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The Relationship Between Systemic Immune Inflammatory Index, Prognostic Nutritional Index, and Postoperative Infection in Patients Undergoing Partial Hepatectomy for Liver Cancer

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ABSTRACT

Postoperative infections (POIs) significantly contribute to morbidity and mortality following partial hepatectomy for hepatocellular carcinoma (HCC). While the Systemic Immune-Inflammation Index (SII) and Prognostic Nutritional Index (PNI) are recognized biomarkers for immune-inflammatory and nutritional status, their combined predictive value for POIs in liver surgery requires further investigation. This study evaluates SII and PNI as preoperative predictors for infections in this patient population.

A retrospective observational study was conducted on 300 patients undergoing partial hepatectomy between 2022 and 2024. Preoperative laboratory data were used to calculate SII and PNI, with POIs identified within 30 days based on CDC guidelines. Statistical analyses, including multivariate logistic regression, were performed to compare infected and non-infected cohorts and identify independent predictors of infection.

Of the 300 patients, 96 (32%) developed POIs. The infected group exhibited significantly higher SII (1142 ± 618 vs 792 ± 450) and lower PNI (40.1 ± 5.8 vs 46.4 ± 5.9) than the non-infected group. Multivariate analysis confirmed high SII (OR 2.85) and low PNI (OR 3.26; 95% CI, 2.01–5.12) as independent predictors. Furthermore, infections were associated with prolonged hospitalization, increased ICU admissions, and higher 30-day mortality.

Preoperative SII and PNI are effective, independent predictors of POIs in patients undergoing hepatectomy for liver cancer. Integrating these biomarkers into routine evaluation enhances risk stratification and guides perioperative optimization. Early identification through these indices allows for targeted interventions, such as nursing-led nutritional support and intensified surveillance, to reduce complications and improve surgical outcomes.

Keywords: Hepatocellular carcinoma; Inflammatory markers; Nutritional status; Partial hepatectomy; Postoperative infection; Prognostic nutritional index; Systemic immune-inflammation index

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INTRODUCTION

Liver cancer is a major global health challenge, with hepatocellular carcinoma (HCC) constituting the majority of primary liver tumors. Partial hepatectomy remains the primary surgical treatment for resectable liver cancer. Despite improvements in surgical techniques, perioperative care, and liver management, postoperative infections (POIs) continue to pose a significant risk to patients. Following surgery, infections lead to longer hospital stays, higher healthcare costs, and worse long-term outcomes, including delays in adjuvant therapy and increased recurrence rates.[1] Identifying and understanding the risk factors for postoperative infections is crucial for patient stratification, early treatment, and the development of preventive strategies. Recently, the role of systemic inflammation and nutritional status in predicting surgical outcomes for cancer patients has gained attention. Among potential biomarkers, the systemic immune-inflammation index (SII) and the prognostic nutritional index (PNI) are of particular interest due to their accessibility and clinical utility.

The SII is calculated by multiplying the peripheral blood platelet and neutrophil counts and dividing the result by the lymphocyte count (SII = platelet × neutrophil/lymphocyte).[2] It reflects the balance between the host immune system and inflammatory status. High SII has been linked to poor outcomes, higher tumor burden, and various complications in malignancies, including those of the digestive and hepatic systems. An elevated SII suggests a compromised postoperative immune response, increasing the patient's susceptibility to infection. The PNI utilizes serum albumin concentration and lymphocyte count to assess the patient's nutritional and immune status (PNI = albumin [g/L] + 5 × lymphocyte count [10^9/L]). Malnutrition and impaired immunity can retard wound healing, increase the risk of infection, and raise the likelihood of postoperative complications. Lower PNI scores are associated with a greater probability of complications and mortality in patients undergoing gastrointestinal or hepatic surgery.[3–6]

Although each of these indices is known to be associated with adverse outcomes in cancer patients, their combined predictive value for infections in patients undergoing liver cancer surgery remains underexplored. As inflammation, nutrition, and preoperative stress interact in complex ways, it is hypothesized that SII and PNI may serve as effective preoperative indicators of infection risk.[7–10] Furthermore, liver cancer patients commonly present with underlying liver disease, cirrhosis, and immune dysfunction, all of which predispose them to infections. Standard tools do not always capture the full clinical picture in these cases. Therefore, clinicians should consider incorporating validated indicators such as SII and PNI into preoperative assessments to optimize treatment decisions and enhance postoperative care.

The aim of this study was to investigate the relationship between SII, PNI, and postoperative infections in liver cancer patients undergoing partial hepatectomy. Utilizing these indices to assess infection risk may improve surgical prognostication, facilitate better care management, and ultimately reduce infectious complications. With this information, targeted anti-inflammatory and nutritional interventions can be implemented to improve surgical outcomes in high-risk patients.

Surgical techniques for treating HCC have improved significantly in recent decades. Despite these advances in surgery and patient care, postoperative infections remain a major source of morbidity. Several studies have sought to identify factors predicting these complications by assessing patients' immune status, nutritional reserve, and systemic inflammation levels before surgery. Two biomarkers, SII and PNI, are now considered pivotal for prognostication and risk stratification in surgical oncology.

Evaluating the SII-derived from platelet, neutrophil, and lymphocyte counts-has improved prognostic accuracy for cancer patients. Previous studies[10–13] have demonstrated that among patients with HCC, an elevated preoperative SII is associated with lower overall and recurrence-free survival following curative surgery. This is supported by studies[14–17] showing that a rise in SII corresponds with impaired immune activity and more aggressive tumor characteristics in liver cancer patients. Elevated neutrophil and platelet count within the index suggest a highly inflammatory state that may promote tumorigenesis, while low lymphocyte counts indicate compromised immune surveillance.

Subsequent studies have reported similar findings. Recent reviews[18–21] of gastrointestinal and hepatobiliary cancers reported that higher SII was linked to poor clinical outcomes, including increased postoperative complications. Preoperative SII has been found to be associated with an increased probability of postoperative infection in patients undergoing liver resection.

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According to these authors, SII may be used to identify high-risk patients requiring enhanced monitoring and early intervention.

In contrast, the PNI is a well-established indicator of nutritional and immune status, incorporating albumin levels and lymphocyte counts.[22] Numerous reports have indicated that low PNI increases the likelihood of postoperative complications and infections. A recent cohort study of 832 gastrointestinal cancer surgery patients found that those with lower PNI scores were more likely to suffer from surgical site infections (SSIs) and endure prolonged hospital stays.[23] Similarly, another study revealed that patients with HCC and low PNI values experienced higher rates of postoperative infections and delayed recovery. Albumin plays a critical role in determining PNI, serving as both a nutritional marker and a negative acute-phase reactant that decreases during inflammation.

Experts have investigated the combined predictive value of SII and PNI. In liver surgery, particularly for HCC, these indices are simple and cost-effective tools for risk stratification. A 2013 study showed that patients with a high SII and low PNI experienced poorer outcomes after liver transplantation and had a higher risk of postoperative sepsis.[24] Consequently, the concurrent use of these indices during preoperative evaluation is likely to be clinically beneficial. Additionally, the role of inflammation in tumor progression and postoperative recovery has been further elucidated in recent years. Elevated neutrophils and platelets release cytokines such as interleukin-6 (IL-6) and tumor necrosis factor-α (TNF-α), which impair T-cell activation and promote tissue damage, setting the stage for bacterial translocation and infection.[25]

The SII and PNI are promising indices that have demonstrated prognostic relevance in predicting postoperative infections. However, further large-scale, prospective studies are needed to establish standardized cut-off values and validate their clinical utility in routine practice. The current study seeks to contribute to this body of knowledge by specifically evaluating the relationship between preoperative SII, PNI, and the risk of postoperative infections in patients undergoing partial hepatectomy for liver cancer.

MATERIALS AND METHODS

Study Design and Setting

This retrospective study was conducted at a tertiary care center dedicated to hepatobiliary surgery. The study covered a 3-year period from January 2022 to December 2024 to determine whether SII and PNI can predict postoperative infections in liver cancer patients undergoing partial hepatectomy. The Institutional Ethics Committee approved the study, and patient confidentiality was maintained throughout. The nursing department was directly involved in the perioperative monitoring process and infection surveillance.

Study Population and Sample Size

The study included 300 patients who underwent partial hepatectomy for confirmed HCC. Patients were identified using medical records and surgical logs from the hepatobiliary unit. Inclusion criteria were: age ≥ 18 years, histopathologically confirmed HCC, and undergoing either open or laparoscopic partial hepatectomy. Exclusion criteria were: history of prior hepatectomy, active infection at the time of surgery, immunocompromised state, or incomplete laboratory data.

Preoperative Evaluation and Data Collection

Preoperative assessment included history taking, physical examination, imaging studies (ultrasound and/or contrast-enhanced computed tomography/ magnetic resonance imaging), and routine laboratory investigations. Laboratory tests included complete blood count, liver function tests, serum albumin, viral markers (hepatitis B virus/hepatitis C virus), and alpha-fetoprotein (AFP). All laboratory measurements were performed in the hospital's central clinical laboratory using standardized automated analyzers. Hematological parameters were analyzed using an automated hematology analyzer (Sysmex Corporation, Kobe, Japan), while biochemical parameters, including serum albumin, were measured using an automated biochemistry analyzer (Roche Diagnostics, Basel, Switzerland). All analyses were conducted according to manufacturer-validated protocols.

Blood samples were obtained within 1 week prior to surgery.

Calculation of SII and PNI

Preoperative hematological data were used to calculate the SII and PNI. SII was calculated as: SII=Platelet count×Neutrophil count/Lymphocyte count (all in 10^9/L). PNI was calculated as: PNI=Serum Albumin (g/L) + 5×Total Lymphocyte Count (10^9/L). Cut-off values for high and low SII/PNI were

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determined based on receiver operating characteristic (ROC) curve analysis to maximize sensitivity and specificity for predicting postoperative infection.

Surgical Procedure

Patients underwent partial hepatectomy via either an open or laparoscopic approach, depending on tumor size, location, and surgeon preference. Intraoperative data regarding operative time, blood loss, blood transfusions, and the need for hepatic inflow control were recorded. Hemodynamic stability was maintained throughout the operation. Intravenous antibiotics were administered in accordance with the hospital's infection control guidelines. Major hepatectomy (resection of ≥3 Couinaud segments) was performed in 128 patients (42.7%), and minor hepatectomy in 172 patients (57.3%). The Pringle maneuver was used in 185 patients (61.7%), and drains were placed in 206 patients (68.7%). All cases followed a standardized Enhanced Recovery After Surgery (ERAS) protocol. Perioperative antibiotics consisted of ceftriaxone 2 g administered within 60 min before skin incision and continued for 48 h postoperatively; no differences in infection type were observed based on antibiotic timing. Surgical site infections (SSIs) were classified according to the U.S. Centers for Disease Control and Prevention (CDC) criteria into superficial incisional, deep incisional, and organ/space categories. Infection prevention bundles—including chlorhexidine skin preparation, normothermia maintenance, and standardized wound closure techniques—were applied in all patients.

Nutritional Assessment

Nutritional status was screened using the Nutritional Risk Screening 2002 (NRS-2002) tool during preoperative assessment. The PNI was calculated as: PNI=[10×serum albumin (g/dL)]+[0.005×total lymphocyte count (/mm^3)]. To account for non-nutritional causes of hypoalbuminemia, serum C-reactive protein (CRP) and liver function tests (AST, ALT) were measured in all patients. Preoperative malnutrition was defined according to Global Leadership Initiative on Malnutrition (GLIM) criteria.

Postoperative Infection Surveillance

Postoperative infections were categorized according to CDC guidelines. These included surgical site infections, pneumonia, urinary tract infections, and sepsis. Nursing staff monitored patients daily for temperature spikes, wound appearance, respiratory distress, urinary symptoms, and inflammatory markers (white blood cell count and CRP). Microbiological cultures were obtained from blood, urine, sputum, or wound exudate to confirm infection. The nursing team ensured early detection and isolation protocols were implemented.

Nursing Care Protocol and Documentation

Nurses followed a structured post-hepatectomy care plan that included: frequent monitoring of temperature, respiratory rate, and surgical wound; wound care; pain assessment using numerical rating scales; and early mobilization protocols. Nutritional support included enteral or parenteral nutrition based on postoperative gastrointestinal tolerance. Infection control practices included hand hygiene compliance, sterile dressing changes, catheter care, and ventilator bundle protocols where applicable. Daily nursing documentation included signs of infection, vital signs, intake/output charting, pain scores, and nutritional intake. These data were crucial for identifying early postoperative complications.

Outcomes Measured

The primary outcome was the occurrence of postoperative infection within 30 days of surgery. Secondary outcomes included length of hospital stay, ICU admission requirements, reoperation rates, and 30-day mortality. Subgroup analyses were performed to evaluate hospitalization rates among patients in different SII and PNI strata.

Statistical Analysis

Data analysis was performed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation (SD) and compared using the Student's t test or Mann–Whitney U test, depending on the normality of the data distribution. Categorical variables were analyzed using the χ^2 test or Fisher exact test. ROC curve analysis was used to determine optimal cut-off values for SII and PNI to predict infection. Interaction terms between SII and PNI were tested by including a multiplicative term in the multivariate logistic regression model. This interaction was not statistically significant (p=0.41), indicating no synergistic effect between the two predictors regarding infection risk. An *a priori* power analysis using PASS 15.0 software determined that a minimum of 240

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patients would be required to detect an odds ratio of 1.8 for postoperative infection with 80% power at a two-sided α of 0.05. The final cohort size of 300 patients exceeded this requirement. Multivariate logistic regression was performed to identify independent predictors of postoperative infection, adjusting for age, sex, comorbidities, operative time, and blood loss. A *p* value <0.05 was considered statistically significant. Missing data were handled using multiple imputation with chained equations for variables with <10% missingness; patients with >10% missing data for key predictors were excluded. Model fit was assessed with the Hosmer–Lemeshow goodness-of-fit test (χ^2=6.27, *p*=0.51), and multicollinearity was evaluated using variance inflation factors (all VIF < 2.0).

RESULTS

Demographic and Anthropometric Characteristics

This study included 300 patients who underwent partial hepatectomy for liver cancer between January 2022 and December 2024. The results are presented below, evaluating demographic characteristics, inflammatory and nutritional indices, infection outcomes, and predictive analysis. Table 1 summarizes the demographic and anthropometric profile of the study population. The mean age was 58.3 ± 10.6 years, with a male predominance (60% males, n=180; 40% females, n=120). The mean BMI was 24.6 ± 3.5 kg/m^2, falling within the normal-to-overweight range. This balanced demographic distribution supports the generalizability of findings to typical surgical populations undergoing liver resection. Age and BMI were not significantly associated with infection status.

Preoperative Inflammatory and Nutritional Indices

Table 2 presents detailed hematological and nutritional profiles. The mean preoperative serum albumin was 37.2 ± 4.1 g/L, with a mean lymphocyte count of 1.55 ± 0.6 × 10^9/L and a neutrophil count of 5.8 ± 2.3 × 10^9/L. The platelet count averaged 240.5 ± 76.3 × 10^9/L. The derived SII was 905 ± 510, and the PNI was 44.0 ± 6.2. The wide inter-patient variability, especially in SII and PNI, justified subgroup analysis. These markers were used to stratify patients into risk categories for postoperative infections. Preoperative inflammatory and nutritional parameters are shown in Figure 1.

Comparison Between Infected and Non-infected Groups

Postoperative infections were observed in 96 patients (32%), while 204 remained infection-free. Table 3 shows that infected patients had significantly higher SII values (1142 ± 618) compared to non-infected patients (792 ± 450, *p*<0.001). In contrast, PNI was significantly lower in infected patients (40.1 ± 5.8 vs 46.4 ± 5.9, *p*<0.001). Similarly, albumin levels and white blood cell (WBC) counts showed significant deviation in infected individuals. These findings confirm that a pro-inflammatory state (high SII) and immunonutritional depletion (low PNI) are strongly associated with postoperative infections. Lower albumin and elevated WBCs further reflect systemic stress and immune dysregulation. Comparison between infected and non-infected groups is shown in Figure 2.

Table 1. Demographic and anthropometric characteristics of the study population (n = 300)

Parameter	Value
Age, y	58.3±10.6
Male, %	180 (60%)
Female, %	120 (40%)
BMI, kg/m^2	24.6±3.5

BMI: body mass index.

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Table 2. Preoperative inflammatory and nutritional parameters

Parameter	Mean±SD
Preoperative albumin, g/L	37.2±4.1
Lymphocyte count, 10^9/L	1.55±0.6
Neutrophil count, 10^9/L	5.8±2.3
Platelet count, 10^9/L	240.5±76.3
Systemic immune-inflammation index (SII)	905±510
Prognostic nutritional index (PNI)	44.0±6.2

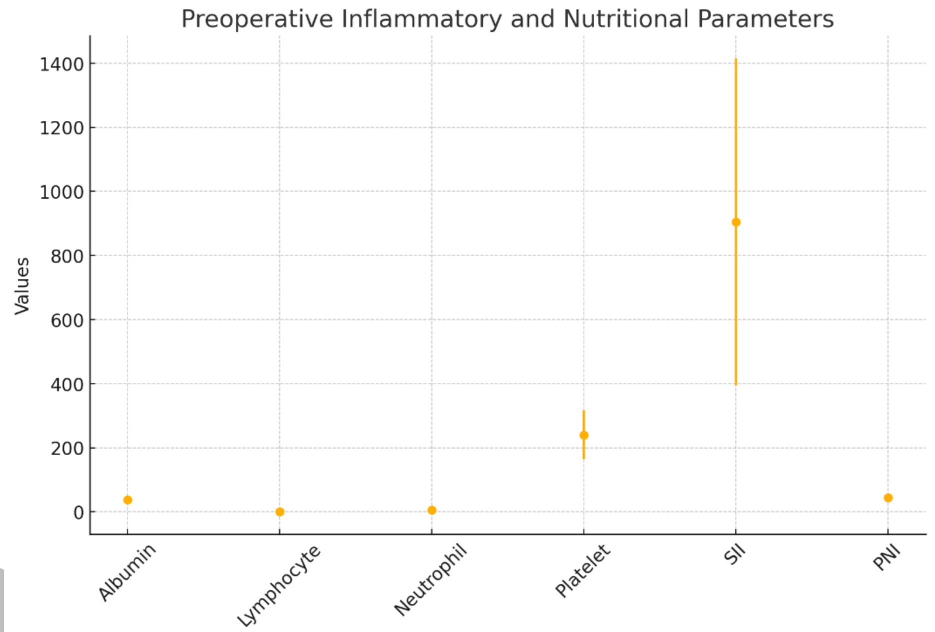

Figure 1. Preoperative inflammatory and nutritional parameters. PNI: prognostic nutritional index; SD: standard deviation; SII: systemic immune-inflammation index.

Table 3. Comparison of key indices between infected and non-infected patients

Parameter	Infected (n = 96)	Non-Infected (n = 204)	*p*
SII, mean±SD	1142±618	792±450	<0.001
PNI, mean±SD	40.1±5.8	46.4±5.9	<0.001
Albumin, g/L	34.5±3.7	38.4±3.9	<0.001
WBC count, 10^9/L	11.3±3.1	8.2±2.5	<0.001

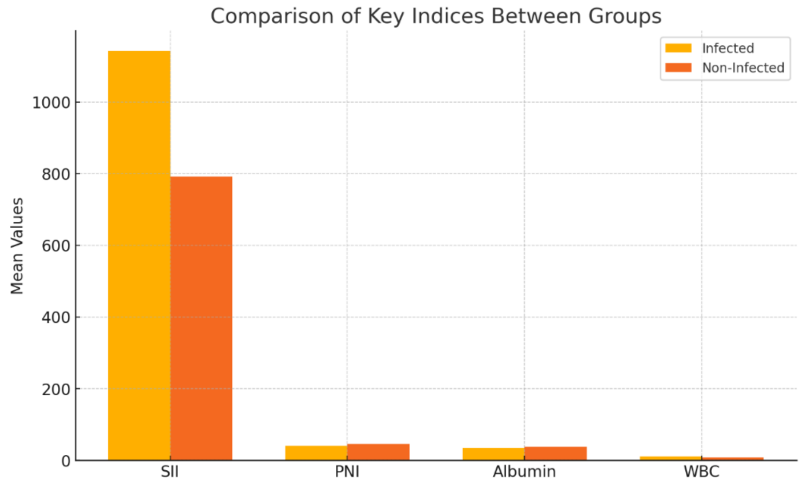

Figure 2. Comparison between infected and non-infected groups. PNI: prognostic nutritional index; SD: standard deviation; SII: systemic immune-inflammation index; WBC: white blood cell.

Types and Frequency of Postoperative Infections

Table 4 outlines the infection types. The most common infection was SSI, affecting 14.0% of patients (n=42), followed by pneumonia (9.3%), urinary tract infections (5.7%), and sepsis (3.0%). SSIs were the most prevalent, consistent with literature on abdominal surgery. Pneumonia incidence reflected perioperative immobility and risks associated with general anesthesia. These outcomes highlight the importance of both surgical technique and postoperative nursing vigilance.

Clinical Outcomes According to Infection Status

Table 5 compares outcomes between groups. The mean hospital stay was significantly longer in infected patients (12.4 vs 7.1 days), and ICU admission rates were higher (33.3% vs 10.3%). The 30-day mortality rate was also significantly elevated in the infected group (6.25% vs 1.47%). Infection was associated with a 1.75-fold increase in hospital stay and a more than 3-fold increase in ICU admissions. These outcomes have profound implications for healthcare resource utilization and patient quality of life, reinforcing the utility of preoperative markers.

Clinical outcomes according to infection status are shown in Figure 3. Stratified analysis showed that elevated SII remained a significant predictor of postoperative infection in both open (OR, 2.31; 95% CI, 1.38–3.86; *p*=0.001) and laparoscopic (OR, 1.94; 95% CI, 1.05–3.60; *p*=0.034) hepatectomy subgroups, indicating that the predictive value of SII is generalizable across surgical approaches.

Multivariate Logistic Regression for Predicting Infection

To identify independent predictors of postoperative infection, multivariate logistic regression analysis was conducted (Table 6). The following variables were statistically significant: high SII (OR, 2.85; 95% CI, 1.77–4.60; *p*<0.001), low PNI (OR, 3.26; 95% CI, 2.01–5.12; *p*<0.001), blood loss > 500 mL (OR, 1.92; 95% CI, 1.15–3.22; *p*=0.013), and operative time > 240 min (OR, 1.64; 95% CI, 1.02–2.64; *p*=0.042). SII and PNI were stronger independent predictors than intraoperative variables. The data confirm that preoperative immune and nutritional status are more reliable predictors of infection than surgery-related metrics alone.

Multivariate logistic regression for predicting infection is shown in Figure 4. The AUC for SII in predicting postoperative infection was 0.78 (95% CI, 0.73–0.83), with an optimal cut-off value of 572×10^9 yielding 76.1% sensitivity and 71.4% specificity. The AUC for PNI was 0.74 (95% CI, 0.69–0.80), with an optimal cut-off of 45.2 providing 70.3% sensitivity and 68.8% specificity. While higher cut-offs increased specificity, they reduced sensitivity for early infection detection. Using GLIM criteria, 92 patients (30.7%) met the definition of preoperative malnutrition. The optimal PNI cut-off in this cohort was comparable to thresholds reported in hepatobiliary surgery literature (range 44–46), supporting external validity.

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Table 4. Types and frequency of postoperative infections (n = 96)

Infection Type	Number of Cases	Percentage, %
Surgical site infection	42	14.0
Pneumonia	28	9.3
Urinary tract infection	17	5.7
Sepsis	9	3.0

Table 5. Clinical outcomes based on postoperative infection status

Group	Mean hospital stay, d	ICU admission, %	30-day mortality, %
Infected (n = 96)	12.4	32 (33.3%)	6 (6.25%)
Non-Infected (n = 204)	7.1	21 (10.3%)	3 (1.47%)

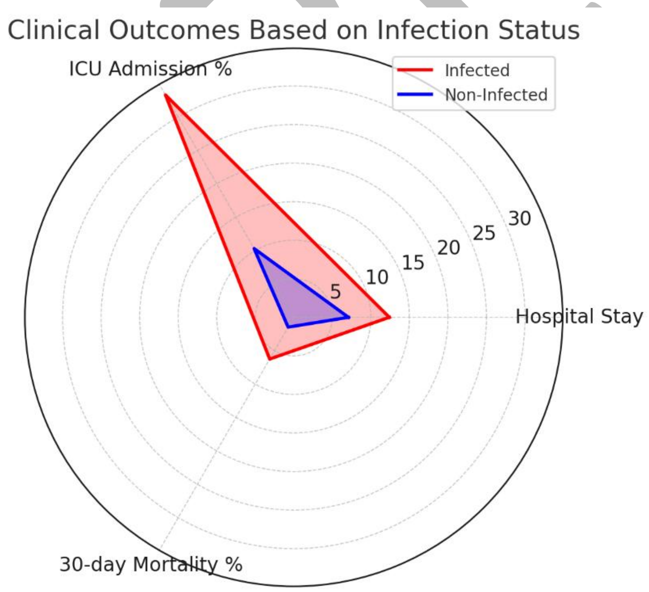

Figure 3. Clinical outcomes according to infection status. ICU: intensive care unit.

Table 6. Multivariate logistic regression for predicting postoperative infection

Variable	Odds ratio (95% CI)	*p*
High SII	2.85 (1.77–4.60)	<0.001
Low PNI	3.26 (2.01–5.12)	<0.001
Blood loss > 500 mL	1.92 (1.15–3.22)	0.013
Operative time > 240 min	1.64 (1.02–2.64)	0.042

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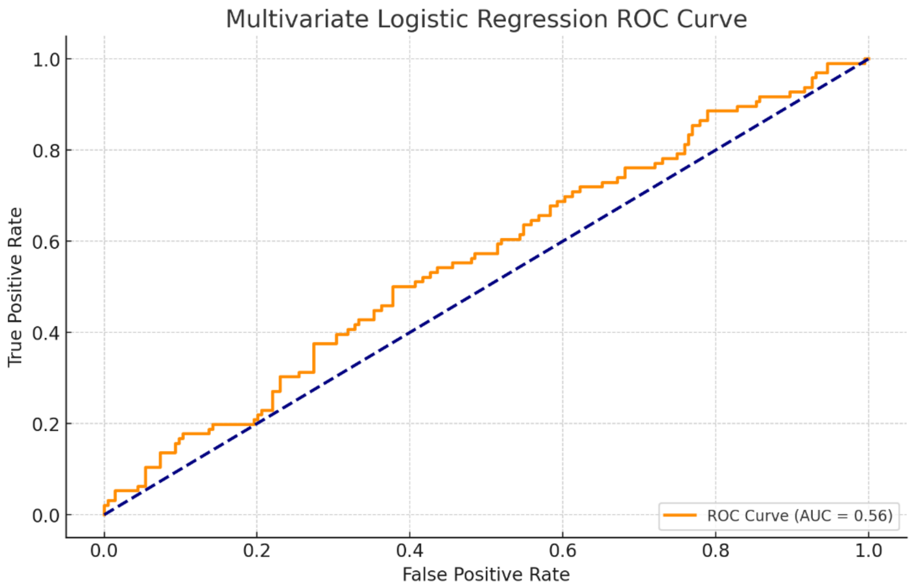

Figure 4. Multivariate logistic regression for predicting infection. CI: confidence interval; OR: odds ratio; PNI: prognostic nutritional index; SII: systemic immune-inflammation index.

DISCUSSION

Postoperative infections following partial hepatectomy for HCC are frequent and may lead to prolonged hospital stays, increased complication risks, and higher medical costs. The present study examined whether the use of two biomarkers—SII and PNI—could predict the risk of developing a postoperative infection in patients with liver cancer. We observed that postoperative infections are more likely if a patient presents with a high SII and a low PNI. The findings align with and contribute to existing literature in this field. Among our cohort, 32% of patients suffered postoperative infections, led by SSIs, followed by pneumonia, urinary tract infections, and sepsis. Infected patients experienced longer hospitalizations, higher ICU admission rates, and increased 30-day mortality compared to those who remained infection-free. Consistent with previous studies, these results suggest that infection following liver surgery compromises recovery and is associated with poor outcomes.[26–28]

Monitoring and Infection Risk Strategy

Incorporating neutrophil, lymphocyte, and platelet counts, the SII depicts the interplay between inflammation and the immune system. Our results indicate that infected patients had significantly higher preoperative SII levels than those without infections (1142 ± 618 vs 792 ± 450, $p<0.001$). Multivariate analysis revealed that SII is an independent risk factor (OR, 2.85; $p<0.001$). Previous studies have shown that the SII is useful for predicting both recurrence risk and mortality. Recent data revealed that a high preoperative SII value could predict lower survival rates, infections, and other early complications in patients with gastrointestinal cancer.[29,30] Initially, neutrophils defend the host from tissue injury but may subsequently weaken the immune system by releasing cytokines and reactive oxygen species. Elevated platelets facilitate tumor growth and metastasis by shielding tumor cells from the immune system, while a lower lymphocyte count suggests compromised immune surveillance. Thus, SII reflects the overall susceptibility of patients to postoperative infections due to heightened inflammation, hypercoagulability, and immune suppression.

PNI and Surgical Immunonutrition

PNI was proven to be a strong indicator of postoperative infections in our study. Patients who developed infections had significantly lower preoperative PNI scores (40.1 ± 5.8) compared to those without infections (46.4 ± 5.9, $p<0.001$). A low PNI was associated with a 3.26-fold higher risk of infection, indicating that inadequate nutritional status greatly increases susceptibility. PNI, derived from albumin

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levels and lymphocyte counts, serves as a proxy for nutritional and immune reserves. Hypoalbuminemia can impair wound healing and increase vascular permeability, facilitating bacterial translocation and infection. A reduced lymphocyte count implies a deficit in T-cell-mediated immunity, rendering the patient more prone to systemic infections. Various studies corroborate our results. According to published literature, PNI is an independent predictor of both postoperative complications and mortality in gastrointestinal and hepatobiliary surgeries.[30] Elevated preoperative neutrophil and platelet counts may contribute to postoperative immune dysfunction through multiple mechanisms, including the release of neutrophil extracellular traps (NETs), platelet-mediated amplification of inflammatory signaling, and suppression of T-cell activation. These processes can impair adaptive immunity and increase vulnerability to infection, as demonstrated in studies of immune suppression following major hepatic resection.

Integrated Value of SII and PNI

A strength of our study was the simultaneous evaluation of SII and PNI, providing a comprehensive view of the patient's immune and nutritional mediators. Specifically, patients with a high SII and low PNI demonstrated a high risk for infections, slower recovery, and increased healthcare utilization. Furthermore, both SII and PNI retained statistical significance after adjusting for intraoperative variables, such as blood loss and operative time. This suggests that infection risk is predetermined preoperatively and supports the use of these factors for risk assessment before surgery.

The prognostic value of SII may also be influenced by perioperative immunomodulatory interventions. Corticosteroid administration, often used to attenuate inflammatory responses after major hepatic surgery, can transiently reduce neutrophil activation and cytokine release, potentially lowering SII values without necessarily improving immune competence. Similarly, immune-supportive nutritional strategies—such as supplementation with arginine, omega-3 fatty acids, and nucleotides—have been shown to enhance lymphocyte proliferation and modulate inflammatory mediators, which may favorably shift the SII profile. Future prospective studies should examine whether adjusting perioperative management to include such interventions could optimize immune balance and improve infection outcomes in high-SII patients.

Clinical and Nursing Implications

Based on these results, clinicians should consider routinely incorporating SII and PNI into the preoperative assessment of liver cancer patients. These indices are derived from routine laboratory tests and are both cost-effective and reproducible. Administering nutritional supplements, anti-inflammatory agents, and immunomodulatory therapies to high-risk patients may be beneficial preoperatively. Nursing personnel play a key role in this process. Successful outcomes depend heavily on accurate preoperative assessment, nutritional screening, continuous monitoring for complications, and strict infection control. If nursing triage is utilized to identify at-risk patients and if SSI and pneumonia prevention protocols are rigorously implemented, the probability of complications may be significantly reduced.

Limitations

Despite its strengths, this study has several limitations. The retrospective design may introduce selection bias, and factors such as specific tumor characteristics, underlying liver pathology, and adherence to post-discharge care were not fully controlled. Serum albumin levels can be reduced by non-nutritional factors such as systemic inflammation and hepatic synthetic dysfunction; we attempted to control for these confounders by measuring CRP and liver enzymes preoperatively. We did not assess inflammatory cytokines such as IL-6 or TNF-α, nor did we perform lymphocyte subset analysis (e.g., $CD4^{+}$/$CD8^{+}$ profiling), which limits the mechanistic interpretation of SII. Additionally, underlying chronic liver disease (cirrhosis, HBV/HCV) may influence baseline immune parameters, and perioperative immunomodulatory strategies, including immune-supportive nutrition or steroid administration, warrant further evaluation in future studies. Multicenter research is necessary to validate these findings and establish standardized cut-off values for clinical practice.

In conclusion, high preoperative SII and low preoperative PNI are independent risk factors for infection following partial hepatectomy for liver cancer. A high SII and a low PNI are associated with an increased risk of infection, prolonged hospital stays, higher ICU admission rates, and increased short-term mortality. The integration of these indices aids clinicians in risk-stratifying patients and selecting optimal care practices in the surgical setting. Early recognition and targeted interventions, such as nursing-led infection surveillance and nutritional optimization, could significantly reduce the incidence of postoperative infections and improve patient recovery.

STATEMENT OF ETHICS

This study was approved by the Ethics Committee of the Second Affiliated Hospital of Naval Medical University.

FUNDING

Not applicable.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author upon reasonable request.

AI ASSISTANCE DISCLOSURE

Not applicable.

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