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Nutritional Indicators and Pulmonary Infection Risk Assessment in Maintenance Hemodialysis Patients

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Abstract: Pulmonary infection is a common complication and an important cause of hospitalization and poor prognosis in maintenance hemodialysis patients, while malnutrition is highly prevalent in this population and may further impair immune defense. To clarify the relationship between nutritional status and pulmonary infection risk, 141 maintenance hemodialysis patients admitted to Hezhou People’s Hospital from June 2024 to December 2024 were enrolled and divided into an infection group (n=55) and a non-infection group (n=86) according to the occurrence of pulmonary infection. Nutritional status was evaluated using the Patient-Generated Subjective Global Assessment (PG-SGA), together with body mass index, triceps skinfold thickness, hemoglobin, serum albumin, prealbumin, and total cholesterol. Compared with the non-infection group, patients with pulmonary infection showed significantly lower body mass index, triceps skinfold thickness, hemoglobin, serum albumin, prealbumin, and total cholesterol, but a significantly higher PG-SGA score (all $P<0.05$). Multivariate logistic regression analysis further demonstrated that serum albumin <35 g/L, prealbumin <200 mg/L, hemoglobin <100 g/L, and PG-SGA score >15 were independent risk factors for pulmonary infection. These findings indicate that poor nutritional status is closely associated with an increased risk of pulmonary infection in maintenance hemodialysis patients. Early nutritional screening and timely individualized nutritional intervention may therefore be of substantial value for identifying high-risk patients and reducing infectious complications.

1. Introduction

Patients with end-stage renal disease (ESRD) predominantly rely on renal replacement therapy to sustain life. This patient population commonly presents with varying degrees of nutritional and metabolic dysfunction [1]. The incidence of protein-energy wasting (PEW) accounts for a substantial proportion [2]. Deterioration in nutritional status not only disrupts physiological homeostasis but may also compromise immune competence, thereby increasing the frequency of infectious complications. Pulmonary infection represents a prevalent cause of hospitalization and mortality among maintenance hemodialysis patients [3], rendering the exploration of its pathogenesis and predictive indicators of significant clinical value. Previous studies have demonstrated a certain correlation between malnutrition and infection risk [4]. However, quantitative investigations

specifically targeting nutritional parameters and pulmonary infection events remain insufficiently substantiated by evidence [5]. The present study aims to analyze the intrinsic association between multidimensional nutritional indicators and pulmonary infection risk through quantitative measurements, thereby providing theoretical foundation and empirical evidence for constructing preventive intervention strategies. We selected a comprehensive nutritional assessment index system encompassing anthropometric parameters, serum biochemical markers, and subjective global assessment scores. Through systematic collection, organization, and in-depth analysis of clinical data, we endeavored to identify critical risk warning factors to guide the optimization of clinical nutritional support strategies. This investigation holds substantial practical significance and clinical utility for reducing infection-related morbidity and mortality rates among maintenance hemodialysis patients.

2. Materials and Methods

2.1. General Data

This study enrolled 141 maintenance hemodialysis patients who were hospitalized in the Department of Nephrology of our hospital between June 2024 and December 2024. According to the occurrence of pulmonary infection, patients were divided into the infection group (Group A, n=55) and the non-infection group (Group B, n=86). The inclusion criteria encompassed three dimensions: First, patients met the diagnostic criteria for end-stage renal disease [6]. Second, patients had received regular hemodialysis treatment at our hospital for more than three months, with a frequency of 2–3 sessions per week, each lasting 4 hours. Third, patients in the pulmonary infection group fulfilled the diagnostic criteria for pulmonary infection [7], including respiratory symptoms, moist rales on physical examination, and radiological evidence from chest CT imaging. The exclusion criteria involved three aspects: First, patients with severe underlying diseases such as malignant tumors or active viral hepatitis. Second, patients who had undergone major surgical procedures or suffered severe trauma within three months prior to this admission. Third, patients receiving high-dose glucocorticoid therapy.

2.2. Methods

Nutritional status was assessed using the Patient-Generated Subjective Global Assessment (PG-SGA) scale for systematic scoring [8]. This instrument encompasses seven core dimensions: body weight change trends, dietary intake status, gastrointestinal symptom manifestations, physical functional status, disease diagnosis and associated factors, metabolic stress conditions, and physical examination findings. Each dimension comprises specific scoring criteria, and the total score is calculated by summing individual items. Higher scores reflect more severe nutritional deterioration. Anthropometric measurements were performed by experienced specialized nurses. Body mass index was calculated from actual measurements of height and dry body weight (kg/m^2). Triceps skinfold thickness was measured at the midpoint between the acromion and the olecranon process using a professional skinfold caliper, with three consecutive measurements averaged and recorded (mm). Venous blood samples were collected to measure clinically commonly used nutritional indicators, including hemoglobin, serum albumin, serum prealbumin concentration, and total cholesterol. All assays were strictly performed in accordance with standardized laboratory operating procedures. All instruments and equipment underwent regular calibration and verification to ensure accurate and reliable data [9].

2.3. Outcome Measures

This study systematically collected and comparatively analyzed the following core parameters between the two groups: baseline demographic characteristics (including chronological age and sex distribution); total duration of hemodialysis treatment (months); comorbidities (diabetes mellitus, hypertension); body mass index values; measured triceps skinfold thickness parameters; blood biochemical indicators: hemoglobin concentration, serum albumin concentration, prealbumin concentration, and serum total cholesterol concentration; comprehensive scores from the Subjective Global Assessment [10]. Additionally, the occurrence of pulmonary infection was systematically evaluated in all patients.

2.4. Statistical Analysis

All data were analyzed using SPSS 25.0 statistical software (IBM Corp., Armonk, NY, USA). Continuous variables were first tested for normality of distribution. Normally distributed data are expressed as mean ± standard deviation. Comparisons between the two groups were performed using independent samples t-test. Categorical variables are described as frequencies and percentages. Intergroup comparisons were conducted using Chi-square test or Fisher's exact probability test, as appropriate. In the multivariate logistic regression analysis for screening independent risk factors of pulmonary infection, the occurrence of pulmonary infection was designated as the binary dependent variable (0 = no occurrence, 1 = occurrence). Independent variables included the dichotomized status of nutritional indicators (based on clinically established cut-off points), age stratification (≤60 years/>60 years), and dialysis duration categorization (≤24 months/>24 months). Odds ratios (ORs) and their 95% confidence intervals (CIs) were calculated. A P-value <0.050 was considered statistically significant.

3. Results

3.1. Comparison of Baseline Characteristics between the Two Groups

A total of 141 maintenance hemodialysis patients were finally enrolled for data analysis. According to the occurrence of pulmonary infection, patients were divided into Group A (infection group, n=55) and Group B (non-infection group, n=86). No statistically significant differences were observed between the two groups in baseline characteristics, including sex distribution, age profile, primary disease composition, and dialysis vintage (P>0.05). Details are presented in Table 1. These findings indicate that, apart from the nutritional parameters and infection outcomes under investigation, the two groups exhibited high comparability in fundamental clinical characteristics, thereby minimizing the potential influence of confounding factors to the greatest extent.

Table 1: Comparison of baseline data between two groups of patients

Characteristic variable	Group A (n=55)	Group B (n=86)	Statistical value	P-value
Age (years)	53.270±8.640	51.890±9.370	0.895	0.372
Sex (male/female)	32/23(58.182%)	52/34(60.465%)	0.0735	0.786
Dialysis vintage (months)	28.430±10.570	30.150±12.360	-0.881	0.380
With hypertension	19(34.5%)	35(40.70%)	0.536	0.464
With diabetes mellitus	11(20%)	18(20.93%)	0.0175	0.895

3.2. Nutritional Indicators

The results of laboratory parameters and scale scores are detailed in Table 2.

Table 2: Comparison of Nutritional Indicators and Scoring Parameters Between the Two Groups

Measured parameters	Group A (n=55)	Group B (n=86)	t-value	P-value
BMI (kg/m²)	20.230±1.870	22.410±2.150	-6.363	p＜0.01
Triceps skinfold thickness (mm)	13.850±1.320	18.230±1.780	-16.730	p＜0.01
Hb (g/L)	96.470±10.360	103.830±12.740	-3.757	p＜0.01
Alb (g/L)	33.670±3.450	37.890±4.120	-6.561	p＜0.01
PAB (mg/L)	192.360±25.740	235.870±31.650	-8.938	p＜0.01
TC (mmol/L)	3.450±0.680	4.120±0.790	-5.354	p＜0.01
SGA score	18.58±3.440	11.66 ±2.86	12.422	p＜0.01

3.3. Multivariate Logistic Regression Analysis

The results clearly demonstrated a causal association between specific nutritional indicators and infection risk, as detailed in Table 3.

Table 3 Multivariate Logistic Regression Analysis of Pulmonary Infection in Maintenance Hemodialysis Patients

Risk variable items	β value	SE	Wald χ^2	P-value	OR	95% CI
Serum albumin <35 g/L	1.254	0.325	14.876	<0.001	3.507	1.854-6.635
Prealbumin <200 mg/L	1.187	0.301	15.564	<0.001	3.278	1.819-5.908
Hemoglobin <100 g/L	0.874	0.287	9.274	0.002	2.396	1.365-4.207
SGA score >15points	1.456	0.352	17.125	<0.001	4.289	2.152-8.547
Age >60 years	0.542	0.315	2.956	0.086	1.719	0.926-3.191
Dialysis vintage >24 months	0.387	0.298	1.687	0.194	1.473	0.821-2.642

4. Discussion

A significant association exists between nutritional status parameters and the probability of pulmonary infection events in maintenance hemodialysis patients. The present study demonstrated that patients who developed pulmonary infection exhibited systematic deterioration in nutritional status. Patients with serum albumin concentrations <35 g/L demonstrated a 3.5-fold increased risk of pulmonary infection. Those with prealbumin concentrations <200 mg/L showed a 3.3-fold elevated risk. Patients with subjective nutritional scores >15 points exhibited a 4.3-fold increased risk. These findings are consistent with previous reports [11]. Protein-energy wasting-induced impairment of immune defense mechanisms constitutes the core pathophysiological foundation [12-13]. Hypoalbuminemia directly compromises macrophage phagocytic activity and complement system activation efficiency. Lymphocyte proliferation and differentiation are significantly suppressed due to inadequate amino acid supply [14]. Immunoglobulin synthesis rates decline markedly because of protein substrate deficiency [15]. Respiratory mucosal barrier integrity is disrupted owing to epithelial cell renewal impairment [16]. These multifaceted dysfunctions in immune defense mechanisms ultimately result in significantly compromised clearance capability of respiratory pathogens. The importance of nutritional status assessment in clinical management of

maintenance hemodialysis patients warrants adequate emphasis. The Patient-Generated Subjective Global Assessment (PG-SGA) serves as a practical screening instrument with substantial clinical utility [17]. This instrument encompasses multidimensional parameters, enabling comprehensive reflection of the overall nutritional profile. In the present study, PG-SGA scores demonstrated good concordance with laboratory nutritional indicators. Patients with scale scores exceeding 15 points exhibited significantly elevated risk of pulmonary infection. This finding supports the clinical necessity of implementing routine systematic nutritional assessment. Optimization of nutritional intervention strategies should become a priority direction in clinical practice. Individualized nutritional support protocols should be formulated based on specific nutritional deficiency profiles of patients. Protein supplementation dosages require precise adjustment according to residual renal function status. Amino acid profile imbalances need targeted correction through specialized medical foods. Trace element deficiencies should be guided by laboratory monitoring for rational supplementation. These comprehensive intervention measures may improve nutritional status parameters and consequently reduce the risk of infectious complications. Several limitations of this study warrant acknowledgment. The single-center design may limit the generalizability of findings. The relatively modest sample size may compromise the power of subgroup analyses. The insufficient observation duration may preclude assessment of long-term nutritional intervention efficacy. Future investigations should expand sample sizes, extend follow-up durations, and adopt multicenter collaborative designs. Randomized controlled trials of nutritional interventions will provide higher-grade evidence-based medical evidence [18].

In conclusion, abnormal nutritional status parameters in maintenance hemodialysis patients demonstrate a significant positive correlation with increased risk of pulmonary infection events. Decreased serum albumin and prealbumin concentrations, as well as elevated subjective nutritional scores, constitute independent risk factors for pulmonary infection occurrence. Systematic nutritional status assessment should be incorporated into routine clinical management pathways for maintenance hemodialysis patients. Early identification of high-risk patients with poor nutritional status and implementation of individualized nutritional intervention strategies hold substantial clinical significance. These measures may reduce the incidence of infectious complications and improve patients' quality of life and long-term prognosis.

5. Conclusions

Poor nutritional status is significantly associated with pulmonary infection in maintenance hemodialysis patients. Lower serum albumin, lower prealbumin, lower hemoglobin, and higher PG-SGA scores were identified as independent risk factors for pulmonary infection. These findings suggest that routine nutritional assessment should be incorporated into the clinical management of maintenance hemodialysis patients, and that early identification of malnutrition combined with individualized nutritional support may help reduce the incidence of pulmonary infection and improve patient prognosis.

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