

INTRODUCTION

Why Use VR for Caregivers

- Estimated 48 million people served as unpaid family caregivers in the U.S. in 2020
- Caring for someone undergoing cancer treatment is difficult and even more challenging with intense treatments such as hematopoietic stem cell transplant (HSCT)
- HSCT caregivers experience high levels of stress and symptoms (fatigue, sleep disturbance, depression, anxiety, and impaired cognition)
- Very few interventions have focused specifically on reducing stress and symptoms
- Virtual reality (VR) technology has become more immersive, affordable, and portable
- VR interventions have been used in a variety of clinical settings (relaxation, mindfulness, distraction, cognitive coping and rehabilitation)

Nature Experience through VR

- Nature exposure has been shown to effectively reduce physiologic and perceived stress (Attention Restoration Theory)
- Limited mobility or time can restrict access to restorative environments
- VR is increasingly used to provide virtual access to nature

Research Gap

- Few efficacy studies focusing on family caregivers
- Research focuses on individual symptoms, despite caregivers facing multiple, co-occurring symptoms
- A few studies have explored physiological changes

PURPOSE

This study aims to assess the feasibility, acceptability, and effectiveness of a four-week nature-based VR intervention on stress, symptoms and stress biomarkers in allogeneic HSCT caregivers.

METHODS

- Design:** Phase 1 as part of the two-Phase study
 - Phase 1: A single-arm pre-post design (Target N=12)
 - Enrollment started in June 2024 and is ongoing
 - Completed (n= 9), currently enrolled and actively participating (n=1)
 - Phase 2: Randomized controlled trial (RCT) (Target N=78)
- Setting:** NIH Clinical Center
- Participants:** Family caregivers of allogeneic HSCT recipients (18 yrs and older)
- Measures**

Variables		
Feasibility/ Acceptability	Feasibility	Adherence to intervention
	Acceptability	Satisfaction, Usability, Safety
Outcomes	Stress ^a	Perceived stress
	Symptoms ^b	Fatigue, Sleep disturbance, Depression, Anxiety, Cognitive impairment
Influential Factors	Physiologic	Age, Sex, Race/ethnicity, Physical health
	Psychologic	Caregiver burden, Loneliness
	Situational	Socioeconomic status, Caregiver/patient relationships, Mutuality, Health behaviors, Patient characteristics
Exploratory Factors	Salivary stress biomarkers (e.g., cortisol) ^c	

Note. ^a Perceived stress was measured using the Perceived Stress Scale (PSS); ^b Symptoms were measured by Patient-Reported Outcomes Measurement Information System (PROMIS); ^c Saliva samples were collected three times at Time 0 baseline visit (before VR, immediately after VR, 20 minutes after VR) and at Time 4 visit (before VR, immediately after VR, 20 minutes after VR). To index cortisol awakening response, the participants were instructed to collect three saliva samples (immediately after awakening, 30 minutes after awakening, bedtime) within three days of Baseline and Time 4.

INTERVENTION

- VR headset:** Pico G3 headset
- Program:** 360° high-definition videos with nature sounds produced by Atmosphaeres
- 20 minutes daily for 4 weeks



Figure 1. Themes and Screenshots of VR Experiences Available to Study Participants



RESULTS

Table 1. Characteristics of the Sample and Study Variables (N = 9)

Variables	Category	Mean (SD) n (%)
Caregiver characteristics		
Age (years), range		45.67 (9.97), 25.0-62.0
Sex	Male	5 (55.6)
Race	White	5 (55.6)
	African American	2 (22.2)
	Asian	1 (11.1)
	Multiracial	1 (11.1)
Ethnicity	Hispanic	1 (11.1)
	Non-Hispanic	8 (88.9)
Marital status	Married/partner	7 (77.8)
	Not married ^a	2 (22.2)
Employment status ^b	Working	6 (66.7)
	Not working	3 (33.3)
Household income	Less than \$50,000	1 (11.1)
	\$50,000-89,999	0 (0.00)
	\$90,000 more	7 (77.8)
Relationship to the patient	Spouse/partner	4 (44.4)
	Non-spouse family member ^c	5 (55.6)
Caregiver role	Sole/primary caregiver	4 (44.4)
	Member of caregiving team	5 (55.6)
Caregiving hours/day		6.67 (6.95), 2-24
Patient characteristics		
Age (years), range		33.2 (15.0), 18-64
Sex	Female	7 (77.8)
Race	White	4 (44.4)
	African American	2 (22.2)
	Asian	2 (22.2)
	Multiracial	1 (11.1)
	Hispanic	1 (11.1)
Ethnicity	Non-Hispanic	8 (88.9)
	Hispanic	1 (11.1)
Primary diagnosis ^d	Hematological malignancy	2 (22.2)
	Non-malignant hematologic	7 (77.8)

Note. ^a Not married = single (never married), separated, divorced, widowed; ^b Employment status = working (full-time, part-time), not working (disabled, unemployed, retired, on leave); ^c Non-spouse family member = parent, sibling; ^d Primary diagnosis = hematological malignancy (acute myelogenous leukemia, non-Hodgkin lymphoma); non-malignant hematologic (inherited bone marrow failure disorder, aplastic anemia, sickle cell disease, primary immunodeficiency disease)

Table 2. Feasibility, Acceptability and VR Symptoms Results (N=9)

Variables		Mean (SD), range n (%)
Feasibility		
Adherence to intervention		20 out of 28 (71.4)
Acceptability		
Satisfaction		12.78 (1.79), 9-15
Usability		14.44 (1.94), 10-16
VR Symptoms (safety)		
General discomfort	None	9 (100)
Fatigue	None	9 (100)
Eyestrain	None	7 (77.8)
	Slight	2 (22.2)
Difficulty focusing	None	8 (88.9)
	Slight	1 (11.1)
Headache	None	9 (100)
Fullness of head	None	9 (100)
Blurred vision	None	9 (100)
Dizzy	None	9 (100)
Vertigo	None	9 (100)
Perceived Restorativeness Scale (PRS)		25.11 (4.23), 18-30

- Feasibility:** The average completion rate was 71.4 %, with no attrition.
- Acceptability:** The results indicate that VR headsets and programs were easy to use and associated with few user VR symptoms.

Table 3. Semi-structed Exit Interview at Week 4 (N=9)

Questions	Responses
1. How did participating in this study make you feel?	- Bit of an escape at times and other times, oh, shoot do I have time. Mixed feelings. Stretched me time-wise. - It was something new. I could discover. Places where normally I can't go, but I was able to visit in VR environment. It was fun. - It made me feel good. - Enjoyable experience. - I thought the videos were very well made.
2. Would you like to participate in a study like this one again?	- Yes (8) - Maybe, depending on the timing (1)
3. Of the 'experiences' you watched, which did you like the most? Why?	- Meadows 1 and 2, beautiful locations transported with combo of visual and sounds - Nature. All nature videos. e.g., Lake - I liked the creek, it was the best, the waterfalls, the clear water, some forest, so calming - Tie between the beach and mountains. Preferred the nature, mountain, creek, river.
4. Of the 'experiences' you watched, which did you like the least? Why?	- Travel (especially travel 1, Paris): repeating itself - Sunset and sunrise. Expected to see different locations and angles but all scenes were similar. The river one, it was kind of boring.
5. What did you think about the duration of the 'experiences? Were they too long? Too short?	20 mins is perfect (8) - Depends, Usually 20 mins fine (1)

- In the interviews, participants reported that VR was easy to use, appealing and relaxing and that they had a positive experience overall.
- Most participants were satisfied with the length of the program (20 minutes) and preferred 'Nature' content over 'Travel.'

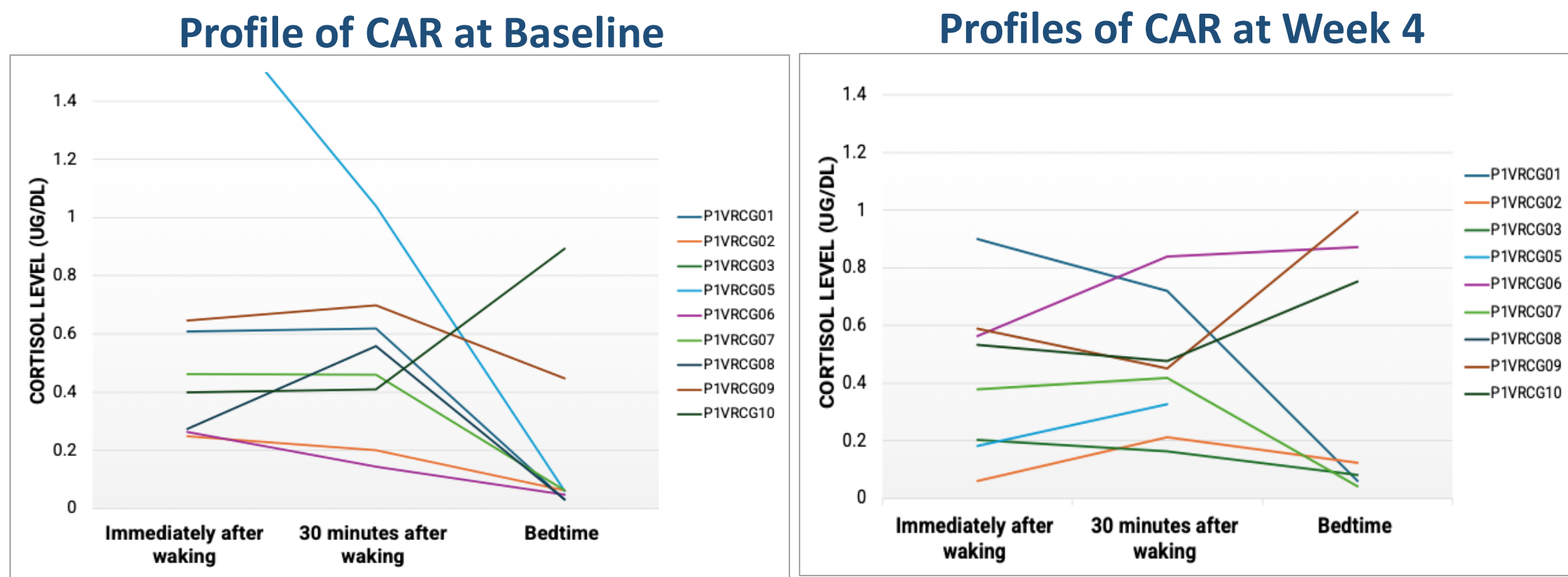
RESULTS

Table 4. Wilcoxon Signed-Rank Test From Pre-to Post-Intervention on Stress and Symptoms (N=9)

Variables	Pre-intervention Mean (SD)	Post-intervention Mean (SD)	p
Perceived stress	15.0 (4.5)	11.8 (6.6)	0.121
Symptoms			
Fatigue	54.9 (10.6)	47.8 (8.3)	0.262
Sleep Disturbance	50.3 (4.4)	49.0 (5.9)	0.110
Depression	48.1 (8.1)	47.4 (8.9)	0.735
Anxiety	50.1 (8.2)	49.7 (8.8)	0.263
Cognitive Impairment	49.3 (6.1)	49.0 (3.4)	0.859

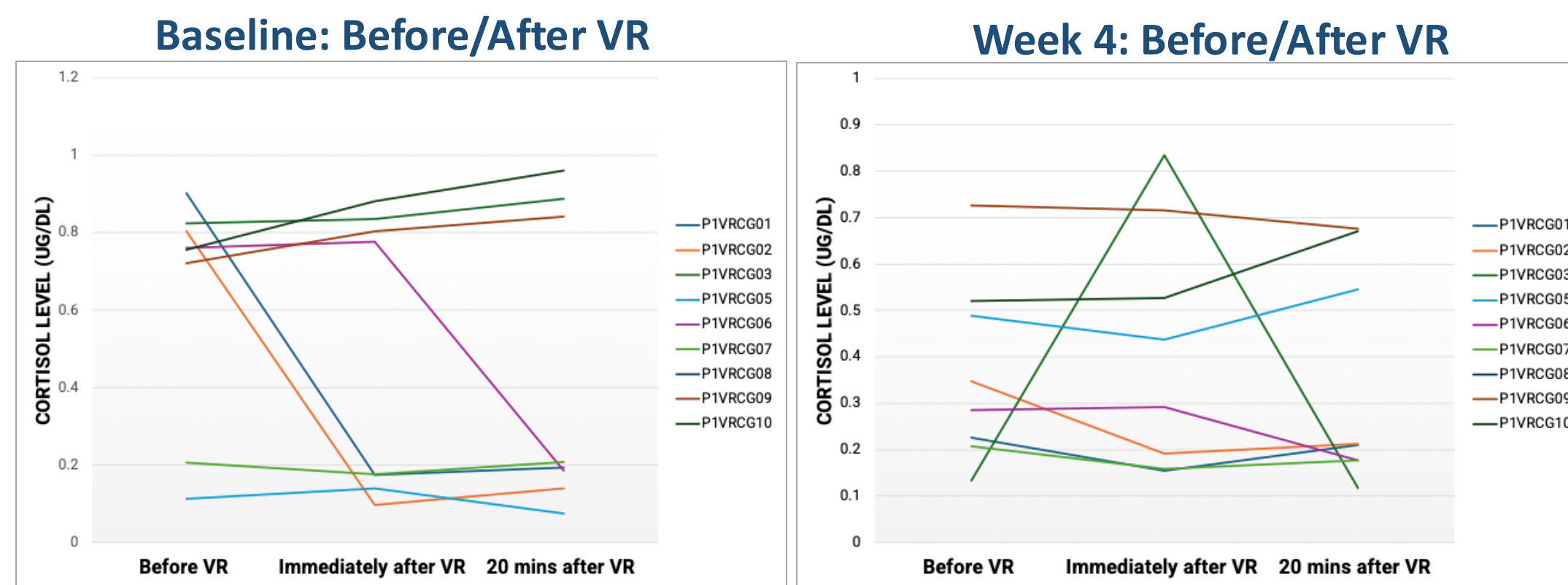
- Pre-intervention and post-intervention comparisons showed no significant differences in perceived stress and symptoms (all p > .05).

Figure 2. Chronic Stress: Profiles of the Cortisol Awakening Response (CAR) at Baseline and Week 4 (N=9)



- At baseline, abnormal CAR patterns (reduced or absent cortisol levels after waking) were observed, indicating dysfunction of the HPA axis, which regulates stress responses and cortisol production.
- At Week 4, normal CARs patterns were observed in some participants

Figure 3. Levels of Salivary Cortisol Before- and After- Intervention at Baseline and Week 4 (N=9)



- At both baseline and Week 4, decreased cortisol levels were observed immediately after VR and 20 minutes post-VR in some participants

DISCUSSION

- Preliminary findings suggest that the nature-based VR experiences for stress reduction may be both feasible and acceptable among family caregivers of HSCT recipients.
- The nature-based VR program could be implemented as a convenient, engaging, and easily applicable intervention to reduce stress and symptoms in family caregivers, anytime and anywhere, distinguishing it from existing stress reduction interventions.
- The findings will lay the groundwork for advancing to the Phase 2 study (RCT), in which we aim to examine whether HSCT caregivers participating in the VR intervention demonstrate improved levels of perceived stress compared to the control group.
- Limitation:** Small sample size, no comparison group
- Future direction:** Future studies with larger samples and more diverse populations (e.g., patients, caregivers of pediatric patients) would provide more robust evidence for the efficacy of a nature-immersive VR intervention.

REFERENCES



Contact
Lena J. Lee, PhD, RN
jumin.park@nih.gov