design

It is a cohort (longitudinal) study that was conducted in Kasr Alainy Teaching Hospital (Cairo, Egypt). This study was designed to determine a simple noninvasive parameter – the NLR – that may assist in the prediction of early postoperative complications following intestinal obstruction surgery.

#### *Population of study*

Patient age varies from 15 to 70 years; males and females would be included.

#### *Study location*

Kasr-Al Ainy Teaching Hospitals, emergency hospital.

#### *Inclusion criteria*

All patients with intestinal obstruction went for surgery, both sexes, all age groups from 15 to 70 years.

#### *Time of the study*

Starting from May 2021 and for 6 months.

#### *Exclusion criteria*

Previous abdominal surgery. Patients less than 15 years old and above 70 years.

#### *Research ethics committee approval*

Approved, Code: MS-355-2021.

### Data collection methods

Data were collected based on a structured data abstraction sheet. The abstraction sheet includes sociodemographic factors, cause of intestinal obstruction, investigations done for the patients, type and time of procedure done for every patient in the operative sheet, and postoperative data either in the ward or in the ICU.

#### *Methodology in details*

All patients would get assessment before intervention. Complete blood count with differential will be done before and after operation. Neutrophil and lymphocytes of total leukocytic count would be measured and NLR is calculated simply by dividing the neutrophil count by the lymphocyte count before and after surgery (1st day after surgery). All routine laboratory preoperative investigations were done.

These investigations include renal function tests in the form of urea and creatinine; liver function tests in the form of liver enzyme, albumin, prothrombin time, and concentration with international normalized ratio, blood gases, and electrolytes. ECG for all patients and echocardiography for patients suspected to have cardiac morbidity or above 60 years old. Plain radiograph, abdominal ultrasonography, and abdominal computed tomography with contrast for more accurate diagnosis of the cause of the obstruction was done for all patients. Differential blood count on admission and first day after surgery. Association between NLR before and after surgery with early complications of intervention is closely monitored.

*Study outcomes*

Primary outcomes (most important measurable outcomes).

Incidence of early postoperative complications: (intra-abdominal sepsis localized or generalized peritonitis, wound infection and/or wound dehiscence, persistent ileus >5 days, mechanical small bowel obstruction, intra-abdominal or anastomotic bleeding or leakage).

Secondary outcome parameters (other outcomes to be assessed).

Length of hospital stay and mortality.

*Discharge criteria*

The criteria for discharge were meal tolerance without nausea or vomiting, defecation or stoma function, adequate pain control by oral analgesia, and independent mobilization.

### Statistical analysis

Statistical analysis was done using IBM SPSS statistics for windows, Version 23.0. Armonk, NY: IBM Corp. Qualitative data will be presented by number and percentage. Quantitative data will be presented by mean, SD, median and interquartile range. Parametric and nonparametric tests of significance will be done. Regression analysis will be used to detect predictors of NLR ratio in predicting postoperative complications of IO surgeries. Level of significance was set at a *P* value equal to or below 0.05.

### Ethical approval

This research was performed at the Department of General Surgery, Cairo University. Ethical Committee approval and written, informed consent were obtained from all participants.

## Results

The number of the male patients in the study is 97 (57.1%) patients, while the females are 73 (42.9%). The age of the patients range between 16 and 70 years with a mean age of 53.16±2.57 years, and their distribution in the age groups is shown in Table 1.

Out of the 170 cases studied, maximum incidence was seen in the age group of 51–60 years followed by above 60 years and 41–50 years age group. Of the cases 57.1% are males and 42.9% are females.

### Causes of intestinal obstruction

In this study, complicated hernia cases are 93 (54.7%), and it was the most common cause of intestinal obstruction followed by colonic mass in different parts of the colon, which are 38 (22.35%) cases. These two major causes are followed by mesenteric vascular occlusion (13 cases, 7.6%) and volvulus mainly of the sigmoid colon (11 cases, 6.47%). Other causes were internal herniation by bands, diverticulitis,

**Table 1 Age and sex distribution of cases with intestinal obstruction**

| Age group | Male | Female | Total | Percentage |
|---|---|---|---|---|
| 16–20 | 2 | 1 | 3 | 1.76 |
| 21–30 | 4 | 1 | 6 | 2.9 |
| 31–40 | 10 | 6 | 16 | 9.4 |
| 41–50 | 16 | 12 | 28 | 16.74 |
| 51–60 | 36 | 28 | 64 | 37.64 |
| Above 60 | 29 | 25 | 53 | 31.75 |

**Table 2 Causes of intestinal obstruction**

| Cause of IO | *n* (%) |
|---|---|
| Complicated hernia | 93 (54.7) |
| Paraumbilical | 57 |
| Inguinal hernia | 29 |
| Femoral hernia | 7 |
| Colonic mass | 38 (22.35) |
| Sigmoid mass | 27 |
| Ileocecal mass | 4 |
| Left colon | 3 |
| Right colon | 2 |
| Transverse colon | 2 |
| Mesenteric vascular occlusion | 13 (7.6) |
| Volvulus | 11 (6.47) |
| Sigmoid volvulus | 9 |
| Ileocecal volvulus | 2 |
| Diverticulitis of the colon | 2 (1.18) |
| Foreign body occlusion | 2 (1.18) |
| Internal herniation and bands | 2 (1.18) |
| Frozen abdomen | 3 (1.76) |
| Intussusception | 3 (1.76) |
| Perforated viscous | 3 (1.76) |

foreign body occluding the lumen of the intestine, and intussusception. Table 2 illustrates details of the causes of intestinal obstruction.

As regards comorbidity, the patient could have more than one comorbid disease. A combination of diabetes with heart disease and hypertension was found in 52 (30.58%) patients. Table 3 illustrates the number of patients with each comorbidity.

As regards postoperative complications, 94 (55.29%) of the 170 patients have postoperative complications. Most of the patients have more than one complications and wound infection is the most accompanied complications. Eighty patients had postoperative superficial wound infection, it is found in all of the 12 patients who had intra-abdominal sepsis, six patients with leakage after anastomosis, and 22 patients with stoma complications. Only six patients with prolonged ileus have wound infection. All patients of extra abdominal complications have another abdominal one especially intra-abdominal sepsis and leakage. The number of patients with stoma was 63, 22 (34.9%) of them had stoma complications (periostomal infection, stoma regression, stoma stenosis) as illustrated in Table 4.

The NLR value in the preoperative investigation ranges between 2 and 25 with an average value of 6.71±8.7. The NLR that was done in the first postoperative day ranges between 0.6 and 31.3 with an average value of 6.77±4.75. Although the NLR increase postoperatively, it was found that there is insignificant difference between the NLR before and after 24 h postoperatively (the *t* value is −0.07129). The *P* value of 0.471606. The result is not significant at *P* value more than 0.05 as illustrated in Fig. 1. However, while comparing the postoperative NLR of the complicated and noncomplicated groups, a significant difference is there as illustrated in Fig. 2.

The postoperative NLR of the complicated patients ranged between 1.61 and 31.3 with an average value of 8.65±4.83, while that of noncomplicated cases has a range of 0.6–7.63 with an average of 3.985±1.47. Consequently, when considering postoperative results, the difference of the mean of NLR in the first postoperative day between complicated and noncomplicated cases is significant which means that the NLR is significantly lower in noncomplicated than complicated cases as the t value is equal to −7.51563 and the *P* value is less than 0.00001 which means that the results is highly significant.

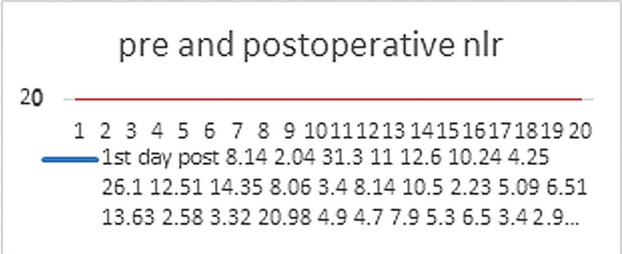
**Table 3 Different types of comorbidity and its percentage**

| Comorbidity | *n* (%) |
|---|---|
| Diabetes | 88 (51.76) |
| Hypertension | 78 (45.88) |
| Cardiac | 69 (40.58) |
| Chest problems | 32 (18.8) |
| Liver disease | 18 (10.6) |
| Renal disease | 20 (11.8) |

**Table 4 Postoperative complications and percentage among total patients of the study and patients with complications**

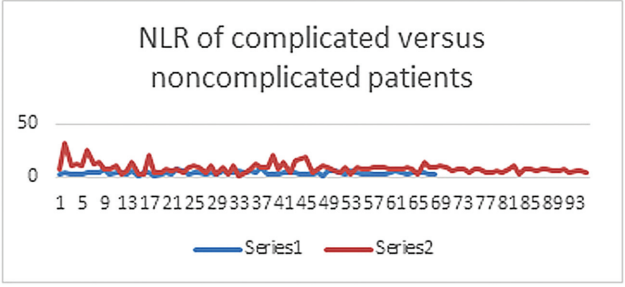
| Postoperative complications | *n* (%) | Percentage as regard complicated patients |
|---|---|---|
| Wound infection | 80 (47.05) | 85.1 |
| Intra-abdominal sepsis | 12 (7.05) | 12.76 |
| Leakage | 6 (3.52) | 6.38 |
| Stoma complications | 22 (12.94) | 23.4 |
| Prolonged ileus | 28 (16.74) | 29.79 |
| Bleeding | 3 (1.76) | 3.19 |
| Heart | 9 (5.29) | 9.57 |
| Chest | 8 (4.7) | 8.51 |
| MOF | 6 (3.52) | 6.38 |
| Renal failure | 3 (1.76) | 3.19 |

**Figure 1**



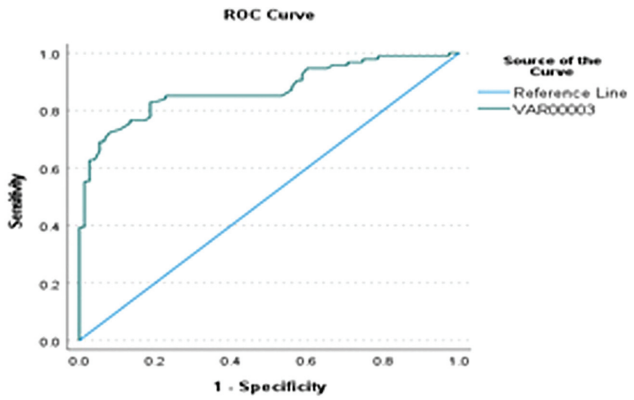

Relation between NLR preoperative and postoperative. There is no significant difference between both. NLR, neutrophil-to-lymphocyte ratio.

**Figure 2**




Relation between postoperative NLR of the complicated (brown line) and noncomplicated cases (blue line). NLR, neutrophil-to-lymphocyte ratio.

**Figure 3**




Receiver-operating characteristic (ROC) curve showing the relations between NLR and early postoperative complications as a relation between sensitivity (true positive) and 1-specificity (true negative) in determining the predictive value of NLR. Also, it shows an area under the curve equal to 0.873, which indicates a powerful relation between high NLR value and occurrence of early postoperative complications. NLR, neutrophil-to-lymphocyte ratio.

All patients with NLR above 10 (31 patients) have postoperative complications, while 60% (54 patients of the 90) of the patients in the NLR range between 4 and 9.9 have complications. The group of patients with NLR of less 4 (59 patients) has only nine (15.25%) patients with postoperative complications. The receiver-operating characteristic (ROC) curve analysis of NLR suggested that a cutoff value of 5.01 was the optimal value for predicting complications, with an area under the curve of 0.873 as illustrated in Fig. 3. This cut off point produced sensitivity of 84.61% [95% confidence interval (CI)= 0.7545–0.9133] and specificity of 78.37% (95% CI=0.6728–0.8711). The overall model quality is good as it is equal to 0.82 (Table 5).

**Table 5 Specificity and sensitivity (at 95% confidence interval) when the cut off value of neutrophil-to-lymphocyte ratio is 5.1**

| Statistic | Value (%) | 95% confidence interval (%) |
|---|---|---|
| Sensitivity | 84.62 | 75.54–91.33 |
| Specificity | 78.38% | 67.28–87.11 |
| Positive likelihood ratio | 3.91 | 2.51–6.09 |
| Negative likelihood ratio | 0.20 | 0.12–0.32 |
| Complication prevalence | 55.15 | 47.23–62.89 |
| Positive predictive value | 82.80 | 75.56–88.22 |
| Negative predictive value | 80.56 | 71.60–87.19 |
| Accuracy | 81.82 | 75.07–87.38 |

## Discussion

Several biomarkers are investigated to detect its abilities as a parameter of the postoperative course and prognosis. These biomarkers include CRP, PCT, delta albumin, and NLR and platelet-to-lymphocyte ratio. Also a combination of more than one biomarkers is used for the prediction of the postoperative course and also the prognosis of many neoplasms [8].

Available biomarkers include CRP and PCT. However, PCT is much expensive and impractical for clinical daily use and follow-up. However, CRP blood levels peak at 72 h after the insult, while postoperative complications might thus be detected much sooner with other biomarkers like PCT and significantly elevated NLR [9].

The current study is the only study known to us after reviewing the literature that investigate the use of NLR in detecting early postoperative complications after abdominal operations for intestinal obstruction. In this study the cutoff point was estimated by ROC curve analysis of NLR. It suggested that a cut off value of 5.01 was the optimal value for predicting complications, with an area under the curve of 0.873 with a sensitivity of 84.61% (95% CI=0.7554–0.9133) and specificity of 78.37% (95% CI=0.6728–0.8711). This result is nearly matching with that of Forget and colleagues, as they found that the optimal cutoff of NLR to predict the occurrence of postoperative complications is 5.5, with a sensitivity of 66% and a specificity of 77% ($P>0.05$), which is nearly similar to the result of the current study. However, Forget and colleagues depend in their study on NLR of the postoperative day +7 results. As they found preoperative NLR was not significantly associated with postoperative complications whereas it is the case of NLR at day +7 (the NLR increased at day +1 and, on average, returned to baseline at day +7 unless complications; $P<0.05$). They found also that CRP presents a delayed peak compared with the NLR, increasing at day +2 and not normalizing at day +7, either there were complications or not.

Yalav and colleagues study the change of the NLR and early complications after operations for colorectal cancer. According to the cutoff value, if the NLR value is above 2.08, it is determined that the patient develops postoperative complications with 90.16% sensitivity and 22.94% specificity. This result has much disagreement with the current study and also with the results of Forget and colleagues study; that is may be because they choose a low cutoff value that gives very high sensitivity with much less specificity [10].

Cook and colleagues found that ROC curve analysis of NLR suggested that a cutoff of 9.3 was the optimal

value for predicting complications, with an area under the curve of 0.66. This cutoff point produced a sensitivity of 0.66 (95% CI=0.47–0.83) and a specificity of 0.69 (95% CI=0.56–0.79). Cook and colleagues also suggest that postoperative NLR may be more useful than CRP and white cell count as both could not differentiate between systemic inflammatory response syndrome and infection. Also, in the current study all patients with NLR above 10 (31) have postoperative complications, while 60% (54 patients of 90) of the patients in the NLR range between 4 and 9.9 have complications. These results are mostly concordant with that of Cook and colleagues [11].

The current study has some limitations. These factors include general condition of the patients on admission in the emergency department and the preoperative nutritional status, the duration of that illness before the patient seek medical advice in the emergency department, and the amount of blood loss during surgery.

## Conclusion

The biomarker with an absolute diagnostic value has not yet been identified, though more than 3300 studies concerning 180 biomarkers have been performed. Postoperative NLR is a good, cheap, and easily available investigation that can predict postoperative early complication after operation for intestinal obstruction with a cutoff point of 5.01. It has a good sensitivity and specificity in predicting early postoperative complications. Further studies that compare other cheap and easily available biomarkers with NLR in prediction of postoperative complications are required. Also, it is required to do NLR during the whole period of postoperative inpatient to detect more information in the relations between NLR and postoperative complications.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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