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ORIGINAL RESEARCH

Sleep Disorders in Young and Middle-Aged Adults with Acute Leukemia Undergoing Chemotherapy: A Qualitative Study from a Biopsychosocial Perspective

Li Yu[1,2], Ying Jiang[2], Qin Zhou[2]

[1]School of Nursing, Qingdao University, Qingdao, People's Republic of China; [2]Department of Hematology, Yantai Yuhuangding Hospital, Yantai, People's Republic of China

Correspondence: Qin Zhou, Department of Hematology, Yantai Yuhuangding Hospital, No. 20, Yuhuangding East Road, Zhifu District, Yantai, Shandong, 264000, People's Republic of China, Email ytzhouqin@163.com

Background and Objectives: Sleep disorders frequently affect acute leukemia patients during chemotherapy, significantly impacting treatment outcomes and quality of life. Using the biopsychosocial model, this study explores young and middle-aged patients' perceptions and influencing factors of sleep disturbances to guide targeted interventions.

Methods: Purposive sampling method was used to select 16 patients from the Department of Hematology of a tertiary hospital in Yantai City from December 2024 to January 2025 for semi-structured interviews, based on the biopsychosocial model, and Colaizzi's seven-step analysis method was used to refine the themes.

Results: Seven themes were extracted: 1) Chemotherapy and the physiological burden of the disease itself (discomfort symptoms such as body pain and fatigue, particularly severe sleep problems during the induced remission period); 2) The physical and mental reactions caused by the uncertainty of disease progression and treatment (anxiety about the condition and treatment, fear of disease progression, and concern about recurrent pain); 3) Cognitive and emotional distress towards sleep (excessive sleep expectations, rumination further affecting sleep); 4) Polarization in coping (actively implementing self-regulation and generating negative avoidance thoughts); 5) Medical environment and institutional barriers (poor hospitalization environment, unmet sleep management needs of medical staff); 6) Economic and role pressures (heavy economic pressure, insufficient social support); 7) Family and peer relationships (yearning for family support and striving to establish peer support).

Conclusion: Young and Middle-Aged Adults leukemia patients during chemotherapy have poor sleep quality, which is influenced by multiple biological, psychological, and social factors. These findings provide new insights into the challenges of patient-centered sleep management during chemotherapy and highlight the inadequacy of psychosocial support and institutional care. Clinicians should combine these influencing factors to develop targeted interventions to improve patients' sleep quality and enhance their quality of life.

Keywords: young and middle-aged, acute leukemia, chemotherapy period, sleep disorders, qualitative study

Introduction

Acute leukemia is a serious hematologic malignancy characterized by rapid proliferation of abnormal leukocytes in the bone marrow, which inhibits normal hematopoiesis and leads to symptoms such as anemia, bleeding, and infection.[1,2] According to cell type, acute leukemia can be divided into acute lymphoblastic leukemia (ALL) and acute myeloid leukemia (AML).[3] In recent years, with the influence of environmental pollution, lifestyle changes and genetic factors, the incidence of acute leukemia has been on the rise, especially in developing countries.[4] In China, the incidence rate of leukemia was 10.87/100,000 and the mortality rate was 4.25/100,000 in 2019, of which acute leukemia occupied a major proportion.[5] Young and middle-aged patients, as the main morbidity group, not only face physiological challenges, but also need to bear family, economic and social pressure, and their health problems are particularly prominent.

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Chemotherapy is the core of acute leukemia treatment,[6] controlling the disease through multi-stage treatment (induction of remission, consolidation, and maintenance).[7] However, while killing cancer cells, chemotherapy also causes damage to normal cells, triggering side effects such as nausea, vomiting, hair loss, and decreased immunity.[8] Sleep disorders refer to clinical syndromes caused by disturbances in the sleep-wake cycle and abnormal sleep quality due to various reasons.[9] Studies have shown that 60% to 80% of cancer patients experience sleep disorders during chemotherapy,[9] and sleep problems are more significant in acute leukemia patients due to the intensity of chemotherapy. Ting Zhang's[2] study showed that 80.2% to 90.3% of acute leukemia patients had difficulty falling asleep, and poor sleep quality became an important factor affecting their quality of survival. Sleep disorders not only exacerbate patients' anxiety and depression,[10] but also reduce treatment outcomes and survival rates by affecting immune function and metabolic homeostasis, increasing the risk of infection and cardiovascular disease.[11,12]

Studies have shown that 89% of middle-aged and young adult patients with acute leukemia experience sleep problems during chemotherapy, and sleep quality improves with age.[13,14] This age-related difference in sleep quality may be related to the more intense treatment reactions and psychosocial stress experienced by younger patients. Young and middle-aged patients are at a critical stage of their career and family responsibilities, and the physical and psychological burdens of the disease are even heavier. Although existing studies have explored sleep disorders and their interventions in acute leukemia patients undergoing chemotherapy from various perspectives, they have limitations. Most studies use standardized scales for quantitative assessment, failing to adequately capture patients' subjective experiences and individual narratives regarding sleep disorders. There is insufficient in-depth exploration of patients' perceptions of sleep disorders, necessitating a more comprehensive theoretical framework to understand the perceptions and influencing factors of sleep disorders in acute leukemia patients undergoing chemotherapy. The biopsychosocial model was proposed by Engel[15] in 1977, which emphasizes that health problems cannot be considered only from a biomedical perspective, but also from three dimensions: psychological factors (eg, emotion, cognition, and behavior) and social factors (eg, environment, interpersonal relationships, and cultural background), and that all three interactions affect the individual's health status. The model is able to integrate the multi-dimensional interactions of physiological, psychological, and social aspects of sleep disorders in patients with leukemia chemotherapy, and comprehensively analyze the complexity of sleep problems. Therefore, this study, based on this model, employs qualitative research methods to deeply explore the sleep disorder experiences of middle-aged and young adult patients with acute leukemia during chemotherapy. By focusing on the unique challenges faced by this specific group during chemotherapy, we can not only understand patients' conditions at the biological, psychological, and social levels but also capture the authentic experiences that existing scales fail to reflect. The findings of this study will provide important insights for clinical practice, facilitating the development of assessment tools that better align with patients' actual needs, guiding the formulation of personalized intervention plans that incorporate patients' spontaneous coping strategies, and promoting the establishment of collaborative care models based on social support systems to improve patients' sleep quality and enhance their overall quality of life.

Methods

Design

A qualitative study of perceived sleep disturbances and factors influencing them in young and middle-aged patients undergoing chemotherapy for acute leukemia based on the biopsychosocial model.

Participants and Settings

A purposeful sampling method was used to select middle-aged and young patients with acute leukemia undergoing chemotherapy (including induction remission, consolidation treatment, and maintenance treatment) admitted to the hematology department of a tertiary hospital in Yantai City, Shandong Province, China, from December 2024 to January 2025 as the study subjects. Inclusion criteria: (1) patients aged 18–59 years old with pathologically diagnosed acute leukemia;[1,14] (2) undergoing chemotherapy; (3) having good communication skills; and (4) giving informed consent to this study. Exclusion criteria: (1) those who suffered from serious mental illness; (2) those who combined serious complications; (3) those who did not cooperate or withdrew halfway. The sample size was determined based on the principle of saturation. The research team conducted independent analyses synchronously after completing every two interviews. When the text data from three consecutive interviews did not produce any new codes or themes after seven steps of analysis, saturation was deemed to have been reached. A total of 16 patients were ultimately included in the study. To protect patient privacy, they were identified by the codes N1 to N16. The purpose and side of this study were explained to the patients before the interviews, and the consent of the patients was obtained before the interviews were conducted, the personal information of the patients and the interviews were kept confidential, and the information of the patients was shown in code.

Data Collection

This study used semi-structured interviews to explore the perceived sleep disorders and influencing factors of young and middle-aged patients with acute leukemia during chemotherapy. The interview process uses easy-to-understand language and guides patients to express their true feelings around sleep-related issues in order to gain a deeper understanding of their sleep quality and influencing factors. According to the purpose of the study, based on the literature review, quantitative research and research group discussion, the interview outline was initially formulated based on the biopsychosocial model. The content of the interviews covered the patients' subjective perception of their own sleep conditions and the main factors affecting their sleep. Three pre-interviews were conducted to verify the feasibility of the outline, and then the outline was modified and improved according to the feedback, and the finalized formal interview outline was as follows: "How was your sleep quality in the last month? Do you have any sleep problems?" "How did physical discomfort (eg, pain, nausea) from chemotherapy affect your sleep?" "Have you had any emotional problems during your treatment? How did these emotions affect your sleep?" "What is your standard for good sleep? Does the gap between reality and expectations cause you stress?" "How do you perceive the quality of your sleep? What do you think are the main reasons for poor sleep?" The interviews were completed by 2 researchers, one researcher was responsible for interviewing the patients and the other researcher was responsible for additional questions and recording the interviews. Before the interview, the researcher clarified the purpose and method of the interview, explained the study to the patient, and ensured that the patient understood and agreed to participate in the interview. The researcher chose an appropriate time and place for the interview, ensured that the environment was quiet and free of interference, and obtained informed consent from the patient. During the interview, the researcher remained neutral and objective and avoided interfering with or evaluating the patient's responses. Questions were asked according to the interview outline, patients were encouraged to express their true feelings and follow up on meaningful content, and the interviews were recorded using a recording device or notes. The researcher also closely observed the patient's facial expressions and body language to obtain additional nonverbal information. The interviews lasted 20 to 40 minutes. After the interviews, the records were organized and checked in a timely manner to ensure the accuracy of the information.

Data Analysis

The audio-recordings were transcribed into textual materials within 24 hours of the conclusion of the interviews. The analysis was conducted using Colaizzi's seven-step analysis method,[16] (1) reads each textual material carefully and exhaustively to achieve a full familiarity with all the interview materials, but avoids extracting themes or tokens; (2) Extract meaningful and consistent statements from the text that are closely related to sleep experiences during chemotherapy; (3) Summarize, refine, and code recurring viewpoints to form meaningful units that reflect the characteristics of sleep disorders; (4) Cluster meaningful units or concepts to form preliminary themes, theme clusters, and categories; (5) Link themes to the research phenomenon, define and describe preliminary themes, and incorporate some original statements; (6) Integrate similar themes to provide a detailed description of the research phenomenon, elucidating the essential structure of sleep disorders in acute leukemia patients during chemotherapy; (7) Feedback of the resulting thematic structure to the research participants for confirmation to enhance the validity of the study If there is any bias, the researcher needs to reanalyze from the first step. Two researchers independently completed the coding work, assessed coding consistency using the Kappa coefficient, reached consensus through discussion on coding discrepancies, and finally invited patients to check and confirm the accuracy of the themes.

Ethics Consideration

The study strictly followed the ethical guidelines of the Declaration of Helsinki and was reviewed and approved by the Medical Ethics Committee of Yantai Yuhuangding Hospital (Approval number: 2025-60). Before the start of the interviews, the researcher explained in detail to each participant the purpose of the study, the methodology, and the expected outcomes, and ensured that he or she fully understood and then signed a written informed consent form covering the authorization for audio recording of the interviews, transcription of the text, anonymization of the citations, and publication of anonymized responses/direct quotes. These patients all agreed to have their interview results published in the paper. During the course of the study, we particularly emphasized that: all collected data will be de-identified and digital codes (eg, N1) will be used in place of real names; the original audio recordings and transcribed texts will be encrypted and stored, and only members of the research team will have access to them; and participants will have the right to withdraw from the study at any time without any reason. The research team members do not have any interest in the interviewees to ensure the objectivity and impartiality of the research process.

Results

Sixteen patients were included in this study. The data were coded according to the order of the interviews, N1-N16. The age of the interviewees ranged from 23 to 55 years old, which is a middle-aged and young group; among them, 9 were female, accounting for 56.3%, and 7 were male, accounting for 43.8%; 9 were married patients, accounting for 56.3%, and 7 were unmarried patients, accounting for 42.8%. Details are shown in Table 1. 7 themes and 15 sub-themes were extracted from the analysis of the interview data of 16 patients, details are shown in Table 2.

Physiologic Burden of Chemotherapy and the Disease Itself

Physical Pain, Fatigue, and Other Discomforts

Symptoms of the disease itself and side effects of the treatment cause physical discomfort to patients and affect their sleep. Most patients report that they experience varying degrees of pain after chemotherapy, such as headaches, mouth

Table 1 Participants' Characteristics (n=16)

Serial Number	Age (Years)	Distinguishing Between the Sexes	Matrimonial	Educational Attainment	Careers	Work Status (Employed or Not)	Caregiver	Pittsburgh Sleep Quality Index (PSQI)
1	24	Female	Unmarried	Three-year college	Former teacher at an art institute	Leave	Motherhood	14
2	57	Female	Married	Junior high school	Farming, cleaning staff	Leave	Mate	10
3	42	Female	Married	Junior high school	Individually	Incumbency	Mate	13
4	37	Male	Unmarried	Junior high school	Decorator	Leave	Paternity	12
5	57	Female	Married	Junior high school	Workers	Retirement (from work)	Mate	13
6	41	Female	Married	Junior high school	Cake store staff	Leave	Mate	14
7	54	Male	Married	Junior high school	Docker	Be dismissed from hospital	Mate	16
8	55	Female	Married	Junior high school	Not have	Not have	Mate	12
9	35	Male	Unmarried	Vocational secondary school	Equipment maintenance	Sick leave	Paternity	14
10	36	Female	Married	Undergraduate (adjective)	Office worker	Sick leave	Not have	12
11	32	Male	Married	Postgraduate student	Veterinary surgeon	Sick leave	Mate	10
12	23	Female	Unmarried	Undergraduate (adjective)	Conference reception	Leave	Motherhood	16
13	40	Female	Unmarried	Three-year college	Accountants	Leave	Motherhood	14
14	24	Male	Unmarried	Undergraduate (adjective)	Schoolchildren	Be in school	Paternity	11
15	55	Female	Married	Junior high school	Cobbler	Retirement (from work)	Sons	15
16	18	Male	Unmarried	Junior high school	Workers	Leave	Paternity	10

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Table 2 Summary of Identified Themes and Subthemes

Biopsychosocial Model	Themes	Sub-Themes	Number of Interviews (n =16)
Biological	Physiologic burden of chemotherapy and the disease itself	Physical pain, fatigue, and other discomforts	15 (94%)
		Sleep problems are particularly severe during induction of remission	9 (56%)
	Physical and psychological responses to disease progression and treatment uncertainty	Anxiety about the condition and treatment	15 (94%)
		Fear of disease progression	12 (75%)
		Concerns about recurring pain	10 (63%)
Psychological aspects	Perceptions of sleep and emotional distress	Excessive sleep expectations	9 (56%)
		Ruminative thinking further affects sleep	9 (56%)
	Polarization of responses	Active implementation of self-regulation	8 (50%)
		Negative avoidance thoughts	8 (50%)
Social aspects	Health care settings and institutional barriers	Adverse hospitalization environment	14 (88%)
		Unmet need for sleep management for healthcare workers	11 (69%)
	Economic and Role Stress	Heavy economic pressure	12 (75%)
		Insufficient social support	10 (63%)
	Family and peer relationships	Desire for family support	12 (75%)
		Efforts to build peer support	7 (44%)

ulcers, back pain, and joint pain, which make it difficult for them to fall asleep or easy to wake up during the night. At the same time, the fatigue associated with chemotherapy exacerbates patients' sleep disturbances, making it difficult to obtain quality sleep even when they feel particularly tired.[17,18] In addition, excessive sweating and hyperthermia are also important factors affecting patients' sleep,[19] and adverse drug reactions also have a significant impact on patients' sleep. Some patients reported that they may experience adverse reactions such as nausea after taking specific medications, which in turn interferes with their sleep quality, which may be related to medication side effects.

> Occasionally a little bit of pain, (chemo) when I go back it's just for a couple of days, not for a long time, just a headache for a little while in the morning, and with chemo it's just the occasional nausea and headache, and then numbness in my hands. (N1)

> I've always felt that the medication I take makes me sleep poorly, especially after taking that medication, I often feel nauseous and tired, and my sleep isn't as deep as it used to be, so maybe it's the effect of the medication. (N2)

Sleep Problems are Particularly Severe During Induction of Remission

During the interviews, more patients reported particularly severe sleep problems during the induction remission period. Many patients experience sleep disturbances in the early stages of chemotherapy, with tossing and turning at night due to weakness, physical discomfort, and anxiety about chemotherapy side effects.

> At that stage when the reaction was the greatest, I was so weak that I always tossed and turned at night. (N2)

> When I first started chemo I couldn't sleep well for a few days, the discomfort combined with the fear of the side effects of chemo kept me awake all night, now it's much better. (N8)

> Shortly after chemotherapy, the sleep problem became particularly serious, I would feel tired during the day, but at night I couldn't sleep at all, and I was anxious. After that, I slowly got used to it, and my body sort of adapted to it. (N9)

Physical and Psychological Responses to Disease Progression and Treatment Uncertainty

Anxiety About the Condition and Treatment

Interviews revealed that anxiety was more prevalent among patients, who may be anxious and stressed due to factors such as their condition, treatment and uncertainty about their future, and this psychological state directly interferes with sleep.

> After I got sick, I was anxious and depressed, worrying about a lot of things. It's a very stressful situation, but my family won't let me worry about it, so I just need to get treatment. (N5)

> The white blood cells won't go up, they seem to have gone up 2+ points for two days in this recent phase, and have been just over 1 point. (frowning tightly) (N10)

> Fear of infection, one infection it kills, scared to death. (N12)

Fear of Disease Progression

Fear of disease progression is also a key factor affecting sleep, with patients fearing deterioration, treatment failure and burdening their families, and these fears lead to difficulties in relaxing at night, which in turn affects the quality and duration of sleep.[20]

> I am afraid of aggravation, and I will end up losing both my money and my family. I'm afraid that I'll drag my children down with me, and my partner is always taking time off work to take care of me. (N5)

> When I hear about leukemia, I feel like it's the kind that can't be cured, and I'm afraid that the later stages won't be good either. (N10)

Concerns About Recurring Pain

Patients fear that the pain will recur, and this psychology triggers sleep problems in some patients, especially in the difficulty in falling asleep.

> I am always worried that the pain will come back again, especially at night, and sometimes the more I think about it, the more I worry and can't sleep. (N2)

> I have a history of multiple headaches, and although things are much better now, I can't help but worry every night when I lie down for fear that the headache will come back out of nowhere and I'll end up losing sleep. (N8)

Perceptions of Sleep and Emotional Distress

Excessive Sleep Expectations

The interviews revealed that some patients had unrealistically high expectations regarding sleep quality. Although objective results from the Pittsburgh Sleep Quality Index (PSQI) indicated that some patients had acceptable sleep quality, not reaching a severely impaired level, such as Patient N2 (PSQI=10) and N10 patients (PSQI=12), they still felt their sleep was shallow, making it difficult to achieve deep rest, and were dissatisfied with their sleep state. They hoped to achieve the ideal state of "no awakenings throughout the night" and "deep sleep" indicating a significant gap between subjective.

> I really want to get back to that sleep-all-day state I used to have, and it feels like getting a good night's sleep is becoming more and more important to me, but it's always hard to achieve that desired result. (N2)

> Every time I feel like I'm sleeping shallowly and not resting deeply, but my charge nurse did that sleep assessment with me before and the score was okay, showing that I'm sleeping pretty well. Lol, maybe it's because I'm too demanding of my own sleep. (N10)

Ruminative Thinking Further Affects Sleep

Interviews revealed that symptom-related rumination and emotion-related rumination had a greater impact on patients, who were prone to rumination manifestations of repeated thoughts, which not only aggravated the psychological burden, but also directly led to difficulties in falling asleep and sleep disruption.

> After each chemotherapy treatment I would think over and over again: will the drugs not work again this time? What if the tumor cells aren't killed? The more I thought about it, the more scared I became, and I often kept my eyes open until dawn. (N6)

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> After chemotherapy I often felt anxious and depressed, always thinking 'How long will I live? What will my family think?' These negative emotions made me toss and turn at night and made it difficult for me to sleep. (N9)

Polarization of Psychological Coping

Active Implementation of Self-Regulation

Some patients self-regulate by adjusting their routine and learning sleep aids.

> I just tried to stay up as long as I could at noon in those days, and at night I slept as early as I could, and I slept pretty well at night. (N7)

> Googled yourself for a sleep aid. (N9)

> I just close my eyes and force myself to count sheep, and I don't think about it anymore, anyway, since I got the disease I'm just optimistic, I'm not like them kinda obsessed with what I should do or what I should do. (N15)

Negative Avoidance Thoughts

Some patients choose to deal with sleep disorders by tolerating or passively coping, and are helpless and powerless in the face of sleep problems.

> No, it just sticks to itself anyway. (N5)

> When I wake up, I can't sleep, I don't play with my cell phone, I just lay here purely, and there's about two hours or two and a half hours before I can go back to sleep again. (N12)

> Wake up and go back to sleep in a different position, and if you can't sleep, go back to sleep the next day. (N16)

Health Care Settings and Institutional Barriers

Adverse Hospitalization Environment

Most respondents responded that the environment was a factor affecting their sleep. The noisy hospital environment mainly comes from the operational noise of medical equipment, the sound of conversations and activities of healthcare workers and family members, and the sound generated by daily medical operations, while frequent medical care operations at night, such as infusion and examination, can affect patients' sleep.[21]

> Not sleeping well when living in the hallway. (N1)

> There's an old man, janitorial, who makes a lot of noise when he scrubs the floor. (N4)

> I like to be quiet when I sleep. The hospital environment is still too noisy. (N5)

> Hot, you stay in this laminar flow bed every time you come, it gets extra hot, you're definitely hot in there. (N16)

Unmet Need for Sleep Management for Healthcare Workers

> The nurse kind of tossed me around a bit and would come by at night to take my blood pressure… because you need to take it every 4 hours now. I'll go back to sleep around 1:00 after the infusion, and I might wake up to take my temperature, and basically all this tossing and turning will wake me up… I might sleep for four or five hours, waking up one at a time. (N11)

> No one thinks about the fact that we patients also need to sleep continuously. I have to take that bottle at night. And then I have to keep the light on, and when I wake up, I definitely can't sleep. (N12)

> Hopefully, I can get my doctor to take my sleep problems more seriously and teach me some sleep aids as well. (N8)

Economic and Role Stress

Heavy Economic Pressure

The heavy burden of out-of-pocket expenses borne by some patients who do not have health insurance or commercial insurance has led to the dilemma they face in choosing treatment options. Some interviewees mentioned that they could only choose relatively inexpensive treatment options due to financial reasons. In addition, the time and cost required for treatment put pressure on their work and life, further affecting the quality of sleep.

> The doctor told me that our family's condition is quite ordinary, if the treatment is good, he will consider doing an autologous transplant for me, which will cost about 100,000 yuan, and I have 70,000 yuan from the Waterdrop Funding, plus a little bit of borrowing, which is almost more than 100,000 yuan. At the beginning, there was a little boy there, he's in college now, he's the same as me, but he got an allogeneic transplant, and they said it would cost 500,000 RMB, so if I had the money, I would have gotten an allogeneic transplant too. (N1)

> No rural cooperative medical care, no commercial insurance. I was able to leave two dollars on my body for my parents, but I can't even keep it in this condition. (low tone, eyes moist) (N4)

> Hospitalization cost less, but some drugs, such as Belintol, cost 600,000 after 2 courses of treatment without reimbursement. (N14)

> When I came in, I started to say that it was high risk and I had to have a transplant, and where do I get the money for a transplant, so much money, and the kids aren't even married yet. (N15)

Insufficient Social Support

Interviews revealed that social support factors also had some degree of influence on patients' sleep, mainly in terms of lack of adequate care and assistance.

> There are basically very few words from coworkers, and you basically just don't contact them. (N1)

> I am surrounded by relatives and friends who seldom bring me practical help, even though they pay lip service to caring about me. Feeling isolated and stressed. (N2)

> My great-aunt is not very well either, my great-aunt has been found to have hyperthyroidism again at home, and yesterday my dad had emphysema, he has a bad windpipe, and he was on oxygen, and there was no one on my side of the family to change the guard and come over. (N4)

Family and Peer Relationships

Desire for Family Support

Family support plays an important role in patients' coping with sleep disorders. Family members help patients alleviate their sleep problems by providing physical care (eg, massage) and psychological support (eg, talking), and patients desire family support for themselves.

> My dad psychologized me. Talks about life and patterns. I wish my dad would stay with me all the time (N14)

> Swollen legs interfering with sleep, waiting for them (family members) to give me some pressure. (N15)

Efforts to Build Peer Support

Peer support is one of the most important ways for patients to cope with sleep disorders. Some patients expressed the desire to communicate with their patients' friends, believing that psychological pressure could be relieved by sharing experiences and emotional support. In addition, the concern and encouragement of friends and fellow patients provided psychological comfort to patients.

> I think our section should have one of these, where we can sit together and talk about things. (N3)

> Friends and whatnot are concerned, can't meet up to chat, tell you to go to bed early for recovery. (N15)

Discussion

The results of the qualitative study showed that young patients with acute leukemia undergoing chemotherapy had poor sleep quality, which was characterized by problems such as dreaminess, difficulty in falling asleep, early awakening, insubstantial sleep, susceptibility to disturbances, and difficulty in falling asleep again after sleep interruption, which is consistent with the findings of Nancy Wu et al.[11] Sleep disorders not only affect patients' recovery, but may also exacerbate their psychological burden, further affecting treatment outcomes and quality of life.[22] Especially during the induction remission period, patients' sleep problems are more serious, which may be related to the side effects of chemotherapeutic drugs, the discomfort of the disease itself, and increased psychological stress.[23] In addition, the interview results also revealed that patients' sleep expectations were too high, which may be related to their urgent need for disease recovery and their over-reliance on sleep function. The gap between excessive expectations and actual sleep quality may further exacerbate patients' psychological distress, creating a vicious cycle.

Physiological factors are important factors affecting the quality of sleep in young patients undergoing chemotherapy for acute leukemia. Symptoms such as pain, fatigue, excessive sweating and hyperthermia are more common during chemotherapy, which not only directly interferes with the patient's sleep, but may also lead to frequent waking up at night or difficulty in falling asleep. Of these, pain, a common adverse experience in young patients undergoing chemotherapy for acute leukemia, significantly reduces the depth of sleep, while hyperthermia and excessive sweating may lead to sleep disruption, which may be associated with disturbances in thermoregulation and fluid balance. During hyperthermia, the body responds to inflammation or the side effects of chemotherapy drugs by sweating to help cool the body. The phenomenon of excessive sweating is not only uncomfortable for the patient, but may also lead to soaked sheets, which affects comfort and in turn disrupts sleep.[24] Especially at night, temperature fluctuations are more drastic, resulting in frequent awakenings and inability to maintain stable sleep. Moreover, elevated body temperature also triggers physiological responses such as rapid heartbeat and shortness of breath, all of which can make it difficult for patients to relax and fall asleep. On the other hand, studies have shown a strong association between cancer-related fatigue and sleep problems,[22,25] especially in leukemia patients, which is consistent with the results of this interview. Chronic sleep problems can reduce quality of life by causing patients to feel extremely tired and unable to regain energy during the day. In turn, decreased sleep quality usually exacerbates cancer-related fatigue, which in turn affects patients' chemotherapy tolerance and survival outcomes. Patients with leukemia often experience sleep disturbances during chemotherapy, such as insomnia, excessive dreaming, and early awakening, which not only affect the patient's physical recovery, but may also exacerbate feelings of fatigue. Sleep and fatigue interact with each other, forming a vicious cycle, which in turn negatively affects the patient's immune function, recovery process and treatment outcome. In addition, the chemotherapy drugs themselves may cause physical discomfort, further exacerbating sleep problems. Anxiety, fear of disease progression and ruminate thinking are common psychological reactions in patients during chemotherapy, and these emotions may lead to difficulties in relaxation, which in turn affects sleep onset and sleep maintenance.[11] In this study, middle-aged patients aged 40–59 years showed more obvious signs of maladjustment to the medical environment, which may be related to their long-established lifestyle habits and higher demands for environmental comfort. Environmental factors such as unfamiliarity with the hospital environment, noise, and lighting may interfere with patients' sleep.[21] Frequent therapeutic manipulation and monitoring, especially during hospitalization, may further interrupt the patient's sleep cycle. Side effects of chemotherapeutic agents, such as nausea, vomiting, and neurotoxicity, may directly contribute to sleep problems. Financial pressure may increase patients' psychological burden, which in turn may affect their sleep. Inadequate social support may cause patients to feel helpless, further increasing their anxiety and depression, which may affect their sleep.

On the physiological side, providing adequate physiological support to young patients undergoing chemotherapy for acute leukemia in the clinical setting is crucial to alleviate symptoms and improve the quality of sleep for patients. Pain control through medication or other effective methods can effectively reduce its interference with sleep. In addition to pain control, hospitals and departments need to improve the ward environment, reduce noise and light interference, and create a comfortable sleep environment for patients, which can help improve sleep quality. In addition, for the possible side effects caused by chemotherapeutic drugs, such as nausea, vomiting and neurotoxicity, timely interventions should be taken to improve somatic discomfort.[26] During the chemotherapy period of acute leukemia, patients' immune system is suppressed and prone to infections,[27] which in turn triggers a persistent hypothermic or hyperthermic response. At this

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time, the side effects of the chemotherapeutic drugs themselves, such as increased body temperature and excessive sweating, may also aggravate the patient's discomfort. Healthcare professionals should appropriately apply antipyretic drugs, adjust the temperature and humidity of the ward, as well as ensure that patients receive adequate hydration to alleviate sleep problems caused by temperature fluctuations and excessive sweating. Another study showed that for patients with hematological malignancies, physical activity can effectively alleviate sleep disorders, improve sleep quality, and enhance the quality of life.[23]

Psychologically, the interviews revealed that during chemotherapy, patients often face severe psychological stress and emotional distress, such as anxiety, depression and fear, and these negative emotions not only affect the outcome of treatment, but also significantly reduce the quality of life. Self-regulation, such as adjusting work and rest or using psychological suggestion, is a common strategy because it is low-cost and easy to implement, although the effect varies from person to person. Peer support and family support alleviate psychological stress through emotional communication and physical care, but some patients have difficulty in obtaining sufficient support due to isolation or family tension, and need to improve the social support network. Some patients adopt negative treatment, and patients are full of helplessness and powerlessness towards sleep disorders, suggesting that clinical need to strengthen professional intervention and psychological support. Shi Peizhuo et al[28] showed that progressive muscle relaxation training can effectively improve the sleep quality of patients with acute myeloid leukemia and reduce anxiety and depression. Su Shaoyan et al[29] found that narrative medicine nursing had an effect on the fear of cancer recurrence, cancer-caused fatigue and sleep quality of patients with acute leukemia. By encouraging patients to talk about their own treatment experiences, narrative medicine helped patients better understand and accept their own conditions, enhanced their psychological tolerance, and could effectively improve patients' sleep. Psychological supportive therapy has a significant effect on improving patients' quality of life and can reduce anxiety and depression.[30] Shen Lian et al[31] showed that drawing therapy can effectively improve the anxiety and depression of acute leukemia patients and improve the quality of life. A variety of psychological interventions can be used in clinical work to effectively improve the patients' bad mood and promote the improvement of their sleep quality.

Social support is dynamic in different environments, mainly refers to the spiritual and material help provided by the outside world to individuals, and is an important pillar to help patients overcome diseases and promote health.[32] The results of this study show that economic factors and weak family support for patients all affect patients' sleep to varying degrees. By enhancing family and social support and providing emotional comfort and practical help, patients' feelings of isolation and helplessness can be reduced, and patients' satisfaction and quality of life can be improved.[33] Studies[34] have shown that most of nurses' knowledge about sleep comes from learning during school and less systematic training after work. Nurses realized that their knowledge of sleep-related knowledge could not meet their work needs and were eager to receive different forms of training. Therefore, it is recommended that nursing managers adopt online and offline training methods, so that more nurses can have the opportunity to receive sleep-related knowledge training, and strive for joint training between doctors and nurses to promote the cooperation between doctors and nurses. By giving appropriate support and assistance and encouraging patients to cope positively, patients' sleep symptoms can be effectively relieved and their quality of life can be improved.[35]

Limitations

This study has certain limitations. On the one hand, the small sample size and concentration on a single medical institution may limit the generalizability of the results. Additionally, the study did not assess potential interviewer bias and social desirability effects during the interviews, and the transferability across different cultural contexts requires further consideration in future research. Findings based on the bio-psycho-social model suggest that future studies should conduct multi-center research to validate the interactions among various dimensional factors and develop more culturally adaptive intervention measures in conjunction with objective indicators. Finally, the study did not address the long-term changes in patients' sleep disorders and their impact on treatment outcomes. Future research could expand the sample size and incorporate.

Conclusion

The sleep quality of middle-aged and young adult patients with acute leukemia undergoing chemotherapy is influenced by a combination of biological, psychological, and social factors. Patients generally exhibit a significant disparity between their subjective sleep expectations and objective assessments. Hospital environmental noise and nighttime medical procedures are important disruptive factors, while the high demand for family support contrasts sharply with the underutilization of peer support. In response to these findings, it is recommended that future clinical interventions be tailored and implemented. Hospitals should actively optimize environmental management and adjust nursing procedures to more reasonable times. Additionally, healthcare providers can use cognitive behavioral therapy to correct sleep expectation biases and offer patients multifaceted support through family caregiver training and peer support group activities. These intervention strategies not only provide specific directions for improving patients' sleep quality but also lay the foundation for supportive care guidelines for leukemia patients, which will help advance the development of precise sleep interventions for leukemia patients.

Data Sharing Statement

For the privacy of individuals who participated in the study, the data will be shared on reasonable request to the corresponding author.

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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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