Original Article

Malnutrition dynamics according to GLIM criteria in hospitalized elderly

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Background and Objectives: Assess the different nutritional status between admission and discharged in older adult patients using the GLIM criteria. **Methods and Study Design:** A retrospective analysis was conducted on a multicenter study which initiated in 34 hospitals in China with 2734 hospitalized older patients. The dynamic changes of malnutrition according to GLIM criteria were performed between at admission and discharge, and their significance was analyzed using the chi-square test. The association between malnutrition and clinical outcomes was analyzed using the chi-square test, t-test, or rank sum test, and divided into different disease types for further analysis. **Results:** The incidence of nutritional risk in elderly patients was 51.6% at admission and 48.4% at discharge. The prevalence of malnutrition according to the GLIM criteria was 19.6% at admission and increased to 33.4% at discharge, which was significantly different. Different age and disease type were related with nutrition status. Malnutrition is significantly association with adverse clinical outcomes such as increased risk of complications and prolonged length of hospital stay. **Conclusions:** The GLIM criteria can be used in elderly patients to assess malnutrition. The prevalence of malnutrition in elderly inpatients is high, and the prevalence of malnutrition at discharge is higher than that observed at admission. Attention should be paid to the dynamic changes of malnutrition in elderly patients during hospitalization.

Key Words: GLIM criteria, malnutrition, admission, discharge, older patient

INTRODUCTION

Older adult inpatients have a high incidence of nutritional risk and malnutrition.[1] Many studies show, malnutrition is associated with many adverse clinical outcomes, including increased morbidity, mortality and health care costs, prolonged length of hospital stay.[2-4]

Previous studies of hospitalized older patients mainly focused on nutrition status at admission.[5-7] Due to disease factors, hospitalized elderly patients receive surgical or medical treatment in hospital. Nutritional problems are usually ignored, resulting in no improvement or further deterioration of nutritional status.[8] Currently, limited studies have assessed dynamic changes of malnutrition during hospitalization.[9]

In 2019 the Global Leadership Initiative on Malnutrition (GLIM) developed and reported new diagnostic criteria for malnutrition.[10] The GLIM criteria's applicability and effectiveness have been verified in retrospective and prospective studies at home and abroad. It can be used not only to diagnose malnutrition, but also to be a predictor of clinical outcomes in patients with surgery, elderly tumors, cardiovascular diseases, etc.[11-15] As the latest malnutrition diagnostic criteria, the GLIM criteria were used in different elderly patients.[14,16,17] This study aimed to assess the different nutritional status between admission and discharged in older patients using the GLIM criteria.

METHODS

Study design

This retrospective analysis was conducted on a multicenter study which initiated in 34 hospitals in China from June to September 2014. The protocol of this multicenter study was approved by the Ethics Committee of Beijing

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Hospital (registration number: 2014BJYYEC-022-02) and registered in the China Clinical Trial Registry (Registered No. ChiCTR-EPC-14005253).

Ethics statement

The studies involving human participants were reviewed and approved by the Ethics Committee of Beijing Hospital. The patients/participants provided their written informed consent to participate in this study

Participants

The inclusion criteria were: (1) aged 65 years or older; (2) being conscious; (3) no emergengcy surgery; (4) willing to accept the multiple nutrition assessment. Exclusion criteria included: (1) emergency patients; (2) refusal to participate; (3) incomplete information; (4) repeat admissions.

Data collection

Demographic and clinical data were collected, including: age, gender, height, weight, body mass index (BMI), calf circumference (CC), upper arm circumference, handgrip strength, and laboratory data. Laboratory test results included leukocyte count, hemoglobin, albumin, total protein, albumin, prealbumin triglycerides (TG), total cholesterol (TC). Disease diagnosis on admission was collected, and clinical outcome data were collected, including mortality, total complications, infectious complications, total hospital cost, length of stays (LOS) and LOS in the ICU.

Nutritional screening and assessment

The prevalence of nutritional risk was performed by nutritional risk screening-2002 (NRS-2002), including impaired nutritional status, disease severity, and age ≥70 years, with score ≥3 indicating nutritional risk.[18] Malnutrition was defined by GLIM criteria. There are two steps of GLIM criteria, nutritional risk and malnutrition diagnosis (including severity grading).

To further assess patients with nutritional risk, the GLIM criteria consist of 3 phenotypic criteria (nonvolitional weight loss, low BMI, and reduced muscle mass) and 2 etiological criteria (reduced food intake or assimilation and disease burden/inflammation), and must have at least one phenotypic criterion and one etiological criterion to diagnose malnutrition. The phenotypic criteria: (1) nonvolitional weight loss: weight loss >5% within the past 6 months, or >10% beyond 6 months; (2)low BMI: following the Asian BMI data, BMI <18.5 kg/m^2 (aged <70 years) and BMI <20 kg/m^2 (aged ≥70 years); (3) reduced muscle mass: since the original database had no human body composition test results, and there was no accurate "cut point value" for muscle mass reduction in China. Hence, in this study we used calf circumference combined with grip strength as alternative measures.[10, 19] According to the Asian Working Group for Sarcopenia 2019 Consensus,[20] low calf circumference including calf circumference <34 cm in male or <33 cm in female; low handgrip strength including handgrip strength <28 kg in male or <18 kg in female. In this study patients with both low calf circumference and low handgrip strength were judged to have reduced muscle mass.

Severe malnutrition can be diagnosed if one of the following two conditions is met: (1) in the past 6 months weight loss >10% or beyond 6 months weight loss >20%; (2) if age <70 years BMI <17.0 kg/m^2 or if age ≥70 years BMI <17.8 kg/m^2.[21] Those malnutritional patients without meeting severe malnutrition conditions were moderate malnutrition.

Statistical analysis

Continuous variables were expressed as mean (SD) and standard deviation, and differences were analyzed by t-test or rank sum test. Categorical variables were expressed as frequencies (percentages), and differences were determined by the chi-square test. Dynamic changes of nutritional risk and malnutrition between admission and discharge in age subgroup and disease type subgroup. Age was subdivided into 4 groups: 65-69 years old, 70 years old, 80 years old and 90 years old. Disease type subgroup was according to the first diagnosis at admission. Chi-square analysis or t-test or rank sum test was used to evaluate the effect of GLIM-defined malnutrition on the incidence of complications, and other clinical outcomes. SPSS 25 version was used for statistical analysis, and $p<0.05$ means the difference is significant.

RESULTS

Study characteristics

A total of 2734 elderly inpatient patients were enrolled in this study, including 1634 male (59.8%) and 1100 female (40.2%), the ratio of male to female was 1.49:1. The age range was 65-97 years, and the mean age was 74.7±7.11 years.

According to the first diagnosis at admission, there were as many as 80 types of diseases, with the highest number of cases accounting for 36.2% (989/2734) of malignant tumors, and the top three diseases with the highest number of cases among malignant tumors were: 228 cases (8.3%) of pulmonary malignant tumors, 214 cases (7.8%) of gastric cancer, and 131 cases (4. 8%) of rectal cancer. The other top three among non -malignant tumors were: cerebral infarction in 159 cases (5.8%), pulmonary infection in 134 cases (4.9%), and gallstones/bile duct stones in 78 cases (2.9%).

Dynamic changes of nutritional status in admission and discharge under GLIM criteria

Among 2734 elderly patients, 1411 and 1323 patients with nutritional risk were screened by NRS-2002, with a total nutritional risk incidence rate of 51.6% and 48.4% at admission and discharge respectively.

19.6% (536/2734) were diagnosed with malnutrition according to GLIM criteria at admission, and 33.4% (912/2734) at discharge. 10.2% (280/2734) of patients had moderate malnutrition, and 9.4% (256/2734) had severe malnutrition on admission; at discharge the incidence of moderate malnutrition was 15.5% (425/2734) and 17.8% (487/2734) of severe malnutrition. The details of admission and discharge of GLIM phenotypic criteria are shown in Table 1. Compared with admission, the number of malnourished people were significantly increased at discharge (Table 1).

Table 1. Nutritional risk and malnutrition at admission and discharge in elderly patients [n (%)]

	Admission	Discharge	χ^2 value	*p* value
Nutritional risk	1411 (51.6)	1323 (48.4)	5.665	0.017
Low BMI	481 (17.6)	421 (15.4)	4.753	0.029
Weight loss	606 (22.2)	375 (13.7)	66.287	<0.001
Reduced muscle mass	588 (22.2)	559 (20.5)	0.928	0.335
Malnutrition	536 (19.6)	912 (33.4)	132.804	<0.001
Moderate malnutrition	280 (52.2)	425 (46.6)	4.295	0.038
Severe malnutrition	256 (47.8)	487 (53.4)		

All values are expressed as number of patients (%).

Anthropometry and laboratory indexes of patients with different nutritional status at admission

The demographic and clinical characteristics of the 2734 elderly patients are shown in Table 2. There were significant differences in age, height, weight, BMI, upper arm circumference, calf circumference, handgrip strength, hemoglobin, total protein, albumin, prealbumin, blood glucose, TG, TC, between the malnourished and non-malnourished groups.

Changes in nutritional status at admission and discharge in different age groups

Nutritional risk and malnutrition have no significant difference in admission and discharge in most age groups, but severe malnutrition has significant difference in admission and discharge in each age group (Table 3).

Nutritional status in different diseases at admission and discharge

We only performed subgroup analysis of disease classifications with a large number of cases, and excluded 92 cases with less than 50 single disease cases (4 cases of herpes zoster, 2 cases of cataract, 4 cases of erysipelas, 41 cases of hernia, 11 cases of thyroid nodules, 12 cases of urinary tract infection, 7 cases of skin infection, and 11 cases of lipoma were not included in the group study.

Among the 2642 patients included in the sub-analysis of disease types, the changes of nutritional status at admission and discharge are shown in Table 4.

The relationship between malnutrition and clinical outcome

The mortality, complications, infectious complications, length of hospital stay, and total hospital cost were significantly higher in malnourished patients than in non-malnourished patients. The relationship between clinical outcomes of different disease types and malnutrition is shown in Table 6-10. Malnutrition is associated with adverse clinical outcomes in multiple disease types. The relationship between malnutrition and length of hospital stay is shown in Figure 1.

DISCUSSION

Our study found that the incidence of malnutrition was 19.6% at admission, increased to 33.4% at discharge according to the GLIM criteria, and the incidence of malnutrition at discharge was significantly higher than that at admission. More attention should be paid to the dynamic changes of nutritional status during hospitalization.

Hospitalization can decline the nutritional status.[22] The incidence of malnutrition in elderly inpatients increases during hospitalization, and the possible reasons may be as

Table 2. Demographic and clinical characteristics of all the patients

Characteristic	Total (n=2734)	With malnutrition	Without malnutrition	*p* value
Gender male (%)	1634 (59.8%)	536(32.8%)	1098(67.2%)	<0.001
Average age	74.7±7.11	76.0±7.02	74.1±7.07	<0.001
Height (cm)	164±8.24	164±8.50	165±8.10	0.040
Body weight(kg)	61.7±11.5	55.8±11.0	64.6±10.7	<0.001
BMI (kg/m^2)	22.8±3.60	20.7±3.37	23.8±3.26	<0.001
Left upper arm circumference	26.3±3.42	24.6±3.15	27.0±3.27	<0.001
Right upper arm circumference	26.2±4.00	25.3±4.38	26.8±3.61	<0.001
Left calf circumference	32.7±4.27	31.0±3.90	33.6±4.19	<0.001
Right calf circumference	32.4±4.15	30.4±4.02	33.5±3.83	<0.001
Left handgrip strength	21.1±9.32	18.3±8.39	22.3±9.45	<0.001
Right handgrip strength	22.9±9.68	20.4±9.10	24.1±9.72	<0.001
Leukocyte count (10^9L)	6.79±3.12	6.95±3.62	6.7±2.82	0.081
Hemoglobin	123±20.3	116±21.5	126±18.0	<0.001
Total protein (g/L)	65.5±6.89	64.1±7.19	66.2±6.61	<0.001
Albumin (g/L)	38.2±5.19	36.2±5.33	39.2±4.80	<0.001
Prealbumin (g/L)	0.23±0.08	0.21±0.09	0.23±0.07	<0.001
Blood glucose (mmol/L)	5.96±2.11	5.74±1.95	6.07±2.18	<0.001
TG (mmol/L)	1.92±1.95	1.50±1.34	2.11±2.15	<0.001
TC (mmol/L)	4.05±1.50	3.89±1.43	4.12±1.52	0.003

BMI: body mass index; TG: total triglyceride; TC: total cholesterol.
All values are expressed as mean±SD.

Table 3. Nutritional status of admission and discharge at different ages [n (%)]

Age group	n	Nutritional risk			Malnutrition (GLIM)			Severe malnutrition		
		Admission	Discharge	*p* value	Admission	Discharge	*p* value	Admission	Discharge	*p* value
65-69	849	327 (38.5)	330 (38.9)	0.881	200 (23.6)	204 (24.0)	0.820	62 (7.30)	127 (15.0)	<0.001
70~	1148	662 (57.7)	612 (53.3)	0.036	401 (34.9)	408 (35.5)	0.760	111 (9.67)	219 (19.1)	<0.001
80~	671	385 (57.4)	350 (52.2)	0.055	265 (39.5)	274 (40.8)	0.616	75 (11.2)	126 (18.8)	<0.001
90~	66	37 (56.1)	31 (47.0)	0.296	24 (36.4)	26 (39.4)	0.720	8 (12.1)	15 (22.7)	0.108

All values are expressed as number of patients (%).

Table 4. The changes of nutritional risk and malnutrition among different diseases at admission and discharge

Disease type	Number	Nutritional risk		χ^2 value	*p* value	Malnutrition		χ^2 value	*p* value
		Admission	Discharge			Admission	Discharge		
Malignant tumors	989	621 (62.8)	622 (62.9)	0.002	0.963	463 (46.8)	431 (43.6)	2.090	0.148
Digestive diseases	517	300 (58.0)	269 (52.0)	3.756	0.053	175 (33.9)	179 (34.6)	0.069	0.793
Nervous diseases	451	165 (36.6)	158 (35.0)	0.236	0.627	47 (10.4)	98 (21.7)	21.374	<0.001
Respiratory diseases	244	135 (55.3)	109 (44.7)	5.541	0.019	111 (45.5)	82 (33.6)	7.208	0.007
Cardiovascular diseases	184	61 (33.2)	53 (28.8)	0.813	0.367	36 (19.7)	46 (25.0)	1.569	0.210
Orthopaedic diseases	164	55 (33.5)	47 (28.7)	0.911	0.340	30 (18.3)	30 (18.3)	0.000	1.000
Endocrine diseases	93	37 (39.8)	29 (31.2)	1.503	0.220	16 (17.2)	22 (23.7)	1.191	0.275

All values are expressed as number of patients (%).

Table 5. Malnutrition and clinical outcome

	With malnutrition	Without malnutrition	*p* value
Mortality	12 (1.34%)	0 (0%)	<0.001[†]
Complications	55 (6.18%)	46 (2.49%)	<0.001
Infectious complications	36 (4.04%)	26 (1.41%)	<0.001
ICU admission	59 (6.63%)	104 (5.64%)	0.306
LOS, days	15.1±6.76	14.0±6.05	<0.001
LOS in the ICU, days	0.29±1.527	0.19±1.206	0.085
Total hospital cost, yuan	34893±70713	29546±40788	0.046

LOS: length of stay; ICU: intensive care unit; yuan: Chinese money unit.
[†]Fisher test.

Table 6. Malnutrition and clinical outcome in malignant tumors

	With malnutrition	Without malnutrition	*p* value
Mortality	9 (0.91%)	0 (0%)	0.001†
Complications	36 (3.64%)	21 (2.12%)	0.011
Infectious complications	24 (2.43%)	12 (1.21%)	0.015
ICU admission	36 (3.64%)	31 (3.13%)	0.379
LOS, days	15.4±7.12	14.5±6.52	0.068
LOS in the ICU, days	0.29±1.492	0.17±0.924	0.148
Total hospital cost, yuan	39162.1±46858	38247.3±62278	0.809

LOS: length of stay; ICU: intensive care unit; yuan: Chinese money unit.
†Fisher test.

Table 7. Malnutrition and clinical outcome in digestive diseases

	With malnutrition	Without malnutrition	*p* value
Mortality	1 (0.19%)	0 (0%)	0.338†
Complications	7 (1.35%)	9 (1.74%)	0.395
Infectious complications	5 (0.97%)	4 (0.77%)	0.151†
ICU admission	9 (1.74%)	18 (3.48%)	0.907
LOS, days	13.7±6.06	12.6±5.66	0.055
LOS in the ICU, days	0.25±1.559	0.20±1.422	0.888
Total hospital cost, yuan	23123±19418	22824.6±23225	0.716

LOS: length of stay; ICU: intensive care unit; yuan: Chinese money unit.
† Fisher test

Table 8. Malnutrition and clinical outcome in nervous diseases

	With malnutrition	Without malnutrition	*p* value
Mortality	0 (0%)	0 (0%)	-
Complications	5 (1.11%)	1 (0.22%)	<0.001†
Infectious complications	2 (0.44%)	1 (0.22%)	0.030†
ICU admission	4 (0.89%)	36 (0.80%)	0.891
LOS, days	16.6±6.79	13.5±5.43	0.005
LOS in the ICU, days	0.30±1.267	0.18±0.78	0.369
Total hospital cost, yuan	32035±36199	24444±25238	0.178

LOS: length of stay; ICU: intensive care unit; yuan: Chinese money unit.
†Fisher test.

Table 9. Malnutrition and clinical outcome in respiratory diseases

	With malnutrition	Without malnutrition	*p* value
Mortality	2 (0.82%)	0 (0%)	0.206†
Complications	4 (1.64%)	4 (1.64%)	0.535†
Infectious complications	3 (1.23%)	3 (1.23%)	0.570†
ICU admission	4 (1.64%)	6 (2.46%)	0.516†
LOS, days	14.6±5.80	14.6±6.18	0.992
LOS in the ICU, days	0.37±1.93	0.43±2.01	0.816
Total hospital cost, yuan	39536±173968	23418±24707	0.317

LOS: length of stay; ICU: intensive care unit; yuan: Chinese money unit.
†Fisher test.

Table 10. Malnutrition and clinical outcome in cardiovascular diseases

	With malnutrition	Without malnutrition	*p* value
Mortality	0 (0%)	0 (0%)	-
Complications	3 (1.63%)	5 (2.72%)	0.190†
Infectious complications	3 (1.63%)	2 (1.09%)	0.253†
ICU admission	1 (0.54%)	3 (1.63%)	0.022†
LOS, days	15.6±7.47	14.9±6.56	0.590
LOS in the ICU, days	0.53±1.86	0.17±2.06	0.340
Total hospital cost, yuan	25000±26746	25897±24496	0.317

LOS: length of stay; ICU: intensive care unit; yuan: Chinese money unit.
†Fisher test.

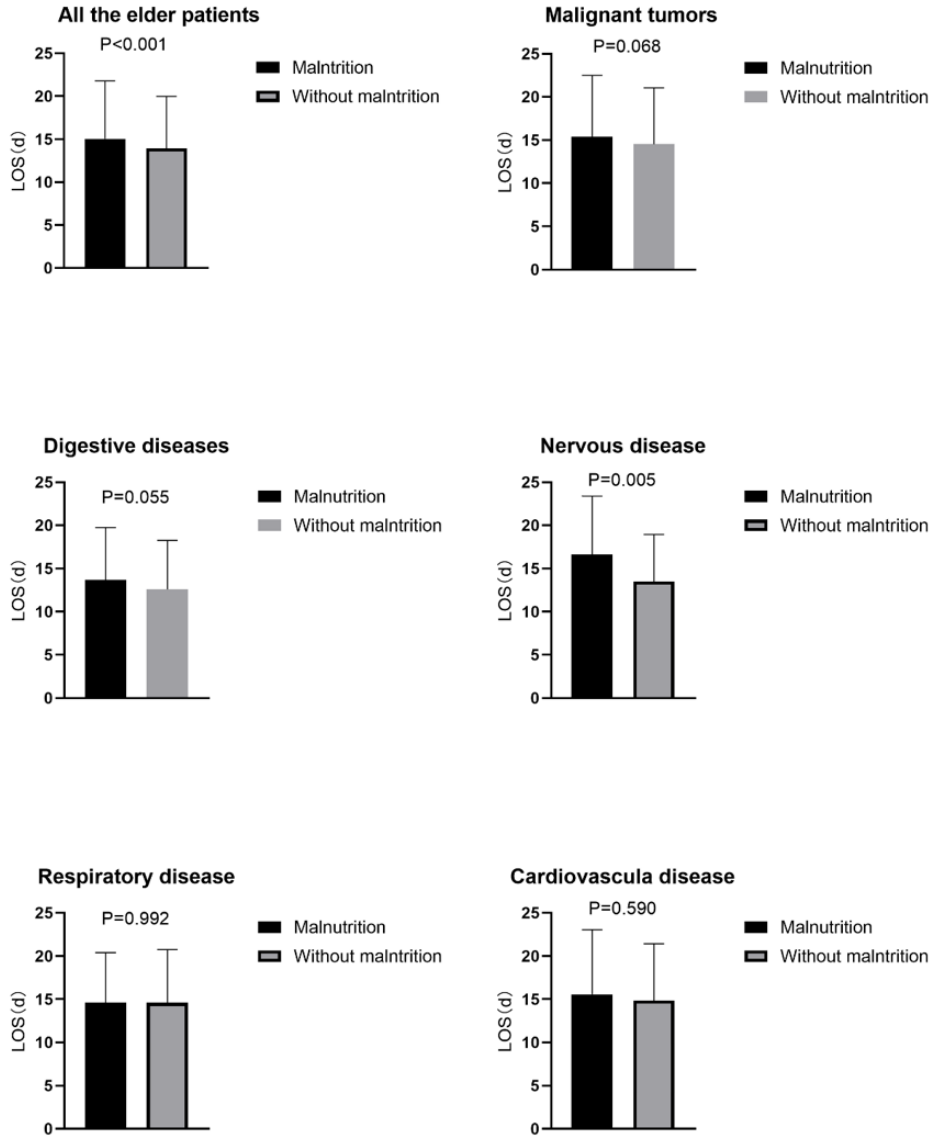

Figure 1. Relationship between malnutrition and hospital stay of different diseases. LOS: length of stays

follows: (1) injury or acute illness can aggravate the loss of body weight during hospitalization;[23] (2) changes in living environment, eating habits and food, the patient's intake may be reduced and malnutrition may be aggravated after hospitalization;[24-27] (3) patients do not take sufficient energy form the hospital meals;[28] (4) regularly malnutrition remains unrecognized in hospital.[28]

After grouping by age, the overall incidence of malnutrition did not change much between admission and discharge, but the patients with severe malnutrition at discharge were significantly higher than those at admission, and the difference was statistically significant (except for those over 90 years old). The grading of malnutrition can further reveal the specific degree of malnutrition.

After grouping different diseases, we found that the incidence of malnutrition in patients with nervous system at discharge was significantly higher than that at admission, and the incidence of malnutrition in patients with respiratory system at discharge was lower than that at admission. Nutritional problems in patients with neurological diseases are more prominent. As patients with nervous system diseases are often accompanied by other chronic diseases, patients with nervous system damage are prone to consciousness disorders or dysphagia, resulting in significantly reduced intake, further prone to nutritional metabolism disorders, and significantly increased incidence of malnutrition.[29] For patients with respiratory system diseases, the incidence of malnutrition during hospitalization has been significantly reduced, which may be related to correcting the primary disease of the respiratory system, improving the patient's respiratory function, and eating status.[30,31]

Many studies now support that malnutrition is associated with adverse clinical outcomes.[32,33] The results of our study showed that the mortality, complications and infection complications, length of hospital stay and hospital costs of all elderly patients with malnutrition were significantly higher than those without malnutrition. The correlation between malnutrition and adverse clinical outcomes of different diseases is slightly different. It should be noted that the nutritional status of patients with benign diseases of the nervous system is closely related to the length of hospital stay.

The main advantage of our study is to dynamically observe the changes of nutritional status during hospitalization of various diseases in elderly patients in a multi-

center study. However, this study still has some limitations. First, our study was a retrospective study containing a certain bias. We try to make a comprehensive analysis, and analyze by disease type subgroup to reduce the influence of disease factors. Second, for the reduction of muscle mass, our study did not use specific muscle mass, but chose grip strength and calf circumference as the evaluation basis, which may lead to bias. However, this is inevitable in the study of measuring muscle mass without dual energy X-ray absorptiometry or bioelectrical impedance analysis. Third, this study is aimed at the elderly hospitalized patients in China, and the results cannot represent the situation of other races.

In conclusion, the prevalence of malnutrition in elderly inpatients is high, and the incidence of malnutrition at discharge was significantly higher than that at admission. The GLIM criteria can be used in elderly patients to assess malnutrition. Attention should be paid to the dynamic changes of malnutrition in elderly patients during hospitalization, and standardized nutritional intervention should be performed in time for malnourished elderly patients to improve clinical outcomes.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

AUTHOR DISCLOSURES

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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