



African Journal of Clinical Medicine and Surgery

Journal homepage: <https://www.afjcms.com/>



Research Paper

Open Access

Role of the CONUT score and systemic inflammatory indices in predicting major postoperative complications following gastrectomy for gastric cancer

Angela Hayes^{1*} and Melissa Adams¹

¹Université du Québec à Trois-Rivières, Québec, Canada.

Article Info

Volume 1, Issue 1, July 2026

Received : 30 March 2026

Accepted : 09 July 2026

Published : 25 July 2026

doi: [10.62587/AFJCMS.1.1.2026.27-37](https://doi.org/10.62587/AFJCMS.1.1.2026.27-37)

Abstract

Background: The nutritional and inflammatory status of patients before surgery may affect recovery following gastrectomy, but the comparative predictability of composite indices is unclear. The present study aimed to assess the usefulness of the Controlling Nutritional Status (CONUT) score and systemic inflammatory indices for predicting major postoperative complications following gastrectomy for gastric cancer. **Methods:** A retrospective cohort of 348 patients with the intent of a curative gastrectomy was studied. Preoperative CONUT score, NLR and PLR were derived based on regular laboratory data. Complications were defined as Clavien-Dindo grade III or higher within 30 days as major complications. Optimal thresholds were obtained by receiver operating characteristic analyses and independent predictors were determined by using a multivariable logistic regression. **Results:** 9.3% of patients had major complications. An increased CONUT score and an increased neutrophil-to-lymphocyte ratio were independently associated with the presence of major complications (adjusted odds ratio 2.86, 95% confidence interval 1.61-5.08 and adjusted odds ratio 2.13, 95% confidence interval 1.19-3.81 respectively). CONUT score had the highest discriminative power with an AUC of 0.73. **Conclusion:** The preoperative CONUT score has been demonstrated to be an independent predictor of major complications following gastrectomy and has performed better than individual inflammatory indices and to have potential for inclusion in a daily surgical risk assessment protocol.

Keywords: CONUT score, Gastric cancer, Gastrectomy, Neutrophil-to-lymphocyte ratio, Postoperative complications, Prognostic nutritional index

© 2026 Angela Hayes and Melissa Adams. This is an open access article under the CC BY license (<https://creativecommons.org/licenses/by/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made.

1. Introduction

Predicting postoperative morbidity and stratifying cancer patients to identify the high-risk group is becoming an increasingly critical factor in optimizing surgical results in oncology. With increasing surgical volumes of gastrointestinal malignancy and the adoption of enhanced recovery pathways, focus has switched from surgical technique on its own to the condition of the patient presenting for surgery. In this context, simple,

* Corresponding author: Angela Hayes and Melissa Adams, Université du Québec à Trois-Rivières, Québec, Canada.

objective markers that are available prior to surgery and can be used for stratification has become particularly valuable, as this allows for optimal use of limited resources available perioperatively for the highest-risk groups likely to benefit most from the intervention (Sung *et al.*, 2021).

Gastric cancer is one of the most prevalent solid tumors and is a major cause of cancer-related mortality worldwide, especially confined to the East Asia, Eastern Europe and some Latin American countries. Gastrectomy with sufficient lymphadenectomy is the mainstay of curative treatment for patients who have resectable disease. However, even with improved surgical technique, perioperative care, and with the use of enhanced-recovery pathways, gastrectomy remains associated with high postoperative morbidity, and major complications such as anastomotic leak, intra-abdominal abscess, pneumonia, and reoperation have the greatest impact on recovery, hospital cost and oncological outcome (Selby *et al.*, 2015).

The occurrence of major complications is not only dependent on the operative factors. The 'physiologic reserve' a patient can offer to the surgeon, based on nutritional status, and the systemic inflammatory reaction to the tumour, is now thought to be a factor of how well they can cope with the metabolic demand of major upper-gastrointestinal surgery (McMillan, 2013). Malnutrition is very common in gastric cancer due to obstruction, decreased intake, and cancer cachexia and affects the healing of wounds, immune competence, and the responsiveness to postoperative stress (Weimann *et al.*, 2017). The chronic, low grade, inflammation observed in malignancy induces catabolism, immune dysfunction and endothelial activation and all of these have relevance on the postoperative healing process and infections (Diakos *et al.*, 2014).

There is a two-way give-and-take, or vicious circle, between nutrition and inflammation in the hosts bearing cancer cells. Anorexia and enhanced breakdown in dietary proteins (especially muscle proteins and adipose tissue) induced by systemic inflammation exacerbates the state of nutritional depletion, and loss of visceral proteins and immune cells further contributes to the decrease in the host's regulation of the inflammatory response (Ignacio de Ulíbarri *et al.*, 2005). The interplay implies that nutritional status and inflammatory activity by themselves are insufficient to describe the biological condition which define surgical resilience. It is therefore logical to expect a marker that provides a simultaneous readout of both dimensions to be more useful in predicting postoperative morbidity than either of the single-axis markers, a hypothesis that led to the direct comparison made in the present work.

Post-operative complications following gastrectomy have consequences that go well beyond the immediate postoperative period. The presence of anastomotic leak and intra-abdominal sepsis is accompanied by significant short-term mortality, increased critical-care use and/or hospital length of stay, and decreased or withheld adjuvants; there is an increasing amount of evidence that severe surgical stress evokes an immunosuppression state that is associated with worse long-term oncological outcomes, either through a septic mechanism, or by masking previous pre-operative disease (Takagi *et al.*, 2019). Therefore, prevention and very early detection of these events is a clinical priority, and if these events could be predicted prior to surgery, then preventive measures could be implemented when they might still influence the pathway of treatment.

A number of composite indices have been introduced to try to complex these processes from the data routinely supplied from the laboratory. The Controlling Nutritional Status (CONUT) score is derived from serum albumin, total lymphocyte count and total cholesterol that are combined to provide a single nutritional and immune assessment and which have been correlated with prognosis in various malignancies (Templeton *et al.*, 2014; Mohri *et al.*, 2013). Indices of systemic inflammation based on the differential blood count, such as the Neutrophil-to-Lymphocyte Ratio (NLR) or the Platelet-to-Lymphocyte (PLR), and the Prognostic Nutritional Index (PNI), have also been associated with survival and in some studies, with post-operative outcomes (Miyamoto *et al.*, 2019; von Elm *et al.*, 2007). These indices are appealing because they are easy to obtain and reproduce, are not expensive, and are available prior to surgery without additional testing; they can also be calculated after a normal blood panel which most patients undergo prior to surgery, so they do not impose additional testing or costs.

But there are important gaps in the evidence base. Most of the literature has concentrated on longer term survival and the relatively small number of studies that have looked at complications tend to focus on individual indices, without it being possible to choose which is more predictive to a surgeon planning for the peri-

operative period (Onodera *et al.*, 1984). Direct comparisons between cohorts based on consistently defined complications, and extensive multivariable adjustments have been limited. The relative performance of these different indices is clinically important as a superior marker could help optimise nutrition prior to surgery, the level of care to be employed after surgery, and shared decision making.

The other issue is that none of the indices are statistically independent, meaning multiple indices share some of the same laboratory variables, and studies that compare any single index with another could falsely suggest there is unique and valuable information in each one. In order to make a meaningful comparison, the candidate indices need to be introduced into a common model and the discriminative power calibrated for the influence on, and influence of, the other indices, as well as the influence of clinical confounders, and the discriminative ability tested against the same outcome in the same patients. This approach (methodological rather than the standalone assessment which defines most previous research) is required to address the pragmatic question of what one marker should be used by the surgeon.

Therefore, the current study aimed to assess the preoperative CONUT score and major systemic inflammatory indices in predicting postoperative complications following gastrectomy for gastric cancer. In particular, we sought to define if these indices are independently associated or not, after controlling for known clinical and surgical risk factors, and to test if they could be discriminated to identify the most useful index for routine surgical risk evaluation.

2. Materials and methods

2.1. Study design and setting

Retrospective observational cohort study performed in a gastrointestinal malignancy tertiary referral centre. Consecutive patients with gastric adenocarcinoma, histologically confirmed, who were operated for gastrectomy at a given time frame were identified from the prospectively maintained surgical database. The study was designed and reported following the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement for cohort studies (STROBE) (Dindo *et al.*, 2004). Retrospective use of anonymised data and approval by the Institutional Review Board was obtained and yielded a waiver of the need for informed consent. All procedures were carried out in this work were in compliance with the principles of the Declaration of Helsinki.

2.2. Participants and eligibility criteria

Patients who were eligible for the study were adult (18 or older) patients who had a total or subtotal gastrectomy with a standard lymphadenectomy for gastric adenocarcinoma performed for curative-intent surgery. The exclusion criteria included emergency surgery for perforation or bleeding, palliative (not curative) resection, distant metastatic disease at the operation, diagnosis of a second active malignancy, haematological disorders or use of medication that could affect the blood count, an active infection or inflammatory disease at the time of preoperative sampling and incomplete laboratory or outcome data. The following criteria were used to ensure that the calculated indices depicted the tumour nutrition and inflammation status and not confounders.

2.3. Sample size considerations

Sample size was limited by the number of major complication events needed for model stability with respect to multiple variables. A sample size of at least 300 patients was deemed necessary given the commonly recommended number of outcome events per candidate variable (10 or more), and expecting a major complication rate of approximately 18-20% and up to 6 covariates to be included in the final model. To maximise the statistical power, all consecutive eligible patients during the study period were enrolled, and the final cohort was larger than this number.

2.4. Laboratory measurements and index calculation

All calculations were made on a venous blood sample drawn within seven days prior to surgery, before any nutritional change. The laboratory information system was used to collect serum albumin, and total cholesterol and Complete Blood Count (CBC) with differential. Using the standard definitions, the following indices were computed for each patient.

CONUT score was calculated by giving the score to each of the components and adding them together, resulting in a total score ranging from 0 to 12, with a high score showing the poor nutritional and immune status of humanity. The NLR was defined as the absolute neutrophils/absolute lymphocytes, and the PLR was defined as platelet count/absolute lymphocytes. Prognostic nutritional index was computed using serum albumin concentration and the total lymphocyte count with the following formula in which a low score represents poorer nutritional status ([Liu et al., 2018](#)). All indices were calculated by an enquiry person who was blinded to the postoperative outcomes.

Table 1: Components and scoring of the Controlling Nutritional Status (CONUT) score				
Parameter	Normal (0)	Light (2)	Moderate (4)	Severe (6)
Serum albumin (g/dL)	≥ 3.5	3.0–3.49	2.5–2.99	< 2.5
Lymphocytes (mm ³)	≥ 1600	1200–1599	800–1199	< 800
Total cholesterol (mg/dL)	≥ 180	140–179	100–139	< 100

2.5. Surgical procedure, perioperative care, and outcome

Experienced upper-gastrointestinal surgeons did all the operations. The extent of resection, subtotal/total gastrectomy was based on the tumour location and whether a safe proximal margin could be achieved and lymphadenectomy performed as per guidelines. Standard procedures for reconstruction were used, and peri-operative care was identical for all patients, with antimicrobial and thromboembolic prophylaxis, early mobilisation and a standardised approach to the reintroduction of enteral intake.

The primary loss was a major postoperative complication (Clavien-Cindo grade III or higher) that is, one requiring endoscopic, radiological, or surgical intervention, organ support, or death, within 30 days of the surgery ([Baiocchi et al., 2019](#)). This classification was chosen as it is objective and can be reproduced by the grading of severity by the treatment needed. Any complications were recorded using a gastrectomy-specific event list that included anastomotic leak, duodenal stump leak, intra-abdominal abscess, postoperative bleeding, pancreatic fistula and major pulmonary/cardiac events and were identified from the clinical record by two clinicians independent to the operating team and blinded to the index values and, if different, resolved by consensus.

2.6. Statistical analysis

Data were extracted using a structured proforma, and the recorded covariates. For continuous data, mean and standard deviation or median and interquartile range were used, and independent samples t test or Mann-Whitney U-test was used for comparison; for categorical data, frequencies and percentages were used, and the Fisher exact test or chi squared test was used for comparison. Adjustment was performed for variables on univariable analysis that were found to be associated with the outcome as well as clinically important confounders using a multivariable logistic regression model, with the results presented as adjusted OR (aOR) and corresponding 95% CI. The area under the R.O.C. was used to compare the discrimination of each index, and the Hosmer-Lemeshow goodness-of-fit test was used to test model calibration. Statistically significant two sided-s p value was set at < 0.05.

3. Results

3.1. Patient characteristics

348 patients were eligible and included in the analysis. The mean age was 63.7 years, and 61.5% were male. All (41.4%) received a total gastrectomy, while 58.6% received subtotal gastrectomy; 54.0% had operations performed through a minimally invasive technique. Advanced tumour stage was frequent, 44.8% of patients having stage III disease and 38.2% had been given the neoadjuvant chemotherapy. According to the ROC calculated threshold, 37.9% of the patients (n = 132) had a high CONUT score and were defined as such. Table 2 shows the baseline characteristics of the cohort according to CONUT (Table 2).

Table 2: Baseline characteristics by CONUT category

Characteristic	Low CONUT (n = 216)	High CONUT (n = 132)	p-value
Age, years, mean (SD)	61.9 (10.8)	66.6 (11.2)	< 0.001
Male sex, n (%)	131 (60.6)	83 (62.9)	0.671
Body mass index, kg/m ² , mean (SD)	23.6 (3.3)	21.4 (3.1)	< 0.001
ASA III-IV, n (%)	58 (26.9)	52 (39.4)	0.014
Diabetes mellitus, n (%)	41 (19.0)	31 (23.5)	0.307
Total gastrectomy, n (%)	82 (38.0)	62 (47.0)	0.098
Minimally invasive approach, n (%)	122 (56.5)	66 (50.0)	0.238
TNM stage III, n (%)	90 (41.7)	66 (50.0)	0.128
Neoadjuvant chemotherapy, n (%)	80 (37.0)	53 (40.2)	0.560

3.2. Incidence of complications

There were 67 of 348 patients (19.3%) who had major postoperative complication of Clavien–Dindo grade III or above. The most common major events were those of anastomotic leak, intra-abdominal collection requiring drainage, and pneumonia requiring escalation of treatment, which combined accounted for the majority of grade III and IV events. A small number of patients needed reoperations and the 30 day mortality was low with only the most complicated complications. Major complications occurred at a significantly increased rate in the patients who had a high CONUT score (31.1%) compared to the low CONUT score group (12.0%). Similar gradient was found within categories of NLR, while below but still significant gradient was found for PPR and for PNI (Table 3).

Table 3: Unadjusted incidence of major complications by index category

Index category	Major complication, n (%)	No major complication, n (%)	p-value
High CONUT score	41 (31.1)	91 (68.9)	< 0.001
Low CONUT score	26 (12.0)	190 (88.0)	
High NLR	38 (28.1)	97 (71.9)	< 0.001
Low NLR	29 (13.6)	184 (86.4)	
High PLR	34 (24.6)	104 (75.4)	0.036
Low PLR	33 (15.7)	177 (84.3)	
Low PNI	37 (27.4)	98 (72.6)	0.001
High PNI	30 (14.1)	183 (85.9)	

Note: NLR, neutrophil-to-lymphocyte ratio; PLR, platelet-to-lymphocyte ratio; PNI, prognostic nutritional index.

3.3. Multivariable analysis

Of these indices, high CONUT score was found to independently predict major complications after adjustment for all variables with an adjusted odds ratio 2.86 (95% confidence interval 1.61–5.08, $p < 0.001$). Additionally, a high NLR was found to be an independent predictor with an adjusted OR of 2.13 (1.19–3.81, $p = 0.011$). The platelet-to-lymphocyte ratio and the prognostic nutritional index were also significant in univariable analysis but lost their independent significance in the adjusted model, indicating that the relationships of these indices with complications were partially accounted for by the CONUT score and the neutrophil-to-lymphocyte ratio. Other clinical covariates that were significantly associated with major complications were an advanced physical status and total gastrectomy, which remained independent (Table 4).

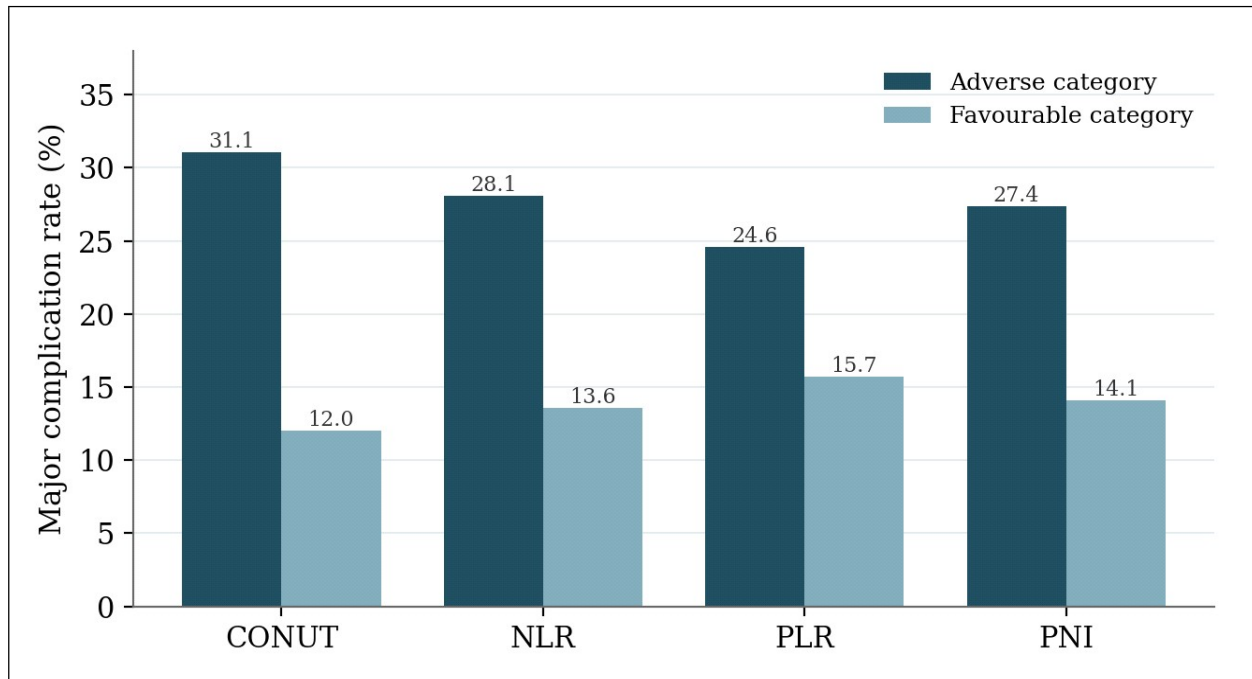


Figure 1: Major postoperative complication rate according to the adverse and favourable category of each preoperative index

Table 4: Multivariable logistic regression for major postoperative complications

Variable	Adjusted OR	95% CI	p-value
High CONUT score	2.86	1.61–5.08	< 0.001
High neutrophil-to-lymphocyte ratio	2.13	1.19–3.81	0.011
High platelet-to-lymphocyte ratio	1.28	0.70–2.34	0.421
Low prognostic nutritional index	1.35	0.72–2.53	0.352
ASA III-IV	1.92	1.07–3.44	0.028
Total gastrectomy	1.86	1.05–3.29	0.033
TNM stage III	1.44	0.81–2.56	0.214
Age (per year)	1.02	0.99–1.05	0.156

Note: OR, odds ratio; CI, confidence interval; ASA, American Society of Anesthesiologists; TNM, tumour-node-metastasis.

This is because the change in platelet-to-lymphocyte ratio and change in the prognostic nutritional index is inherently informative. When analyzed separately, these were clearly linked with major complications but their effect estimate moved towards the null when the CONUT score and the neutrophil to lymphocyte ratio were included, so much of the apparent predictive effect of these was plausible to be shared, rather than independent. This is likely to be due to the degrees of biological overlap between all the indices based on a shared underlying nutritional/inflammation state; such overlap highlights the need for mutual adjustment when comparing not-statistically-independent markers.

3.4. Comparative discriminative ability

Among the discriminative ability of the indices, the CONUT score was the highest (0.73), followed by the P/L ratio (0.60), N/L ratio (0.67), and prognostic nutritional index (PNI, 0.64). This advantage was statistically significant for the CONUT score compared to the PLT, and the advantage is also present when the CONUT score is compared to the NPL, but at a lower magnitude than that of the PLT. When the model was created and introduced with the inflammatory score (neutrophil to lymphocyte) the area under the curve was slightly

higher at 0.76, suggesting that an inflammatory score given to the nutritional score would have limited incremental value. The indices’ relative performance is presented in Table 5.

The multivariable analysis that included the CONUT score and clinical and operative co-factors (covariates) revealed acceptable overall model performance, positive calibration by Hosmer–Lemeshow test, and no significant difference between observed and predicted event probability. Given the sensitivity and specificity of the CONUT score at its optimal threshold (68% and 71% respectively) it is actually a marker useful for stratification but, like all individual markers, is not by itself sufficient for management. Therefore, its main use is to signal patients that may require further investigation, not to make a definitive prediction for the individual patient’s outcome.

Table 5: Discriminative ability of the indices for major complications			
Index	AUC	95% CI	Sensitivity/Specificity
CONUT score	0.73	0.66–0.79	68% / 71%
Neutrophil-to-lymphocyte ratio	0.67	0.60–0.74	62% / 66%
Prognostic nutritional index	0.64	0.57–0.71	60% / 63%
Platelet-to-lymphocyte ratio	0.60	0.52–0.67	55% / 61%
CONUT + NLR combined	0.76	0.70–0.82	70% / 73%

Note: AUC, area under the receiver operating characteristic curve; CI, confidence interval; NLR, neutrophil-to-lymphocyte ratio.

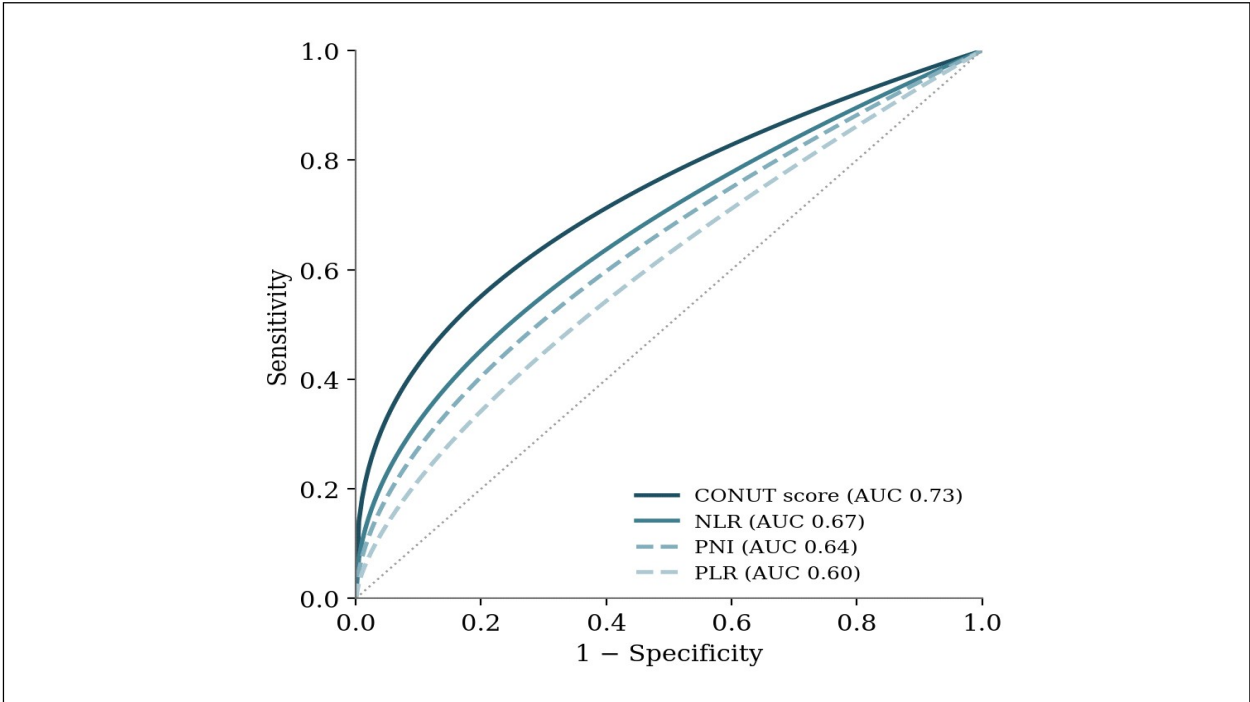


Figure 2: Receiver operating characteristic curves for the preoperative indices in predicting major postoperative complications

3.5. Subgroup analysis

This relationship of high CONUT score with major complications was studied in clinically meaningful sub-populations. There was no significant interaction between groups, and the predictive effect was consistent in patients who had total or subtotal gastrectomy, and those who had or did not have neoadjuvant chemotherapy, and across age strata. This uniformity suggested that the CONUT score has a more general prognostic indicating use outside of a specific operable or treatment scenario; therefore, it could be safely used for other measurements within the surgical population examined (Table 6).

Table 6: Association between high CONUT score and major complications across subgroups			
Subgroup	Adjusted OR	95% CI	p (interaction)
Total gastrectomy	3.02	1.42–6.42	0.64
Subtotal gastrectomy	2.68	1.21–5.94	
Neoadjuvant chemotherapy	2.74	1.24–6.05	0.78
No neoadjuvant chemotherapy	2.95	1.39–6.26	
Age < 65 years	2.61	1.18–5.77	0.71
Age ≥ 65 years	3.08	1.44–6.59	

4. Discussion

This study revealed that CONUT score is an independent predictor of major postoperative events in this series of gastric cancer patients who underwent curative gastrectomy and the area under the curve was the highest of these indices. A high NLR was also an independent predictor, while a high PLR and PNI, which were linked to complications on unadjusted analysis, lost significance on adjusted analysis. All these findings show that the combination of these nutritional and immune indicators is more representative of the perioperative risk than a single inflammation ratio.

4.1. Interpretation and biological rationale

The biological coherence of the predictive strength of the CONUT score. It has three components each reflecting a different but related aspect of the host state – the serum albumin reflecting visceral protein reserve and indirectly chronic inflammation; the lymphocyte count reflecting immune competence; and the total cholesterol reflecting nutritional and metabolic reserve. Together these provide a more complete characterisation of the patient's potential for an effective healing and immune response to the surgical insult than a differential of the leucocyte numbers alone. A high score may be linked to specific complications observed: low levels of albumin diminish wound healing and increase the risk of failure of the suturing site, while low levels of lymphocytes hinder defence against surgical-site infection and respiratory infection; and reduced energy reserves curtail metabolic response to the postoperative stress. In addition, albumin is a negative acute-phase reactant with a low albumin level indicating reduced synthesis during the malnourished state, but also indicating the negative transcription, which occurs with systemic inflammation; partly for this reason the albumin component of the score contains nutrition-related and inflammation-related information.

The independent role of NLR is consistent with the notion that systemic inflammatory response to the tumour is associated with pro-catabolic/immunosuppressed state which predisposes to complications. This ratio was also found to be predictive in addition to the CONUT score, but neither platelet-to-lymphocyte ratio nor the prognostic nutritional index were, which means that the information provided by an increase in neutrophilic inflammation and a decrease in lymphocytes is at least partially distinct from the information on nutritive status provided by the conjunctive score. Since the incremental value of applying the two markers is modest, it is likely that there is a lot of overlap in the risk they confer, and that the CONUT score contains most of the predictive signal.

One potential explanation for the relative sub-optimal performance of the platelet-to-lymphocyte ratio and the prognostic nutritional index is each of them measures only a small component of host biology. The platelet count is influenced by many non-specific stimuli and cannot be a good marker of tumour related inflammatory process; therefore, the platelet-to-lymphocyte ratio is more platelet dependent; on the other hand, the CONUT score includes two of the three components of prognosis nutritional index, namely albumin and lymphocyte count, but also importantly the lipid component (cholesterol) that captures information about metabolic reserve (Gillis *et al.*, 2018). By combining three complementary parameters, the CONUT score seems to better summarise both the nutritional and immune status, another explanation being its consistently better performance in the adjusted analysis and in comparing discriminative abilities.

4.2. Comparison with existing literature

These findings are consistent with and expand on a previous large body of data on host markers in gastric cancer surgery. Some previous studies have shown an association between CONUT score and poor long-term outcome in gastrointestinal malignancies, and several have suggested an association between this score and postoperative morbidity, however, not always with reference to other inflammatory scores (Yang *et al.*, 2016; Kanda *et al.*, 2016). There has been a greater number of reports on the NLR and these have been even more varied as some cohorts have detected an association with complications whilst others have detected a predictive value for survival alone. Through this study, that appraised the main indices in the same cohort of patients, using a strict definition of complication, and that made a complex multivariable adjustment, it is possible to understand the relative standing, which confirms that the CONUT score is the most superior score for evaluating short-term surgical risk, as previously suggested by comparative studies that demonstrated its superiority against other nutritional and inflammatory scores (Sun *et al.*, 2017).

Major complication rate in its entirety observed here is within the spectrum reported in modern series of curative gastrectomies which corroborates the representativeness of the cohort. The clustering of such events in those with poor nutritional and inflammatory profile, in the absence of significant intergroup differences in tumour stage and operation type in each CONUT category, suggests that this association is related to host status while not necessarily indicative of differences in tumour burden and/or surgical complexity.

It's also worth asking these results in the context of the broader literature for inflammation-based prognostic scores. In many studies of various types of tumour, composite measures incorporating a combination of an inflammatory and a nutritional aspect have been seen to perform better than blood count-based ratios alone, as was also observed in this study, where gastrectomy was the context (Guner *et al.*, 2018; Coussens and Werb, 2002). That a nutritional-immune composite is of most value in prediction, with a purely inflammatory ratio providing only marginal information, reflects what has been suggested in the surgery of the colon and hepatobiliary tract and provides a rational framework for the increasingly comprehensive picture of the cancer-bearing state conferring surgery risk across both domains (Proctor *et al.*, 2011).

4.3. Clinical implications

A major advantage of the clinical use of the CONUT score is its simplicity. It is computed using three easily and frequently acquired laboratory parameters, does not necessitate any special equipment, and can be stored automatically in an electronic documentation before the operation. Such an identification of "high-risk" may potentially be used to make decisions regarding targeting of nutrition optimisation prior to surgery, more rigorous monitoring for infective and anastomotic issues postsurgery and an informed consideration of operative risk. The format of the score remains modifiable and is potentially the nutritional component that supports the idea that structured pre-op intervention may have an impact on complication rates, which for this purpose should be formally tested (Kim *et al.*, 2019).

The time of the assessment adds to practical value as well. Since the information is obtained from laboratory results long before the actual day of surgery, a high score can be detected in the pre-operative work-up and still there's time to take action. Falls below 40 – In patients not in immediate need of surgery, this window of time may allow for a brief period of nutritional intervention, correction of hypoalbuminaemia if possible and structured prehabitating – each of which have been positively linked to surgical recovery in patients who were nutritionally depleted. Even when the interval is too short to do something meaningful, knowledge of the increased risk can help to guide intra-operative decision making, the intensity of post-operative monitoring and the threshold of investigation in the event of suspected complication.

The CONUT score could be used as part of an existing risk assessment framework, with the potential of optimising the selection of patients who are most likely to benefit from prehabilitation and enhanced-recovery protocols. Considering that the incremental value of the use of inflammatory indices is minimal a pragmatic approach would be to use the CONUT score as one's basic host-status marker and adopt the NLR as an additional measure for some extra stratification if desired in routine practice. In this respect, simplicity is sought, and this parsimony is one of the strengths recognised in any surgical risk prediction tool, as it is easier to use and adopt a simple tool than a composite one (Lu *et al.*, 2019).

5. Conclusions

In gastric cancer, pre-operative CONUT score was an independent predictor of major postoperative complications following gastrectomy and was shown to have better discriminative power than each systemic inflammatory index on its own, and an elevated NLR added to the pre-op CONUT score was an independent predictor. The CONUT score, a practical and attractive marker with potentially modifiable parameters, is easily calculated from routinely obtained laboratory values. These findings should be validated by prospective, externally validated studies before the routine adoption of interventional studies focused on the nutrition deficits identified by the score can determine whether or not surgical morbidity can be reduced by surgical optimisation guided by this score.

Ethics approval and consent to participate

The study was approved by the Institutional Ethics Committee, and written informed consent was obtained from all participants.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Data availability

The datasets generated and analysed during the current study are available from the corresponding author on reasonable request.

Author contributions

All authors contributed to the conception and design of the study, data acquisition, analysis and interpretation, drafting and critical revision of the manuscript, and approved the final version for submission.

References

- Baiocchi, G.L., Giacomuzzi, S., Marrelli, D., Reim, D., Piessen, G., Matos da Costa, P. *et al.* (2019). [International consensus on a complications list after gastrectomy for cancer](#). *Gastric Cancer*, 22(1): 172-89.
- Coussens, L.M. and Werb, Z. (2002). [Inflammation and cancer](#). *Nature*, 420(6917): 860-7.
- Diakos, C.I., Charles, K.A., McMillan, D.C. and Clarke, S.J. (2014). [Cancer-related inflammation and treatment effectiveness](#). *Lancet Oncol*, 15(11): e493-503.
- Dindo, D., Demartines, N. and Clavien, P.A. (2004). [Classification of surgical complications: A new proposal with evaluation in a cohort of 6336 patients and results of a survey](#). *Ann Surg*, 240(2): 205-13.
- Gillis, C., Buhler, K., Bresee, L., Carli, F., Gramlich, L., Culos-Reed, N. *et al.* (2018). [Effects of nutritional prehabilitation, with and without exercise, on outcomes of patients who undergo colorectal surgery: A systematic review and meta-analysis](#). *Gastroenterology*, 155(2): 391-410.
- Guner, A., Kim, S.Y., Yu, J.E., Min, I.K., Roh, Y.H., Roh, C. *et al.* (2018). [Parameters for predicting surgical outcomes for gastric cancer patients: Simple is better than complex](#). *Ann Surg Oncol*, 25(11): 3239-47.
- Ignacio de Ulíbarri, J., González-Madroño, A., de Villar, N.G., González, P., González, B., Mancha, A. *et al.* (2005). [CONUT: A tool for controlling nutritional status: First validation in a hospital population](#). *Nutr Hosp*, 20(1): 38-45.
- Jian-Hui, C., Iskandar, E.A., Cai, S.I., Chen, C.Q., Wu, H., Xu, J.B. *et al.* (2016). [Significance of Onodera's prognostic nutritional index in patients with gastric cancer after curative resection](#). *Tumour Biol*, 37(3): 3277-83.
- Kanda, M., Mizuno, A., Tanaka, C., Kobayashi, D., Fujiwara, M., Iwata, N. *et al.* (2016). [Nutritional predictors of postoperative outcome in pancreatic cancer](#). *Br J Surg*, 103(3): 267-75.
- Kim, E.Y., Kim, Y.J., Kim, Y.N., Yoon, H.J., Lee, J.H., Kim, H.K. *et al.* (2019). [The preoperative controlling nutritional status score predicts survival after curative surgery in patients with gastric cancer](#). *Ann Surg Treat Res*, 96(2): 76-82.

- Liu, X., Zhang, D., Lin, E., Chen, Y., Li, W., Chen, Y. *et al.* (2018). Preoperative controlling nutritional status (CONUT) score as a predictor of long-term outcome after curative resection for gastric cancer. *J Surg Oncol*, 117(4): 655-64.
- Lu, J., Xu, B.B., Zheng, Z.F., Xie, J.W., Wang, J.B., Lin, J.X. *et al.* (2019). CONUT score is superior to other nutritional and inflammatory indices for predicting outcomes after radical gastrectomy. *Surgery*, 166(3): 297-304.
- McMillan, D.C. (2013). The systemic inflammation-based Glasgow Prognostic Score: A decade of experience in patients with cancer. *Cancer Treat Rev*, 39(5): 534-40.
- Miyamoto, Y., Hiyoshi, Y., Daitoku, N., Okadome, K., Sakamoto, Y., Yamashita, K. *et al.* (2019). Naples prognostic score is a useful prognostic marker in patients with metastatic colorectal cancer. *Dis Colon Rectum*, 62(12): 1485-93.
- Mohri, Y., Inoue, Y., Tanaka, K., Hiro, J., Uchida, K. and Kusunoki, M. (2013). Prognostic nutritional index predicts postoperative outcome in colorectal cancer. *World J Surg*, 37(11): 2688-92.
- Onodera, T., Goseki, N. and Kosaki, G. (1984). Prognostic nutritional index in gastrointestinal surgery of malnourished cancer patients. *Nihon Geka Gakkai Zasshi*, 85(9): 1001-5.
- Proctor, M.J., Morrison, D.S., Talwar, D., Balmer, S.M., Fletcher, C.D., O'Reilly, D.S. *et al.* (2011). A comparison of inflammation-based prognostic scores in patients with cancer. *Eur J Cancer*, 47(17): 2633-41.
- Selby, L.V., Vertosick, E.A., Sjoberg, D.D., Schattner, M.A., Janjigian, Y.Y., Brennan, M.F. *et al.* (2015). Morbidity after total gastrectomy: Analysis of 238 patients. *J Am Coll Surg*, 220(5): 863-71.
- Sun, J., Wang, D., Mei, Y., Jin, H., Zhu, K., Liu, X. *et al.* (2017). Value of the prognostic nutritional index in advanced gastric cancer treated with preoperative chemotherapy. *J Surg Res*, 209: 37-44.
- Sung, H., Ferlay, J., Siegel, R.L., Laversanne, M., Soerjomataram, I., Jemal, A. *et al.* (2021). Global cancer statistics 2020: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. *CA Cancer J Clin*, 71(3): 209-49.
- Takagi, K., Buettner, S. and Ijzermans, J.N.M. (2019). Prognostic significance of the controlling nutritional status (CONUT) score in patients undergoing gastrectomy for gastric cancer: A systematic review and meta-analysis. *BMC Surg*, 19(1): 129.
- Templeton, A.J., McNamara, M.G., Šeruga, B., Vera-Badillo, F.E., Aneja, P., Ocaña, A. *et al.* (2014). Prognostic role of neutrophil-to-lymphocyte ratio in solid tumors: A systematic review and meta-analysis. *J Natl Cancer Inst*, 106(6): dju124.
- von Elm, E., Altman, D.G., Egger, M., Pocock, S.J., Gøtzsche, P.C. and Vandenbroucke, J.P. (2007). The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) statement: Guidelines for reporting observational studies. *Lancet*, 370(9596): 1453-7.
- Weimann, A., Braga, M., Carli, F., Higashiguchi, T., Hübner, M., Klek, S. *et al.* (2017). ESPEN guideline: Clinical nutrition in surgery. *Clin Nutr*, 36(3): 623-50.
- Yang, Y., Gao, P., Song, Y., Sun, J., Chen, X., Zhao, J. *et al.* (2016). The prognostic nutritional index is a predictive indicator of prognosis and postoperative complications in gastric cancer: A meta-analysis. *Eur J Surg Oncol*, 42(8): 1176-82.