Prognostic Nutritional Index as a Predictive Marker for Acute Kidney Injury in the Adult Critical Illness Population: A Systematic Review and Meta-Analysis

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Introduction

- Acute kidney injury (AKI) is a frequent complication in the critically ill, with varying incidences across patient groups
- Multiple factors contribute to AKI susceptibility, such as sepsis, pre-existing diabetes or cardiovascular disease, chronic kidney disease, advanced age, anemia, and hypoalbuminemia
- The **Prognostic Nutritional Index (PNI)**, initially developed by Buzby and later modified by Onodera and Kosaki, is a readily accessible marker evaluating nutritional and inflammatory status
- Calculated by **10 × serum albumin (g/dL) + 0.005 × total lymphocyte count (/mm3)**
- Linked to post-operative or peri-treatment morbidity and mortality across various patient groups, including those with various malignancy, heart failure and diabetes mellitus
- PNI as a prognostic factor for outcomes or AKI risk factor in critically ill populations, including acute coronary syndrome, major abdominal surgery
- Systematic examination of PNI's predictive role for AKI development or as a risk stratification tool in AKI has yet to be conducted

Methods and Materials

- **Material:** A systematic review was conducted using databases: MEDLINE, EMBASE, PubMed, and CNKI up to August 2023.
- **Data extraction:** The AKI event numbers, total sample size and true positive (TP), false positive (FP), true negative (TN), false negative (FN) for PNI as AKI prediction
- **Method (Summary of the effect):** We calculate the summary measures (pooled sensitivity, specificity, positive likelihood ratio [+LR], negative likelihood ratio [−LR]) by univariate model. We calculated the diagnostic odds ratio [DOR] by bivariate model. We used a random-effects model with maximum likelihood estimation to estimate the between-study variance. To assess the predictive performance of the PNI regarding AKI development, we also use a summary receiver operating characteristics (SROC) curve with a bivariate.
- **Method (Analysis of heterogeneity between studies):** We examined the threshold effect by using the Spearman correlation coefficient test. A ρ value ≥ 0.6 indicates considerable threshold effect. If no significant threshold effect, we further performed subgroup analysis or meta-regression analysis to explore the sources of heterogeneity. Between-study variance (tau-squared) was evaluated through maximum likelihood estimation and the result of heterogeneity examination was presented as the I^2 index and p value of Chi-squared test. A $I^2 > 50\%$ indicating substantial heterogeneity. Several potential covariates were identified, including patient population (population: medical vs. surgical patients, procedure: underwent percutaneous coronary intervention [PCI] or not, including chronic kidney disease or not, hypoalbuminemia or not [serum albumin level less than 3.5 g/L], used AKI diagnosis criteria by KDIGO criteria or others). Subgroup analysis was performed to examine whether there is difference of the diagnostic performance in different subgroups. The overall PNI diagnostic performance between subgroups was examined according to RDOR (relative diagnostic odds ratio).

Conclusions

PNI serves as an effective tool for identifying patients at low risk for AKI development (**Figure 3**), particularly in non-CKD populations.

Results

- The analysis encompassed 16 studies with 17 separate cohorts, totaling 21,239 patients
- The pooled sensitivity and specificity of PNI for AKI prediction were 0.67 (95% CI 0.58–0.74) and 0.74 (95% CI 0.67–0.80), respectively. The pooled positive likelihood ratio was 2.49 (95% CI 1.99–3.11), and the negative likelihood ratio was 0.46 (95% CI 0.37–0.56).
- The pooled diagnostic odds ratio (DOR) was 5.54 (95% CI 3.80–8.07), with an SROC indicating a pooled diagnostic accuracy of 0.76. (**Figure 1 & 2**)
- Subgroup analysis showed that PNI's sensitivity was higher in medical versus surgical populations (0.72 vs. 0.55; p < 0.05) and in studies excluding CKD patients compared to those including them (0.75 vs. 0.56; p < 0.01). Overall, diagnostic performance was superior in the non-CKD group (**Table**).

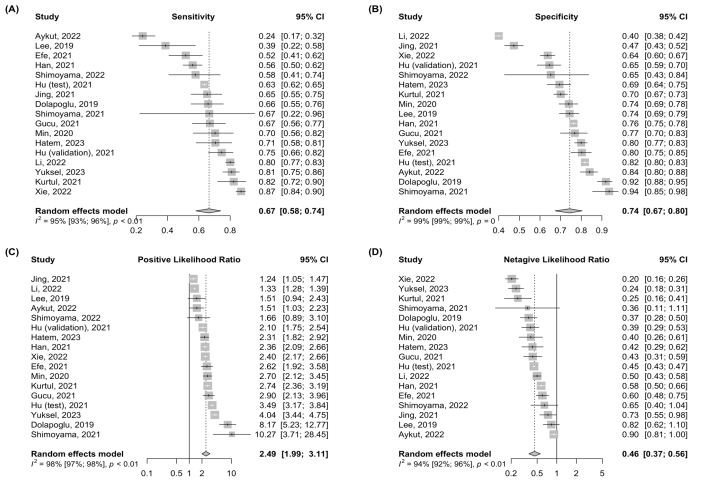

Figure 1. Forest plot of prognostic nutritional index diagnostic accuracy for acute kidney injury

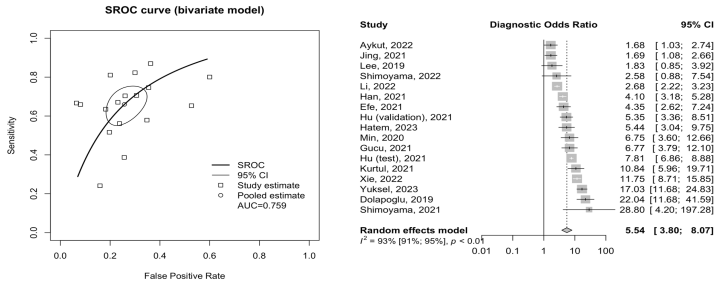

Figure 2. Pooled Diagnostic odds ratio (right) and SROC curves (left) of prognostic nutritional index for prediction of AKI

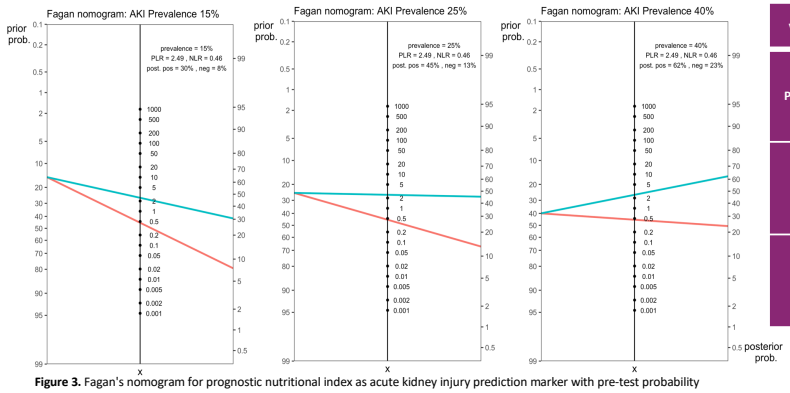

Figure 3. Fagan's nomogram for prognostic nutritional index as acute kidney injury prediction marker with pre-test probability

Variables	Subgroups	Sensitivity (95% CI)	Specificity (95% CI)	Positive LR (95% CI)	Negative LR (95% CI)	Diagnostic odd ratio (95% CI)	RDOR (95% CI)
Population	Surgical (6)	0.55* (0.40 - 0.70)	0.77 (0.74 - 0.86)	2.36 (1.44 -3.87)	0.58* (0.43 - 0.79)	4.13 (1.92 – 8.92)	0.63 (0.28-1.42); 0.27
	Medical (10; 11 cohort)	0.72* (0.64 - 0.79)	0.73 (0.64 - 0.80)	2.54 (2.06 – 3.12)	0.40* (0.32 - 0.50)	6.46 (4.47 – 9.33)	
CKD	Including CKD (7; 8 cohort)	0.56** (0.43-0.67)	0.75 (0.65 - 0.84)	2.12 (1.55 – 2.88)	0.61** (0.49 - 0.76)	3.50 (2.15 – 5.62)	0.44 (0.22-0.88); 0.02
	Excluding CKD (9)	0.75** (0.67 - 0.81)	0.74 (0.64 - 0.82)	2.81 (2.12 – 3.72)	0.36** (0.29 - 0.46)	7.92 (5.15 – 12.18)	
Albumin	Alb < 3.5 g/L (5)	0.68 (0.52 - 0.80)	0.79 (0.67 - 0.87)	2.84 (2.26 – 3.57)	0.42 (0.28 - 0.36)	7.19 (4.60 – 11.23)	1.52 (0.58 – 3.97); 0.39
	Alb ≥ 3.5 g/L (10)	0.64 (0.52 - 0.74)	0.73 (0.63 - 0.81)	2.31 (1.67 – 3.21)	0.50 (0.39 - 0.64)	4.68 (2.74 – 8.00)	

Table 1. Heterogeneity analysis by meta-regression for prognostic nutritional index as an acute kidney injury prediction marker
* P value for subgroup difference < 0.05; ** P value for subgroup difference < 0.01

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