*Original Research Article*

# Prospective Assessment of The Prognostic Value of Different Nutritional Assessment Scores on Short-term Outcome after Emergency colorectal surgery


**ABSTRACT**

**Background:**

Pre-operative nutritional state has a direct impact on complications following surgery and the prognosis of individuals with malignant tumors. It has been shown that enhancing perioperative nutrition may save costs while also improving clinical outcomes for patients having major gastrointestinal surgeries. As a result, individuals having significant abdominal surgery should have careful evaluation to their nutritional condition. So, accurate scoring method to detect patients with inadequate nutritional status has been looked for by several studies. The controlling nutritional status (CONUT) scoring, the nutrition risk index (NRI) and the prognosis nutritional index (PNI) are some of them. The objective of this research was to prospectively assess the prognostic effect of the PNI, the CONUT score and the NRI on postoperative wound problems following urgent colorectal cancer procedures.

**Patients and methods:**

This prospective research was conducted between November 2020 and June 2022 at Tanta University's emergency department, general surgery department, and gastrointestinal surgery unit. The research comprised thirty individuals who were hospitalized for emergency colorectal cancer procedures. We calculated the three scores (CONUT, PNI and NRI) after measuring the pre-operative blood albumin level, total peripheral lymphocyte number and serum cholesterol, and compared them to the post-operative result.

**Results:**

Based on CONUT score: 38.89% patients had normal nutrition, 47.22% had light malnutrition, 13.89% had moderate malnutrition with a cut-off value 4.The mean value of NRI is 45.9 ± 2.95, and cut off value is 46.1. The mean value of PNI is 46.3 ± 5.68 and cut off value is 45.23.

**Conclusion:**

This study revealed significant relation between PNI blew a cut-off value 45.2, low CONUT score blew a cut-off value 4, low NRI blew a cut-off value 46.1, and the development of postoperative complication after urgent surgeries for colorectal cancer with a diagnostic accuracy of 72%, 67% and 65%, respectively. PNI is superior to CONUT and NRI in predicting postoperative complications in urgent surgeries for colorectal cancer.

**Keywords:**

Urgent colorectal cancer surgery, Nutritional status, Perioperative period

# 1. Introduction

Malnutrition is widely acknowledged as the most significant single hazard to public health. Actually, when an individual is admitted to the hospital, as much as fifty percent of them are malnourished. For surgeries for cancer individuals, increasing perioperative nutrition has been shown to improve clinical results and save money. **(1)**.

Malnutrition is often associated with altered inflammatory responses, cellular and humoral immunological dysfunction, and an acceleration or failure of the wound recovery process. Preoperative dietary status has been found to influence both the probability of postoperative complications and the prognosis for individuals with tumours that are malignant. **(2)**.

In the immediate postoperative period, patients are at risk for postoperative catabolism and changes in the immune, endocrine, neuroendocrine, and metabolic systems. These factors lead to increased postoperative morbidity as well as death. Therefore, it is necessary to forecast the prognosis properly in order to increase patient survival and provide patients crucial information **(2).**

One of the most frequent postoperative problems related to surgical patients is wound infection. Its prevalence may have a significant effect on complications following surgery and hospital stay duration **(3)**.

Therefore, it's crucial to accurately assess a person's nutritional status before significant abdominal surgery. A valid, accurate scoring method to detect patients with inadequate nutritional status has been suggested by numerous studies. Numerous nutrition risk scores have been established to predict nutrition-related issues following surgery. The regulating nutritional status (CONUT) score, the nutrient risk index (NRI), and the prognosis nutritional index (PNI) are a few of them. **(4, 5)**.

In order to prevent postoperative wound problems, we wanted to assess the relationship between the PNI, NRI, and CONUT scores and complications of wounds in urgent procedures for patients with colorectal cancer.

The CONUT score is determined by taking into account the total peripheral lymphocytic number serum albumin level, and total cholesterol level. According to the total score for the three variables, nutritional status has been classified as normal nutrition, light malnutrition, moderate malnutrition, or severe malnutrition **(Table 1) (6)**.

**Table 1: Assessment of the nutritional status using the CONUT score(6)**

| | None | Light | Moderate | Severe |
|---|---|---|---|---|
| Serum albumin (g/dl) | ≥ 3.50 | 3.00-3.49 | 2.50-2.99 | < 2.50 |
| Score | 0 | 2 | 4 | 6 |
| Total lymphocyte count) mm$^3$) | >1600 | 1200-1599 | 800-1199 | <800 |
| Score | 0 | 1 | 2 | 3 |
| Total cholesterol (mg/dl) | ≥ 180 | 140 – 179 | 100 - 139 | <100 |
| Score | 0 | 1 | 2 | 3 |
| Total score | 0-1 | 2-4 | 5-8 | 9-12 |

The following equation is used to determine the PNI: 10 x serum albumin concentration (g/dl) + 0.005 x total lymphocyte count (per mm$^3$) The PNI was first intended to evaluate individuals who had undergone gastrointestinal surgery in terms of their nutritional and immunology states. **(2)**.

The following formula, which is based on a mathematical calculation, may be used to apply the NRI in a therapeutic context without risk: NRI is equal to (41.7 current weight/usual weight) + (1.489 serum albumin, g/L). A constant weight six months or more before to sickness was referred to as the typical weight **(7)**.

## 2. Materials and methods

The General Surgery Department, Emergency Sector, Tanta University Hospitals, Tanta, Egypt, undertook this prospective observational research from November 2020 to June2022. It contained 36 eligible individuals.

### 2.1 Inclusion Criteria

All adult patients submitted to urgent colorectal cancer surgeries at the Emergency sector, General Surgery Department, Tanta University Hospital.

### 2.2 Exclusion Criteria

1. Individuals classified as grade 3 or above by the American Society of Anesthesiologists.
2. Patients under the age of Eighteen.
3. Patients managed by conservative measures.
4. Patients refused by themselves or their nearest relatives to be included in the study.

**All patients in the study were subjected to:**

1. Careful history taking including their weights during the last 6 months or more.
2. Complete clinical examination including measurements like; height, weight, and bmi at time of admission.
3. Standard laboratory investigation including those required for calculation of the three scores (serum albumin, total peripheral lymphocytic count, and serum cholesterol).
4. Special laboratory investigations according to the diagnosis of the case.
5. Radiological investigations according to the presentation of the case to achieve diagnosis (plain x-ray, ultrasound examination, ct with or without contrast and or mri).

Then from the collected data, the following nutritional indices were calculated and recorded for each patient:

a) **The CONUT score,** determined using the total peripheral lymphocytic count, serum albumin level, and total cholesterol level as shown in table (1):

The following formula is used to determine the PNI: 10 + 0.005 + total number of lymphocytes in peripheral blood (per mm3) (2) = serum albumin amount (g/dl).

The following formula, which is based on a mathematical estimation, may be used to apply the NRI in a therapeutic context without risk: NRI is equal to (41.7 current weight/usual weight) + (1.489 serum albumin, g/L). A constant weight for 6 months or longer prior to to sickness was referred to as the typical weight.**(6)**.

1. All included patients were submitted to their specific surgery and received their postoperative care either in the surgical ICU or in the surgical ward.
2. Postoperative oral intake, medications, wound care, and discharge followed the standard rules according to the provided surgery.
3. Postoperative data specifically postoperative wound complications and their grades according to the Calvin Dindo classification of complication were recorded. **(Table2)**.

**Table2: Illustrates Clavin Dindo's classification of complication(8)**

| Grade | |
|---|---|
| 1 | Any deviation from the normal postoperative course without the need for pharmacological treatment or surgical, endoscopic and radiological interventions.<br>Acceptable therapeutic regimens are: drugs as antiemetics, antipyretics, analgetics, diuretics and electrolytes and physiotherapy.<br>This grade also includes wound infections opened at the bedside. |
| 2 | Requiring pharmacological treatment with drugs other than such allowed for grade I complications. Blood transfusions, antibiotics and total parenteral nutrition are also included. |
| 3 | Requiring surgical, endoscopic or radiological intervention |
| 3a | Intervention under regional/local anesthesia |
| 3b | Intervention under general anesthesia |
| 4 | Life-threatening complication requiring intensive care/intensive care unit management |
| 4a | Single organ dysfunction |
| 4b | Multi-organ dysfunction |
| 5 | Patient demise |

Statistical analysis of the correlation between the calculated nutritional indices preoperatively and the developed postoperative complications and their grades were studied.

**Statistical Analysis:**

SPSS v26 (IBM Inc., Chicago, Illinois, USA) was utilized to conduct the statistical study. The unpaired Student's t-test was used to evaluate quantitative variables between measurements after they were given as mean and standard deviation (SD). The Chi-square test or Fisher's exact test was used to analyze qualitative variables that were reported as frequency and percentage (%). Analysis of the Receiver Operating Characteristic curve (ROC-curve) A curve that expands from the lower left corner to the upper left corner and then to the upper right corner is regarded as a perfect test. The overall diagnostic performance of every test was evaluated using ROC curve analysis. The total test performance is assessed using the area under the curve (AUC), with an area under the curve of roughly 100% being the best test performance and one of >50% denoting satisfactory performance. a two tailed P value < 0.05 was considered statistically significant.

## Results

The mean age of the individuals under study was 58.33 (18.02) years. Nine of the individuals (25%) were female, while 27 (75%) were men. The mean BMI (± standard deviation) was 28.88 (± 5.1) kg/m2, and twenty-one individuals (58.33%) smoked. Regarding comorbidities, 15 (41.67%) patients were hypertensive, 12 (33.33%) patients were diabetics and 3 (8.33%) patients complained from chronic kidney diseases. regarding past Surgical history was mesh hernioplasty in 6 (16.67%) patients hemorrhoidectomy in 3 (8.33%) patients, abdominal exploration in 3 (8.33%) patients, and appendectomy in 3 (8.33%) patients, hysterectomy in 3 (8.33%) patients other surgeries in 6 (16.67%) patients.

**Table 3: Demographic data, medical history and surgical history of the studied patients**

| | | **(n=36)** |
|---|---|---|
| **Age (years)** | | 58.3 ± 18.02 |
| **Sex** | **Male** | 27 (75%) |
| | **Female** | 9 (25%) |
| **BMI (Kg/m$^2$)** | | 28.9 ± 5.1 |
| **Special habits** | **Smokers** | 21 (58.33%) |
| **Medical history** | **HTN** | 15 (41.67%) |
| | **DM** | 12 (33.33%) |
| | **CKD** | 3 (8.33%) |
| **Surgical history** | **Mesh hernioplasty** | 6 (16.67%) |
| | **Hemorrhoidectomy** | 3 (8.33%) |

| | | |
|---|---|---|
| | **Hysterectomy** | 3 (8.33%) |
| | **Abdominal exploration** | 3 (8.33%) |
| | **Appendectomy** | 3 (8.33%) |
| | **Others** | 6 (16.67%) |

Data are presented as mean ± SD or frequency (%), BMI: Body mass index, DM: diabetes mellitus, HTN: hypertension, CKD: Chronic kidney disease.

Regarding the diagnosis, we discovered perforated cancer splenic flexure in 3 (8.33%) individuals as well as cancer rectum complicated with intestine obstruction in 9 (25%) individuals, cancer descending colon complicated with intestinal obstruction in 6 (16.67%) individuals, cancer transverses colon complicated with intestinal obstruction in 6 (16.67%) individuals, and cancer ascending colon complicated with intestinal obstruction in 6 (16.67%) individuals. Regarding to operation done, colon cancer resection and colostomy were done 15 (41.67%) patients, proximal colostomy in 9 (25%) patients, resection and anastomosis in 9 (25%) patients and resection anastomosis after peritoneal lavage in 3 (8.33%) patients.

**Table 4: Diagnosis and operation of the studied patients**

| | | **(n=36)** |
|---|---|---|
| **Diagnosis** | **Cancer rectum complicated with intestinal obstruction** | 9 (25%) |
| | **Cancer descending colon complicated with intestinal obstruction** | 6 (16.67%) |
| | **Perforated sigmoid cancer colon** | 6 (16.67%) |
| | **Cancer transverses colon complicated with intestinal obstruction** | 6 (16.67%) |
| | **Perforated cancer splenic flexure** | 3 (8.33%) |
| | **Cancer ascending colon complicated with intestinal** | 3 (8.33%) |

| | | |
|---|---|---|
| | **obstruction** | |
| | **Obstructed cancer sigmoid colon** | 3 (8.33%) |
| **Operation** | **Resection and colostomy** | 15 (41.67%) |
| | **Proximal colostomy** | 9 (25%) |
| | **Resection anastomosis** | 9 (25%) |
| | **Resection and anastomosis after peritoneal lavage** | 3 (8.33%) |

Data are presented as frequency (%).

The mean (± SD) HB concentration was 10.75 (±1.18) gm/dl. Platelets had a mean value (± SD) of 267.92 (±47.99) cells/dl. The serum creatinine concentration was 1.51 (±0.46) mg/dl on mean (±SD). Serum urea had a mean value (± SD) of 33.5 (±4.53) mg/dl. The SGPT had a mean value of 38.42 (±12.49) U/L. SGOT had a mean value (± SD) of 33.33 (±13.98) U/L.

**Table 5: Laboratory data of the studied patients**

| | **(n=36)** |
|---|---|
| **HB (gm/dl)** | 10.8 ± 1.18 |
| **Platelets (cells/dl)** | 267.9 ± 47.99 |
| **Serum creatinine (mg/dl)** | 1.5 ± 0.46 |
| **Serum urea (mg/dl)** | 33.5 ± 4.53 |
| **SGPT (U/L)** | 38.4 ± 12.49 |
| **SGOT (U/L)** | 33.3 ± 13.98 |

Data are presented as mean ± SD, HB: Hemoglobin, SGPT: Serum glutamic pyruvic transaminase, SGOT: Serum glutamic-oxaloacetic transaminase.

The lymphocyte count was 2055.6 (±718.52) cells/dl on mean (±SD). Albumin had a mean (±SD) value of 3.6 (±0.5) gm/dl. The mean cholesterol level (± SD) was 155.3 (±27.04) mg/dl.

**Table 6: Lymphocyte, albumin and cholesterol of the studied patients**

| | **(n=36)** |
|---|---|
| **Lymphocyte (cells/dl)** | 2055.6 ± 718.52 |

| | |
|---|---|
| **Albumin (gm/dl)** | 3.6 ± 0.5 |
| **Cholesterol (mg/dl)** | 155.3 ± 27.04 |

Data are presented as mean ± SD, *: Significant as P value ≤0.05.

The mean value (± SD) of PNI was 46.3 (±5.68). The mean value (± SD) of NRI was 45.9 (±2.95). CONUT was normal nutrition in 14 (38.89%) patients, light malnutrition in 17 (47.22%) patients and moderate malnutrition in 5 (13.89%) patients.

**Table 7: NRI, PNI and CONUT scores of the studied patients**

| | | (n=36) |
|---|---|---|
| **PNI** | | 46.3 ± 5.68 |
| **NRI** | | 45.9 ± 2.95 |
| **CONUT** | **Normal nutrition** | 14 (38.89%) |
| | **Light malnutrition** | 17 (47.22%) |
| | **Moderate malnutrition** | 5 (13.89%) |

Data are presented as mean ± SD or frequency, *: Significant as P value ≤0.05, NRI: Nutritional risk index, PNI: Prognostic nutritional index, CONUT: Controlling of nutritional status.

Postoperative wound infections occurred in 24 (66.66%) patients in the $1^{st}$ week and 12 (33.3%) patients in the $2^{nd}$ week .

Regarding Calvin Dindo-classification, class II complications occurred in 24 (66.66%) patients in $1^{st}$ week and 12 (33.3%) patients in $2^{nd}$ week

**Table 8: Post-operative Complications and calvin dindo classification score of the studied patients**

| | | $1^{st}$ week | $2^{nd}$ week |
|---|---|---|---|
| **Post-operative Complications** | **Wound infection** | 24 (66.66%) | 12 (33.34%) |
| **Calvin dindo classification** | **II** | 24 (66.66%) | 12 (33.34%) |

NRI can significantly predict complications (P =0.042 and AUC = 0.682) at cut-off >46.1 with 91.67% sensitivity, 45.83% specificity, 45.8% PPV and 91.7% NPV, Diagnostic accuracy 65%

**Table 9: Role of NRI score in prediction of complications**

| | Cut-off | Sensitivity | Specificity | PPV | NPV | AUC | Diagnostic accuracy | P value |
|---|---|---|---|---|---|---|---|---|
| **NRI** | >46.1 | 91.67% | 45.83% | 45.8% | 91.7% | 0.682 | 65% | **0.042*** |

PPV: positive predictive value, NPV: negative predictive value, AUC: area under the curve, *: Significant as P value ≤0.05, NRI: Nutritional risk index.

PNI can significantly predict complications (P <0.001 and AUC = 0.833) at cut-off >45.23 with 75.00% sensitivity, 62.50% specificity, 50.0% PPV, 83.3% NPV. and Diagnostic accuracy 72% .

**Table 10: Role of PNI score in prediction of complications**

| | Cut-off | Sensitivity | Specificity | PPV | NPV | AUC | Diagnostic accuracy | P value |
|---|---|---|---|---|---|---|---|---|
| **PNI** | >45.23 | 75.00% | 62.50% | 50.0% | 83.3% | 0.833 | 72% | **<0.001*** |

PPV: positive predictive value, NPV: negative predictive value, AUC: area under the curve, *: Significant as P value ≤0.05, PNI: Prognostic nutritional index.

CONUT can significantly predict complications (P =0.001 and AUC = 0.771) at cut-off value 4 with 83.33% sensitivity, 50% specificity, 45.5% PPV and 85.7% NPV. Diagnostic accuracy 67%.

**Table 11: Role of CONUT score in prediction of complications**

| | Cut-off | Sensitivity | Specificity | PPV | NPV | AUC | Diagnostic accuracy | P value |
|---|---|---|---|---|---|---|---|---|
| **CONUT** | 4 | 83.33% | 50% | 45.5% | 85.7% | 0.771 | 67% | **0.001*** |

PPV: positive predictive value, NPV: negative predictive value, AUC: area under the curve, *: Significant as P value ≤0.05, CONUT: Controlling of nutritional status.

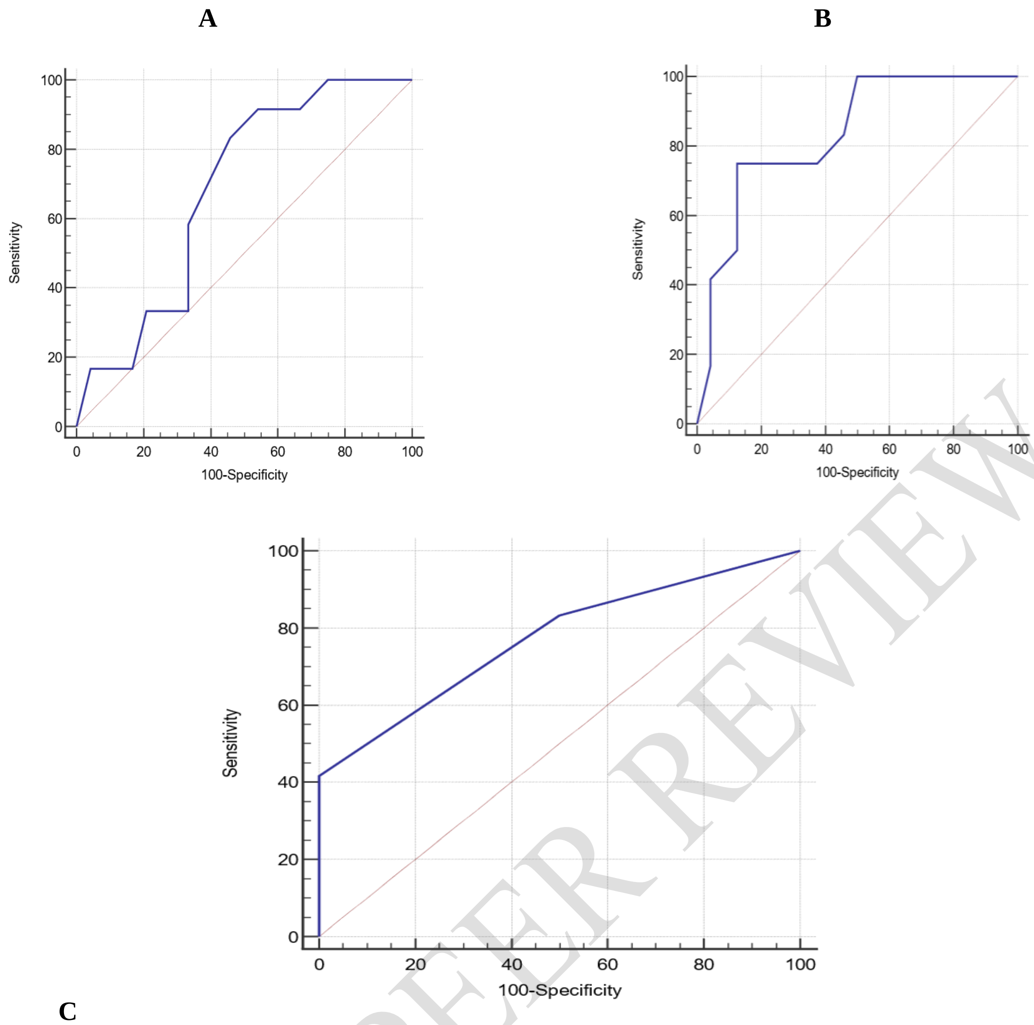


**Figure 1: ROC curve of (A) NRI, (B) PNI, (C) CONUT scores in prediction of complications**

## Discussion

It is crucial to have reliable indicators of postoperative outcome available while having abdominal surgery because they could speed up recovery and shorten hospital stays. Numerous quick nutritional evaluation and screening methods have been developed and validated in recent years to detect individuals who are malnourished or at risk for the effects of malnutrition. They might help prevent surgical infections and wound problems. **(3)**

Between 30% and 50% of individuals undergoing gastrointestinal surgery have been found to be malnourished. According to **Oh et al (7)**, the frequency and severity of postoperative complications were both directly related with malnutrition.

According to our patients' characteristics, the mean value (± SD) of age was 58.33 (±18.02) years. **Tebou et al, 2017(9)** reported age ranging from 19 to 50 years. **Mohil et al (10)** reported an age of their study populations ranging from 13 to 75 years. All Patients in the previous studies were subjected only to emergency gastrointestinal surgery. While **Akula et al. (11)** combined both emergency and elective gastrointestinal surgery patients in his study and reported age group of his studied patients ranged from 40 to 60 years.

The mean value (± SD) of BMI was 28.88 (±5.1) $Kg/m^2$and (40%) of the studied patients were obese. According to **Tebou et al, 2017(9)** 9 individuals, 69.6% were within normal weight range, 21.7% were overweight, and 8.7% were obese.

In our study PNI can significantly predict complications (P <0.001 and AUC = 0.833) at cut-off >45.23 blew it was associated with significantly more complications.

Similar to our study **Mohri et al (12)** found that cut-off of PNI to detect complicatons was 45. 69 (42.6%) of 162 individuals who had < PNI 45 had postoperative problems, as contrast to 65 (32%) of 203 individuals with PNI ≥ 45. On the other hand it is retrospective study on elective cases but our study is prospective study on urgent ones.

**Jiang N et al. (2)** discovered that the PNI's ideal cut-off level was 46, which is similar to what we discovered. On gastric cancer patients but it is also retrospective on elective cases.

Another study by **Mohil et al 2008, (10)** reported that, mean value of PNI score was 53.43 ± 17.11, of which 65 patients had a high PNI score > 50 and 15 patients had intermediate PNI score 40_50 and 21 patients had low PNI score < 40. And reported that, Postoperative complications were substantially related with poor PNI scores. He observed that urgent individuals with colorectal cancer in our research are less likely to have malnutrition than urgent gastrointestinal surgery individuals who had appendicitis and complex abdominal hernia.

In our study, NRI can significantly predict complications (P =0.042 and AUC = 0.682) at cut-off >46.1 blew it was associated with significantly more complications.

**Tebou et al 2008, (9)** reported that normal nutritional risk index >97.5 is associated with a favorable post-operative outcome and below this value patients had unfavorable post-operative outcome. The cut-off value for NRI in our study cut-off >46.1 compared to 97.5 of **Tebou et al 2008**, **(9)** may be explained by our selection criteria which included only urgent colorectal cancer surgeries which is considered major abdominal procedures and more susceptible for malnutrition due to long fasting time. While in **Tebou et al**, most of the cases were minor procedures.

The Nutritional Risk Index is a useful and validated tool to identify individuals who might benefit from nutritional assistance, according to **Cerantola et al. (1)**. If the Nutritional Risk Index (NRI) is more than 97.5, individuals were thought to be receiving enough nutrition. Just a little undernourishment was assessed when NRI is between 84 and 97.5. When NRI, severe malnutrition <84.

In our study, according to CONUT score, 14(38.89%) patients had normal nutrition , 17 (47.22%) patients had light malnutrition 5 (13.89%) patients had moderate malnutrition. There are 2 groups: high CONUT group (CONUT score ≥ 4) and low COUNT group (CONUT score < 4), with 4 being the ideal cut-off number and with a 50% specificity and 83.33% sensitivity.

On the other hand, **Iseki et al. (4)** discovered that 3 was the most acceptable cut-off number for the CONUT score using the receiver operating characteristic (ROC) curve (AUC; 0.624, the sensitivity was 0.5263, and the specificity was 0.7622). It's possible that we only included individuals who had urgent colorectal cancer operations.

Additionally, according to **Iseki et al (4)**, the CONUT score predicts survival in CRC patients more precisely than the PNI. This is as a result of the CONUT score's increased weighting of the peripheral lymphocyte number. The CONUT score also takes into consideration total cholesterol levels, which is not measured by the PNI.

## Conclusion

1. This study revealed significant relation between, PNI blew a cut-off value 45.23, low CONUT score blew a cut-off value 4, and NRI blew a cut-off value 46.3 the development of postoperative complication in urgent colorectal cancer surgeries with a diagnostic accuracy of 72%, 67% and 65%, respectively.
2. PNI is better than CONUT and NRI in predicting postoperative problems in urgent procedures for colorectal cancer because it is an easy-to-use marker that not only identifies individuals at a higher risk for postoperative difficulties but also predicts long-term survival following urgent surgeries.
3. The PNI should be included in the routine assessment of colorectal cancer patients in urgent surgeries.

## Limitation of our study

Weak points of our work were the small size of the study population and being a single-center study.

## Ethical approval and consent

Before participating in the trial, each patient provided written informed permission. The Tanta University Faculty of Medicine's Quality Assurance Unit and research ethics committee both gave their approval to the research (34229/11/20).

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