

Time toxicity experiences and dyadic coping among older patients with liver cancer and their caregivers

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Research Article

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Abstract

Objective: To explore the experience of time toxicity among older patients with liver cancer and their caregivers from a dyadic coping perspective.

Methods: A qualitative descriptive study was conducted using semi-structured interviews with patient–caregiver dyads. Data were analyzed using thematic analysis.

Results: Time toxicity was characterized by both explicit burdens (e.g., frequent hospital visits, prolonged waiting) and implicit psychological costs (e.g., anxiety, guilt). Dyadic coping played a critical role in shaping temporal experiences, with both stress transmission and collaborative coping observed.

Conclusion: Time toxicity in liver cancer extends beyond objective time expenditure to a relational and psychological phenomenon. Interventions targeting healthcare processes and dyadic coping may help reduce time burden and improve quality of life.

Introduction

With the acceleration of population aging, primary liver cancer has become a high-burden malignancy worldwide. According to data released by the National Cancer Center of China ^[1, 2], there were 367,700 new cases of primary liver cancer in China in 2022, accounting for 42.5% of global cases. It ranked fourth in the number of new cancer cases and fifth in incidence among all malignancies.

Liver cancer is characterized by an insidious onset and a complex disease trajectory. Patients often undergo prolonged and frequent medical interventions, including surgery, interventional therapy, targeted therapy, and immunotherapy. While such intensive medical engagement may prolong survival, it also gives rise to time toxicity.

Time toxicity is an emerging metric of treatment burden in oncology, referring to the cumulative time patients spend on treatment- and care-related activities, which substantially affects their quality of life and social functioning^[3, 4]. This extensive time commitment markedly reduces time available for daily life and overall well-being. Notably, the impact of time toxicity extends beyond the individual patient. Within the context of family-centered culture in China, older patients heavily rely on family members during diagnosis and treatment, and the associated time burden is often transferred to caregivers^[5, 6]. However, research on how patient–caregiver dyads jointly cope with time toxicity remains limited. Research on how patient–caregiver dyads cope with time toxicity is limited. This study explores these experiences among older adults with liver cancer and their primary caregivers, providing insights for optimizing care and reducing family burden.

Methods

1.1 Participants

Participants were recruited using purposive sampling, guided by the principle of maximum variation. Twelve dyads of older adults diagnosed with primary liver cancer and their primary family caregivers were recruited from the Department of Gastroenterology in a tertiary hospital in Henan Province between January and February 2026. Variation was considered for age, sex, education level, and disease stage to capture diverse experiences.

Patients were eligible if they were aged 60 years or older, had a confirmed diagnosis of primary liver cancer according to the 2026 Chinese Guidelines^[7], had received antitumor treatment for at least six months with stable disease, had no significant cognitive impairment, and provided written informed consent to participate voluntarily.

Primary caregivers were included if they were informal caregivers providing the main support for the patient (e.g., spouses or children), offered unpaid care for at least 14 hours per week for a minimum of three months, were aged 18 years or older, had no cognitive impairments, and provided written informed consent.

Patients were excluded if they had severe cognitive impairment or consciousness disturbances, or comorbid psychiatric disorders. Caregivers were excluded if they were formal professional caregivers or unable to complete the interview for any reason.

Sampling continued until data saturation was achieved. In the first stage of interviews, no new themes emerged after the 11th dyad; one additional dyad was subsequently included, resulting in a total of 12 patient–caregiver dyads. Participants were assigned identification numbers sequentially. The general characteristics of patients and caregivers are presented in Table 1 and Table 2, respectively.

Ethical approval for this study was obtained from the Ethics Committee of the First Affiliated Hospital of Henan University of Chinese Medicine (No. 2025HL-151). Detailed ethical procedures and consent information are provided in the 'Declarations' section.

Table 1 General Information of Patients (n=12)

ID	Gender	Age (Years)	Marital Status	Educational Level	Disease Course (Years)	Disease Stage
A1	Male	63	Married	Farmer	2.3	HCC, CNLC-Ib
A2	Male	60	Married	Primary school	2	HCC, CNLC-Ib
A3	Male	77	Married	Farmer	3	HCC, CNLC-Ib
A4	Female	77	Widowed	Farmer	5	HCC, CNLC-Ib
A5	Male	62	Married	Junior high school	2	HCC, CNLC-Ib
A6	Male	74	Married	Primary school	2	HCC, CNLC-IIa
A7	Male	75	Married	Primary school	1	HCC, CNLC-Ib
A8	Male	72	Married	Farmer	12	HCC, CNLC-IIa
A9	Female	63	Married	Farmer	3	HCC, CNLC-Ib
A10	Male	69	Married	Farmer	5	HCC, CNLC-IIa
A11	Male	66	Married	Primary school	0.6	HCC, CNLC-IIa
A12	Male	78	Married	Junior high school	3	HCC, CNLC-Ib

Table 2 Baseline Characteristics of Caregivers (n=12)

ID	Gender	Age (Years)	Marital Status	Educational Level	Occupation
P1	Female	60	Married	Farmer	Retired
P2	Female	58	Married	Primary School	Retired
P3	Male	50	Married	Primary School	Employed
P4	Female	52	Married	Junior High School	Employed
P5	Female	60	Married	Junior High School	Retired
P6	Female	32	Married	Junior High School	Employed
P7	Male	48	Married	Primary School	Employed
P8	Female	45	Married	Junior High School	Employed
P9	Male	40	Married	Bachelor's Degree	Employed
P10	Female	42	Married	Junior High School	Employed
P11	Male	38	Married	Junior High School	Employed
P12	Female	50	Married	Junior High School	Employed

1.2 Study Design

1.2.1 Development of Interview Guide and Timing of Interviews

This study employed a descriptive qualitative design. In-depth, semi-structured interviews were conducted with patient–caregiver dyads to explore experiences of time toxicity from a dyadic perspective.

The interview guides were developed based on a comprehensive review of literature on time toxicity and dyadic coping, considering the clinical context of liver cancer management in older adults. Pilot interviews with several dyads were conducted, and the guides were refined based on emerging issues and participant feedback to ensure clarity and relevance. The final interview guides were as follows:

Interview guide for patients

- (1) During the course of illness and treatment, what major changes have occurred in your time arrangement and perceptions compared with before? Were there any particularly difficult or memorable moments?
- (2) Throughout the treatment process, which aspects consumed the most time and energy?
- (3) When facing time-consuming treatments and feelings of frustration, how do you usually cope? What support do your family members provide, and how does this affect your emotions?

- (4) In jointly coping with time demands of treatment, which aspects worked well and which involved disagreements or difficulties?
- (5) What kind of support would you expect from hospitals or healthcare professionals to reduce time and energy expenditure during treatment?

Interview guide for caregivers

- (1) Please briefly describe your daily experience accompanying the patient during diagnosis and treatment, as well as your physical and psychological status.
- (2) During caregiving, which tasks consume most of your time and energy?
- (3) How has long-term caregiving and accompanying treatment affected your daily routine, work, emotions, and physical health?
- (4) How do you usually cope with time-related pressure? Has the patient ever engaged in behaviors that made you feel supported or helped reduce your time burden?
- (5) When jointly managing time-consuming caregiving and treatment-related tasks, how do you support each other? Are there any difficulties in communication or coordination?
- (6) What support would you expect from hospitals, communities, or society to reduce time burden and caregiving pressure?

1.2.2 Data Collection and Quality Control

Data were collected using semi-structured, dyadic in-depth interviews. Based on expert consultation and pilot interviews, separate semi-structured interview guides were developed for patients and caregivers.

Interviews were conducted by researchers who had received standardized training. To minimize mutual influence, patients and caregivers were interviewed separately in quiet, private consultation rooms within the wards. Interviews were audio-recorded and lasted approximately 15–20 minutes each.

Interviews used primarily open-ended questions with probing and follow-up to elicit detailed accounts. Data collection continued until thematic saturation was reached, defined as the point when no new themes or subthemes emerged. A total of 12 patient–caregiver dyads were ultimately included.

1.2.3 Data Analysis

Audio recordings were transcribed verbatim by two researchers within 24 hours of each interview. Transcripts were analyzed using Colaizzi's seven-step phenomenological method^[8], combined with dyadic cross-analysis. Open, axial, and selective coding were applied in two stages: within-case analysis followed by cross-dyad comparisons to identify core themes and subthemes. Credibility and

trustworthiness were enhanced through independent coding by two researchers, participant member checking, and review by qualitative research experts.

The research team reflected on their professional backgrounds and potential influences on data interpretation throughout the analysis process to enhance reflexivity.

Results

A total of four core themes and eight subthemes were identified, comprehensively reflecting the experiences of time toxicity, dyadic interactions, and coping needs of older patients with liver cancer and their caregivers throughout the disease trajectory.

2.1 Manifestations of Time Toxicity

2.1.1 Fragmentation and Disorganization of Time

Patients' previously continuous and structured daily lives were repeatedly disrupted by frequent hospitalizations, cyclical treatments, intensive imaging, and laboratory monitoring. As a result, time became fragmented, and natural life rhythms were continuously interrupted.

Participant A6 stated, "My days are basically spent in the hospital—infusions today, examinations tomorrow—I have no time of my own."

Prolonged infusions, indwelling catheters, and extended periods of bed rest and waiting created a perception of time as slow and burdensome. Time was no longer perceived in terms of day and night, but rather measured by the rate of intravenous infusion and the duration of waiting for examinations. Consequently, patients' lives became highly disrupted and passive.

2.1.2 Anxiety Associated with Sunk Medical Time Costs

The findings indicated that time toxicity among older patients with liver cancer was not only attributable to geographical distance and procedural complexity, but also closely related to the multi-stage, repetitive trajectory of hospitalization, evaluation, and subsequent treatment. This process resulted in a pattern of continuously accumulating time investment with uncertain returns.

For patients residing far from the hospital, commuting and appointment scheduling constituted a substantial time burden. As one patient (A4) described, "The whole appointment process takes a lot of time. We live far away and have to drive to the hospital every time, which takes a long time."

In addition, the scarcity of resources in tertiary hospitals led to difficulties in securing hospital beds and prolonged waiting times for examinations, making extended and disorganized waiting a common experience. As another patient (A3) stated, "I feel this is really time-consuming. Every time I have to queue to make an appointment for examinations. Once, I waited three days just to get an appointment, and most of the time was spent waiting."

2.2 Psychological Burden in Dyadic Coping

2.2.1 Self-Blame and Guilt in Dyadic Coping

The findings revealed that, within the context of dyadic coping, patients gradually internalized their illness experiences as a source of time burden, as the prolonged and repetitive treatment process consumed substantial time and energy from caregivers. This internalization led to persistent feelings of guilt and self-blame. Patients commonly expressed concerns about becoming a burden or causing inconvenience to their caregivers, and some even concealed their discomfort or refused assistance in an effort to reduce the caregiving burden.

As one patient (A2) stated, “My illness has delayed my children’s work. They all have their own lives, and I don’t want to disturb them.”

Caregivers who were only children often faced significant challenges, including difficulty taking leave, lack of alternative support, and career disruption, forcing them to shoulder caregiving responsibilities alone. As one caregiver (P9) described, “I am an only child and not married. I worked in another city, but because of her illness, I had to put my job on hold and stay here to take care of her.”

Their silent dedication and accumulated fatigue further intensified patients’ feelings of self-blame and guilt.

2.2.2 Cognitive Misalignment and Emotional Spillover

The findings indicated that discrepancies between patients and caregivers in their perceptions of time value, disease progression, and treatment scheduling often led to tension and conflict. Prolonged waiting, physical discomfort, and accumulated stress further exacerbated these tensions.

As one caregiver (P1) described, “He feels so uncomfortable that he doesn’t want to talk, and sometimes I’m too exhausted to cope. As we talk, we end up arguing.”

Such stress was also accompanied by feelings of guilt arising from the inability to fulfill family roles due to time conflicts. As one patient (A5) stated, “Because of my prolonged illness, when my children needed my involvement and support during their growth, I was unable to be there due to the time and money spent on treatment.”

The tension between caregivers’ exhaustion and patients’ emotional restraint led to reduced communication and insufficient mutual understanding, resulting in gaps in support and emotional misalignment, which further compounded the psychological burden on both patients and caregivers.

2.3 Temporal Regulation in Dyadic Coping

2.3.1 Collaborative Coping Strategies

The findings indicated that, as the disease trajectory progressed, patients with liver cancer and their caregivers gradually shifted from passively adapting to medically imposed time schedules to actively negotiating the use of time. This shift led to the development of time reallocation strategies oriented toward quality of life. Rather than being fully constrained by treatment procedures, decisions were increasingly made jointly based on patients' physical condition and overall well-being.

Both patients and caregivers demonstrated a more accepting and composed mindset, characterized by mutual tolerance, reduced urgency, and fewer complaints. Periods of hospitalization and waiting were reframed as opportunities for companionship. As one caregiver (P3) described, "We just do the treatment when needed and rest when needed. There's no special solution—we just wait."

Through this process of acceptance and cognitive reframing, the impact of time toxicity was gradually mitigated.

2.3.2 Positive Compensation in Dyadic Coping

Repeated interventions and follow-ups disrupted temporal structure. Patients and caregivers gradually developed a shared capacity to adapt. This reflects dyadic resilience, achieved through self-regulation and social support.

At the individual level, during periods of uncertainty—such as awaiting examination results or between treatment cycles—patients coped with temporal unpredictability associated with disease progression by lowering expectations and engaging in emotional self-regulation. As one patient (A7) stated, "When I'm undergoing treatment or waiting for results, I listen to audiobooks or watch videos to distract myself. It helps reduce the feeling that time is being wasted." Caregivers, in turn, reduced their reliance on the healthcare system by internalizing caregiving skills. As one caregiver (P6) noted, "We live far from the hospital, so I've learned some basic caregiving skills. I try to handle simple care tasks myself to reduce the time spent traveling back and forth and waiting for appointments."

In addition, seeking support from family members for rotational caregiving was an important strategy. As one caregiver (P13) explained, "I have two sisters. When I don't have enough time, they come to help share the caregiving. This kind of support allows me to catch my breath." Through this collaborative coping pattern, time burdens were redistributed, participants described previously fragmented and inefficient toxic time into meaningful periods of interaction and companionship. Participants described that over time, they became more accepting of treatment schedules and began to reinterpret waiting periods as opportunities for rest or companionship.

2.4 Clinical needs: caregiver support

2.4.1 Process Optimization and One-Stop Services

Participants expressed expectations for improvements in healthcare processes, particularly regarding coordination and time efficiency. As one patient (A8) stated, "After being diagnosed in a tertiary hospital,

patients often go through multiple hospitals for examinations. We hope that, after completing examinations, we can continue treatment in nearby hospitals through internet-based services without repeating tests.”

Participants also expressed an urgent need for simplified medical insurance settlement procedures. As one patient (A10) noted, “Because of cross-regional healthcare, medical insurance reimbursement is also an issue. Treatment in tertiary hospitals may not have better reimbursement rates than local hospitals.”

2.4.2 Respite Services and Dyadic Empowerment

Caregivers, particularly only children and elderly spouses, expressed an urgent need for rotational caregiving, respite services, and home-care guidance to alleviate prolonged fatigue. They also hoped to receive professional support in communication skills, emotional regulation, and time management to optimize dyadic interactions, reduce interpersonal strain, and enhance long-term coping with the disease.

As one caregiver (P6) stated, “I’m basically attending to him every day and rarely have any time for myself. It would be much better if someone could take over occasionally.” Another caregiver (P8) noted, “Balancing hospital visits and work is particularly stressful.”

Participants also emphasized the need for professional support in communication, emotional regulation, and time management to further improve dyadic interactions. One patient remarked, “I can feel that she is very tired, but sometimes we don’t know how to communicate.” Another patient (A12) suggested, “I hope arrangements could be more patient-centered—for example, having a CT scan immediately after a fasting blood draw to reduce waiting and repeated procedures.”

These statements indicate that families affected by cancer not only focus on treatment outcomes, but also value optimized caregiving support and streamlined clinical processes to reduce time burden, enhance quality of life, and maintain autonomy over their time.

Discussion

3.1 Dual Nature of Time Toxicity in Families of Older Patients with Liver Cancer

The findings of this study indicate that time toxicity in families of older patients with liver cancer is not merely a matter of physical time expenditure, but rather a structural time burden arising from the combined effects of the cyclical nature of cancer treatment and the uncertainty of disease progression. On the one hand, frequent hospital visits, prolonged waiting periods, and cross-regional consultations constitute a prominent explicit time burden^[9]. Previous studies have shown that patients recognize some time consumption during cancer care as necessary, while also noting that certain aspects of the treatment process yield no tangible benefit^[10]. On the other hand, under sustained time pressure, older

patients and their caregivers experience anxiety, guilt, and exhaustion, representing implicit psychological costs, consistent with the mechanisms of psychological burden identified in studies of financial toxicity^[11].

Moreover, the complexity and fragmentation of the healthcare system have been identified as significant contributors to patients' time wastage, consistent with previous findings^[12]. This study further demonstrates that time toxicity manifests not only as time occupied, but also as inefficient or even futile time expenditure. In particular, repeated travel, multiple appointments, and fragmented care processes transform time into a continuously accumulating source of stress.

Therefore, to mitigate both explicit and implicit time toxicity, optimization of treatment processes at the system level is essential. Integrating diagnostic and therapeutic procedures, reducing redundant consultations, and minimizing unproductive waiting may help alleviate the time burden^[13]. Additionally, implementing a nurse navigation system—where specialized nurses provide guidance and coordination throughout the treatment trajectory—may reduce waiting times and prevent patients from becoming disoriented within the healthcare system. Promoting cross-institutional information sharing and coordinated appointment scheduling may further enhance overall resource allocation efficiency^[14].

3.2 Modulatory Role of Dyadic Coping on Time Toxicity

From a dyadic perspective, this study revealed that time toxicity exhibits significant interactivity and transference between patients and caregivers. During the cyclical process of prolonged liver cancer treatment, result waiting, and subsequent decision-making, patients' time-related anxiety arising from treatment uncertainty may be transmitted to caregivers and gradually accumulate. However, this stress can be partially alleviated through collaborative coping. This finding extends previous research, which has primarily conceptualized time burden as an individual experience^[15].

Patients' self-blame and emotional restraint, combined with caregivers' fatigue and stress, mutually reinforce each other. This interaction forms an emotion–time interplay. In this process, negative emotions accumulate and are continuously adjusted. This process exacerbates individuals' subjective perception of time expenditure and aligns with established dyadic stress transmission mechanisms^[16]. Conversely, when both parties achieve concordant understanding and employ collaborative coping strategies—particularly during waiting periods for examinations or between treatment cycles—previously fragmented and disordered time can be reconstructed as time for companionship, thereby mitigating its toxic effects through cognitive reframing of temporal experience.

Furthermore, the study identified that insufficient dyadic coping capacity itself constitutes a key mechanism exacerbating time toxicity. This finding not only corroborates but also extends prior research, which has predominantly focused on the impact of poor communication and emotional dysregulation on stress^[17, 18]. Specifically, deficits in time management skills were found to amplify time toxicity by increasing the disorganization inherent in the care and treatment process.

Interventions should reduce objective time expenditure and enhance temporal experience by strengthening dyadic coping. This includes communication, emotional regulation, and time management training. Additional strategies such as rotational family support, counseling, and social work interventions help establish effective collaborative coping^[19].

3.3 Nursing Needs from a Dyadic Coping Perspective

Traditional nursing care for liver cancer has primarily focused on symptom management and treatment adherence, with limited attention to the fragmented temporal experiences arising from repeated treatments and follow-up processes. However, the findings of this study suggest that caregivers also engage in sustained involvement in time allocation, decision-making, and emotional support, and are subject to substantial time-related burden.

Furthermore, this study demonstrated that patients with liver cancer and their caregivers are highly interdependent in the caregiving process, with their time arrangements exhibiting shared and mutually influential characteristics. These findings suggest that caregiving roles and time-related experiences are shared between patients and caregivers, indicating the importance of considering both parties in understanding time burden. Ongoing assessment of time-related stress and its sources in both parties is warranted, with individualized support strategies developed accordingly^[20].

For example, during clinical encounters, nurses can assist patients and caregivers in basic time planning and information integration to reduce unnecessary waiting and repeated travel. Where feasible, psychological support or brief guidance on emotional regulation may also be provided. In addition, standardized educational materials and tools—such as question prompt lists—can be utilized to mitigate time burdens arising from information asymmetry and ineffective communication. These measures may help mitigate the impact of time toxicity^[21, 22].

3.4 Optimizing Interventions for Time Toxicity

The findings of this study suggest that alleviating time toxicity in families of older adults with liver cancer is influenced not only by individual-level adjustment, but also by factors related to healthcare process organization and caregiving support contexts. Participants were particularly sensitive to time demands during healthcare encounters, especially in terms of travel frequency, waiting duration, and continuity of care processes. They generally perceived that such time-related burdens could influence their treatment planning and decision-making^[23, 24].

Meanwhile, caregivers operating under conditions of prolonged high-intensity involvement and insufficient substitute support often experienced negative outcomes such as psychological exhaustion. These experiences may, in turn, affect patients with liver cancer through emotional and behavioral pathways, thereby exacerbating the subjective perception of time toxicity.

Based on these findings, future practice may benefit from greater attention to the impact of healthcare process design and caregiving support on temporal experience. For example, efforts should be made to optimize coordination of multi-stage follow-up examinations and treatment processes for patients with liver cancer, thereby minimizing time fragmentation resulting from dispersed testing and discontinuous information flow. In addition, phased or structured support for caregivers—such as rotational family support, home-based care guidance, and communication and emotional support interventions—is recommended to help alleviate time-related pressures and improve experiences throughout the care and treatment trajectory^[25].

Conclusion

This study demonstrates that older adults with liver cancer and their caregivers develop a form of time toxicity characterized by fragmentation, discontinuity, and uncertainty, shaped by the combined influences of repeated treatments, cyclical imaging follow-ups, and uncertainty in disease progression. This experience is reflected not only in the quantity of time consumed, but also in the persistent psychological burden resulting from disruptions in temporal structure.

From a dyadic coping perspective, this study elucidates the interactive mechanisms of time-related stress between patients and caregivers, extending the conceptualization of time toxicity from an individual-level experience to a relational process. Furthermore, these findings provide empirical insights into how time-related experiences are constructed within patient–caregiver dyads.

Declarations

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki and was approved by the Ethics Committee of the First Affiliated Hospital of Henan University of Chinese Medicine (No. 2025HL-151). Written informed consent was obtained from all individual participants (patients and caregivers) included in the study prior to data collection.

Consent to publish

Consent to publish: Not applicable. (The manuscript does not contain any individual person's data in any form, including individual details, images, or videos).

Clinical trial registration

Clinical trial registration: Not applicable. (This study is a qualitative study and does not constitute a clinical trial).

Data Availability Statement

The datasets generated during and/or analysed during the current study are not publicly available due to participant privacy and confidentiality but are available from the corresponding author on reasonable request.

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Conflict of interest

The authors declare no conflict of interest.

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