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Quality of life and symptom burden among hematologic malignancy patients undergoing CAR-T therapy: a cross-sectional study

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Few studies have thoroughly evaluated the symptom burden and quality of life (QOL) among patients diagnosed with hematologic malignancies who underwent chimeric antigen receptor T-cell (CAR-T) therapy. In total, 97 eligible patients completed the Functional Assessment of Cancer Therapy generic scale (FACT-G) at week 4 after CAR-T cell infusion. We used the Common Terminology Criteria Adverse Events (CTCAE) to measure symptom burden of CAR-T patients during the same period. We studied factors associated with QOL using liner regression analysis. During the period of hospitalization after CAR-T treatment, the prevalence of self-reported symptoms among CAR-T patients was highest for fatigue (89.7%), followed by sleep disorders (79.4%) and decreased appetite (66.0%). And the mean score of FACT-G was 69.06 (SD = 13.88). Liner regression analysis showed that decreased appetite (β = -0.30, 95% CI = -7.48 to -1.83, P = 0.002), fatigue (β = -0.28, 95% CI = -7.23– -1.69, P = 0.002), nausea (β = -0.26, 95% CI = -10.50 to -2.16, P = 0.003) and a history of hematopoietic stem cell transplantation (HSCT) (β = -0.21, 95% CI = -13.38– -1.56, P = 0.014) were associated with poorer quality of life. The symptom burden experienced by patients undergoing CAR-T treatment is substantial during their hospitalization, and it is closely associated with a diminished quality of life. It is imperative for clinical medical staff to be attentive to the symptom burden of CAR-T patients and to enhance the effectiveness of symptom management interventions.

Keywords Chimeric receptor antigens T-cell therapy, Quality of life, Symptom burden, Hematological malignancies

The advancement of treatment modalities has contributed to the improvement of both survival rates and quality of life in individuals with hematological malignancies[1,2]. However, hematological malignancies, including leukemia, lymphoma, and myeloma, continue to pose significant challenges due to their resistant nature and propensity for frequent relapse[3,4]. A comprehensive analysis, along with two cross-sectional investigations conducted in Europe, has revealed that patients afflicted with hematological malignancies experience a lower quality of life in comparison to the general population[5–7]. The physiological, psychological, and social dimensions significantly impact the quality of life for individuals diagnosed with hematological cancer. Specifically, these patients are prone to experience a higher prevalence of adverse symptoms[8], including pain[9], fatigue[10], and loss of appetite[7], which subsequently contribute to a deterioration in their functional capabilities[5]. Currently, there is a dearth of knowledge regarding the experiences of hospitalized patients with hematologic cancers, all we know is that symptom burden is amplified during hospitalization and that individuals participating in clinical trials may encounter a further decline in their quality of life[8].

Chimeric antigen receptor T-cell (CAR-T) therapy, a form of cellular immunotherapy, utilizes genetic engineering techniques to activate T cells and equip them with chimeric antigen receptors (CARS) capable of precisely recognizing and killing tumor cells within the body. Consequently, these modified T cells exhibit

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heightened efficacy in eliminating malignant tumor cells, thereby offering a promising treatment option for individuals afflicted with relapsed and refractory hematological malignancies[11]. To date, a number of CAR-T therapies have demonstrated remarkable efficacy in managing relapsed/refractory acute lymphoblastic leukemia (ALL), diffuse large B lymphoma (DLBCL), and multiple myeloma (MM). Currently, the primary focus of clinical investigations involving CAR-T patients revolves around assessing efficacy, long-term safety, and the management of toxic and adverse effects[12].

Clinical trials have demonstrated that a majority of patients encounter significant and potentially life-threatening adverse effects, namely cytokine release syndrome (CRS) and neurotoxicity, subsequent to the administration of CAR-T cell infusion[13,14]. These reports suggest that the incidence rates of CRS and neurotoxicity are approximately 92–95% and 11–60%, respectively[15–17]. Such complications can substantially compromise the therapeutic effects of CAR T-treatment during hospitalization and exert a profound influence on their overall quality of life (QOL). A qualitative investigation conducted on patients undergoing CAR-T therapy revealed significant impairments in eight domains following treatment, namely social function, emotional function, fatigue, physical function, cognitive function, role function, sleep, and pain/discomfort[18]. Our prior research demonstrated that CAR-T patients experienced compromised mental well-being during their hospitalization post-treatment, with depressive symptoms being particularly severe[19]. Furthermore, the current clinical trials have demonstrated the remarkable efficacy of CAR-T therapy, however, the durability of its effect remains suboptimal[16,20].

The utilization of quality of life as a metric for assessing the effectiveness of anticancer medications is provided by the US Food and Drug Administration[21]. Quality of life encompasses health outcomes in a more comprehensive manner than morbidity or mortality, as it is evaluated from the patient's standpoint. This metric enables the evaluation of the condition's impact on the patient's health and daily activities, and additionally offers valuable prognostic information that cannot be obtained through routine clinical observation[22]. A research investigation conducted on breast cancer patients revealed a significant association between higher quality of life scores and reduced mortality rates as well as a decreased risk of recurrence[23]. Additionally, a separate study focusing on patients with MM identified Psychosocial QOL as an independent prognostic factor for overall survival[24]. Existing literature has extensively examined the detrimental effects of patients' diminished quality of life on various treatment outcomes, including treatment adherence and their ability to cope with the diagnosis and prognosis[25]. As a result of the limited duration of clinical implementation of CAR-T therapy technology, healthcare professionals have limited experience in providing care for patients undergoing such treatment. Jennifer M. Knight et al.[26]utilized validated tools to assess anxiety, depressive symptoms, fatigue, sleep, and pain in CAR-T patients following infusion. Additionally, they investigated data on neurotoxicity, tryptophan and its metabolites, and serum cytokines. Their research focused on the relationship between kynurenine, a metabolite of CAR-T cell receptors, and patients' depressive symptoms and neurotoxicity. In a longitudinal study of adult patients with r/r DLBCL, Richard T. Maziarz et al.[27]demonstrated sustained improvements in health-related quality of life (HRQoL) among those achieving complete or partial remission. The study included a detailed analysis of minimal clinically important differences (MCID) across various HRQoL dimensions. However, the authors did not measure or analyze potential contributing factors. Consequently, certain scholars advocate for an accurate assessment of the post-treatment quality of life and its associated factors[28]. Simultaneously, a comprehensive evaluation of post-treatment symptom burden is essential, as it holds significant implications for the management and care of patients during their hospitalization following CAR-T cell infusion[29].

In summary, this study examined the patient-reported outcomes of individuals diagnosed with hematological malignancies who underwent CAR-T cell therapy during hospitalization. The primary objective was to investigate the self-reported symptom burden and quality of life, and to explore the factors associated with quality of life.

Materials and methods

Participants

Data were collected in the affiliated hospital of Xuzhou Medical University (Xuzhou, China) over a period between October 2019 and April 2021. Patients who have been receiving CAR-T therapy and age 16 years or older were included in the study. Exclusion criteria included patients who received other treatment after CAR-T cells infusion, unable to communicate, physicians rejected and death. A total of 97 patients participated in our voluntary convenience-sampled survey. The flow model diagram of the recruitment process is shown in Fig. 1.

We obtained the informed consents signed by the patients and cooperation of their families. Approval for the study was obtained from the Ethics Committee of the Affiliated Hospital of Xuzhou Medical University (XYFY2019-KL201-01). All methods were performed in accordance with the relevant guidelines and regulations. Patients baseline characteristics were extracted from electronic medical records and obtained by patients' self-report. Face-to-face questionnaire was administered in week 4 after CAR-T cell infusion.

Patient-reported measures

The Functional Assessment of Cancer Therapy generic scale (FACT-G)[30]was used to assess QOL. The FACT-G contains 27 items that comprise 4 subscales assessing physical, functional, emotional and social well-being. The scale used a 5-point Likert scale, ranging from 0 (not at all) to 4 (very much). High total and subscales scores represented better QOL. The Chinese version of the FACT-G has good reliability and validity and has been applied in a wide range in clinical[31,32].

The Common Terminology Criteria Adverse Events (CTCAE)[33] was used to evaluate the symptom burden of patients after treatment. The latest iteration of this tool, Version 5.0, encompasses a comprehensive checklist of diverse adverse reactions and events. The severity of these adverse effects is assessed through a 5-point scoring system, wherein each adverse effect is assigned a grade ranging from 1 to 5, accompanied by a specific clinical description. Grade 1 signifies a mild adverse effect that is typically asymptomatic and does not

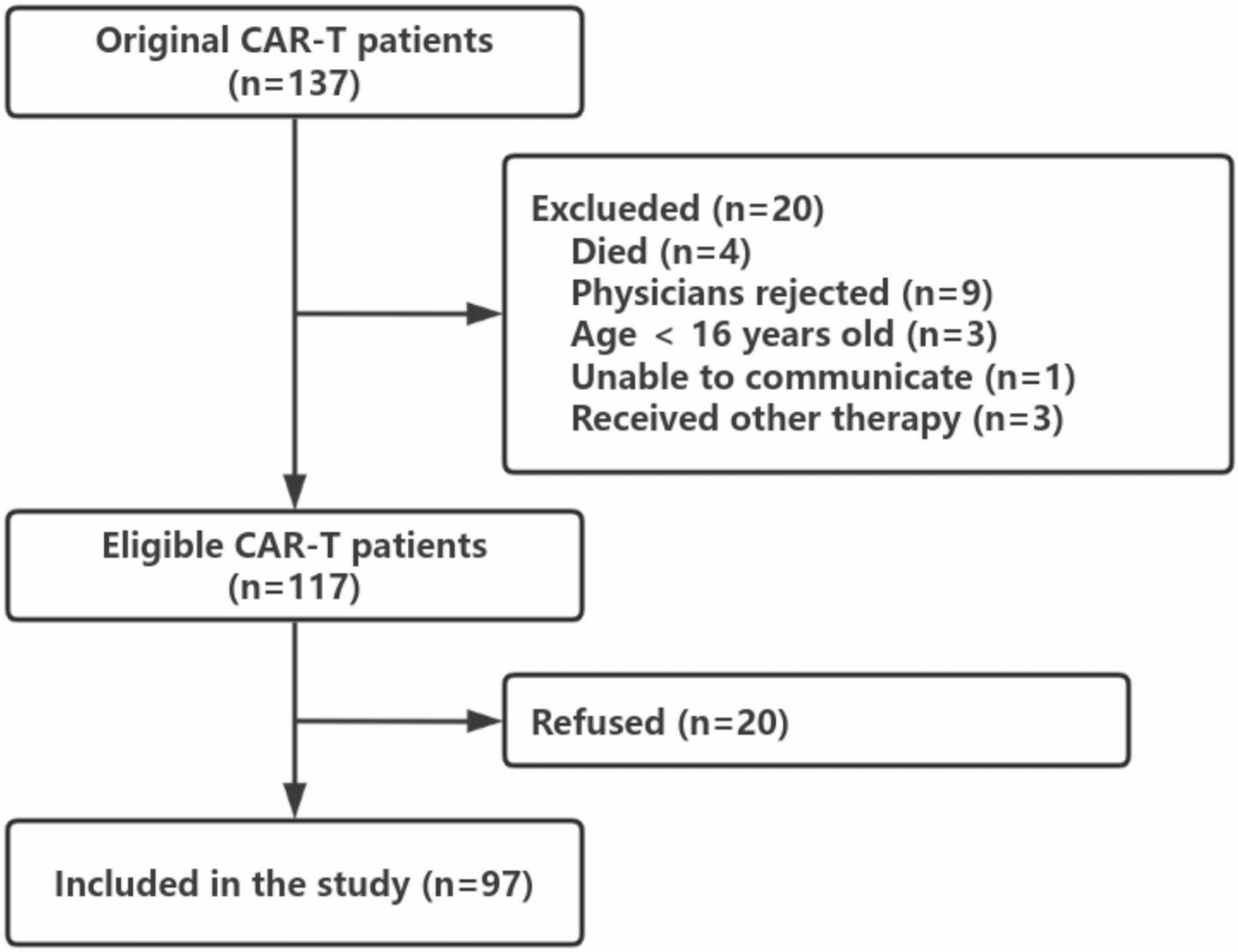

Fig. 1. The flow model diagram of the recruitment process.

necessitate intervention. Grade 2 denotes moderate adverse effects accompanied by clinical symptoms, for which appropriate intervention can be undertaken. Grade 3 indicates more severe adverse reactions that necessitate active intervention. Grade 4 signifies adverse reactions that may potentially endanger life and cause significant harm to the body. A grade 5 adverse effect is defined as resulting in death. It is important to note that not all adverse effects adhere to the grading criteria ranging from 1 to 5. In general, reactions classified as grade 1–2 were deemed to be of low severity, while grade 3–4 reactions were considered severe. The utilization of patient-reported measurements of adverse symptoms in the CTCAE facilitates a more precise evaluation and intervention of diverse adverse symptoms by researchers. This tool and data collection method, as reported by patients, have gained widespread adoption in clinical trial reports[34]. The ASTCT Consensus Grading criteria for CRS and neurotoxicity associated with chimeric antigen receptor T-cell (CAR-T) therapy were employed[35].

Statistical analysis

Demographic and clinical characteristics were summarized using descriptive statistics, with continuous variables reported as mean ± standard deviation (SD) and categorical variables as frequencies (percentages). Quality of life outcomes were assessed by comparing FACT-G scores between CAR-T patients and general population normative means[36] using one-sample t-tests. For between-group comparisons, we applied appropriate parametric tests (independent Student's t-tests for two groups, one-way ANOVA for multiple groups) when data met normality and homogeneity of variance assumptions, and non-parametric alternatives (Mann-Whitney U tests) when these assumptions were violated.

For multivariate analysis, multiple linear regressions analysis was performed with the scores of FACT-G and its sub-scales as the dependent variable. Independent variables that had significance on univariate analysis were eligible for inclusion in multivariate analysis.

Two-sided *P*-value were calculated, and $P < 0.05$ was considered to indicated a statistically significant difference. Participants with missing data will be excluded from further analysis. Data was analyzed with the SPSS software (version 25.0; SPSS).

Results

Patients characteristics and demographics

In total, 97 patients completed questionnaire, and 20 patients qualified for the study refused to participate. The average age of the patients was 50.5 years old (SD = 14.7), with a percentage of 35.1% women. The average duration of illness was 3.7 years (SD = 2.7). Of 54 (55.7%) patient with multiple myeloma, 1 (1.8%) patients had stage I cancer, 19 (35.2%) had stage II cancer, 34 (63.0%) had stage III cancer. Of 31 (32.0%) patients with lymphoma, 2 (6.5%) had stage II cancer, 10 (32.3%) had stage III cancer, 19 (61.3%) had stage IV cancer. Myeloma and lymphoma staging was reported using the Revised International Staging System[37] and the modified Ann Arbor staging system[38], respectively. Additionally, 4 and 6 patients were missing data on medical expenditure and monthly household income per capital, respectively. Detailed clinical and demographic characteristics data are presented in Table 1.

Characteristics	No. of patients(%), *N* = 97
Gender	
Male	63(64.9)
Female	34(35.1)
Age, year	
≤ 44	27(27.8)
45–59	40(41.3)
≥ 60	30(30.9)
Household registration	
Urban	60(61.9)
Rural	37(38.1)
Religion	
No	81(83.5)
Yes	16(16.5)
Education	
Junior high school and below	48(49.5)
High school and above	49(50.5)
Occupation	
Manual	42(43.3)
Non-manual	55(56.7)
Marital status	
Unmarried	19(19.6)
Married	78(80.4)
Monthly household income per capita, dollors	
< 450	55(56.7)
≥ 450	36(37.1)
Missing	6(6.2)
Diagnosis	
Leukemia	12(12.4)
Multiple myeloma	54(55.6)
Lymphoma	31(32.0)
Duration of illness, year	
< 2	27(27.8)
2–4	41(42.3)
> 4	29(29.9)
Medical expenditure, dollors	
< 45 thousand	35(36.1)
≥ 45 thousand	58(59.8)
Missing	4(4.1)
Comorbidity	
No	63(64.9)
Yes	34(35.1)
History of bone marrow transplant	
No	80(82.5)
Yes	17(17.5)

Table 1. CAR-T patients demographic and clinical characteristics.

Symptom	Any grade	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Fatigue	87(89.7)	35(36.1)	38(39.2)	14(14.4)	–	–
Sleep disturbances	77(79.4)	43(44.3)	24(24.7)	10(10.4)	–	–
Decreased appetite	64(66.0)	29(29.9)	32(33.0)	3(3.1)	0	0
Pain	50(51.5)	22(22.7)	27(27.8)	1(1.0)	–	–
Cough	39(40.2)	28(28.9)	11(11.3)	0	–	–
Indigestion	32(33.0)	15(15.5)	17(17.5)	0	–	–
Nausea	27(27.9)	22(22.7)	5(5.2)	0	–	–
Dyspnea	26(26.8)	11(11.3)	11(11.3)	4(4.2)	0	0
Expectoration	26(26.8)	18(18.6)	8(8.2)	0	–	–
Chills	22(22.7)	22(22.7)	0	0	–	–
Constipation	21(21.7)	5(5.2)	15(15.5)	1(1.0)	0	0
Vomiting	21(21.6)	20(20.6)	1(1.0)	0	0	0
Diarrhea	20(20.6)	14(14.4)	5(5.2)	1(1.0)	0	0
Adverse reactions						
Cytokine release syndrome	80(82.4)	50(51.5)	24(24.7)	4(4.1)	2(2.1)	0
Neurotoxicity	15(15.4)	7(7.2)	4(4.1)	4(4.1)	0	0
-No such grade						

Table 2. Most symptoms and adverse reactions related to CAR-T therapy (n (%), $N = 97$).

Scale	CAR-T patients score, mean (SD)	Normative mean (SD)[#]	*P*
FACT-G total	69.06 (13.88)	80.1 (18.1)	< 0.001
Physical well-being	17.07 (5.58)	22.7 (5.4)	< 0.001
Functional well-being	14.18 (5.57)	18.5 (6.8)	< 0.001
Emotional well-being	18.46 (4.61)	19.9 (4.8)	0.003
Social well-being	19.35 (3.51)	19.1 (6.8)	0.484

Table 3. Comparisons of Patients-reported quality of life with population normative means. FACT-G, The Functional Assessment of Cancer Therapy generic scale (Quality of life). #From literature point estimates.

Symptoms burden

During the period of hospitalization subsequent to CAR-T treatment, the prevalence of self-reported symptoms among CAR-T patients was highest for fatigue (89.7%), followed by sleep disorders (79.4%) and decreased appetite (66.0%). Additional symptoms with an incidence exceeding 20% included pain, cough, dyspepsia, nausea, dyspnea, expectoration, chills, vomiting, constipation, and diarrhea. The occurrence rates of CRS and neurotoxicity associated with CAR-T therapy were 82.4% and 15.4%, respectively. The classification of symptoms and adverse effects can be found in Table 2.

Patients-reported quality of life

When week 4 after CAR-T cells infusion, the mean score of FACT-G was 69.06 (SD = 13.88), and the mean scores of physical, functional, emotional and social well-being dimensions of FACT-G were 17.07 (SD = 5.58), 14.18 (SD = 5.57), 18.46 (SD = 4.61), 19.35 (SD = 3.51), respectively. Except social well-being dimension, the total mean scores of FACT-G and each dimension were significantly below the normative means. The comparison of QOL between the means of CAR-T patients scores and normative means are listed in Table 3.

Univariate analysis of quality of life

Preliminary univariate analysis revealed significant associations between higher medical expenditure, a history of hematopoietic stem cell transplantation (HSCT), fatigue, sleep disorders, decreased appetite, nausea, vomiting, and diarrhea with lower FACT-G total scores. Additionally, higher medical expenditure, a history of HSCT, fatigue, sleep disorders, decreased appetite, pain, nausea, and diarrhea were found to be associated with poorer physical well-being. Higher medical expenditure and experienced cytokine release syndrome, fatigue, sleep disorders, decreased appetite were associated with poorer functional well-being score. Having comorbidity, fatigue, sleep disorders, decreased appetite, nausea and vomiting were associated with poorer emotional well-being score. Expectoration was associated with social well-being score. The results of univariate analysis are listed as F value or t value in Table 4.

Associated factors of quality of life

Multiple linear regression analysis demonstrated that decreased appetite (β = -0.20, 95%CI = -2.38 to -0.05, P = 0.042), diarrhea (β = -0.20, 95%CI = -3.49 to -0.23, P = 0.026), fatigue (β = -0.26, 95%CI = -2.81 to -0.54, P =

Independant variable	Univariate analysis¶					Multivariate analysis§				
	PWB	FWB	EWB	SWB	FACT-G	PWB	FWB	EWB	SWB	FACT-G
Age	NS	NS	NS	NS	NS					
Diagnosis	NS	NS	NS	NS	NS					
Duration of illness	NS	NS	NS	NS	NS					
Gender	NS	NS	NS	NS	NS					
Household registration	NS	NS	NS	NS	NS					
Religion	NS	NS	NS	NS	NS					
Education	NS	NS	NS	NS	NS					
Occupation	NS	NS	NS	NS	NS					
Marital status	NS	NS	NS	NS	NS					
Monthly household income per capita	NS	NS	NS	NS	NS					
Medical expenditure	2.40*	2.04*	NS	NS	2.62*	NS	NS			NS
Comorbidity	NS	NS	-2.13*	NS	NS			NS		
History of bone marrow transplant	2.57*	NS	NS	NS	2.34*	-0.20*				-0.21*
Cytokine release syndrome	NS	2.15*	NS	NS	NS		NS			
Neurotoxicity	NS	NS	NS	NS	NS					
Fatigue	6.89#	4.29*	3.51*	NS	6.95#	-0.26*	NS	-0.26*		-0.28
Sleep disturbances	5.16*	10.21#	4.53*	NS	9.69#	NS	-0.25*	NS		NS
Decreased appetite	6.71#	9.25#	3.98*	NS	9.82#	-0.20*	-0.31*	NS		-0.30*
Pain	3.73*	NS	5.28*	NS	NS			-0.23*		
Cough	NS	NS	NS	NS	NS					
Indigestion	NS	NS	NS	NS	NS					
Nausea	7.21*	NS	7.27*	NS	8.21*	-0.23*		-0.28*		-0.26
Dyspnea	NS	NS	NS	NS	NS					
Expectoration	NS	NS	NS	3.11*	NS				-0.24*	
Chills	NS	NS	NS	NS	NS					
Constipation	NS	NS	NS	NS	NS					
Vomiting	NS	NS	5.37*	NS	3.99*			NS		NS
Diarrhea	5.57*	NS	NS	NS	3.59*	-0.20*				NS

Table 4. Univariate and multivariate analysis of QOL (n (%), $N = 97$). ¶F value or t value. §Standardized β coefficients. *$P < 0.05$. #$P < 0.001$.

0.004), nausea (β = -0.23, 95%CI = -3.90 to -0.50, $P = 0.012$) and a history of HSCT (β = -0.20, 95%CI = -5.27 to -0.41, $P = 0.023$) were associated with poorer physical well-being. Decreased appetite (β = -0.31, 95%CI = -3.29 to -0.53, $P = 0.007$) and sleep disorders (β = -0.25, 95%CI = -2.94 to -0.20, $P = 0.025$) was associated with poorer functional well-being. Nausea (β = -0.28, 95%CI = -3.71 to -0.71, $P = 0.004$), fatigue (β = -0.26, 95%CI = -2.33 to -0.41, $P = 0.005$) and pain (β = -0.23, 95%CI = -2.16 to -0.21, $P = 0.018$) was associated with poorer emotional well-being, and expectoration (β = 0.24, 95%CI = -2.47 to -0.26, $P = 0.016$) was associated with better emotional well-being. Decreased appetite (β = -0.30, 95%CI = -7.48 to -1.83, $P = 0.002$), fatigue (β = -0.28, 95%CI = -7.23– -1.69, $P = 0.002$), nausea (β = -0.26, 95%CI = -10.50 to -2.16, $P = 0.003$) and a history of HSCT (β = -0.21, 95%CI = -13.38– -1.56, $P = 0.014$) was associated with poorer quality of life. The results of the multivariate linear regression analysis, with the FACT-G and its sub-scales as dependent variables, are reported as standardized β coefficients in Table 4.

Discussion

To our knowledge, this investigation constitutes the earliest systematic characterization of quality-of-life (QOL) and symptom burden profiles in CAR-T patients during the first-month post-infusion.

Following the administration of CAR-T cell therapy, a majority of patients encountered treatment-associated adverse reactions, specifically cytokine release syndrome (82.4%) and neurotoxicity (15.4%), aligning with the documented incidence in various CAR-T clinical trials[15–17]. The magnitude of symptomatology experienced by cancer patients surpasses that of individuals in good health. Within this investigation, the foremost three self-reported symptoms among CAR-T patients were fatigue, sleep disturbance, and decreased appetite. These primary adverse symptoms were consistent with the findings of Rebecca Cheng et al.'s qualitative research on CAR-T patients[18].

Fatigue is widely acknowledged as a prevalent and distressing adverse symptom experienced by patients with hematological cancers, particularly during the administration of diverse treatments[5,39]. The reported prevalence rates of fatigue and other associated symptoms differ across studies due to variations in patient cohorts, treatment modalities, and assessment methodologies. In this study, after receiving CAR-T therapy, various biochemical indicators of patients will be greatly deranged, such as hypoalbuminemia, thrombocytopenia, anemia, etc[40]. , and

fatigue is closely associated with these hematological indicators[41]. During this time frame, patients commonly experience decreased appetite and reduced food intake, which further exacerbates fatigue due to poor nutritional status[42]. As previously stated, the majority of patients undergoing CAR-T therapy will develop cytokine release syndrome, a significant treatment-related adverse reaction that profoundly affects patients. When patients experience cytokine release syndrome, the primary manifestation is the presence of fever, which tends to be intermittent. In addition, the patient's sleep quality is also significantly compromised, which exacerbates the symptoms of fatigue. Several studies have indicated that fatigue may serve as a susceptibility, precipitating, and enduring factor for sleep disorders, while sleep disorders themselves can contribute to heightened fatigue levels[43,44]. These findings imply the potential existence of a detrimental cycle involving the aforementioned symptoms.

According to a scholarly review[45], symptoms frequently manifest in groups, a phenomenon that is particularly noticeable among CAR-T patients. The present investigation revealed that all participants experienced two or more symptoms. Several studies[46,47] have indicated a potential association between certain inflammatory markers and the severity of symptom burden. Notably, heightened levels of Interleukin-6 (IL-6) have been linked to fatigue, impaired cognitive function, and sleep disorders. Furthermore, a separate investigation conducted on breast cancer patients[48] has demonstrated that the manifestation of numerous symptoms among individuals with cancer can be ascribed to the liberation of proinflammatory factors. Notably, the cytokine release syndrome that arises subsequent to CAR-T cell therapy exhibits a strong correlation with the elevation of IL-6 concentration[49]. Consequently, this association may serve as a key explanation for the heightened symptom burden experienced by CAR-T patients.

However, prior investigations[41,50]have suggested that the monitoring of nonspecific patient-reported symptoms is frequently insufficient compared to toxic effects, primarily due to underreporting by patients or underestimation of the symptoms' significance by healthcare providers. Consequently, it is imperative for clinical medical personnel to actively prioritize and provide suitable symptom management for patients undergoing CAR-T therapy.

In the present study, it was observed that the overall quality of life (QOL) score among CAR-T patients during their hospitalization post-treatment was significantly lower than the standard mean. This is consistent with findings from the prior research conducted on patients with hematological malignancies[9], and has also been found in the same time point from longitudinal studies involving CAR-T patients[28,51]. However, it is important to acknowledge that certain investigations on long-term survivors of hematologic cancers have reported no discernible disparity in the overall QOL when compared to the general population[6]. This discrepancy may be attributed to the fact that the patients included in our study were hospitalized and undergoing treatment. Research findings indicate that patients who undergo hospitalization, receive medical intervention, and experience relapse exhibit a diminished quality of life[5,8]. The receipt of medical intervention is correlated with a deterioration in functional capacity, and the prolonged clinical treatment of individuals with hematological malignancies entails enduring lasting impairments[6].

This study found that CAR-T patients experienced significant impairments in their quality of life in terms of physical well-being, functional well-being, and emotional well-being, aligning with previous research on the quality of life of individuals with hematological cancer[5,7]. In contrast to previous studies[6], the social well-being dimension score of CAR-T patients did not differ significantly from the standard mean, and in fact, was slightly higher, representing a noteworthy finding in this study. Prior to undergoing CAR-T therapy, patients will typically undergo conventional treatments such as chemotherapy and bone marrow transplantation. The prolonged duration of the disease necessitates substantial medical expenses. Furthermore, as previously mentioned, the long-term effectiveness and safety of CAR-T therapy are not highly promising, thereby presenting economic and treatment outcome challenges for patients and their families. In this particular scenario, patients who maintain their intention to undergo CAR-T treatment must adequately equip themselves, a process that is intricately intertwined with the compassionate assistance and financial backing from family members, alongside the nurturing support and motivation from friends.

The findings from the linear regression analysis indicated a significant association between severe symptom burden, encompassing fatigue, sleep disorders, decreased appetite, nausea, and other related symptoms, and the overall quality of life as well as its various dimensions of CAR-T patients. These results align with previous research conducted on individuals with hematological malignancies[52]. Additionally, a qualitative study[53] demonstrated that treatment-related side effects have the potential to adversely impact the quality of life among patients receiving hospital care. In general, patients experience a significant burden of symptoms, resulting in severe impairment of their physical and functional well-beings, ultimately leading to a diminished quality of life. The limitation of mobility can hinder normal social activities, further exacerbating the impact on patients' quality of life. Additionally, the abrupt escalation in symptom burden may contribute to the development of psychological disorders and adversely affect patients' mental well-being[54]. Fatigue and sleep disorders can contribute to inadequate rest and physical strength, while symptoms such as decreased appetite, nausea, and vomiting fall within the gastrointestinal symptom cluster. Hence, it is imperative for clinical nursing practice to enhance the provision of sleep care and gastrointestinal care for patients undergoing CAR-T therapy.

The examination revealed a perplexing association between lower QOL scores in the social well-being and expectoration, a phenomenon lacking substantial empirical support. Consequently, further research endeavors are warranted to delve into the intricacies of expectoration and elucidate its underlying nature.

In this study, CAR-T patients who had undergone hematopoietic stem cell transplantation had poor global quality of life and physical well-being. A review of multiple myeloma patients reveals that HSCT negatively affects quality of life and exacerbates symptom burden[55]. This may be attributed to the adverse effects of transplantation therapy, such as immune rejection. Furthermore, the already frail physiological state of patients'

post-transplantation is further compromised when they undergo CAR-T therapy. Consequently, it is imperative for clinical medical staff, to prioritize the care and monitoring of CAR-T patients following HSCT.

Previous studies have confirmed the correlation between acute adverse reactions following treatment and a diminished quality of life[56]. However, the present study did not observe a significant link between treatment-related adverse reactions and quality of life, thereby deviating from the anticipated findings of the study. It has been observed that despite the lack of definitive evidence establishing a causal relationship between the occurrence of adverse reactions and the efficacy of CAR-T treatment[17,57], patients undergoing CAR-T therapy tend to perceive adverse reactions as indicative of the treatment's effectiveness. This phenomenon necessitates a dialectical examination. On one hand, adverse reactions have the potential to diminish patients' physical and functional well-being, while on the other hand, they may align with patients' expectations of effectiveness, thereby bolstering their confidence and instilling hope. In the future, the intricate association between adverse reactions and the quality of life of CAR-T patients will be further explored.

Our study has several limitations. First, the cross-sectional survey of a convenience sample also limits firm conclusions. Second, the analysis did not incorporate alterations in the disease progression among these patients due to limitations in the study design. It is important to note that the disease remission following CAR-T therapy is a dynamic process. Typically, patients enter a "Stable disease" phase approximately one month post-surgery, after which there may be diverse changes, including either further improvement or deterioration leading to mortality[57]. In our study, the measurement point coincided with the fourth week of treatment, rendering accurate determination of response to CAR-T therapy unfeasible. Consequently, we intend to longitudinally monitor the correlation between disease remission and quality of life. Third, it should be noted that the measurement of symptom burden in our study was conducted using the ATCAE rather than a validated scale. While the use of a validated scale, such as the Edmonton Symptom Assessment Scale, may seem more conventional, it could potentially restrict the comprehensive understanding of the symptom burden experienced by CAR-T patients. This is due to the limited number of symptom items included in such scales, which may not encompass the full range of symptoms experienced by CAR-T patients. In contrast, the ATCAE has the capability to measure nearly all symptoms. In future studies, we intend to delve deeper into the investigation of symptom burden among patients. Finally, the heterogeneity of diseases among the patients in this study may impose limitations on the generalizability of the findings. Nonetheless, the data analysis revealed no statistically significant disparity in the quality of life among CAR-T patients with varying diseases.

In conclusion, the symptom burden experienced by patients undergoing CAR-T cell infusion during hospitalization is severe and significantly compromises their quality of life. The prior history of HSCT has a notable impact on the global QOL and physical well-being of CAR-T patients, thus warranting attention from clinical medical staff. It is imperative for nursing professionals to prioritize the management of symptom burden in CAR-T patients and implement effective interventions, particularly in enhancing sleep quality and mitigating gastrointestinal reactions.

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Data availability

The patient data supporting this study cannot be publicly disclosed to protect patient privacy. However, anonymized portions of the data may be made available upon reasonable request from qualified researchers, subject to ethical approval. For inquiries regarding this work or data requests, please contact the first author, Hongyuan Dai, at Dai.hongyuan@outlook.com.

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Author contributions

H.D.: Conception and design of work, data collection and analysis, writing draft. S.X.: Data collection and analysis, writing draft. Z.W.: editing draft. Z.L.: data collection, editing draft, supervision. J.C.: editing draft, supervision. T.H.: data collection, editing draft, supervision. F.Z.: Conception and design of work, writing draft, supervision.

Declarations

Competing interests

The authors declare no competing interests.

Additional information

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