

BIOMEDICAL SCIENCES

Evaluating the Impact of a Structured Health Education Program on Caregiver Knowledge in Pediatric Oncology: A Pre–Post Intervention Study at a Tertiary Hospital in Central Vietnam

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Abstract

Background: In lower-middle-income countries, home-based care provided by primary caregivers is critical to the survival and quality of life of children with cancer. Limited caregiver health literacy contributes to preventable complications, treatment abandonment, and poorer clinical outcomes.

Objective: To evaluate baseline knowledge among primary caregivers of children with cancer and determine the effectiveness of a structured nursing-led educational intervention at a tertiary referral hospital in Central Vietnam.

Methods: A prospective pre–post intervention study was conducted among 80 primary caregivers at the Pediatric Center, Hue Central Hospital (January–December 2025). The intervention combined individualized nursing counseling with the standardized Childhood Cancer Care Handbook, available in print and via QR code. Caregiver knowledge was assessed before and at least one month after the intervention using a structured questionnaire covering five domains: general cancer knowledge, side-effect management, infection prevention, home monitoring and warning signs, and cultural misconceptions.

Results: Most caregivers were mothers (66.3%), female (75.0%), and from rural areas (75.0%). Baseline knowledge was lowest for general cancer concepts ($61.6 \pm 26.5\%$) and cultural misconceptions ($34.5 \pm 39.9\%$), with poor recognition of eye changes (31.2%) and bone pain/limb swelling (51.2%) as warning signs. Following the intervention, significant improvements were observed in general cancer knowledge ($90.1 \pm 14.7\%$), side-effect management ($96.4 \pm 7.7\%$), infection prevention ($99.8 \pm 1.9\%$), and misconception rejection ($54.1 \pm 41.7\%$) (all $p < 0.05$). Home-monitoring knowledge remained high and showed no significant change ($92.6 \pm 15.2\%$ vs. $95.1 \pm 10.1\%$, $p > 0.05$). Although educational level influenced baseline knowledge ($p < 0.05$), these differences were no longer significant after the intervention.

Conclusions: A standardized, nursing-led educational program substantially improved caregiver health literacy and reduced knowledge disparities across educational backgrounds. Structured, culturally appropriate education should be integrated into pediatric oncology care to strengthen home-based management and reduce healthcare inequities in resource-limited settings.

Keywords: childhood cancer; caregiver education; health literacy; nursing intervention; health equity.

Introduction

Childhood cancer represents a complex spectrum of malignant neoplasms that stands as a leading cause of non-communicable disease mortality among children worldwide. While advancements in risk-stratified therapies and supportive care have pushed pediatric survival rates past 80% in high-income nations, a profound survival gap persists in low- and middle-income countries (LMICs), where survival rates frequently stall between 20% and 40% [1, 2]. This stark disparity is driven heavily by high rates

of treatment-related mortality, including preventable infections, severe toxicities, acute malnutrition, and therapy abandonment [1, 2]. In Vietnam, where an estimated 2,000–3,000 children are diagnosed with cancer annually, clinical outcomes remain heavily compromised by these treatment-related toxicities and significant gaps in home-based supportive care frameworks [3, 4].

Because complex, toxic, and protracted therapeutic cycles require substantial outpatient management, the primary caregiver becomes an indispensable pillar within the multidisciplinary care team. The responsi-

bilities thrust upon family members are exceptionally demanding, requiring them to monitor treatment toxicities, maintain rigorous infection control, manage nutrition, and recognize emergency warning signs. Caregiver vigilance and clinical proficiency directly determine patient safety, treatment adherence, and overall prognosis [3, 5].

Despite the critical nature of home care, primary caregivers frequently face severe gaps in baseline oncology health literacy during the acute phase following a child's diagnosis. In Vietnam, this vulnerability is compounded by socioeconomic and geographical barriers. Caregivers from rural or remote regions often lack access to verified health information, leading to critical delays in seeking emergency care or the adoption of harmful traditional medicine practices. Furthermore, deeply rooted cultural misconceptions regarding childhood cancer, such as false beliefs concerning the transmissibility of malignancies, fertility deficits, or shortened lifespans among survivors, foster social stigma and cause profound psychological distress within the family unit [4, 6]. To address these barriers, international guidelines mandate that family education must be structured, iterative, and dynamic [7]. In high-resource settings, pairing face-to-face counseling with standardized visual aids has been shown to reduce catheter-related infections, minimize emergency readmissions, and enhance medication adherence [3].

As a premier national safety-net tertiary referral hospital, the Pediatric Center at Hue Central Hospital treats a highly vulnerable patient population coming from multiple provinces in Central Vietnam. While routine verbal counseling has long been practiced by nursing staff, the lack of an objective, verifiable educational framework has historically precluded a systematic evaluation of its clinical efficacy. To bridge this gap, a standardized tool, the "Childhood Cancer Care Handbook" (Sổ tay ung thư trẻ em – những điều cần biết), was developed through a collaborative national initiative involving pediatric oncology specialists and supported by the Asian Children's Cancer Alliance (ACCL) and St. Jude Children's Research Hospital. However, its performance and direct impact on caregiver comprehension had yet to be empirically verified within the region. Therefore, this prospective intervention study was designed to characterize the baseline socio-demographic profiles and initial oncology knowledge gaps among primary caregivers at Hue Central Hospital, and to rigorously evaluate the clinical efficacy of a structured nursing-led health education program combining personalized counseling with this standardized handbook in improving knowledge scores across key clinical domains.

Materials and Methods

Study Design and Setting

This clinical study utilized a prospective, pre- and post-intervention design conducted over a 12-month

period from January 2025 to December 2025. The research was localized within the Department of Pediatric Oncology, Hematology, and Bone Marrow Transplantation at the Pediatric Center of Hue Central Hospital, Vietnam. As a premier national safety-net tertiary medical institution, this specialized center serves as the primary regional hub for complex pediatric hematology and oncology care across the central and western highland provinces of Vietnam.

Participant Selection

A convenience sampling strategy was used to recruit study participants from the target hospital population.

Inclusion Criteria: Eligible candidates were defined as primary caregivers (including biological parents, grandparents, or legal guardians) who held direct, daily responsibility for the inpatient or outpatient care of a child undergoing active oncological therapy; were aged ≥ 18 years; had the ability to communicate, read, and respond in Vietnamese; and voluntarily provided informed consent after full explanation of study objectives.

Exclusion Criteria: Caregivers were excluded if they did not directly participate in childcare; could not complete the interview due to psychological, health, or cognitive reasons; or refused to participate or did not complete all study components.

Sample Size: A total of 80 primary caregivers were enrolled.

The Structured Health Education Intervention

The health education program consisted of a dual-component intervention pairing a standardized written/visual communication tool with personalized, structured face-to-face clinical counseling.

The Educational Tool: The intervention centered on the implementation of the standardized manual "Childhood Cancer Care Handbook" (Sổ tay ung thư trẻ em – những điều cần biết). This booklet was developed through a collaborative national initiative involving senior pediatric oncology specialists, clinical pharmacists, and nursing leadership across major national oncology centers in Vietnam, with support from ACCL and St. Jude Children's Research Hospital. The content was structurally validated and adapted from international guidelines, including those from the Children's Oncology Group (COG) and the World Health Organization (WHO), to match the sociocultural and health literacy landscape of families in developing regions.

The Delivery Protocol: Upon enrollment, caregivers underwent a baseline pre-intervention evaluation to map existing clinical knowledge. Following the pre-test, each primary caregiver was provided with a physical copy of the handbook and guided to access a PDF version via QR code. Clinical nursing staff executed individual face-to-face teaching sessions

during inpatient admission. The intervention utilized a dynamic, iterative feedback cycle; nurses regularly checked on the families during clinical ward rounds to answer questions, clarify specific instructions, and reinforce care methods throughout the child's hospital stay. The post-intervention knowledge assessment was systematically administered at least one month after the intervention.

Data Collection Instruments

Data collection was facilitated via a structured, multi-part questionnaire administered at pre- and post-intervention intervals. The instrument was split into two primary segments:

Socio-demographic Profiles: Captured critical baseline characteristics, including caregiver age, gender, familial relationship to the pediatric patient, geographic origin (urban vs. rural), formal educational background (lower secondary and below, high school, or tertiary/university levels), and current occupational status.

Core Oncology Knowledge Questionnaire: Comprised targeted questions designed to assess caregiver literacy across five core clinical dimensions:

General Disease Concepts: Basic pathology of childhood malignancies, including definition of cancer, curability, and non-contagious nature.

Early Warning Signs: Recognition of 10 critical warning signs of childhood cancer (pallor/bruising, lumps/swelling, unexplained weight loss/persistent cough/fever/night sweats, eye changes, abdominal distension, persistent headache/vomiting, bone pain/limb swelling).

Side Effect Management: Strategies for managing common toxicities, including exercise, sleep hygiene, small frequent meals, high-protein foods, foods to avoid, fiber/fluid intake, and soft diet preparation.

Infection Control and Nutrition: Practical implementation of infection precautions, including food expiration checks, refrigeration, hand hygiene, oral care, crowd avoidance, and room cleanliness.

Home Monitoring and "Red Flag" Symptoms: Immediate identification of acute medical emergencies requiring urgent care, including high fever ($\geq 38^{\circ}\text{C}$), uncontrolled vomiting, diarrhea/constipation, uncontrolled pain, seizures/altered mental state, respiratory changes, bleeding, inability to eat, lack of urination within 12 hours, and no bowel movement within 48 hours.

Cultural Misconceptions: Evaluation of myths surrounding childhood cancer survivorship, including beliefs about transmissibility, "weak genes", shortened lifespan, poor school/work performance, social difficulties, need for continued follow-up, and future stigma.

Statistical Analysis

All analytical processes were computed using SPSS software version 26.0. Continuous variables and overall knowledge scores were presented as means with standard deviations, whereas categorical demographic variables were summarized via frequencies and percentages. To measure the clinical efficacy of the structured health education program, pre- and post-intervention knowledge scores were compared using paired sample t-tests or non-parametric Wilcoxon signed-rank tests as appropriate. To determine the modifying effects of baseline socioeconomic indicators, specifically the caregiver's formal education level, on knowledge acquisition and score improvements, Chi-square tests or analysis of variance (ANOVA) were used. Statistical significance across all operations was pre-defined at a two-tailed p-value < 0.05 .

Results

Socio-Demographic Characteristics of Caregivers and Patients

A total of 80 primary caregivers of children diagnosed with oncological malignancies were enrolled in the study. The detailed socio-demographic profiles of the participants are summarized in Table 1.

The cohort was predominantly female (75.0%), with biological mothers constituting the majority of primary caregivers (66.3%). In terms of geographic distribution, a significant portion of families (75.0%) originated from rural regions, reflecting the hospital's status as a regional referral center. Regarding formal educational attainment, the cohort was distributed relatively evenly across three levels: 37.5% had completed lower secondary school or below, 30.0% completed high school, and 32.5% held a tertiary (college/university) degree. The mean caregiver age was 37.2 ± 8.6 years, with 72.5% aged ≤ 40 years. Regarding occupation, 43.8% were homemakers, 21.3% had other occupations, 16.3% were farmers, 10.0% were workers, and 8.8% were office staff.

Regarding the pediatric patients, 55.0% were ≥ 6 years old (mean age 6.2 ± 4.0 years). Solid tumors accounted for 65.0% of cases (neuroblastoma being the most common at 30.0%), while hematologic malignancies accounted for 35.0% (acute lymphoblastic leukemia being the most common at 27.5%).

Baseline Knowledge Assessment and Post-Intervention Improvements

The baseline pre-intervention assessment revealed significant vulnerabilities in caregiver health literacy, particularly in general cancer concepts and early warning sign recognition. While general awareness of cancer as a serious disease was moderate, targeted clinical knowledge was critically low.

As detailed in Table 2, caregivers scored particularly poorly in recognizing less common warning signs of

Table 1: Baseline socio-demographic characteristics of primary caregivers (N = 80)

Characteristic	Category	n	%
Gender	Female	60	75.0
	Male	20	25.0
Relationship to Patient	Mother	53	66.3
	Father	21	26.3
	Grandparent / Other	6	7.5
Geographic Origin	Urban	20	25.0
	Rural	60	75.0
Educational Level	≤ Lower Secondary	30	37.5
	High School	24	30.0
	College / University	26	32.5
Occupational Status	Homemaker	35	43.8
	Other	17	21.3
	Farmer	13	16.3
	Worker	8	10.0
	Office Staff	7	8.8
Age	Mean ± SD	37.2 ± 8.6 years	

Table 2: Baseline knowledge assessment: general cancer concepts and early warning signs (N = 80)

Knowledge Item	Pre-Intervention Correct (%)	Post-Intervention Correct (%)	p-value
Definition of cancer	71.2	95.0	<0.05
Cancer is not a death sentence	77.5	98.8	<0.05
Cancer is not contagious	90.0	97.5	<0.05
Warning signs:			
Pallor/bruising/bleeding, bone pain	72.5	100.0	<0.05
Lump or swelling	51.2	81.2	<0.05
Unexplained weight loss/persistent cough/fever/night sweats	63.8	87.5	<0.05
Eye changes	31.2	71.2	<0.05
Abdominal distension	53.8	88.8	<0.05
Persistent headache with vomiting	53.8	88.8	<0.05
Bone pain/limb swelling	51.2	92.5	<0.05
Overall correct rate	61.6 ± 26.5	90.1 ± 14.7	<0.05

childhood cancer. Only 31.2% correctly identified eye changes as a warning sign, 51.2% recognized bone pain or limb swelling, and 51.2% recognized lumps or swelling. The overall correct rate for general cancer knowledge was only 61.6 ± 26.5%.

Knowledge of side effect management was relatively higher at baseline (87.0 ± 21.9%) but still showed significant room for improvement, particularly regarding soft diet preparation (73.8% correct).

Infection control knowledge was already high at baseline (95.8 ± 11.4%), reflecting the emphasis placed on these practices during routine clinical care.

Home monitoring and red-flag symptom recognition was already high at baseline (92.6 ± 15.2%), with no statistically significant change post-intervention (95.1 ± 10.1%, $p > 0.05$).

Cultural misconceptions were highly prevalent at baseline, with only 34.5 ± 39.9% of caregivers correctly rejecting common myths. The most concerning misconceptions were the beliefs that survivors have "weak genes" and cannot have children (only 28.8% correctly rejected) and that survivors perform poorly at school or work (only 31.2% correctly rejected).

Following the structured face-to-face counseling and provision of the Childhood Cancer Care Handbook, post-intervention scores demonstrated a statistically significant improvement across most assessed clinical domains ($p < 0.05$).

The most profound improvements were observed in general cancer knowledge and early warning sign recognition. For instance, correct recognition of eye changes as a warning sign increased dramatically from 31.2% to 71.2%. Understanding that cancer is not a death sentence improved from 77.5% to 98.8%. The overall correct rate for general cancer knowledge improved significantly from 61.6 ± 26.5% to 90.1 ± 14.7% ($p < 0.05$).

Similarly, side effect management knowledge improved significantly from 87.0 ± 21.9% to 96.4 ± 7.7% ($p < 0.05$). Infection control knowledge, already high at baseline, improved from 95.8 ± 11.4% to 99.8 ± 1.9% ($p < 0.05$).

However, home monitoring knowledge showed no significant change, as it was already high at baseline: 92.6 ± 15.2% pre-intervention versus 95.1 ± 10.1% post-intervention ($p > 0.05$).

Misconception rejection improved significantly

Table 3: Baseline knowledge assessment: side effect management (N = 80)

Knowledge Item	Pre-Intervention Correct (%)	Post-Intervention Correct (%)	p-value
Short walks or regular exercise	87.5	96.2	<0.05
Ensure adequate sleep	88.8	88.8	>0.05
Small, frequent meals	87.5	97.5	<0.05
Choose protein and energy-rich foods	85.0	100.0	<0.05
Foods to avoid	91.2	96.2	>0.05
Increase fiber and water intake	95.0	100.0	<0.05
Soft diet	73.8	96.2	<0.05
Overall correct rate	87.0 ± 21.9	96.4 ± 7.7	<0.05

Table 4: Baseline knowledge assessment: infection control (N = 80)

Knowledge Item	Pre-Intervention Correct (%)	Post-Intervention Correct (%)	p-value
Check food expiration dates	98.8	100.0	>0.05
Store food in refrigerator	83.8	98.8	<0.05
Frequent hand washing	100.0	100.0	>0.05
Good oral hygiene	96.2	100.0	>0.05
Avoid crowds and infected people	97.5	100.0	>0.05
Keep patient room clean	98.8	100.0	>0.05
Overall correct rate	95.8 ± 11.4	99.8 ± 1.9	<0.05

Table 5: Baseline knowledge assessment: home monitoring and red-flag symptoms (N = 80)

Knowledge Item	Pre-Intervention Correct (%)	Post-Intervention Correct (%)	p-value
Fever ≥ 38°C	100.0	100.0	>0.05
Uncontrolled vomiting	95.0	93.8	>0.05
Diarrhea or constipation	96.2	92.5	>0.05
Uncontrolled pain	92.5	92.5	>0.05
Seizures or altered mental state	92.5	87.5	>0.05
Respiratory rate changes	88.8	98.8	<0.05
Bleeding from any site	98.8	92.5	>0.05
Inability to eat	93.8	96.2	>0.05
No urination within 12 hours	88.8	98.8	<0.05
No bowel movement within 48 hours	80.0	98.8	<0.05
Overall correct rate	92.6 ± 15.2	95.1 ± 10.1	>0.05

Table 6: Baseline knowledge assessment: cultural misconceptions (N = 80)

Misconception Item	Pre-Intervention Correct Rejection (%)	Post-Intervention Correct Rejection (%)	p-value
Children with cancer are carriers of disease	40.0	47.5	>0.05
Survivors have "weak genes" and cannot have children	28.8	45.0	<0.05
Survivors have shortened lifespans	32.5	61.2	<0.05
Survivors perform poorly at school/work	31.2	62.5	<0.05
Survivors have poor social skills	37.5	58.8	<0.05
Cured children need no further follow-up	33.8	55.0	<0.05
Survivors face a future of suffering	36.2	53.8	<0.05
Survivors carry lifelong stigma	36.2	48.8	>0.05
Overall correct rejection rate	34.5 ± 39.9	54.1 ± 41.7	<0.05

from $34.5 \pm 39.9\%$ to $54.1 \pm 41.7\%$ ($p < 0.05$), though this remained the lowest-performing domain post-intervention.

Impact of the Intervention Across Educational Strata

A stratified analysis was conducted to determine how baseline educational levels influenced knowl-

edge acquisition. Pre-intervention data indicated a significant health literacy disparity: caregivers with only lower secondary education or below scored significantly lower ($68.0 \pm 13.3\%$) compared to those with a university education ($78.9 \pm 11.9\%$) ($p < 0.05$).

However, the structured intervention successfully mitigated this disparity. As illustrated in Table 7, while

Table 7: Mean composite knowledge scores stratified by caregiver educational level (N = 80)

Caregiver Education Level	Pre-Intervention Score (Mean $\pm$ SD)	Post-Intervention Score (Mean $\pm$ SD)	Score Increase (Δ)	Intragroup p-value*
$\leq$ Lower Secondary	68.0 $\pm$ 13.3%	84.2 $\pm$ 10.9%	+16.2	<0.05
High School	73.6 $\pm$ 13.3%	87.4 $\pm$ 9.7%	+13.8	<0.05
College / University	78.9 $\pm$ 11.9%	89.2 $\pm$ 9.3%	+10.3	<0.05
Intergroup p-value (ANOVA)	p < 0.05	p > 0.05 (NS)	—	—

Note: Paired *t*-test for pre/post comparisons; NS = not significant.

all groups showed significant improvement, the lowest education cohort demonstrated the largest absolute score increase (+16.2 points). Post-intervention, the composite knowledge scores equalized across all three educational strata (ranging from 84.2% to 89.2%), rendering the initial statistical difference between the educational groups non-significant ($p > 0.05$). This confirms that the handbook and structured counseling model is uniformly effective and accessible, regardless of a caregiver's prior formal education.

No significant differences were observed in knowledge scores based on age, gender, geographic origin, or occupation at either time point (all $p > 0.05$).

Discussion

The findings of this study demonstrate that a structured health education program—combining personalized clinical nursing counseling with a standardized, visually accessible handbook—yields profound improvements in caregiver health literacy. Traditionally, family education in resource-constrained settings relies heavily on ad-hoc, unstructured verbal instructions provided during busy ward rounds. This method is highly susceptible to information loss and cognitive overload, particularly in the acute distress phase following a pediatric cancer diagnosis. By employing a paired approach, the intervention delivered immediate verbal clarification while simultaneously equipping caregivers with a tangible, culturally adapted reference tool. This multimedia strategy facilitated superior knowledge retention by allowing caregivers to review critical, complex information at their own pace. The physical handbook acted as a persistent cognitive anchor, reducing the acute mental burden on caregivers and reinforcing memory recall regarding highly technical care tasks, such as infection control protocols and neutropenic diet preparation.

Crucially, the baseline assessment exposed severe knowledge deficits and deeply ingrained cultural misconceptions among caregivers, such as the erroneous beliefs that childhood cancer is contagious, or that survivors inevitably face truncated lifespans and compromised fertility. Beyond merely representing clinical knowledge gaps, these myths act as significant sources of psychosocial distress, fostering social stigma and exacerbating the emotional trauma experienced by the family unit. The structured educational intervention

directly confronted and dismantled these misconceptions. In doing so, the formalized communication framework functioned not only as an educational tool but as a profound agent of psychosocial relief. By replacing fear-inducing myths with scientifically accurate, easily digestible facts, the intervention empowered caregivers, restoring a sense of agency and significantly mitigating the psychological burden associated with the pediatric oncology trajectory.

These findings resonate strongly with existing global literature mapping family health literacy in other pediatric oncology settings across low- and middle-income countries (LMICs). Studies originating from Latin America, Sub-Saharan Africa, and other developing regions in Asia consistently report similar baseline vulnerabilities, particularly regarding infection prevention and the delayed recognition of emergency “red flag” symptoms [3, 8]. The success of the standardized educational intervention at Hue Central Hospital aligns with international benchmarks which advocate for structured, locally adapted communication tools to bridge the supportive care gap. Just as multidisciplinary educational interventions in these global settings have successfully reduced preventable treatment-related mortalities and therapy abandonment, our results validate the universal applicability of combining standardized visual aids with targeted nursing counseling to optimize home-based pediatric oncology care in resource-limited environments.

Perhaps the most socially significant finding of this study is the capacity of the structured educational intervention to actively reduce health inequities. Baseline data revealed a stark disparity in health literacy, with caregivers from lower educational backgrounds scoring significantly lower than their highly educated counterparts (68.0% vs. 78.9%, $p < 0.05$). However, post-intervention outcomes demonstrated that the standardized materials effectively leveled the playing field, resulting in uniformly high knowledge scores across all educational strata (84.2–89.2%, $p > 0.05$). This confirms that when complex medical jargon is distilled into an accessible, culturally resonant format, a caregiver's formal educational background ceases to be a barrier to clinical comprehension. Consequently, structured health education emerges as a vital tool for health equity, ensuring that socioeconomically disadvantaged caregivers are equally equipped to provide safe, highly competent home care for their

Table 8: Effect of other socio-demographic factors on knowledge (N = 80)

Factor	Category	Pre-Intervention Score (Mean $\pm$ SD)	p-value	Post-Intervention Score (Mean $\pm$ SD)	p-value
Age	≤ 40 years	74.2 $\pm$ 13.1	>0.05	86.5 $\pm$ 10.2	>0.05
	> 40 years	70.7 $\pm$ 15.6		87.5 $\pm$ 10.2	
Gender	Male	72.0 $\pm$ 15.1	>0.05	83.8 $\pm$ 9.4	>0.05
	Female	73.7 $\pm$ 13.4		87.8 $\pm$ 10.2	
Geographic Origin	Urban	73.4 $\pm$ 15.2	>0.05	84.5 $\pm$ 11.4	>0.05
	Rural	73.2 $\pm$ 13.4		87.6 $\pm$ 9.7	
Occupation	Worker	64.9 $\pm$ 17.6	>0.05	85.4 $\pm$ 12.7	>0.05
	Office staff	79.4 $\pm$ 10.1		90.9 $\pm$ 10.6	
	Farmer	71.7 $\pm$ 17.5		86.9 $\pm$ 9.5	
	Homemaker	72.3 $\pm$ 12.7		87.2 $\pm$ 11.2	

children.

The implications of these findings for clinical nursing practice are substantial. The demonstrated efficacy of this paired educational model justifies a paradigm shift in how oncology nursing is conceptualized and executed in developing healthcare systems. Rather than viewing family education as a passive, secondary, or time-permitting task, nursing protocols should integrate formalized, tracked educational checkpoints at critical junctures, most notably during hospital admission, treatment transitions, and pre-discharge cycles. Institutionalizing these mandatory checkpoints ensures that every primary caregiver achieves a verified standard of competence in supportive care and symptom management before assuming responsibility for the patient at home, thereby standardizing the quality and safety of outpatient oncology care.

Despite these robust findings, the study is not without limitations. First, the research was conducted at a single tertiary care center utilizing a convenience sampling method, which may limit the generalizability of the results to primary or secondary healthcare settings with differing resource capacities. Second, the knowledge questionnaire used a binary "know/don't know" format, which reflects basic recognition ability but does not assess depth of understanding, confidence level, or practical application capacity in daily care. Furthermore, while the immediate post-intervention data demonstrated highly significant improvements in caregiver knowledge, the study design lacked long-term follow-up testing (e.g., at 3 or 6 months post-discharge). As a result, the long-term retention of this acquired knowledge remains unknown. Future multi-center longitudinal studies with larger sample sizes, multi-level assessment scales, and extended follow-up periods are warranted to evaluate the durability of caregiver health literacy over time and to meticulously assess the direct correlation between these educational interventions and tangible clinical outcomes, such as reduced emergency readmission rates and decreased treatment-related mortality.

Conclusion

In conclusion, this study demonstrates that a structured health education program effectively mitigates

severe health literacy deficits among primary caregivers of pediatric cancer patients. By systematically pairing targeted, face-to-face nursing counseling with a culturally adapted and standardized visual tool (the Childhood Cancer Care Handbook), the intervention successfully transformed profound baseline vulnerabilities into high levels of clinical comprehension. The program not only equipped caregivers with the critical skills necessary to identify oncological emergencies and manage complex home-based supportive care, but it also actively dispelled deep-seated cultural misconceptions that contribute to the psychosocial burden of the disease. Most notably, this standardized educational approach proved to be a powerful equalizer, bridging the knowledge gap for caregivers from lower-educational backgrounds. Ultimately, the systematic integration of standardized, structured educational frameworks into routine pediatric oncology nursing practice represents a low-cost, high-impact strategy. Mandating such protocols is essential for optimizing outpatient patient safety, reducing preventable treatment-related complications, and advancing health equity in resource-limited clinical settings.

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Ethics Approval and Consent to Participate

The study protocol was reviewed, approved, and monitored by the Institutional Ethics Committee of Hue Central Hospital under formal Approval Directive Number BVH.25.23. The clinical trial was conducted in accordance with the ethical tenets of the Declaration of Helsinki. All participating primary caregivers were provided with full written explanations regarding the study objectives, risks, and benefits, and subsequently

provided executed informed consent documents before the start of any data collection activities. Absolute patient-family autonomy was preserved, guaranteeing participants the right to withdraw from the program at any time without compromising the quality or delivery of their child's medical therapies. Data confidentiality was maintained by assigning unique alphanumeric codes to anonymize all collected datasets.

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Competing Interests

The authors declare that they have no competing interests.

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