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Research on the Current Situation and Influencing Factors of Heart Failure Complicated with Cognitive Impairment

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Abstract **Objective:** To explore the current status and influencing factors of cognitive impairment in patients with heart failure. **Methods:** A total of 119 patients with heart failure admitted to the cardiology department from October 2023 to October 2025 were selected through convenience sampling. They were investigated using general information questionnaires, the Montreal Cognitive Assessment Scale, the Activities of Daily Living Scale, and the 8-item Social Frailty Scale. Patients were divided into the cognitive impairment group (n=57) and the non-cognitive impairment group (n=62) based on the scores of the Montreal Cognitive Assessment Scale for univariate comparison. Multivariate Logistic regression was used to analyze the independent risk factors for cognitive impairment in patients with heart failure. **Results:** Among the 119 patients with heart failure, 57 had cognitive impairment, with an incidence rate of 48%. In the univariate analysis, there were statistically significant differences between the two groups in terms of age, marital status, educational level, smoking status, Barthel Index, history of coronary heart disease, N-terminal pro B-type natriuretic peptide (NT-proBNP), NYHA classification, left ventricular ejection fraction, and degree of social frailty ($P<0.05$). In the multivariate Logistic regression analysis, educational level, smoking status, and left ventricular ejection fraction were independent risk factors for cognitive impairment in patients with heart failure ($P<0.05$). **Conclusion:** Low educational level, smoking, and low left ventricular ejection fraction are risk factors for cognitive impairment in patients with heart failure. In addition to standardized drug treatment and improvement of cardiac function, interventions should be made in terms of lifestyle, cognitive training, and psychological support to reduce the incidence of cognitive impairment in patients with heart failure.

Keywords*: Heart failure, Cognitive impairment, Current situation, Influencing factors*

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1. Introduction

Heart failure (HF) is a syndrome characterized by impaired cardiac pumping function due to various causes, where the cardiac output cannot meet the basic metabolic needs of the entire body. It represents the terminal stage of cardiovascular diseases [1]. Research shows that the prevalence of heart failure among Chinese people over 35 years old is 1.3%, and the 5-year mortality rate is as high as 56.7% [2], making it a public health issue of global concern [3]. In recent years, with the in-depth study of heart failure, it has been found that a considerable proportion of heart failure patients have concurrent cognitive impairment (CI) [4], including language communication, thinking ability, memory, attention, and executive function. CI is closely related to the increased hospitalization rate, mortality rate, and poor clinical prognosis of heart failure patients [5]. Currently, there is no effective treatment for heart failure with CI. Therefore, early prevention of CI or delaying cognitive decline during the period of CI is the focus of current research. This study will explore the current situation of heart failure with CI and, in combination with the general condition, clinical characteristics, and living status of heart failure patients, investigate their impact on cognitive function, providing a basis for delaying the decline of cognitive function in heart failure patients and finding more effective intervention strategies.

2. Participants and Methods

2.1. Participants

By using the convenience sampling method, 119 patients with heart failure admitted to the cardiology department from October 2023 to October 2025 were selected as the research subjects. Questionnaires were

conducted on the general information of the patients, the Montreal Cognitive Assessment (MoCA) [6], the Activity of Daily Living Scale (ADL) [7], and the 8-item Social Frailty Scale (SFS-8) [8]. Based on the commonly used principle for sample size estimation in multi-factor analysis, which is typically 5 to 10 times the number of independent variables [9], this study includes 14 independent variables such as gender, age, marital status, educational level, and social frailty degree. The calculated required sample size is 70 to 140 cases. Considering a 10% dropout rate, the sample size should be 77 to 154 cases. The final survey sample was 119 cases. This study has been approved by the hospital ethics committee (approval number: KY2024-06-101).

Inclusion criteria: (1) Meeting the diagnostic criteria for chronic heart failure as stipulated in the“Chinese Guidelines for the Diagnosis and Treatment of Heart Failure” [10] (2018 Edition); (2) Patients with stable conditions; (3) Conscious and having normal reading and writing abilities; (4) Voluntary participation in the study and signing of the informed consent form by the patient or their family members.

Exclusion criteria: (1) Patients with acute heart failure; (2) Patients who are unable to cooperate in completing the survey content, such as those with consciousness disorders, deafness, or aphasia; (3) Patients with a clear diagnosis of Alzheimer's disease or dementia after cerebrovascular disease; (4) Patients with dementia caused by neurodegenerative diseases; (5) Patients with current or previous malignant tumors, immune system diseases, severe liver or kidney function disorders, etc.

2.2. Investigation Tools

2.2.1. General Information Collection Form

After conducting literature research and consulting relevant experts, we confidently compiled the questionnaire in advance. The content includes: gender, age, educational level, smoking history, drinking history, disease history, medication history, and the New York Heart Association (NYHA) classification [11] (Class I, Class II, Class III, Class IV), etc.

2.2.2. MoCA

MOCA is an assessment tool used for rapid screening of CI. It consists of 11 examination items covering 8 cognitive domains, including attention and concentration, executive function, memory, language, visuospatial skills, abstract thinking, calculation and orientation. The total score is 30 points, with a score of ≥ 26 indicating normal cognitive function and a score of < 26 indicating the presence of CI.

2.2.3. ADL

ADL is a tool used to assess an individual's ability to independently perform basic daily life activities. This assessment uses the Barthel Index for evaluation, covering ten items including eating, bathing, grooming, dressing, control of bowel and bladder, toileting, transferring from bed to chair, walking on flat ground, and going up and down stairs. Each item is scored based on the degree of independence as 0, 5, 10, or 15 points, with a total score ranging from 0 to 100. According to the total score, self-care ability is classified into four levels: severe dependence, moderate dependence, mild dependence, and no dependence.

2.2.4. SFS-8

This scale consists of eight items, covering three major aspects: social resources and economic resources, social activities, and satisfaction of social needs. The options are "Yes" and "No", corresponding to 1 point and 0 point respectively. The total score ranges from 0 to 8 points. The lower the score, the lower the degree of social frailty. A score of 0-1 indicates non-social frailty, 2-3 indicates pre-social frailty, and 4-8 indicates social frailty.

2.3. Survey Methods

The members of the investigation team, after undergoing training, used uniform instructions to conduct the investigation on patients with heart failure. After introducing the purpose of the investigation and the instructions for filling out the questionnaire to the patients and their families and obtaining their consent, they guided them to complete the questionnaire survey based on the actual situation.

2.4. Quality Control

After reviewing a large number of documents and consulting relevant experts, the research determined the survey questionnaire to be used, choosing scales with high reliability and validity and high usage and recognition in China. Before the survey, a small sample of patients was selected for a pre-survey, and the content and structure of the questionnaire were adjusted and modified based on the results of the pre-survey. During the implementation of the survey, the research subjects were strictly screened according to the inclusion and exclusion criteria in the research design. The questionnaires were distributed and collected on-site. When collecting the questionnaires, the completeness and logic of the questionnaires were checked. If there were any missing items or logical errors, the patients were asked again to complete or modify the questionnaires. Before data entry, the completeness and logic of the questionnaires were checked, and invalid questionnaires were excluded. Then, the questionnaires were numbered in sequence for entry, and a database was established by double data entry and verification.

2.5. Data Analysis Methods

The questionnaires were sorted out, numbered in sequence and entered into the computer to establish a database. Statistical analysis was conducted using SPSS 25.0 statistical software. The general conditions of the patients and other count data were expressed as frequency and composition ratio, and the comparison between groups was conducted using the χ^2 test. The cognitive ability, daily living ability and other measurement data were tested for normal distribution using the K-S test. If they conformed to the normal distribution, they were described as ($\overline{x} \pm s$) , and the comparison between

groups was conducted using the t-test. If they did not conform to the normal distribution, they were described as M (Q1, Q3), and non-parametric tests were used. The factors influencing heart failure combined with CI were analyzed by multivariate analysis.

3. Result

3.1. Univariate Analysis of Heart Failure Complicated with CI

The general information, disease data and social frailty degree of the two groups of patients with CI and Non-CI were compared. There was no statistically significant difference in gender, living situation (whether living alone), whether drinking alcohol, sleep quality, history of diabetes, history of atrial fibrillation, and history of hypertension (P > 0.05). There were statistically significant differences in age, marital status, educational level, whether smoking, Barthel index, history of coronary heart disease, N-terminal pro B-type natriuretic peptide (NT-proBNP), NYHA classification, left ventricular ejection fraction and social frailty degree (P < 0.05). See Table 1.

3.2. Multifactorial Analysis of Heart Failure Complicated with CI

To further explore the risk factors for CI in patients with heart failure, a multivariate logistic regression analysis was conducted with the items that showed significant differences in the univariate analysis (age, marital status, educational level, smoking status, Barthel index, history of coronary heart disease, NT-proBNP, NYHA classification, left ventricular ejection fraction, and degree of social frailty) as independent variables and the presence or absence of CI (CI = 0, non-CI= 1) as the dependent variable. See Table 2. The results showed that educational level, smoking status, and left ventricular ejection fraction were independent risk factors for CI in patients with heart failure (P < 0.05). See Table 3.

Table 1. Univariate Analysis of Heart Failure Complicated with CI [n (%) / $\overline{x} \pm s$]

Variables		CI group (n=57)	Non-CI group (n=62)	χ^2/Z	P
Gender	Male	27	35	0.982	0.322
	Female	30	27		
Age (years)		79 (70,83)	65 (55,75)	-5.192	0.000
Marital status	unmarried	2	5	6.891	0.032
	married	38	50		
	Widowed	17	7		
Educational attainment	Primary school and below	36	11	36.841	0.000
	Junior high school or technical secondary school	16	15		
	Senior high school	4	23		
	College or above	1	13		
Residential situation	Living alone	7	12	1.108	0.293
	Not living alone	50	50		
History of smoking	Yes	16	5	8.179	0.004
	No	41	57		
History of alcohol consumption	Yes	10	19	2.766	0.096
	No	47	43		
Sleep quality	Good	27	40	3.549	0.060
	Poor	30	22		
Barthel Index		50 (30,60)	65 (50,75)	773.000	0.000
Medical history	coronary heart disease	49	31	17.435	0.000
	diabetes	26	22	1.266	0.260
	Atrial fibrillation	12	6	2.993	0.084
	hypertension	27	22	1.732	0.188
NT-proBNP (pg/mL)		2630 (2147,3059)	1490 (875,2584)	-4.163	0.000
NYHA grading	Grade I	0	0	46.362	0.000
	Grade II	2	31		
	Grade III	24	27		
	Grade IV	31	4		
LVEF (%)		38 (33,43)	50 (45,55)	-7.585	0.000
Degree of social weakness	No social weakness	0	4	30.600	0.000
	Pre-social weakness	19	47		
	Social weakness	38	11		

Table 2. Assignment of risk factors for CI in patients with heart failure

Independent variable	Assignment
Age (years)	Original value input
Marital status	be married =0，unmarried =1
Educational attainment	Primary school and below =1，Junior high school or technical secondary school =2，Senior high school =3，College or above =4
History of smoking	Yes=0，No=1
Barthel Index	≤40=1，41~60=2，61~99=3，100=4
Coronary heart disease	Yes=0，No=1
NT-pro BNP	Original value input
NYHA grading	Grade I=1，Grade II 级=2，Grade III=3，Grade IV=4
LVEF（%）	Original value input
Degree of social weakness	No social weakness =1，Pre-social weakness =2，Social weakness =3

Table 3. Multifactorial analysis of heart failure complicated with CI

Variables	B	SE	β	t	P	95%CI
Age	-0.004	0.003	-0.106	-1.315	0.191	-0.009~0.002
Marital status	0.084	0.072	0.073	1.155	0.251	-0.060~0.227
Educational attainment	0.111	0.039	0.232	2.883	0.005	0.035~0.188
History of smoking	0.262	0.080	0.200	3.259	0.001	0.103~0.421
Barthel Index	-0.020	0.052	-0.032	-0.379	0.705	-0.123~0.083
Coronary heart disease	-0.035	0.077	-0.033	-0.457	0.649	-0.188~0.117
NT-pro BNP	-2.794E-5	0.000	-0.069	-1.001	0.319	0.000~0.000
NYHA grading	-0.112	0.067	-0.169	-1.663	0.099	-0.244~0.021
LVEF	0.024	0.007	0.398	3.573	0.001	0.011~0.038
Degree of social weakness	-0.047	0.073	-0.052	-0.651	0.516	-0.192~0.097

$F=17.359$, $R^2=0.616$, Adjusted $R^2=0.581$，$P<0.001$

4. Discussion

Heart failure is a disease with serious harm, characterized by poor quality of life, numerous complications, high mortality and readmission rates [12]. Studies have shown that the high mortality and readmission rates of heart failure patients are related to poor treatment compliance and failure to recognize the early symptoms of heart failure deterioration, which may also be closely related to CI [13]. The association between heart failure and CI was first proposed in an editorial in The Lancet in 1977 with the term "cardiac dementia" [14], suggesting that the aging brain has weakened recovery ability and significantly increased risk of damage when deprived of oxygen, thus leading to cognitive decline due to insufficient blood flow. This study shows that the incidence of heart failure combined with CI is 48%, which is consistent with the results of many studies [15,16,17]. Matsue et al. [18] conducted a survey of 1,180 elderly heart failure patients, and 37.1% of them had CI. However, Gou et al. [19] evaluated heart failure patients over 60 years old, and only 19.7% had CI. Currently, there is no unified diagnostic standard for CI, and there are certain differences in assessment based solely on scales; moreover, factors such as region and culture may also have an impact on the accuracy and applicability of CI assessment, resulting in significant differences in the incidence of heart failure combined with CI. Therefore, investigating the current situation of CI in heart failure patients and exploring and analyzing related risk factors are of great significance for early identification and timely intervention, which is beneficial to the prognosis of the disease and the quality of life of patients.

The broad spectrum of CI ranges from mild CI to dementia. Patients with heart failure and CI have a 3.75 times higher risk of death compared to those without CI [20]. However, the intrinsic mechanism underlying the relationship between heart failure and CI remains unclear. Some studies suggest that reduced cerebral blood flow, systemic inflammation, protein toxicity, and thromboembolism may be the causes of CI in patients with heart failure [21]. Heart failure and CI are mutually influential and difficult to detect [22], making early diagnosis of CI in heart failure patients crucial. In this study, low educational attainment, smoking, and low left ventricular ejection fraction were identified as independent risk factors for CI in heart failure patients. The reasons for this are as follows: (1) Educational attainment: Heart failure patients with lower educational attainment have a higher probability of developing CI. Wleklik et al. [23] investigated 250 heart failure patients using the Mini-Mental State Examination (MMSE) and found that the number of years of education was positively correlated with MMSE scores. For each additional year of education, the MMSE score increased by an average of 0.161 points. In a study by Cheng et al. [24] involving 723 elderly patients, it was found that over half (54%) of the patients with less than 9 years of education had CI, while only 30% of those with longer education periods had CI. This is related to the patient's cognitive reserve, health literacy and disease management ability, social support and psychological factors, etc. [25]. Patients with a higher educational level usually have a richer knowledge reserve and stronger processing ability. Their brains can more

effectively utilize neural networks to compensate for neurodegenerative damage and delay functional decline [26]. At the same time, higher health literacy enables patients to better understand disease information and treatment plans, actively participate in disease management, and effectively control the condition [27]. Therefore, during the admission assessment stage, nursing staff will learn about the patient's educational level and flexibly choose various educational methods such as written materials and popular science videos based on their understanding ability differences to adapt to the cognitive levels of different patients, helping them fully understand disease-related knowledge and improve treatment compliance. They also use patient education meetings and carry out nurse-patient activities to stimulate brain neural activity and slow down cognitive decline. (2) Smoking: The impact of smoking on cognitive function is controversial. Benito-León et al. [28] conducted a three-year follow-up study on 2,624 elderly people and found that smokers had a decrease in MMSE total score of 1.05 to 1.17 points compared to non-smokers. Zhao Yujin [29] conducted a survey on the influencing factors of CI among residents over 60 years old in northern China and found that smoking was a risk factor. However, in some studies, smoking was not associated with cognitive decline [30,31]. The mechanism of smoking and cognitive decline is still unclear at present. However, nicotine in tobacco interferes with the balance of neurotransmitters, leading to memory decline, slow thinking, and increasing the risk of CI [32]. Smoking can cause atherosclerosis, thrombosis, and other conditions, which greatly damage the cardiovascular system. Coupled with the abnormal self-regulation of cerebral blood flow in patients with heart failure, it leads to insufficient cerebral perfusion and CI [33,34]. Therefore, for heart failure patients at risk of CI, they should be guided to quit smoking in a timely manner, and long-term follow-up and out-of-hospital intervention should be carried out in combination with hospital smoking cessation clinics to reduce the occurrence of diseases caused by smoking. (3) Left ventricular ejection fraction: Left ventricular ejection fraction (LVEF) is an important indicator for measuring the heart's pumping function. A decrease in LVEF is a potential risk factor for CI [35]. The results of this study show that the lower the LVEF, the more severe the degree of CI. Militaru et al. [36] investigated 190 patients at high risk of cardiovascular disease and found that left ventricular ejection fraction was negatively correlated with the risk of CI. For every 1% decrease in the score, the risk of CI increased by 7.2%. However, in the study by Faulkner et al. [37] on heart failure patients with preserved ejection fraction, there was no statistical difference in attention, language ability, executive ability, and overall cognitive function between these patients and those with reduced ejection fraction. This may be related to the overlapping of the same pathophysiological mechanisms, comorbidities and risk factors, and the differences in assessment tools may also lead to inconsistent results. The key factor for CI in heart failure is insufficient cerebral perfusion [38]. Reduced cardiac output leads to insufficient blood supply to the brain, which can affect neuronal function over the long term and cause cognitive decline. Constriction, stenosis or abnormal blood flow regulation of cerebral microvessels reduces the oxygen reserve of brain tissue. Even when the overall cerebral blood flow is not significantly reduced, insufficient local microvascular blood supply can also cause neuronal damage and lead to CI [35]. For heart failure patients, in addition to standardized drug treatment and improvement of cardiac function, lifestyle intervention, cognitive training and psychological support are particularly important. They can effectively improve memory, attention and executive ability. In clinical work, appropriate intervention measures should be selected based on the patient's condition and implemented as early as possible to delay the decline in cognitive ability.

In this study, the age, marital status, activities of daily living, disease history, NT-proBNP, NYHA classification and social frailty of heart failure patients had no statistically significant impact on CI. This might be related to the small sample size, insufficient research duration and regional restrictions. In the next step, the sample size will be expanded, and the development of cognitive function levels in heart failure patients will be continuously tracked. A more in-depth study of the relationship between the two and related influencing factors will be conducted to provide a basis for the implementation of assessment work and intervention measures.

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