

Psychosocial adaptation in patients undergoing peripheral blood hematopoietic stem cell transplantation: current status, influencing factors, and mediating effects

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Abstract

Purpose: To investigate the current status of psychosocial adaptation in patients undergoing hematopoietic stem cell transplantation (HSCT), analyze the correlations among related factors and their mediating effects, and provide evidence for clinical nursing psychological interventions.

Methods: A total of 213 patients admitted to the stem cell transplantation center of our hospital for HSCT between January 2024 and June 2025 were enrolled. General information, the Mishel's Uncertainty in Illness Scale, the Medical Coping Modes Questionnaire, and the Connor-Davidson Resilience Scale were collected. Univariate, multivariate, and correlation analyses were performed. The mediating effects of confrontation, avoidance, and acceptance-resignation on the relationship between illness uncertainty and resilience were further tested.

Results: The mean total illness uncertainty score was 80.48 (SD = 14.263). For medical coping styles, the mean scores were 20.25 for confrontation (SD = 5.060; range, 8-32), 14.66 for avoidance (SD = 4.387; range, 7-28), and 8.81 for acceptance-resignation (SD = 3.699; range, 5-20). The mean total resilience score was 63.20 (SD = 12.816). Univariate analysis showed that residence, employment status, educational level, marital status, medical payment method, and monthly per capita family income had statistically significant effects on the total resilience score ($P < 0.05$). Multiple linear regression further confirmed that residence, employment status, educational level, medical payment method, and monthly per capita family income were independent factors associated with resilience. Confrontation was significantly negatively correlated with illness uncertainty, whereas avoidance and acceptance-resignation were significantly positively correlated with illness uncertainty. Illness uncertainty was significantly negatively correlated with resilience. Confrontation was significantly positively correlated with resilience, whereas avoidance and acceptance-resignation were significantly negatively correlated with resilience. Confrontation, avoidance, and acceptance-resignation all showed significant mediating effects between illness uncertainty and resilience. Illness uncertainty could affect resilience directly as well as indirectly through confrontation, avoidance, and acceptance-resignation.

Conclusion: The resilience component of psychosocial adaptation in patients undergoing HSCT was relatively low. Clinical staff should consider patients' general characteristics and psychological assessments, improve resilience, promote optimistic coping with disease, reduce illness uncertainty, and help ensure the smooth completion of the entire transplantation process.

Introduction

Peripheral blood hematopoietic stem cell transplantation (PBSCT) is an effective standardized treatment for a variety of malignant hematologic diseases, some hereditary diseases, and immunodeficiency disorders^[1, 2], and the number of cases continues to increase worldwide^[3]. Various high-dose conditioning regimens used before HSCT may lead to complications such as graft-versus-host disease, severe infection, and bleeding^[4, 5], thereby increasing post-transplant mortality and recurrence. Studies have shown that patients experience different degrees of psychological problems before, during, and after transplantation^[6]. Resilience refers to the ability of individuals to adjust and restore normal psychological status when facing challenges and adversity^[7, 8], and is also known as psychological hardiness or psychological recovery. According to the theoretical framework of resilience^[9], resilience is a modifiable capacity and can be understood as a dynamic process through which individuals adapt to adversity. Patients usually obtain information through internet searches or peer groups, but such information is often fragmented, insufficiently targeted, and lacking in systematic and comprehensive resources. As a result, patients

may worry about transplantation outcomes, and a lack of knowledge often gives rise to illness uncertainty^[10]. Research has shown that whether patients adopt positive coping styles directly affects the adaptation process and outcomes of illness uncertainty. Coping style refers to the cognitive or behavioral strategies individuals adopt when facing frustration or stressful events and includes both positive and negative coping styles^[11]. This study aimed to explore the current status of psychosocial adaptation in patients undergoing HSCT and to analyze the mediating effects of coping styles on related psychological factors, so as to provide evidence for clinical treatment and nursing care aimed at improving psychological status during transplantation.

Materials and methods

1.1 General information

This study was approved by the institutional ethics committee of Ruijin Hospital, Shanghai Jiao Tong University School of Medicine (approval no.2024222). All participants or their legal representatives signed the informed consent form.

A total of 213 patients admitted to the stem cell transplantation center of our hospital for HSCT between January 2024 and June 2025 were enrolled. The inclusion criteria were: (1) voluntary participation with informed consent; (2) a confirmed diagnosis of a hematologic disease; (3) age ≥ 15 years; (4) receiving HSCT; and (5) normal verbal communication ability. The exclusion criteria were: (1) concomitant other malignant tumors; (2) severe organ dysfunction or complications; and (3) pre-existing mental illness. This study was approved by the hospital ethics committee.

1.2 Instruments

1.2.1 General information questionnaire.

This questionnaire was designed according to the purpose of the study and included sex, age, residence, diagnosis, current employment status, educational level, marital status, medical payment method, and monthly per capita family income.

1.2.2 Mishel's Uncertainty in Illness Scale-Adult (MUIS-A)

This scale was developed by Mishel^[12] and translated into Chinese by Xu Shulian et al.^[13]. It includes 25 items in two dimensions, ambiguity and complexity. Each item is rated on a 5-point scale ranging from strongly disagree to strongly agree, with scores from 1 to 5 for each item and a total score of 12–125. According to the total score, illness uncertainty is classified as low (25.0–58.3), moderate (58.4–91.7), or high (91.8–125). A higher score indicates a more severe degree of illness uncertainty. The Chinese version of the scale had a Cronbach's alpha of 0.89 and a content validity of 0.96.

1.2.3 Medical Coping Modes Questionnaire (MCMQ)

This questionnaire was developed by Feifel et al.^[14] and adapted into Chinese by Jiang Qianjin et al.^[15]. It includes 20 items in three dimensions: confrontation, avoidance, and acceptance-resignation. Each item is scored on a 4-point scale. Higher scores on a given dimension indicate a greater tendency to use that coping style. In this study, the Cronbach's alpha coefficients for the three dimensions were 0.890, 0.825, and 0.841, respectively.

1.2.4 Connor-Davidson Resilience Scale (CD-RISC)

The CD-RISC was developed by Connor et al.^[16] in 2003 and translated into Chinese by Zhang Jianxin and Yu Xiaonan^[17]. The original questionnaire contains 25 items scored on a 5-point Likert scale, with higher scores indicating better resilience. The scale includes three factors: tenacity, strength, and optimism. The predictive validity of the CD-RISC for resilience has been widely recognized, and the Cronbach's alpha of the scale was 0.91.

1.3 Data collection

Trained researchers conducted face-to-face questionnaire surveys using standardized instructions. For patients who had difficulty completing the questionnaire independently, appropriate assistance was provided. All questionnaires were collected on the spot and checked for completeness. A total of 220 questionnaires were distributed, 213 valid questionnaires were returned, and the valid response rate was 96.8%.

1.4 Statistical analysis

SPSS 25.0 was used for data analysis. Pearson correlation and multiple linear regression were used to analyze the relationships among resilience, illness uncertainty, and coping styles. A P value < 0.05 was considered statistically significant. Mediation analysis was performed using the PROCESS plugin in SPSS 25.0, and the Bootstrap method was used to test the significance of the mediation effects; P < 0.05 indicated statistical significance.

Results

2.1 General characteristics

Among the 213 valid participants, men accounted for a higher proportion (55.4%), whereas 95 participants were women (44.6%). Participants ranged in age from 15 to 71 years. A total of 176 patients lived in urban areas and 37 in rural areas. Two patients were diagnosed with severe thalassemia, and the remaining patients had malignant hematologic diseases, including leukemia, myeloma, and lymphoma.

2.2 Current status of illness uncertainty, medical coping styles, and resilience among patients undergoing HSCT

The maximum illness uncertainty score in this study was 119, the minimum was 38, and the mean score was 80.48 +/- 14.263. Details of the level classification are shown in Table 1. For medical coping styles, the mean scores of the three dimensions from highest to lowest were confrontation, avoidance, and acceptance-resignation. The maximum resilience score was 86, the minimum was 25, and the mean score was 63.20 +/- 12.816. See Table 2.

Table 1
Descriptive statistics of illness uncertainty levels

Level	Frequency (%)
Low (25-58.3)	15(7)
Moderate (58.4–91.7)	160(75.1)
High (91.8–125)	38(17.8)
Total	213(100)

Table 2
Descriptive statistics for all variables and dimensions

Variable and dimension	N	Minimum	Maximum	Mean (SD)
Ambiguity	213	23	73	48.46(9.43)
Complexity	213	14	50	32.02 (7.89)
Total illness uncertainty score	213	38	119	80.48 (14.26)
Confrontation	213	8	32	20.25 (5.06)
Avoidance	213	7	28	14.66 (4.39)
Acceptance-resignation	213	5	20	8.81 (3.70)
Tenacity	213	12	46	31.16 (6.23)
Strength	213	9	31	22.27 (4.89)
Optimism	213	2	16	9.77 (2.91)
Total resilience score	213	25	86	63.20 (12.82)

2.3 Univariate analysis of resilience

The general characteristics of 213 patients undergoing HSCT were analyzed by univariate analysis of resilience. Residence, employment status, educational level, marital status, medical payment method, and monthly per capita family income all had statistically significant effects on the total resilience score ($P < 0.05$), as shown in Table 3.

Table 3
Results of the univariate analysis of resilience

Background information	Group	N	Mean (SD)	t/F	P
Sex	Male	118	62.31(13.69)	-1.153	0.250
Sex	Female	95	64.31(11.61)	-1.153	0.250
Age	15–19 years	7	72.29(14.16)	1.079	0.376
Age	20–29 years	27	64.04(15.03)	1.079	0.376
Age	30–39 years	35	59.69(14.11)	1.079	0.376
Age	40–49 years	61	63.43(13.27)	1.079	0.376
Age	50–59 years	57	63.82(10.20)	1.079	0.376
Age	60–69 years	25	62.68(12.10)	1.079	0.376
Age	>=70 years	1	63.00(/)	1.079	0.376
Residence	Urban	176	66.48(9.86)	7.941	0.000
Residence	Rural	37	47.57(13.76)	7.941	0.000
Diagnosis	Leukemia	36	58.92(14.24)	2.097	0.102
Diagnosis	Thalassemia	2	65.50(23.34)	2.097	0.102
Diagnosis	Myeloma	33	61.73(14.57)	2.097	0.102
Diagnosis	Lymphoma	142	64.59(11.72)	2.097	0.102
Employment status	Employed	120	66.64(10.36)	21.791	0.000
Employment status	Retired	52	65.25(9.75)	21.791	0.000
Employment status	Unemployed	24	51.50(16.15)	21.791	0.000
Employment status	Student	17	49.12(13.47)	21.791	0.000
Educational level	Junior high school or below	47	54.17(13.34)	20.545	0.000
Educational level	High school or technical secondary school	35	58.80(11.68)	20.545	0.000
Educational level	Junior college	56	64.63(10.76)	20.545	0.000
Educational level	Bachelor's degree	75	69.84(9.31)	20.545	0.000
Marital status	Unmarried	45	60.73(15.71)	6.523	0.002
Marital status	Married	165	64.28(11.36)	6.523	0.002
Marital status	Divorced	3	40.33(19.63)	6.523	0.002
Medical payment method	Self-pay	14	45.93(14.89)	21.458	0.000
Medical payment method	Rural cooperative medical scheme	32	52.34(12.34)	21.458	0.000
Medical payment method	Clinical trial	2	53.50(40.30)	21.458	0.000

Background information	Group	N	Mean (SD)	t/F	P
Medical payment method	Urban basic insurance	157	66.22(9.34)	21.458	0.000
Medical payment method	Public expense	2	74.00(7.07)	21.458	0.000
Medical payment method	Commercial insurance	6	81.83(3.06)	21.458	0.000
Monthly per capita family income	< 3000 RMB	31	52.90(17.14)	25.568	0.000
Monthly per capita family income	3000–6000 RMB	112	61.94(10.35)	25.568	0.000
Monthly per capita family income	6000–10000 RMB	53	66.15(9.41)	25.568	0.000
Monthly per capita family income	> 10000 RMB	17	81.06(3.13)	25.568	0.000

2.4 Multiple linear regression analysis of resilience

This study further explored the factors associated with resilience in patients undergoing HSCT. The results showed that residence, employment status, educational level, medical payment method, and monthly per capita family income were independent factors associated with resilience ($P < 0.05$), as shown in Table 4.

Table 4
Multiple linear regression analysis

Predictor	B	SE	Beta	t	P
Constant	53.222	7.416		7.177	0.000
Residence	-7.094	2.716	-0.210	-2.612	0.010
Current employment status	-2.219	0.823	-0.166	-2.698	0.008
Educational level	1.590	0.720	0.144	2.209	0.028
Marital status	1.673	1.562	0.056	1.071	0.286
Medical payment method	2.348	1.037	0.195	2.265	0.025
Monthly per capita family income	2.808	1.023	0.176	2.744	0.007
R ²	0.464				
Adjusted R ²	0.448				
F	29.727 ($P < 0.001$)				

2.5 Correlations among illness uncertainty, medical coping styles, and resilience in patients undergoing HSCT

In patients undergoing HSCT, the confrontation dimension of medical coping was significantly negatively correlated with illness uncertainty, whereas the avoidance and acceptance-resignation dimensions were significantly positively correlated with illness uncertainty. Confrontation was significantly positively correlated with resilience, whereas avoidance and acceptance-resignation were both significantly negatively correlated with resilience. Illness uncertainty was significantly negatively correlated with resilience. See Tables 5–7.

Table 5
Correlation analysis between illness uncertainty and medical coping styles

Variable	Ambiguity	Complexity	Total illness uncertainty	Confrontation	Avoidance	Acceptance-resignation
Ambiguity	1					
Complexity	.351**	1				
Total illness uncertainty	.855**	.786**	1			
Confrontation	– .369**	– .431**	– .483**	1		
Avoidance	.364**	.313**	.413**	– .519**	1	
Acceptance-resignation	.349**	.180**	.330**	– .443**	.687**	1

Note: * $P < 0.05$, ** $P < 0.01$.

Table 6
Correlation analysis between medical coping styles and resilience

Variable	Confrontation	Avoidance	Acceptance-resignation	Optimism	Strength	Tenacity	Total resilience score
Confrontation	1						
Avoidance	– .519**	1					
Acceptance-resignation	– .443**	.687**	1				
Optimism	.591**	– .542**	– .513**	1			
Strength	.605**	– .523**	– .438**	.738**	1		
Tenacity	.657**	– .499**	– .475**	.703**	.766**	1	
Total resilience score	.684**	– .565**	– .514**	.850**	.921**	.938**	1

Note: * $P < 0.05$, ** $P < 0.01$.

Table 7
Correlation analysis between illness uncertainty and resilience

Variable	Ambiguity	Complexity	Total illness uncertainty	Optimism	Strength	Tenacity	Total resilience score
Ambiguity	1						
Complexity	.351**	1					
Total illness uncertainty	.855**	.786**	1				
Optimism	– .417**	– .360**	– .475**	1			
Strength	– .342**	– .381**	– .437**	.738**	1		
Tenacity	– .343**	– .400**	– .447**	.703**	.766**	1	
Total resilience score	– .391**	– .422**	– .492**	.850**	.921**	.938**	1

Note: * $P < 0.05$, ** $P < 0.01$.

2.6 Mediating effects of medical coping styles on the relationship between illness uncertainty and resilience

Taking illness uncertainty as the independent variable, confrontation, avoidance, and acceptance-resignation as the mediating variables, and resilience as the dependent variable, mediation analysis showed that illness uncertainty could directly and significantly negatively predict resilience. At the same time, illness uncertainty significantly negatively predicted confrontation and significantly positively predicted avoidance and acceptance-resignation.

After the three dimensions of medical coping were included as mediators, the explanatory power of the regression model increased substantially to 55.8%, and the direct effect of illness uncertainty on resilience was significantly attenuated but remained statistically significant. Confrontation significantly positively predicted resilience, whereas avoidance and acceptance-resignation significantly negatively predicted resilience. In the confrontation-mediated pathway (illness uncertainty → confrontation → resilience), the indirect effect was – 0.200, and the corresponding 95% confidence interval did not include 0, indicating a significant indirect effect. In the avoidance-mediated pathway (illness uncertainty → avoidance → resilience), the indirect effect was – 0.059, and the corresponding 95% confidence interval did not include 0, indicating a significant indirect effect. In the acceptance-resignation-mediated pathway (illness uncertainty → acceptance-resignation → resilience), the indirect effect was – 0.045, and the corresponding 95% confidence interval did not include 0, indicating a significant indirect effect. See Tables 8 and 9.

Table 8

Test of the mediating effects of medical coping styles on the relationship between illness uncertainty and resilience

Outcome variable	Predictor	R	R ²	F	Beta	Bootstrap lower limit	Bootstrap upper limit	t
Resilience	Illness uncertainty	0.492	0.242	67.317***	-0.442	-0.548	-0.336	-8.205***
Confrontation	Illness uncertainty	0.483	0.233	64.029***	-0.171	-0.213	-0.129	-8.002***
Avoidance	Illness uncertainty	0.413	0.171	43.457***	0.127	0.089	0.165	6.592***
Acceptance-resignation	Illness uncertainty	0.330	0.109	25.837***	0.086	0.052	0.119	5.083***
Resilience	Illness uncertainty	0.747	0.558	65.719***	-0.138	-0.234	-0.043	-2.858**
Resilience	Confrontation	0.747	0.558	65.719***	0.681	0.879	1.457	7.970***
Resilience	Avoidance	0.747	0.558	65.719***	-0.464	-0.856	-0.072	-2.335*
Resilience	Acceptance-resignation	0.747	0.558	65.719***	-0.520	-0.957	-0.082	-2.341*

Note: * $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$.

Table 9
Bootstrap analysis of mediation effects

Effect type	Effect pathway	Effect value	Bootstrap SE	BootCI lower limit	BootCI upper limit
Total effect	Illness uncertainty -> resilience	-0.442	0.054	-0.548	-0.336
Direct effect	Illness uncertainty -> resilience	-0.138	0.048	-0.234	-0.043
Indirect effect	Illness uncertainty -> confrontation -> resilience	-0.200	0.033	-0.265	-0.136
Indirect effect	Illness uncertainty -> avoidance -> resilience	-0.059	0.027	-0.116	-0.012
Indirect effect	Illness uncertainty -> acceptance-resignation -> resilience	-0.045	0.026	-0.107	-0.006

Discussion

3.1 Current status of illness uncertainty, medical coping styles, and resilience among patients undergoing HSCT

This study showed that 7% of patients undergoing HSCT were in the low illness uncertainty group, 75.1% were in the moderate group, and 17.8% were in the high group. The moderate level accounted for the largest proportion, and the

mean total illness uncertainty score was 80.48 +/- 14.263, which was lower than that reported by Shi Nan et al.^[18]. This may be related to the lengthy hospitalization required for HSCT, the complex and variable complications, the many unknown situations patients need to face, and the continued need for professional and meticulous nursing guidance after discharge.

In terms of medical coping styles, the mean scores were 20.25 +/- 5.060 for confrontation (range, 8–32), 14.66 +/- 4.387 for avoidance (range, 7–28), and 8.81 +/- 3.699 for acceptance-resignation (range, 5–20). Confrontation had the highest mean score and acceptance-resignation had the lowest. This suggests that even when facing the complex and highly variable treatment process of transplantation, patients still maintain expectations for favorable treatment outcomes and a better life, do not readily surrender to the setbacks of illness, and are still able to face treatment in a relatively calm manner. This finding is consistent with that of Wu Yanli et al.^[19].

For resilience and its dimensions, the mean total score was 63.20 +/- 12.816, with a range of 25–86. Tenacity had the highest mean score, whereas optimism had the lowest. Compared with the findings of Wang Miaomiao et al.^[20], the score in the present study was slightly lower. This may be attributable to the long hospitalization period, the inability of family members to visit or accompany patients, high-dose chemotherapy or radiotherapy during pre-transplant conditioning, and a series of adverse reactions such as nausea, vomiting, and gastrointestinal symptoms, together with subsequent complications. These ongoing challenges continuously test patients' physical and psychological limits, leading to more anxiety, fear, and other negative emotions, poorer psychological status, and lower resilience.

3.2 Analysis of general factors influencing resilience

The univariate analysis of demographic characteristics showed that residence, employment status, educational level, marital status, medical payment method, and monthly per capita family income all had statistically significant effects on the total resilience score ($P < 0.05$). Specifically, the mean resilience score of urban participants was 66.48, significantly higher than the 47.57 observed in rural participants. This difference may be related to structural disparities between urban and rural areas in medical resource allocation, social support systems, and economic pressure. Studies have shown that rural patients face many challenges in using medical services during recovery, such as uneven distribution of medical resources, insufficient rehabilitation and follow-up services, and low coverage of health education^[21, 22], which may explain their lower resilience scores. Regarding current employment status, employed and retired patients had significantly higher mean resilience scores than unemployed patients and students, possibly because employment or retirement plays an important role in promoting social connection and maintaining economic independence^[23], thereby increasing patients' sense of psychological security. With respect to educational level, the mean resilience score increased with higher educational attainment, which may be because patients with higher education better understand and accept disease treatment, rehabilitation, and health education. For marital status, married participants had higher resilience scores than unmarried and divorced participants ($F = 6.523$, $P = 0.002 < 0.01$), and stable caregivers and supporters in the married group are important sources of psychosocial support^[24]. In terms of medical payment method, the commercial insurance group had the highest mean score (81.83), whereas the self-pay group had the lowest (45.93) ($F = 21.458$, $P = 0.000 < 0.001$). Regarding monthly per capita family income, resilience scores increased with income, with the highest mean score in the > 10000 RMB group and the lowest in the < 3000 RMB group ($F = 25.568$, $P = 0.000 < 0.001$). One possible explanation is that high financial toxicity increases anxiety and depression, reduces treatment adherence, and lowers quality of life^[25, 26]. Therefore, patients with better medical coverage and higher monthly per capita family income tended to have higher resilience scores.

3.3 Correlations among illness uncertainty, medical coping styles, and resilience, and test of mediation effects

Correlation analysis in this study showed that illness uncertainty was significantly negatively correlated with resilience ($r = -0.492$, $P < 0.01$), indicating that the greater the uncertainty patients experienced regarding prognosis, the treatment process, and complications, the poorer their psychological adjustment and stress resistance. This finding is consistent with previous research^[18]. At the same time, the confrontation dimension of medical coping was significantly positively correlated with resilience ($r = 0.684$, $P < 0.01$), whereas avoidance and acceptance-resignation were significantly negatively correlated with resilience ($r = -0.565$ and -0.514 , respectively, $P < 0.01$). These findings suggest that positive coping strategies help patients maintain psychological stability in adversity, whereas negative coping exacerbates psychological depletion.

To further clarify the pathways among variables, mediation analysis was performed. The results showed that illness uncertainty not only directly negatively predicted resilience (direct effect = -0.138 , $P < 0.05$) but also indirectly affected resilience through three coping styles. The specific mechanisms were as follows:

Mediating effect of confrontation (effect value – 0.200, accounting for 45.2%)

Illness uncertainty significantly negatively predicted confrontation ($\beta = -0.171$, $P < 0.001$), and confrontation significantly positively predicted resilience ($\beta = 0.681$, $P < 0.001$). This indicates that when patients lack disease-related information and are unable to anticipate the course of treatment, their willingness to actively confront the disease tends to decline, which in turn reduces their tendency to seek support and solve problems proactively, ultimately leading to lower resilience. In other words, confrontation is a key pathway through which patients transform fear of the unknown into the power to act.

Mediating effect of avoidance (effect value – 0.059, accounting for 13.3%)

Illness uncertainty significantly positively predicted avoidance ($\beta = 0.127$, $P < 0.001$), and avoidance significantly negatively predicted resilience ($\beta = -0.464$, $P < 0.05$). This indicates that when patients feel unable to control the disease, they are more likely to adopt avoidant responses, such as refusing to discuss their condition or avoiding treatment-related topics. Although this psychological defense mechanism may relieve anxiety in the short term, in the long term it causes patients to miss opportunities for psychological adjustment and social support, thereby further weakening resilience.

Mediating effect of acceptance-resignation (effect value – 0.045, accounting for 10.2%)

Illness uncertainty significantly positively predicted acceptance-resignation ($\beta = 0.086$, $P < 0.001$), and acceptance-resignation significantly negatively predicted resilience ($\beta = -0.520$, $P < 0.05$). This indicates that excessive illness uncertainty can create a sense of helplessness and leaving things to fate, leading patients to give up active coping. Such a negative mindset directly aggravates psychological vulnerability.

Overall, this study found that medical coping styles played partial mediating roles in the relationship between illness uncertainty and resilience. Among them, confrontation showed the strongest mediation effect (45.2% of the total effect) and should be a key protective factor in psychological interventions, whereas avoidance and acceptance-resignation were risk pathways that amplified the detrimental effect of illness uncertainty on resilience. These findings suggest that while reducing illness uncertainty, healthcare professionals should also pay attention to guiding coping styles. Information provision alone may not directly improve resilience; rather, cognitive-behavioral

interventions, psychological counseling, and similar approaches are needed to help patients shift from avoidance or acceptance-resignation toward confrontation, thereby enhancing resilience and psychosocial adaptation throughout the transplantation process.

Conclusion

During hospitalization and throughout the recovery period, care for patients undergoing HSCT should extend beyond basic medical treatment to include focused attention on both their general circumstances and psychological status. Therefore, clinical nursing should emphasize the following aspects: (1) Strengthening psychological assessment and intervention: resilience, illness uncertainty, and coping styles should be incorporated into the routine psychological assessment system for transplant patients so that high-risk individuals can be identified early and individualized intervention plans can be developed to improve psychological adaptation. (2) Building a multilevel information support system: in response to patients' needs for disease-related information, healthcare professionals should provide systematic, scientific, and easy-to-understand educational materials and organize special lectures or peer support groups to help patients correctly understand the disease and treatment process and reduce illness uncertainty. (3) Strengthening family and social support: family members should be encouraged to participate in psychological care, especially during critical transplantation periods, by providing emotional support and companionship. At the same time, attention should be paid to the psychological needs of vulnerable groups such as patients from rural areas, those with low income, and those who are unemployed, and multiple channels of social support, such as volunteer services and psychological hotlines, should be explored. (4) Improving the psychological care capacity of healthcare professionals: psychological nursing knowledge should be incorporated into continuing education and specialty training for hematology nurses to enhance their ability to identify, communicate with, and intervene in patients' psychological problems and to create a supportive care environment. (5) Promoting multidisciplinary collaboration: a multidisciplinary team composed of physicians, nurses, psychologists, nutritionists, and social workers should be established to participate in the whole process of patient care and comprehensively improve psychosocial adaptation. Because this study was conducted in a single center with a limited sample size, it has certain limitations. Future studies should include patients from multiple centers, expand the sample size, and conduct multicenter longitudinal research to explore more effective psychological intervention strategies and provide stronger evidence for clinical practice.

Additionally, incorporating diverse demographic variables—such as age, gender, socioeconomic status, and cultural background—will enhance the generalizability of findings. Standardized assessment tools and consistent intervention protocols across sites are essential to ensure data reliability. Longitudinal tracking will clarify long-term outcomes and identify critical intervention windows. Integrating qualitative feedback from participants can further refine strategy relevance and acceptability. These refinements will collectively strengthen the translational value of psychological interventions in real-world clinical settings.

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Declarations

Author Contribution

Author Contributions Conceptualization: Lindi Zhao, Yan Shen, Shan Gao; Methodology: Lindi Zhao, Yan Shen; Data curation: Yan Shen, Lindi Zhao; Validation: Lindi Zhao, Shan Gao, Liyuan Qin; Formal analysis: Lindi Zhao, Yan Shen;

Investigation: Lindi Zhao, Yan Shen, Shan Gao; Data acquisition: Lindi Zhao, Yan Shen; Data management and maintenance: Lindi Zhao, Yan Shen, Shan Gao; Writing – original draft: Lindi Zhao, Yan Shen; Writing – review & editing: Lindi Zhao, Shan Gao, Liyuan Qin; Visualization: Lindi Zhao, Shan Gao, Liyuan Qin; Supervision: Lindi Zhao, Shan Gao, Liyuan Qin; Project administration: Lindi Zhao, Shan Gao, Liyuan Qin, Yang He; Funding acquisition: Lindi Zhao, Shan Gao, Liyuan Qin, Yang He. All authors read and approved the final manuscript, and are jointly responsible for the authenticity and accuracy of the research findings.

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