

Association between Postoperative GNRI and Chemotherapy Dose Intensity with Survival Outcomes in Biliary Tract Cancer

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BACKGROUND

- Biliary tract cancer (BTC) is a heterogeneous and aggressive malignancy with poor prognosis even after curative resection.
- Although adjuvant chemotherapy is recommended to improve survival, determinants of relative dose intensity (RDI) remain unclear.
- Nutritional and inflammation-based markers have emerged as objective indicators of systemic inflammation and host immune-nutritional status; however, their prognostic relevance in resected BTC has not been fully elucidated.

METHOD

- We retrospectively analyzed 172 patients with pathologically confirmed BTC who underwent curative resection followed by adjuvant chemotherapy at Seoul National University Hospital between 2011 and 2023.
- Postoperative nutritional and inflammation-based indices—including prognostic nutritional index (PNI), geriatric nutritional risk index (GNRI), neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-monocyte ratio (LMR), systemic inflammation response index (SIRI), and platelet-to-albumin ratio (PAR)—were evaluated.
- Recurrence-free survival (RFS) and overall survival (OS) were analyzed using Cox proportional hazards models.

RESULT

Table 1. Baseline characteristics

	Study patients (n = 172)
Age	65.5 ± 8.8
Sex (Male)	113 (65.7%)
ECOG	
-0 / 1,2	129 (75.0%) / 43 (25.0%)
Tumor site	
-Intrahepatic Cholangiocarcinoma	25 (14.5%)
-Perihilar Cholangiocarcinoma	37 (21.5%)
-Distal cholangiocarcinoma	55 (32.0%)
-Gallbladder cancer	55 (32.0%)
Pathological differentiation	
-Well-differentiated	22 (13.1%)
-Moderately differentiated	125 (74.4%)
-Poorly differentiated	14 (8.3%)
-Not determined	7 (4.2%)
Resection margin	
-R0 / R1	152 (88.4%) / 20 (11.6%)
Perineural invasion	115 (67.3%)
Lymphovascular invasion	112 (65.5%)
CA 19-9	805.8 ± 2602.2
CEA	10.9 ± 46.9
Adjuvant chemotherapy	
-Capecitabine	58 (33.7%)
-Gemcitabine	21 (12.2%)
-5-Fluorouracil/Leucovorin	93 (54.1%)
Relative Dose Intensity (RDI) (%) of Adjuvant chemotherapy	85.6 ± 22.5
Palliative chemotherapy	85 (49.4%)
Recurrence	91 (52.9%)
Death	66 (38.4%)

Table 2. Postoperative nutritional and inflammation-based prognostic markers

	All patients (n = 172)
Prognostic Nutritional Index (PNI)	48.1 ± 6.5
Geriatric Nutritional Risk Index (GNRI)	102.8 ± 9.5
Glasgow Prognostic Score (GPS) : 0 / 1,2	131 (76.2%) / 41 (23.8%)
Modified GPS : 0 / 1,2	143 (83.1%) / 29 (16.9%)
High-sensitivity mGPS : 0 / 1,2	92 (53.5%) / 80 (46.5%)
Neutrophil-to-Lymphocyte Ratio (NLR)	3.9 ± 2.5
Lymphocyte monocyte ratio (LMR)	3.9 ± 2.5
Platelet-to-Lymphocyte Ratio (PLR)	154.5 ± 80.3
Systemic immune inflammation index (SII)	505.8 ± 369.1
Systemic inflammation response index (SIRI)	1189.4 ± 1001.0
C-reactive protein to Albumin Ratio (CAR)	0.2 ± 0.3
Albumin globulin ratio (AGR)	1.3 ± 0.3
Platelet-to-Albumin Ratio (PAR)	61.7 ± 28.0

Figure 1. Recurrence-free survival (RFS) and overall survival (OS) according to prognostic nutritional index (PNI) (A, B) RFS and OS according to geriatric nutritional risk index (GNRI). (C, D) RFS and OS according to platelet-to-albumin ratio (PAR) (E, F) RFS and OS according to high-sensitivity mGPS (hs-mGPS) (G, H)

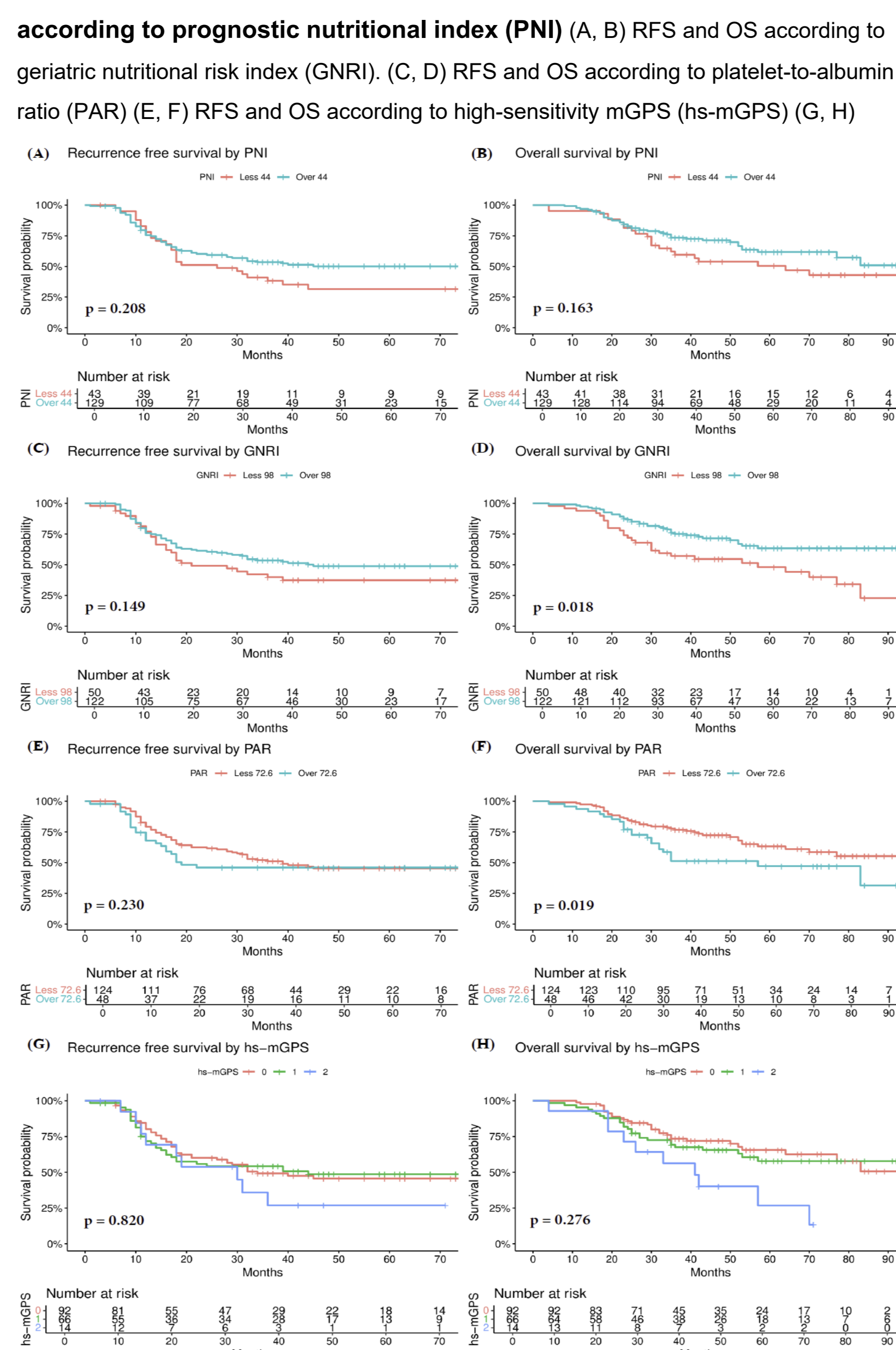


Table 3. Univariable regression for recurrence-free survival and overall survival

	RFS		OS	
	HR (95% CI)	p	HR (95% CI)	p
Adjuvant regimen				
-Gemcitabine vs. Capecitabine	0.89 (0.43–1.84)	0.747	1.08 (0.45–2.60)	0.865
-5-FU vs. Capecitabine	1.09 (0.68–1.74)	0.717	1.43 (0.77–2.64)	0.252
Sex (Female vs. Male)	0.79 (0.50–1.24)	0.310	0.90 (0.54–1.52)	0.704
Age (Per years)	1.00 (0.98–1.03)	0.857	1.01 (0.99–1.04)	0.329
ECOG* (ECOG 1,2 vs. ECOG 0)	1.03 (0.64–1.66)	0.902	0.93 (0.51–1.68)	0.798
Tumor site				
IHCC vs others	0.58 (0.34–1.01)	0.053	0.94 (0.46–1.90)	0.860
T stage (T2,3,4 vs. T1)	3.41 (1.79–6.51)	<0.001	1.19 (0.48–2.98)	0.705
N stage (N1,2 vs. N0)	2.20 (1.42–3.40)	<0.001	1.96 (1.17–3.28)	0.010
Histological differentiation (Moderate, Poorly vs. Well)	5.10 (0.71–36.66)	0.902	3.09 (0.43–22.29)	0.263
Resection margin (R1 vs. R0)	1.10 (0.61–1.99)	0.740	0.86 (0.39–1.90)	0.713
Perineural invasion (Yes vs. No)	1.65 (1.03–2.66)	0.037	2.01 (1.11–3.63)	0.021
Lymphovascular invasion (Yes vs. No)	1.82 (1.15–2.89)	0.011	1.98 (1.13–3.48)	0.018
Post-operative CA 19-9* (Per Unit/dL)	1.00 (1.00–1.00)	0.913	1.00 (1.00–1.00)	0.557
Post-operative CEA* (Per Unit/dL)	1.01 (1.00–1.02)	0.039	1.01 (1.00–1.02)	0.090
Relative Dose Intensity (RDI) (Above 70 vs. Less 70)	1.03 (0.56–1.89)	0.931	0.47 (0.26–0.83)	0.010
Prognostic Nutritional Index (PNI) (Above 44 vs. Less 44)	0.73 (0.46–1.14)	0.164	0.67 (0.40–1.13)	0.134
Geriatric Nutritional Risk Index (GNRI) (Above 98 vs. Less 98)	0.72 (0.46–1.11)	0.139	0.50 (0.30–0.81)	0.005
hs-mGPS (2 vs. 1, 0)	0.82 (0.20–3.35)	0.786	1.38 (0.34–5.69)	0.651
Platelet-to-Albumin Ratio (PAR) (Above 72.6 vs. Less 72.6)	1.23 (0.78–1.93)	0.383	1.79 (1.08–2.96)	0.024
Neo adjuvant (Yes vs. No)	1.16 (0.54–2.51)	0.707	0.64 (0.20–2.03)	0.443
Palliative chemotherapy in recurrent patients (Yes vs. No)			0.61 (0.22–1.70)	0.339

Table 4. Multivariable regression for recurrence-free survival and overall survival (PAR)

	RFS		OS	
	HR (95% CI)	p	HR (95% CI)	p
PAR (Above 72.9 vs. Less 72.9)	1.20 (0.71–2.03)	0.492	1.97 (1.14–3.43)	0.016
Sex (Female vs. Male)	0.70 (0.42–1.16)	0.166	0.79 (0.45–1.37)	0.399
Age (Per years)	1.01 (0.98–1.03)	0.709	1.01 (0.98–1.05)	0.410
Tumor site (IHCC* vs others)	0.64 (0.31–1.33)	0.23		
T stage (T2,3,4 vs. T1)	2.40 (1.14–5.05)	0.021		
N stage (N1,2 vs. N0)	1.75 (1.07–2.86)	0.027	1.41 (0.81–2.43)	0.223
Histological differentiation (Moderate, poorly vs. Well)	4.39 (0.58–33.34)	0.153		
Perineural invasion (Yes vs. No)			1.90 (0.97–3.73)	0.062
Lymphovascular invasion (Yes vs. No)	1.38 (0.83–2.29)	0.218	1.59 (0.85–2.98)	0.143
Post-operative CEA* (Per Unit/dL)	1.01 (0.99–1.03)	0.342		
Relative Dose Intensity (RDI) (Above 70 vs. Less 70)	0.99 (0.46–2.13)	0.981	0.29 (0.15–0.57)	<0.001

Table 5. Multivariable regression for recurrence-free survival and overall survival (GNRI)

	RFS		OS	
	HR (95% CI)	p	HR (95% CI)	p
GNRI (Above 98 vs. Less 98)	0.84 (0.51–1.39)	0.489	0.60 (0.36–1.01)	0.054
Sex (Female vs. Male)	0.72 (0.43–1.20)	0.206	0.85 (0.49–1.50)	0.579
Age (Per years)	1.01 (0.98–1.03)	0.68	1.02 (0.98–1.05)	0.331
Tumor site (IHCC* vs others)	0.59 (0.28–1.25)	0.168		
T stage (T2,3,4 vs. T1)	2.39 (1.13–5.03)	0.022		
N stage (N1,2 vs. N0)	1.77 (1.08–2.89)	0.022	1.53 (0.90–2.63)	0.118
Histological differentiation (Moderate, poorly vs. Well)	4.04 (0.54–29.94)	0.172		
Perineural invasion (Yes vs. No)			1.68 (0.86–3.27)	0.130
Lymphovascular invasion (Yes vs. No)	1.33 (0.80–2.22)	0.265	1.57 (0.84–2.91)	0.156
Post-operative CEA* (Per Unit/dL)	1.01 (0.99–1.03)	0.301		
Relative Dose Intensity (RDI) (Above 70 vs. Less 70)	1.03 (0.49–2.19)	0.937	0.35 (0.18–0.66)	0.001

CONCLUSION

- Postoperative GNRI, PAR, and RDI were independently associated with OS in patients undergoing curative resection for BTC.
- These findings underscore the importance of perioperative nutritional assessment and optimization.
- Systematic nutritional management combined with adequate supportive care may help maintain chemotherapy dose intensity and improve long-term survival outcomes in this population.

Patient-Friendly Summary

- Background :** Biliary tract cancer often requires chemotherapy after surgery, but outcomes vary between patients.
- Method :** We studied how patients' nutritional and overall health status after surgery, along with chemotherapy dose intensity, affect survival.
- Result :** Patients with better nutritional status and those who received sufficient chemotherapy doses had better survival.
- Conclusion :** Maintaining good health and adequate chemotherapy dosing after surgery may improve survival in these patients.