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Correlation of ARISCAT score and prognostic nutrition index with postoperative pulmonary complications in post-abdominal surgery patients in the Intensive Care Unit

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Abstract

***Objective*: This study aimed to determine the relationship between the ARISCAT score and Prognostic Nutrition Index with the incidence of Postoperative Pulmonary Complication (PPC) in post-abdominal surgery patients in the intensive care unit (ICU).**

***Design*: This research is a study with observational analytical methodology using a retrospective cohort research design**

***Setting*: The research was conducted from 24 October to 31 November 2023 in the ICU of Dr. Wahidin Sudirohusodo Hospital Makassar, South Sulawesi.**

***Patient and participants*: Post-abdominal surgery patients treated in ICU.**

***Interventions*: None.**

***Measurement and results*: Data collected included demographic data (age, gender, and body mass index), ARISCAT score, Prognostic Nutrition Index (PNI), PPC incidence, mortality incidence, and length of stay in the ICU. The ARISCAT score is grouped into low, moderate, and high, while PNI is divided into normal and malnutrition PNI groups. There is a relationship between the ARISCAT score and the incidence of PPC with a Likelihood Ratio of 6.915 with a p-value <0.05. There is a relationship between PNI and the incidence of PPC with an Odds Ratio of 5.642 with a p-value <0.05. There is a difference in the incidence of PPC and mortality in the combination of ARICAT score + PNI with a p-value < 0.05. There is a difference in length of ICU stay, mechanical ventilation duration, and incidence of mortality in the sample with PPC with a p-value <0.05.**

***Conclusions*: There is a significant relationship between the ARISCAT score and the incidence of PPC as well as PNI in post-abdominal surgery patients treated in the ICU.**

Key words: Abdominal surgery, ARISCAT score, prognostic nutrition index, PPC.

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Introduction

Postoperative pulmonary complication (PPC) is a collection of complications in the respiratory system after surgery and anesthesia. Some of those included in PPC are respiratory infections, pneumonia, pleural effusion, atelectasis, bronchospasm, and others. (1) The incidence of PPC varies between <1-23% and causes up to 68% of unplanned intensive care unit (ICU) admissions. (1,2) PPC can increase the duration of mechanical ventilation, ICU length of stay, and mortality incidence. (3,4)

Factors that can influence the occurrence of PPC include advanced age, preoperative anemia, type of surgery, duration of anesthesia and surgery, comor-

bidities, and nutrition. (1) Malnutrition may lead to a weakened respiratory muscles, diminished respiratory drive, and a compromised imunity againts infections. (5) One of the scoring systems used to screen for PPC risk factors is the Assess Respiratory Risk in Surgical Patients in Catalonia score (ARISCAT score). (6) Apart from the ARISCAT score, the Prognostic Nutrition Index (PNI) is another scoring system for evaluating post-surgical patient outcomes. (5)

In research conducted by Nithiuthai from 2016 to 2019 involving 1100 geriatric patients undergoing upper abdominal surgery, a relationship was found between the ARISCAT score and the incidence of PPC with a correlation coefficient of 0.0226 ($p<0.001$). (4) Research conducted by Ulger in 2021 highlighted the predictive value of combining a high ARISCAT score with hypoalbuminemia in foreseeing the incidence of PPC among patients following thoracic surgery. (7) Mazo's prospective validation demonstrated regional variations in the performance of the ARISCAT score in predicting PPC incidence, with differing sensitivity and specificity observed across Western Europe, Eastern Europe, and Spain. (8) Additionally, research conducted by Shaik in India from 2018 to 2019 revealed differences in sensitivity and specificity values compared to research by Mazo. (9)

The researchers aimed to explore the connection between the ARISCAT score and PNI with the occurrence of PPC, along with subsequent events like duration of mechanical ventilation use, length of ICU stay, and patient mortality.

Methods

This research was an observational analytical study that used a retrospective cohort approach. This research was carried out in the ICU of Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, South Sulawesi. The research was carried out from 24 October to 31 November 2023. The research sample was all post-abdominal surgery patients treated in the Intensive Care Unit of Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, in 2021-2022. The sampling technique was carried out using total sampling. The study was cleared by the Ethical Research Committee (574/UN4.6.4.5.1/PP36/2023) and issued on 23 August 2023. The inclusion criteria in this study were post-abdominal surgery patients treated in the Intensive Care Unit of Dr. Wahidin Sudirohusodo Central General Hospital, Makassar, in 2021-2022 (**Figure 1**). The exclusion criteria included patients with comorbid diabetes mellitus, hypertension, or coronary heart disease.

The information gathered consisted of various data points such as gender, age, body mass index, ARISCAT score, PNI, incidence of PPC, incidence of mortality, and duration of stay in the ICU. Researchers examined the relationship between the ARISCAT score on PPC and PNI on PPC.

We analyzed the data using descriptive statistics in high, medium, and low ARISCAT score groups, normal PNI and malnutrition with a cut-off value of 45, and the incidence of PPC. The chi-square test was used to see the relationship between the ARISCAT score and the incidence of PPC; the relationship between PNI and the incidence of PPC; the relationship between the combination of the ARISCAT score and PNI and the incidence of PPC; and the relationship between the combination of the ARISCAT score and PNI and the incidence of mortality. A significance limit (p alpha) of 5% was used for data interpretation.

We determined the relationship between ARISCAT score with PNI on the incidence of PPC and ARISCAT score with PNI on the incidence of mortality by logistic regression test. Tests were carried out on the ARISCAT score and PNI to determine the cut-off value, sensitivity, and specificity in predicting the incidence of PPC using the area under the curve (AUC curve). Data analysis was conducted on the Windows operating system using the IBM SPSS version 25 (IBM Corp., Armonk, New York).

Results

From 287 research samples of post-upper abdominal surgery patients, a total of 62 patients suffered PPC. **Table 1**, **Table 2**, and **Table 3** show the characteristics of the research sample.

The incidence of PPC increased in the high ARISCAT score and malnutrition groups, as shown in **Table 4** and **Table 5**. There was a relationship between the ARISCAT score and the incidence of PPC with a likelihood ratio of 6.915 ($p<0.05$). The highest incidence of PPC was found in the malnutrition group. There was a relationship between PNI and the incidence of PPC with an odds ratio of 5.642 ($p<0.05$).

We grouped samples based on a combination of ARISCAT scores and PNI. Most of the samples were included in the malnutrition group and the moderate ARISCAT score. Based on **Table 6**, the highest incidence of PPC occurred in the malnutrition and high ARISCAT score groups. Based on **Table 7**, the highest incidence of mortality occurred in the malnutrition and high ARISCAT score groups.

There was a significant relationship between the ARISCAT score and the incidence of PPC and mor-

tality in patients after abdominal surgery in the ICU. There was a significant relationship between PNI and the incidence of PPC and mortality in patients after abdominal surgery in the ICU, as shown in **Table 8** and **Table 9**.

Length of stay in the ICU, duration of mechanical ventilation, and the incidence of mortality increased in patients who suffered PPC compared to those who did not, as shown in **Table 10** and **Table 11**.

Based on **Figure 2**, from the measurement results using the receiver operating characteristic (ROC) curve and the Youden index, it could be seen that from the significant variable, namely the ARISCAT score, the cut-off point value was 41.50 with a sensitivity of 53.2% and a specificity of 73.3%. Meanwhile, PNI obtained a cut-off point value of 37.21 with a sensitivity of 60.9% and a specificity of 75.8%.

Discussion

In this study, the total number of patients studied was 287 from 2021 to 2022. Sixty-two patients suffered PPC, with 35 people suffering pneumonia, 26 people suffering pleural effusion, and 1 person suffering atelectasis.

These results were not much different from research conducted by Tilak in 2019, which found the most frequent types of PPC, including pneumonia (31.57%), while research conducted by Nithiutai found the most frequent types of PPC, including pleural effusion 36%, atelectasis 28%, and pneumonia 24%. (4,10) Pneumonia is a PPC that often occurs due to bacterial colonization of the respiratory and digestive tracts, aspiration of secretions, and decreased patient immunity. (11)

Based on **Tables 2 and 3**, it can be seen that in the age and gender variables, there were no differences found in the PPC group ($p>0.05$). These results indicated that the two groups had homogeneous data and were suitable for comparison tests.

Table 4 shows that the highest incidence of PPC was found in the high ARISCAT score group. There was a relationship between the ARISCAT score and the incidence of PPC with a likelihood ratio of 6.915 ($p<0.05$).

ARISCAT score is the sum of several indicators, including age, preoperative oxygen saturation, respiratory tract infection in the last month, preoperative anemia, surgical incision, surgery duration, and emergency nature. (12) Oxygen saturation reflects respiratory and cardiovascular functional status, so a decreased oxygen saturation in room air indicates a respiratory or cardiovascular system disturbance. A history of respiratory tract infection one month before surgery can induce local changes in airway reactivity and lung function. It is important to note that a lung infection can result from an immune disorder triggered by the infection itself or the use of antibiotics. (13-15)

Age is a consistently reported predictor of PPC. Aging is related to changes in the physiology of the respiratory system in old age, such as decreased respiratory muscle function, stiffer chest walls, and changes in lung structure, causing increased breathing effort in elderly patients. (13) Respiratory changes in aging become even more severe when combined with the side effects of anesthetic agents. Canet found that at the age of 80 years, PPC levels increase sharply (OR 5.6 after this age). (12) A study conducted by Kokotovic et al. showed that the ARISCAT score could predict the incidence of PPC in geriatricians aged 70 years who underwent major emergency abdominal surgery. (16)

Recent studies have demonstrated that preexisting anemia may increase the likelihood of PPC by up to threefold. (12) Anemia reduces the oxygen supply to tissues and lowers immune function, thereby predisposing individuals to PPC. Additionally, the administration of blood products for anemia correction entails an additional risk of post-transfusion pulmonary complications. (17,18)

This study observed that the incidence of PPC increased in correlation with higher ARISCAT scores. These findings were consistent with previous research conducted by Amma et al., which found a heightened likelihood of PPC in patients classified under the high-risk ARISCAT score category compared to those in the moderate-risk category (OR=10.667, 95% CI 2.387-47.659, $p=0.002$). (19) Mazo, in prospective external validation study conducted in Europe, obtained a likelihood ratio 7.12. (8) Furthermore, Ulger and Eldabossi reported that a high ARISCAT score served as a significant risk factor for PPC. (7,20) Similar results were also noted in a multicenter study conducted by Fernandez-Bustamante, which identified age as another risk factor for PPC (OR=1.03, 95% CI 1.02-1.05). (3) Additionally, a multicenter study conducted by Gebeyehu in Ethiopia highlighted age over 65 years as a substantial risk factor for PPC ($p<0.001$, OR=12.09, 95% CI 3.31-44.1). (21)

Table 5 shows that the highest incidence of PPC was found in the malnutrition group. There was a relationship between PNI and the incidence of PPC with OR=5.642 ($p<0.05$). This study found that the incidence of PPC increased among patients included in the PNI malnutrition group. The results of this study followed the research conducted by Yu et al. (OR=3.308, $p<0.001$) and Park et al. (OR=1.7, 95% CI 1.3-2.3), who reported that PNI malnutri-

tion was associated firmly with the incidence of PPC. (22,23)

The PNI is a scoring system comprising serum albumin and lymphocyte levels. (24) This scoring system facilitates routine and straightforward assessment of a patient's nutritional status prior to surgery. Lymphocytes play a crucial role in infection control; hence, perioperative lymphopenia poses a risk for post-surgical infections. (5) Hypoalbuminemia can lead to immune disorders such as lymphopenia and impaired phagocytosis function, thereby elevating the risk of post-surgical infections. (25) A low PNI value indicates immunonutrition disorders associated with compromised tissue healing and immunity. In particular, malnutrition can attenuate respiratory muscles, reduce ventilatory drive, compromise defense mechanisms against infection, weaken expiratory muscles, and diminish chest wall expansion. (22)

Based on **Table 6** and **Table 7**, a notable discrepancy in the incidence of death and PPC was observed within the combination of ARISCAT score and PNI. Specifically, the incidence of PPC was 26 (33.3%), while the incidence of mortality was 16 (20.51%) in the malnutrition and high ARISCAT score groups. This study combined the ARISCAT score and PNI groups to examine PPC incidence and mortality. We found that the combination of these two groups was significant in the incidence of PPC and mortality with a p-value<0.05. Notably, this study represented the first attempt to integrate these two scoring systems to elucidate their relationship to PPC and mortality.

Based on **Table 8** and **Table 9**, the logistic regression analysis indicated a remarkable association between the ARISCAT score and the incidence of PPC with OR=2.010, 95% CI 1.207-3.346, p<0.05. Similary, there was exist a relationship between PNI and the incidence of PPC, characterized by an OR of 5.286, 95% CI 2.012 -13.889, p<0.05. There was also an association between the ARISCAT score and the incidence of mortality with an OR of 1.746, 95% CI 0.949-3.212, p<0.05. Likewise, a relationship between the PNI and the incidence of mortality was evident, with an OR of 6.894, 95% CI 1.597-29.762, p<0.05.

Kayhan et al. concluded that PNI was an independent risk factor for mortality in the ICU (OR=1.210, 95% CI 1.048-1.396, p=0.009). (26) Their findings aligned with those of Peng, whose research revealed a mortality rate of 38.3% among ICU patients with a PNI<36.2. (27) Lee et al. also reported higher mortality incidence among patients who underwent heart surgery with a low PNI (9%) compared to a high PNI (2%). (28) Gucu et al. also concluded that a low PNI value independently predicted cardiac surgery mortality. (29)

In this study, a significant disparity was observed in the mean length of ICU stay among patients experiencing PPC (6.56±8.99 days) compared to those without PPC (1.18±2.28 days) (p<0.05). Moreover, there was a significant difference in the mean duration of mechanical ventilation among patients experiencing PPC (5.94±9.16 days) compared to those without (0.97±1.76 days) (p<0.05). These findings were similar to research conducted by Nithiuthai, which identified a difference in ICU length of stay between PPC and non-PPC patients of 4 versus 1 day (p<0.05). Also, a difference was observed in the duration of mechanical ventilation in PPC patients of 73 hours a day compared to non-PPC patients of 20 hours (p<0.05). (4)

Additionally, a notable difference emerged in ICU mortality incidence between patients with PPC, which was 24 people (38.7%), and those without PPC, which was 14 people (73.5%) (p<0.05). This finding closely resembled the ICU mortality incidence reported by Tilak (37.9%). (10)

Furthermore, employing the ROC curve and the Youden index, it can be seen that the significant variable, namely the ARISCAT score, yielded a cut-off point value of 41.50 with a sensitivity of 53.2% and a specificity of 73.3%. This aligned with Mazo's study, in which the cut-off point for the ARISCAT score for PPC was 45, with a sensitivity of 69.31% and specificity of 75.25%. (8) In this study, the PNI cut-off point value was determined as 37.21, with a sensitivity of 60.9% and a specificity of 75.8%. Conversely, Peng's research on ICU patients obtained a PNI cut-off value for mortality of 31.8, with a sensitivity of 62.3% and a specificity of 64.1%. (27)

Conclusion

A higher ARISCAT score and low PNI value emerge as notable risk factors for PPC and mortality in ICU patients following surgery. The combination of the ARISCAT score and PNI exhibits a significant relationship with the incidence of PPC and mortality. Significant disparities were observed in the length of ICU stay, duration of mechanical ventilation, and mortality rates between PPC and non-PPC patients. These findings provide a foundational framework for further research aimed at evaluating ARISCAT score and PNI parameters to predict PPC incidence, facilitating perioperative management in patients at high risk of postoperative pulmonary complications.

Table 1. Characteristics of the research sample based on the types of PPC

Types of PPC	n	%
Pneumonia	35	56.45
Pleural effusion	26	41.93
Atelectasis	1	1.62
Total	62	100

Legend: PPC=postoperative pulmonary complication.

Table 2. Characteristics of research samples with research variables

		PPC	p-value
Age (years) (mean±SD)		53.98±16.03	0.053^{ns}
Gender	Men, n (%)	26 (18.18)	0.161^{ns}
	Women, n (%)	36 (25)	
BMI (mean±SD)		22.75±4.58	0.169^{ns}
Total patients, n (%)		62 (22.64)	

Legend: SD=standard deviation; BMI=body mass index; PPC=postoperative pulmonary complication; ^{ns}non significant.
Age and BMI data were processed using the Mann-Whitney U test, while gender data using the chi-square test.

Table 3. Characteristics of research samples with research variables

		Died	p-value
Age (years) (mean±SD)		52.63±16.92	0.324^{ns}
Gender	Men, n (%)	16 (11.18)	0.307^{ns}
	Women, n (%)	22 (15.27)	
BMI (mean±SD)		22.88±3.83	0.073^{ns}
Total patients, n (%)		38 (13.24)	

Legend: SD=standard deviation; BMI=body mass index; ^{ns}non significant.
Age and BMI data were processed using the Mann-Whitney U test, while gender data using the chi-square test.

Table 4. Correlation between ARISCAT score and the incidence of PPC in post-abdominal surgery patients treated in the ICU

ARISCAT score	PPC				Total sample		p-value	Likelihood ratio
	Yes		No					
	n	%	n	%	n	%		
High	27	32.14	57	67.86	84	100	0.032*	6.915
Moderate	32	17.78	148	82.22	180	100		
Low	3	13.04	20	86.96	23	100		

Legend: ARISCAT=Assess Respiratory Risk in Surgical Patients in Catalonia; PPC=postoperative pulmonary complication; ICU=intensive care unit; *significant.
Data were processed using the Pearson chi-square test.

Table 5. Relationship between PNI and the incidence of PPC in post-abdominal surgery patients treated in the ICU

PNI	PPC				Total sample		p-value	Odds ratio
	Yes		No					
	n	%	n	%	n	%		
Normal	5	6.57	71	93.43	75	100	0.000*	5.642
Malnutrition	57	27.01	154	72.98	211	100		

Legend: PNI=Prognostic Nutrition Index; PPC=postoperative pulmonary complication; *significant.
Data were processed using the chi-square test.

Table 6. Relationship between the combination of ARISCAT and PNI on PPC

	PPC		Non-PPC		Total		p-value
	n	%	n	%	n	%	
Malnutrition - low ARISCAT	3	17.64	14	82.36	17	100	0.002*
Malnutrition - moderate ARISCAT	28	24.13	88	75.87	116	100	
Malnutrition - high ARISCAT	26	33.33	52	66.66	78	100	
Normal - low ARISCAT	0	0	6	100	6	100	
Normal - moderate ARISCAT	4	6.25	60	73.75	64	100	
Normal - high ARISCAT	1	16.66	5	83.33	6	100	

Legend: ARISCAT=Assess Respiratory Risk in Surgical Patients in Catalonia; PNI=Prognostic Nutrition Index; PPC=postoperative pulmonary complication; *significant.
Data were processed using the chi-square test.

Table 7. Relationship between the combination of ARISCAT and PNI on the incidence of mortality

	Died		Lived		Total		p-value
	n	%	n	%	n	%	
Malnutrition - low ARISCAT	3	17.64	14	82.36	17	100	0.002*
Malnutrition - moderate ARISCAT	17	14.65	99	85.34	116	100	
Malnutrition - high ARISCAT	16	20.51	62	79.49	78	100	
Normal - low ARISCAT	0	0	6	100	6	100	
Normal - moderate ARISCAT	1	1.5	63	98.5	64	100	
Normal - high ARISCAT	1	16.66	5	83.33	6	100	

Legend: ARISCAT=Assess Respiratory Risk in Surgical Patients in Catalonia; PNI=Prognostic Nutrition Index; *significant.
Data were processed using the chi-square test.

Table 8. Correlation between ARISCAT score and PNI for post-abdominal surgery patients who suffered PPC treated in the ICU

	p-value	OR (Exp(B))	95% CI
ARISCAT score	0.007*	2.010	1.207-3.346
PNI	0.001*	5.286	2.012-13.889

Legend: ARISCAT=Assess Respiratory Risk in Surgical Patients in Catalonia; PNI=Prognostic Nutrition Index; PPC=postoperative pulmonary complication; ICU=intensive care unit; OR=odds ratio; CI=confidence interval; *significant.
Data were tested using a logistic regression test.

Table 9. Relationship between ARISCAT score and PNI on the mortality rate of post-abdominal surgery patients treated in the ICU

	p-value	OR (Exp(B))	95% CI
ARISCAT score	0.037*	1.746	0.949-3.212
PNI	0.010*	6.894	1.597-29.762

Legend: ARISCAT=Assess Respiratory Risk in Surgical Patients in Catalonia; PNI=Prognostic Nutrition Index; ICU=intensive care unit; OR=odds ratio; CI=confidence interval; *significant.
Data were tested using a logistic regression test.

Table 10. Length of stay in the ICU and duration of mechanical ventilation in patients suffering PPC

	Length of stay in ICU	Duration of mechanical ventilation	p-value
PPC	6.56±8.99 days	5.94±9.16 days	0.000*
Non-PPC	1.18±2.28 days	0.97±1.76 days	

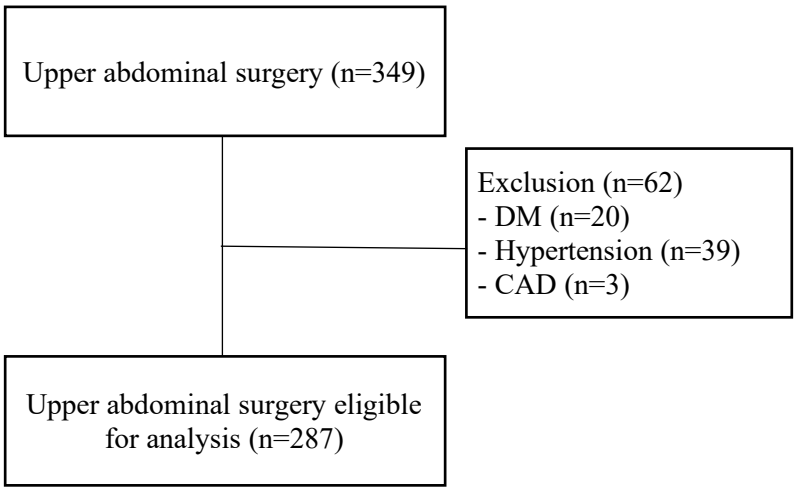
Legend: ICU=intensive care unit; PPC=postoperative pulmonary complication; *significant.
Data were processed using the Mann-Whitney test.

Table 11. Mortality in patients suffering PPC

	Mortality		p-value
	n	%	
PPC	24	38.7	0.000*
Non-PPC	14	73.5	

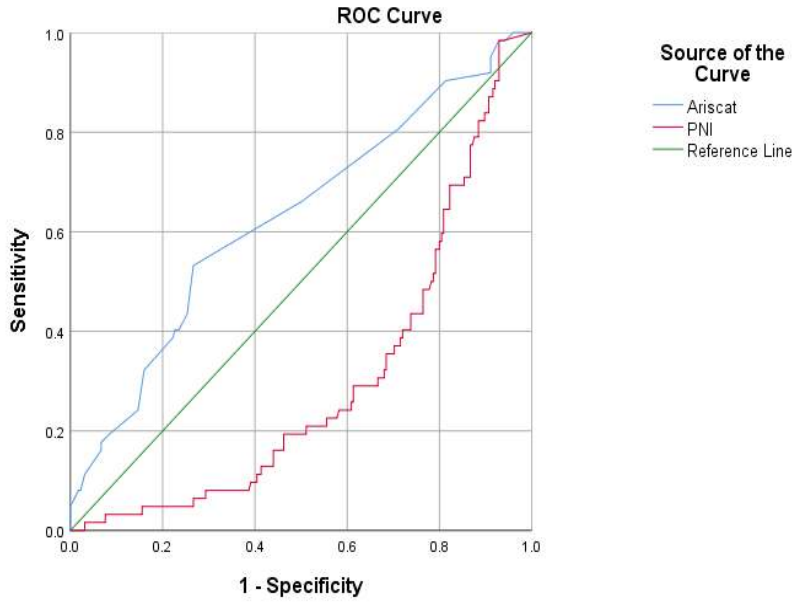
Legend: PPC=postoperative pulmonary complication; *significant.
Data were processed using the chi-square test.

Figure 1. Participant recruitment



Legend: DM=diabetes mellitus; CAD=coronary artery disease.

Figure 2. ROC curve of ARISCAT score and PNI



Legend: ROC=receiver operating characteristic; ARISCAT=Assess Respiratory Risk in Surgical Patients in Catalonia; PNI=Prognostic Nutrition Index.

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