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ORIGINAL RESEARCH

Association Between Depressive Symptoms and Blood Biomarkers in Adult Hospitalized Patients: A Multicenter Analysis Across Hospital Districts in Luzhou, China

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Objective: The aim of this study was to investigate the depressive symptoms of patients hospitalized in different hospitals and to further analyze the correlation between depressive symptoms and blood biomarker.

Methods: This is a large-scale, multicenter cross-sectional study conducted in Luzhou, China. A total of 149554 inpatients from January 2022 to December 2023 in our hospital's Wellness Center Hospital District, Zhongshan Hospital District, and Comprehensive Ward were selected for the study. *t*-test, chi-square test and Pearson correlation analysis were used to explore associations between depressive symptoms and blood biomarker, age and gender.

Results: The levels of depressive symptoms were 8.25 for patients in the Zhongshan Campus, 8.45 in the Health Center Campus, and 8.05 in the Other Campuses. In terms of blood biomarker, we found a positive correlation between depressive symptoms and lactate dehydrogenase (LDH) levels ($r = 0.425$, $P < 0.01$). In addition, thyrotropin (TSH) levels were also positively correlated with depressive symptoms ($r = 0.352$, $P = 0.024$). Regarding gender, the depressive symptoms were slightly higher in female patients (11.25) than in male patients (8.35%), but this difference was not statistically significant ($P = 0.053$). Age was positively correlated with depressive symptoms, with younger patients having a relatively better psychological state, whereas the prevalence of depressive symptoms increased with age, especially in the older age groups.

Conclusion: There were significant differences in the prevalence of depressive symptoms among hospitalized patients in different hospital districts, and depressive symptoms showed correlation with a variety of blood biomarker. More systematic psychological assessment and intervention should be conducted for high-risk patients, especially elderly female patients.

Keywords: hospitalized patients, depressive symptoms, psychological assessment, blood biomarker, clinical psychological intervention

Introduction

With the development of society and the improvement of living standards, mental health issues are receiving increasing attention globally. According to statistics from the World Health Organization (WHO), depression has become one of the high-burden mental illnesses worldwide, affecting about 3.8% of the population.[1] This statistic not only reflects the widespread nature of depression but also highlights the far-reaching impact of this type of mental health problem. Many patients who suffer from depression often experience a significant decline in quality of life and impaired social functioning, which further affects their daily lives, ability to work, and interpersonal relationships.[2] Therefore, the prevention and intervention of depression has become a major challenge for public health today.

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The hospitalized patient population, due to the severity of their illnesses and the specificity of long-term hospitalization, generally has poorer mental health and a relatively higher incidence of depressive symptoms. This phenomenon is not only related to the nature and duration of the illnesses suffered by the patients but is also affected the hospital environment.[3] Studies have shown that the prevalence of depressive symptoms is significantly higher in hospitalized patients than in the general population.[4–7] For different types of diseases, the mental health challenges faced by patients are unique. For instance, cardiovascular disease patients exhibit 2–3 times higher depression rates, often linked to chronic disease management and lifestyle adjustments.[5,8] Similarly, cancer and psychiatric patients face exacerbated psychological distress during hospitalization due to treatment side effects and isolation.[4,9–11] In addition, as age increases, the physical function of elderly patients gradually declines, the chance of hospitalization increases, and they face more challenges in terms of mental health.[12,13] Mental health problems faced by hospitalized patients vary across diseases, but psychological challenges such as depressive symptoms are common. Therefore, systematic depressive symptoms assessment of hospitalized patients not only helps to improve their mental health but also provides important clinical guidance and support.[14]

Currently, depressive symptoms have been increasingly linked to blood biomarkers.[15] Despite these insights, systematic data on depressive symptoms in the hospital setting and their association with blood biomarkers remain limited. In this context, we conducted a large-scale multicenter cross-sectional survey in Luzhou, China, aiming to investigate the depressive symptoms of patients hospitalized in different hospitals and to further analyze the correlation between depressive symptoms and blood biomarkers.

Materials and Methods

Study Subjects

This is a large-scale, multicenter cross-sectional study conducted in Luzhou, China. Patients who received inpatient treatment in our hospital's Wellness Center Campus, Zhongshan Campus and other hospitals during the period from January 2022 to December 2023 were selected as the study subjects. A total of 146,718 patients' depressive symptoms data were included. This study was approved by the Ethics Committee of the Affiliated Hospital of Southwest Medical University. All methods were carried out in accordance with the Declaration of Helsinki.

Inclusion and Exclusion Criteria

Inclusion criteria: hospitalized patients were 18 years old and above; agreed to participate in this study and signed an informed consent form; had a complete record of psychological assessment and blood biomarker data during their hospitalization; and received a depressive symptom assessment (SDS) within the collection timeframe.

Exclusion criteria: patients who were currently in acute psychotic episode or manic phase; patients who had a history of major psychological trauma or a history of related diseases in the last 6 months; patients with a combination of serious physical illnesses, such as malignant tumors, end-stage organ failure, etc.; and patients who did not complete the relevant questionnaires or blood tests during the assessment process.

Research Methods

In this study, the Self-Rating Depression Scale (SDS) was used to assess patients' depressive symptoms. SDS is a self-assessment scale containing 20 items, which each item scores 0–3 points. Higher scores indicated higher depressive symptoms. SDS has been widely used in Chinese adults.[16] At the same time, the patient's blood biomarker data were collected, including LDH, TSH and white blood cell count, among others. These blood biomarker can be used as biomarkers of depressive symptoms and correlated with the patient's psychological state. All data is collected by medical professionals and recorded by the hospital. The illustrative of hospital procedures in this study is shown in Figure 1.

Statistical Methods

Data were analyzed using SPSS 26.0 statistical software. Measurement data were expressed as mean ± standard deviation ($\bar{X} \pm S$), and *t*-test was used for comparison between groups; count data were expressed as percentage, and chi-square

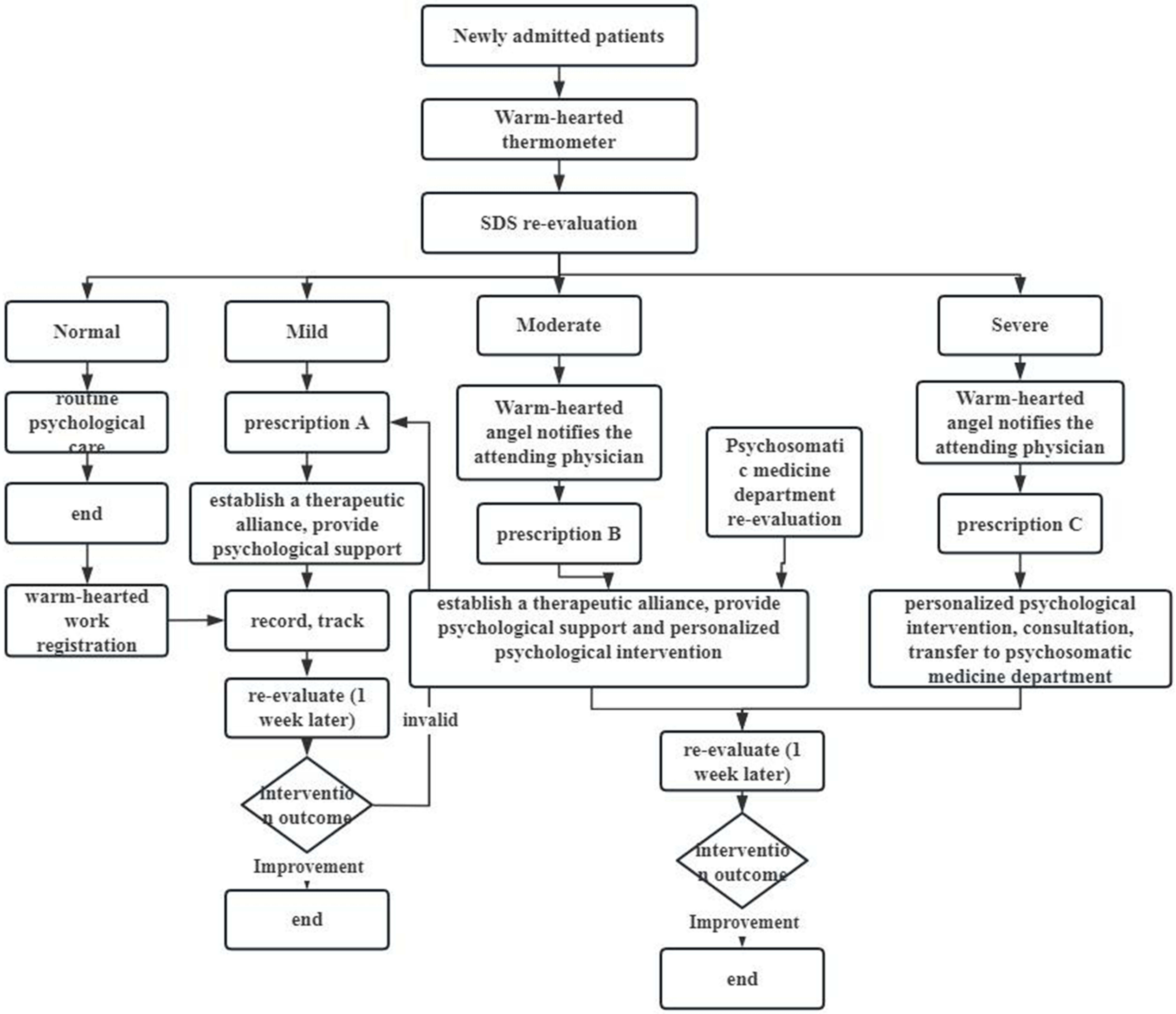

Figure 1 Illustrative of hospital procedures.

test was used for comparison. Pearson correlation analysis was used to explore associations between depressive symptoms and blood biomarker, age and gender, and categorical variables were set as dummy variables for analysis. P-value <0.05 was considered statistically significant. For multiple comparisons.

Results

General Statistics of Patients

There were 75,372 male patients and 71,376 female patients. There were 105,460 patients in Zhongshan Hospital, 34,695 patients in Kangjian Center Hospital, and 6,563 patients in other hospitals. Zhongshan Hospital had the most patients, and the patients in Kangjian Center Hospital had the highest SDS score.

The ward with the largest sample size was the Department of Cardiovascular Medicine, accounting for 5.11% of the total sample, followed by the Department of Oncology and the Department of Respiratory and Critical Care Medicine, accounting for 2.45% and 2.94%, respectively. The SDS score showed an overall high trend, with an average of about 15.40. Among them, the top five wards with the highest SDS scores were the Department of Rheumatology and Immunology, the Department of Neurology, the Department of Neurosurgery, the Department of Oncology, and the Department of Nephrology. See Table 1.

Table 1 General Information of Study Subjects (n=146718)

Ward Name	Number OF Patients	Percentage (%)	SDS score
Different campuses			
Zhongshan campus	105460	71.88%	15.75±4.50
Health Center campus	34695	23.65%	15.90±4.35
Other campuses	6563	4.47%	15.55±4.45
Different wards			
PICU Ward	2	0.00%	14.21 ± 4.02
Obstetrics Ward	4,755	1.62%	15.43 ± 4.28
Otorhinolaryngology, Head and Neck Surgery Ward	4,336	1.48%	15.37 ± 4.32
Rheumatology and Immunology Ward	2,488	0.85%	15.76 ± 4.49
Gynecology Ward	3,927	1.34%	15.24 ± 4.16
Hepatobiliary Surgery Ward	940	0.32%	15.58 ± 4.37
Infectious Respiratory Surgery Ward	5,785	1.97%	15.12 ± 4.04
Infectious Gastroenterology Ward	1,287	0.44%	15.34 ± 4.26
Orthopedics Ward	4,816	1.64%	15.41 ± 4.29
Nuclear Medicine Isotope Ward	102	0.03%	15.07 ± 3.98
Respiratory and Critical Care Medicine Ward	8,614	2.94%	15.19 ± 4.08
Emergency Medicine Ward	3,495	1.19%	14.93 ± 3.87
Spine Surgery Ward	3,765	1.28%	15.36 ± 4.27
Thyroid Surgery Ward	1,734	0.59%	15.46 ± 4.31
Rehabilitation Medicine Ward	8,530	2.91%	15.67 ± 4.48
Oral and Maxillofacial Surgery Ward	1,004	0.34%	15.56 ± 4.36
Geriatrics Surgery Ward	862	0.29%	15.82 ± 4.53
Urology Surgery Ward	3,943	1.34%	15.27 ± 4.18
Endocrinology Ward	3,454	1.18%	15.59 ± 4.38
Dermatology Ward	3,471	1.18%	15.44 ± 4.34
General Medicine Ward	994	0.34%	15.47 ± 4.32
Emergency Day Surgery Ward	1,759	0.60%	15.32 ± 4.24
Day Surgery Center Ward	2,016	0.69%	15.39 ± 4.29
Breast Surgery Ward	1,619	0.55%	15.48 ± 4.33
Neurology Ward	7,793	2.66%	15.94 ± 4.57
Neurosurgery Ward	6,113	2.08%	15.92 ± 4.56
Nephrology Ward	3,046	1.04%	15.73 ± 4.47
Pain Medicine Ward	1,369	0.47%	15.72 ± 4.46
Surgical Complex Ward	1,714	0.58%	15.49 ± 4.34
Gastrointestinal Surgery Ward	4,820	1.64%	15.43 ± 4.30
Gastroenterology Ward	6,167	2.09%	15.54 ± 4.35
Psychosomatic Medicine Ward	8	0.00%	16.28 ± 4.72
Cardiac Surgery Ward	1,425	0.48%	15.64 ± 4.44
Cardiovascular Medicine Ward	14,992	5.11%	15.68 ± 4.41
Thoracic Surgery Ward	3,728	1.27%	15.38 ± 4.28
Vascular Surgery Ward	2,329	0.79%	15.57 ± 4.37
Hematology Ward	3,211	1.10%	15.58 ± 4.37
Ophthalmology Ward	7,634	2.59%	15.42 ± 4.30
Plastic and Burn Surgery Ward	732	0.25%	15.26 ± 4.17
Poisoning Rescue Center Ward	3	0.00%	14.16 ± 3.96
Chinese Medicine Ward	2,254	0.77%	15.48 ± 4.33
Oncology	7,185	2.45%	15.79 ± 4.49
Critical Care Medicine	60	0.02%	14.54 ± 3.99
Comprehensive Ward	14	0.00%	14.91 ± 3.85
Other Wards	8,476	2.89%	15.43 ± 4.30

Comparison of SDS Scores and Blood Biomarker in Different Hospital Districts

The average SDS score in the health center campus was the highest. Zhongshan Campus followed closely, while the remaining campuses had the lowest scores. There was a statistically significant difference in the severity of depressive symptoms between different hospitals (P=0.032). Among the individual scores, only "I don't sleep well at night" and "I eat as much as usual" have statistically significant differences (P<0.05). The other individual scores have no differences between different hospital districts. It is not significant (P>0.05). Among the blood biomarker, only total bilirubin has a statistically significant difference between different hospital areas (P<0.05). See Table 2 and Supplementary Table 1.

Correlation Between Psychological Scores SDS and Age/Sex

The mean SDS score for the young group (18–29 years) group was 3.62 with a standard deviation of 3.12. The mean SDS score for the young and middle-aged group (30–39 years) group was 6.52 with a significant increase in the standard deviation to 5.62. The mean SDS score for the middle-aged group (40–49 years) group increased further to 9.85 with a standard deviation of 5.84. The quasi-elderly group (50–59 years) group had a mean SDS score of 10.52 with a standard deviation of 6.52. In the older age group (60–69 years) group, the mean SDS score reached 12.85 with a standard deviation of 6.42. The senior age group (70 years and above) group had the highest mean SDS score of 15.21 with a standard deviation of 7.14. Although the mean SDS scores were higher for females than males and the correlation between scores and gender was stronger for females than for males, the overall results showed that they were not statistically significant (p > 0.05), see Table 3.

Correlation Between Psychological Score SDS and Blood Biomarker

Lactate dehydrogenase (LDH) showed a significant positive correlation with SDS scores (r = 0.425, P < 0.01). Thyrotropin (TSH) showed a significant positive correlation (r = 0.352, P = 0.024). Furthermore, total cholesterol showed a non-significant positive correlation, although its P value was close to 0.05 (r = 0.341, P = 0.051). See Table 4.

Table 2 Comparison of SDS Scores in Different Hospital Districts

Statistical Indicators	Zhongshan Campus (n=105460)	Health Center Campus (n=34695)	Other Campuses (n=6563)	F value	P value
Average SDS score	8.25 ± 4.50	8.45 ± 4.35	8.05 ± 4.45	3.854	0.032
Distribution of SDS scores					–
I do not sleep well at night	1.45 ± 0.85	1.52 ± 0.92	1.38 ± 0.78	2.141	0.047
I eat as much as usual	0.55 ± 1.25	0.62 ± 1.42	0.48 ± 1.18	2.118	0.045
Blood indicators					
Total bilirubin (μmol/L)	15.54 ± 4.56	16.34 ± 4.87	14.76 ± 4.12	3.254	0.032

Table 3 Correlation Between Psychological Scores SDS and Age/Sex

		Average SDS Score	Standard Deviation	r-value	P-value
Age group (years)	18-29	3.62	3.12	0.314	<0.01
	30-39	6.52	5.62	0.355	<0.01
	40-49	9.85	5.84	0.474	<0.01
	50-59	10.52	6.52	0.456	<0.01
	60-69	12.85	6.42	0.521	<0.01
	70+	15.21	7.14	0.552	<0.01
Sex	Male	8.35	4.52	−0.152	0.103
	Female	11.25	3.96	0.152	0.053

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Table 4 Correlations Between Psychological Score SDS and Blood Indices

Indicator	Average SDS Score	(Statistics) Standard Deviation	r-value	P-value
Direct bilirubin(μmol/L)	2.34	0.86	0.155	0.214
Aspartate aminotransferase(AST,U/L)	29.43	7.98	−0.251	0.151
Total cholesterol(mmol/L)	4.67	0.89	0.341	0.051
Triglycerides(mmol/L)	1.32	0.52	0.222	0.152
Lymphocyte count (x10^9/L)	2.34	0.54	−0.181	0.252
Thyrotropin (TSH, mIU/L)	1.85	0.46	0.352	0.024
Platelet count (x10^9/L)	256.34	34.56	−0.121	0.314
Lactate dehydrogenase(LDH,U/L)	215.65	22.56	0.425	<0.01

Discussion

The results of the study showed that there were significant differences in the prevalence of depressive symptoms among hospitalized patients in different hospital districts. This may be related to the types of diseases admitted to the hospital districts, the characteristics of the patient population, the allocation of medical resources, and the culture and environment of the hospital districts. For example, the highest prevalence of depressive symptoms in Zhongshan Hospital District may be related to its higher number of elderly patients admitted, as elderly patients tend to face more physical and psychological challenges. In addition, healthcare resources and professional staffing between hospital districts may have influenced patients' depressive symptoms.

Association Between Depressive Symptoms and Blood Biomarkers

In this study, the most robust findings in this study were the significant correlations between depressive symptoms (SDS scores) and two biomarkers: lactate dehydrogenase (LDH) ($r = 0.425$, $P < 0.01$) and thyrotropin (TSH) ($r = 0.352$, $P = 0.024$). Previous studies have shown that elevated LDH levels are usually associated with body tissue damage, hemolysis, or neoplasia, which may increase an individual's psychological burden and thus affect the level of depressive symptoms.[17] Similarly, thyrotropin (TSH) showed a significant positive correlation with SDS scores, which may imply that changes in thyroid function also affect depressive symptoms. TSH function is related to short- and long-term brain changes, including neuronal plasticity processes, angiogenesis, and neurogenesis in adults,[18] and these alterations are related to depressive symptoms.[19,20] In addition, patients with hypothyroidism have been described to present with features such as energy loss and fatigue, which are also diagnostic criteria for depressive symptoms.[21] While total cholesterol showed a positive correlation ($r = 0.341$, $P = 0.051$), its non-significance limits interpretability, especially given inconsistent prior findings.[22] Methodological and sample heterogeneity (eg, age and diet) may underlie these discrepancies. Future studies should prioritize clinically diagnosed depression and longitudinal designs to clarify causal relationships, particularly for LDH and TSH, which emerged as promising biomarkers.

Association Between Depressive Symptoms and Age

The mean SDS score of the young group (18–29 years old) was 3.62 with a standard deviation of 3.12, indicating that the depressive symptoms of this age group was relatively good and less fluctuating, and the incidence of depressive symptoms was lower. The mean SDS score of the middle-aged group (30–39 years old) was 6.52, with a significant increase in standard deviation to 5.62, showing an increase in depressive symptoms, which may be related to occupational stress, family responsibilities and other factors common in this age group.[23] The mean SDS score for the middle-aged group (40–49 years old) further increased to 9.85 with a standard deviation of 5.84, suggesting that depressive symptoms begin to be more prominent at this stage and may be related to the increase in factors such as stress in life and work, and health problems. The mean SDS score for the quasi-elderly group (50–59 years old) was 10.52 with a standard deviation of 6.52, showing a trend of increased depressive symptoms and greater volatility, possibly reflecting problems of life adaptation and health concerns at the stage of entering middle and old age.[24] In the older age group (60–69 years old), the mean SDS score reached 12.85 with a standard deviation of 6.42, indicating that this age group faced greater depressive symptoms, which may be related to life adjustment, reduced social support, and declining health after retirement. The highest mean SDS score of 15.21 with a standard deviation of 7.14 was found in the senior age group (70 years and above), further confirming the severity of depressive symptoms among the elderly population, with possible causes including physical health problems, loneliness, and declining social mobility.[25] In a meta-analysis, Cuijpers et al[26] assessed the psychological status and treatment effects of depressive symptoms in different age groups and showed that the mean effect sizes of depressive symptoms were significantly lower in children and adolescents than in middle-aged adults, significantly larger in young adults than in middle-aged adults, and no significant differences in effect sizes were found between older adults and the elderly, similar to the results of the present study. Overall, it can be seen from the table that SDS scores gradually increase with age, suggesting a possible subsequent decline in patients' depressive symptoms. This trend demonstrates the differences in depressive symptoms risks faced by different age groups and suggests that when targeting different age groups, appropriate mental health interventions need to be developed to better support the mental health of patients of all ages.

Association Between Depressive Symptoms and Sex

The present study showed that although the mean SDS scores for females (11.25) were higher than males (8.35) and the gender correlation of the scores for females was stronger ($r = 0.152$, $P = 0.053$), the overall results did not reach statistical significance ($P > 0.05$). This is inconsistent with previous study that females are more susceptible to mood swings and depressive symptoms in mental health than males, which is associated with biological factors (eg, hormonal changes) and sociocultural factors (eg, role expectations and stress).[27] This may be due to the limitations of the measurement tool or other variables besides gender (such as socioeconomic status, education level, personal experience, etc). Future research should consider using more precise measurement tools and controlling for more potential confounders to further explore the relationship between gender and mental health scores. The influence of gender in mental health problems may also involve women being more likely to seek support and express emotions, while men may be more likely to suppress emotions.[28]

Strength and Limitations

The strength of this study is providing an up-to-date epidemiological analysis of the correlation between depressive symptoms and blood biomarker in patients hospitalized, and provides strong evidence based on a comprehensive and large-scale dataset. Our findings have important references for future research. However, several limitations should be noted and considered when interpreting our findings. First, participants were from hospitals, which introduces the possibility of selection biases. Second, data from the present study were cross-sectional, which limits causal inferences regarding associations. Third, our study did not adequately control for confounding variables such as type of primary diagnosis, pharmacological treatment, length of stay, or socio-demographic variables (eg, education and income), which may have weakened the association.

In summary, this study provides a comprehensive analysis of depressive symptoms and their correlation with blood biomarker in patients hospitalized in different hospital districts, which provides a scientific basis for clinical psychological interventions and offers new ideas for future research directions. By strengthening mental health services and biomarker research, it is expected to improve the mental health status of hospitalized patients and enhance the treatment effect and quality of life.

Data Sharing Statement

The datasets used and analysed during the current study available from the corresponding author on reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of the Affiliated Hospital of Southwest Medical University. All methods were carried out in accordance with the Declaration of Helsinki.

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Consent for Publication

Informed consent was obtained from all the participants.

Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors declared that they have no conflicts of interest regarding this work.

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