Research Article

Strengthening Pediatric Oncology Capacity Through Online Learning: Insights from an Inaugural Course for Physicians in a Low-Resource Setting

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Abstract: Background: In low-and-middle income countries (LMIC), childhood cancer outcomes are poor because of multiple factors including delayed diagnosis, which may be due to limited healthcare professional training and ineffective referral systems.

Objective: To evaluate the impact of a newly developed blended-learning pediatric oncology course designed for physicians in Pakistan.

Materials and Methods: A pre-and-post interventional study was conducted at Indus Hospital and Health Network to evaluate the effectiveness of a pilot pediatric oncology course from 2nd September till 29th November, 2024. The study was reviewed by the Institutional Ethical Review Committee (IHHN_IRB_2025_08_004) (18-Aug-25) and was granted exemption. Twenty doctors were enrolled in the course that included recorded lectures, case-based discussions, and live interactive sessions. A 5-point Likert scale was used to assess knowledge of pre- and post-module. Participants' performance was assessed by end-of-module exam scores, and course content and delivery satisfaction by online questionnaire.

Result: Seventeen physicians successfully completed the course and were included in the analysis. Overall performance in the end-of-module assessments demonstrated good knowledge acquisition across all modules, with the highest scores observed in the palliative care module and comparatively lower scores in solid tumor module. Participants also showed substantial improvement in their self-perceived knowledge across all learning objectives following completion of course. Despite issues related to technology, participants reported high satisfaction, which was reflected in positive ratings for course organization, clarity, and relevance.

Conclusion: The inaugural e-learning pediatric oncology course was associated with improvements in participant's perceived knowledge and confidence, highlighting the role of structured online training in strengthening capacity in LMICs. Development of improved version of similar multidisciplinary training programs could further contribute to improving early diagnosis and management of childhood cancers by enhancing physician's knowledge and awareness of pediatric oncology.

Keywords: Pediatric oncology, E-learning, Capacity building, Physician training, Healthcare.

INTRODUCTION

Childhood cancer is a significant global health concern, with an estimated 400,000 new cases diagnosed annually among children and adolescents aged 0–19 years [1]. According to the 2019 Global Burden of Disease report, cancer was the leading cause of death in this age group in 2017, accounting for approximately 150,000 deaths [2]. While high-income countries (HICs) report cure rates exceeding 80%, outcomes in low- and middle-income countries (LMICs) remain alarmingly low at approximately 30%, despite the fact that the majority of the pediatric cancer burden resides in LMICs [3,4]. In Pakistan alone, approximately 8,000 children are diagnosed with cancer each year [4, 5]. A major challenge in improving childhood cancer outcomes in LMICs is delayed diagnosis, which is frequently the result of limited access to healthcare facilities and lack of awareness among healthcare workers regarding early cancer signs and symptoms [6-8].

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Late presentations with advanced disease are further exacerbated by the lack of effective referral networks which, significantly worsens the prognosis [9, 10]. The World Cancer Declaration (2013), addressed these challenges and emphasized the importance of enhanced education and training of healthcare professionals to improve global cancer control systems.[11] Childhood cancers are frequently misdiagnosed or detected late in remote and underserved areas of Pakistan due to a shortage of trained professionals and vague early symptoms [10, 11]. These factors lead to delayed diagnosis, inappropriate initial management, and late referral, ultimately resulting in poor treatment outcomes [12,13].

In an effort to address these gaps, the Cancer Academy was established in 2024 by the Pediatric Hematology and Oncology Department at the Indus Hospital and Health Network (IHHN) under the "My Child Matters" grant by Foundation S. in collaboration with Health Professions Education Department of the Indus University of Health Sciences. This initiative aims to strengthen the early recognition and initial management of childhood cancers in peripheral and shared care settings. As part of this initiative, the inaugural course for physicians was delivered using a blended learning model that combined asynchronous recorded lectures with synchronous live sessions and case-based discussion. The primary objective of this study was to evaluate effectiveness of the inaugural course for physicians by examining the changes in the participants self-perceived knowledge before and after the course, performance in each end-of-module exam and overall satisfaction with the course structure, content, and delivery methods. Additionally, the study aimed to identify strengths and challenges of the pilot training program, to help in improvement of this course and in the development of comprehensive training programs for pharmacists and nurses.

MATERIALS AND METHODS

This pre and-post interventional study evaluating changes in participants' perceived knowledge before and after completion of the course was conducted at the Indus Hospital and Health Network (IHHN), Korangi Campus, Karachi, from 2nd September till 29th November, 2024. The study was reviewed by the Institutional Ethical Review Committee (IHHN_IRB_2025_08_004) (18-Aug-25) and was granted exemption.

A total of forty applicants applied for the course, of whom twenty participants were enrolled. Selection priority was given to internal candidates and to physicians working in pediatrics, family medicine or, pediatric oncology units as these clinicians serve as the first point of contact for children and are directly involved in early detection, referral, and ongoing management of pediatric conditions, including childhood cancer. The majority of enrolled participants were residents and medical officers working in pediatrics or pediatric oncology. Of the twenty selected participants seventeen successfully completed the course. Three participants didn't complete the program: two were unable to finish the required modules and one withdrew due to competing work commitments. For the purpose of this study, only participants who passed all modules on learning management system (LMS) and attended at least five out of six modules were included.

Participants who successfully completed all course modules on the LMS, attended at least 5 of 6 (83%) interactive sessions, and completed the required questionnaires, were included.

Participants who did not complete the modules on LMS, attended fewer than 5 (83%) interactive sessions or failed to complete the required questionnaires, were excluded.

Pre-and post-module questionnaires were administered online via a secure survey platform to assess the participants perceived knowledge for each module. The pre and post module questionnaires were identical and evaluated participants self-perceived understanding of the specific learning objectives for each module. The first questionnaire also collected the demographic details of the participants. Responses were recorded using a five-point Likert-scale ranging from 1("Very limited knowledge") to 5 ("Expert knowledge). The pre-module survey was administered before the start of each module while the post-module was shared immediately after the completion of the module. The questionnaire came from the learning objectives of each individual module's learning objective. It was assessing the perceived knowledge of the participants on a particular topic before and after completing the module.

To evaluate the performance of each participant in end of module exam, scores were retrieved from the learning management system, which automatically recorded participant performance as part of routine assessment. Each end of module exam consisted of 15 multiple choice questions. The exam grades were categorized into three groups based on the scores obtained: Excellent (12-15), Average (9-11), and Low (0-8). The minimum passing

grade for the end-of-module exam was 9.

Another form was used to assess the overall satisfaction regarding the course, the participants completed an online survey which included items on course content, structure, quality of recorded lectures and interactive videos, effectiveness of interactive sessions and overall learning experience. Responses were recorded using a five-point Likert-scale ranging from "strongly agree" to "strongly disagree". This questionnaire was derived from the standardized course evaluation form of the Higher Education Commission (HEC) and routinely utilized at Indus University of Health Sciences (IUHS), was adapted with minor modifications to suit the online course format. To ensure confidentiality, responses were collected anonymously and stored using system generated participant codes.

The primary outcome was the change in participants' self-perceived knowledge scores before and after completion of the course. Secondary outcomes included participants' performance in end of module exams and their satisfaction with the course structure, content, and delivery.

STATISTICAL ANALYSIS

Quantitative data was analyzed using descriptive and inferential statistical tools in SPSS, Version 24. Descriptive statistics (mean, standard deviations and frequencies) were calculated for the participants demographics. Multiple pre and post module comparisons were conducted across several learning objectives using the Wilcoxon signed rank-test. No formal p-value correction was applied, as the analysis was exploratory and based on predefined outcomes. One sample test was used for grades evaluation by taking 15 as test value. Data on participants satisfaction was summarized by descriptive statistics.

RESULT

The participants included 52.9% males and 47.1% females. The candidates were working in the departments of Pediatric oncology (41.2%), Pediatric medicine (47.0%), and emergency medicine (11.8%). The mean years of experience was 5.8 with 4.8 standard deviation. Out of 17 participants, 10 had experience of working in pediatric oncology department.

The table shows the average scores of 17 participants for each module in the end-of-module exam. The participants achieved the highest average score of 13.29 in the palliative care module, while in the solid tumor module they had the lowest average score of 10.0. The modules in supportive care (1.49), palliative care (1.53), and solid tumor (1.65) exhibited lower standard deviations, indicating greater consistency in scores (Table **1**).

Table **1**. Module-Based Average Score Analysis.

	Mean	SD	p-value
Leukemia	13.06	1.98	0.001
Lymphoma	11.53	2.12	0.000
Neuro-Oncology	10.94	1.98	0.000
Solid tumor	10.00	1.65	0.000
Supportive	11.29	1.49	0.000
Palliative	13.29	1.53	0.000

The palliative care and leukemia modules had the highest number of participants achieving outstanding scores, with 15 and 14 participants, respectively. Overall, nine participants received low grades in the entire course, four of whom were from the solid tumor module. Additionally, the solid tumor module recorded the highest number of average grades (Fig. **1**).

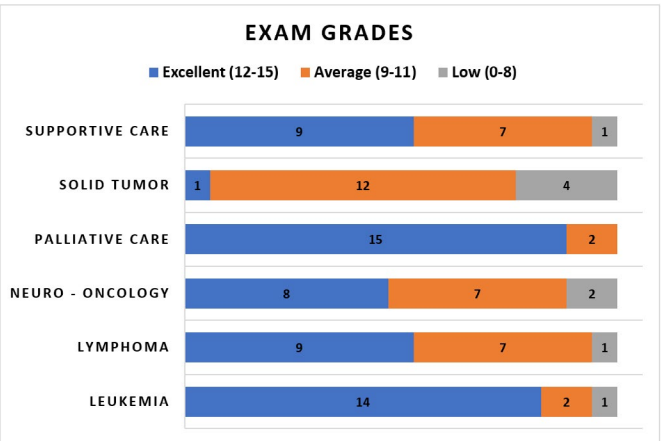

Fig. (1). Module-wise Distribution of Exam Grades.

Course satisfaction was assessed at the end of course through a questionnaire-based survey. The resulting heatmap shows (Fig. **2**) that participants had a generally favorable opinion of the course. The responses to the majority of the questions were either "strongly agree" or "agree", with few being neutral and a minimal number of "disagree" responses. The themes that received the highest rating were the following: clear definition of learning objectives, well-organized course and manageable workload, the utility of recorded lectures and interactive

sessions, and the clarity of exams. The least number of "strongly agree" responses and the only question with a small number of "neutral" and "disagree" responses was about the technical quality of the course.

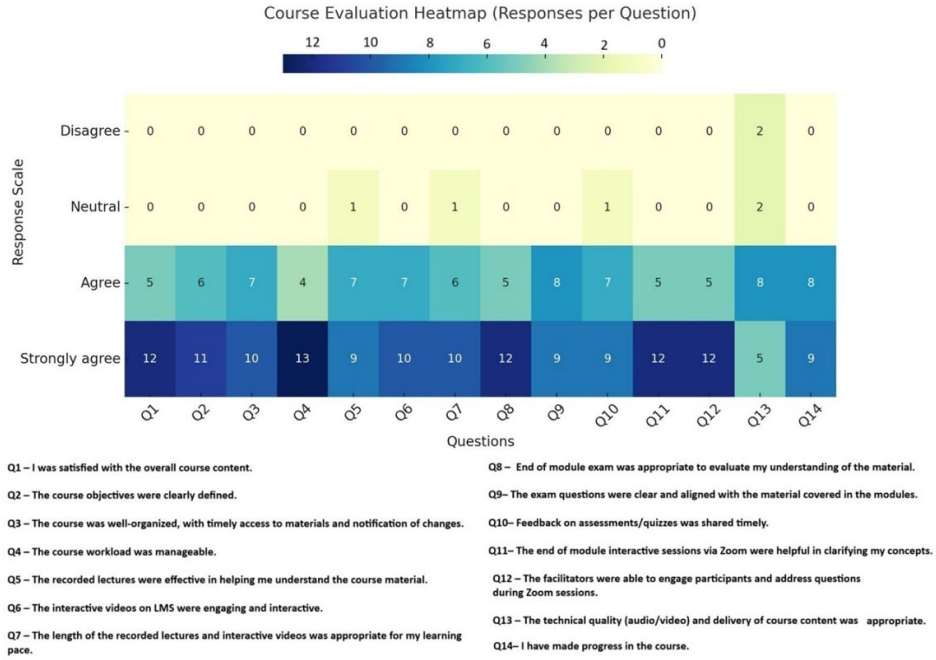

Fig. (2). Course Evaluation Heatmap.

The difference in perception between the pre-and post-learning objectives is shown in Table **2**. Large effects are indicated by an r value exceeding 0.50. It indicates that each learning objective had an r value of at least 0.50 or more, suggesting a substantial shift in the participant's knowledge perception. The average value of r for each module was as follows: Leukemia (0.74), Lymphoma (0.78), Neuro-oncology (0.79), Solid tumor (0.75), Supportive care (0.83), and Palliative care (0.73). Based on the aggregated results, the supportive care module demonstrated the highest average, whereas the palliative care module had the lowest.

Table 2. Comparison of Perception Ordinal Scores from the Course Module using the Wilcoxon Signed-Rank Test.

Leukemia				**Lymphoma**			
	Z score	**r**	**p-value**		**Z score**	**r**	**p-value**
1. Understanding of leukemia.	3.358	0.82	0.001*	1. Evaluation of a child with lymphadenopathy.	2.835	0.69	0.005*
2. Identification of the signs and symptoms.	3.066	0.74	0.002*	2. Common causes of cervical lymphadenopathy.	3.392	0.82	0.001*
3. Diagnostic modalities.	3.307	0.8	0.001*	3. Signs and symptoms of malignant cervical lymphadenopathy.	3.126	0.76	0.002*
4. Classification of leukemia.	3.002	0.73	0.003*	4. Diagnostic modalities used for cervical lymphadenopathy.	3.216	0.78	0.001*
5. Stabilization and appropriate referral.	2.803	0.68	0.005*	5. Classification of childhood lymphoma.	3.178	0.77	0.001*
6. Available treatment options available for different types of leukemia.	3.247	0.79	0.001*	6. Risk grouping of childhood lymphoma.	3.461	0.84	0.001*
7. Understanding of hyperleukocytosis.	2.979	0.72	0.003*	7. Treatment modalities and prognosis of childhood lymphoma.	3.216	0.78	0.001*

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8. Identification of signs and symptoms of hyperleukocytosis.	2.836	0.69	0.005*	8. Evaluation of a child with mediastinal mass.	3.247	0.79	0.001*
9. Management of hyperleukocytosis.	2.976	0.72	0.003*	9. Diagnostic modalities used for mediastinal mass.	3.235	0.79	0.001*
10. Prognostic factors and outcomes.	2.986	0.72	0.003*	10. Initial treatment and safe referral of a patient with mediastinal mass.	3.351	0.81	0.001*
Neuro-oncology				**Solid tumor**			
1. Classification of CNS tumor.	3.126	0.76	0.002*	1. History and examination of children with suspected solid tumors.	3.066	0.74	0.002*
2. Signs and symptoms of CNS tumor.	3.104	0.75	0.002*	2. Types of commonly presenting abdominal masses/ tumors and their clinical features in children.	3.002	0.73	0.003*
3. Evaluation of a child with CNS tumor.	3.448	0.84	0.001*	3. Types and clinical features of bone tumors and soft tissue sarcomas in children.	3.247	0.79	0.001*
4. Diagnostic modalities used for CNS tumor.	3.384	0.82	0.001*	4. Diagnostic modalities used for the identification and evaluation of childhood solid tumors.	3.134	0.76	0.002*
5. Initial management and safe referral of a child with CNS tumor.	3.482	0.85	<0.001*	5. Interpretation of diagnostic imaging and pathological findings.	3.115	0.76	0.002*
6. Treatment modalities and prognosis of a child with CNS tumor.	3.341	0.81	0.001*	6. Treatment modalities and prognosis.	2.889	0.7	0.004*
7. Signs and symptoms of retinoblastoma.	2.97	0.72	0.003*	7. Identification and management of potential complications.	2.915	0.71	0.004*
8. Evaluation of a child with retinoblastoma.	3.376	0.82	0.001*	8. Significance of multidisciplinary approach.	3.133	0.76	0.002*
9. Diagnostic modalities used for retinoblastoma.	3.33	0.81	0.001*	9. Importance of safe and timely referral of a patient with solid tumor.	3.345	0.81	0.001*
10. Treatment modalities and prognosis of retinoblastoma.	3.36	0.82	0.001*	10. Effective communication with a patient's family regarding the diagnosis, treatment and prognosis.	3.233	0.78	0.001*
11. Initial counselling and safe referral of a child with retinoblastoma.	3.068	0.74	0.002*				
12. Diagnosis and initial management of a child with spinal cord compression.	3.264	0.79	0.001*				
Palliative care				**Supportive care**			
	Z score	r	p-value		Z score	r	p-value
1. Recognizing the importance of accurate pain assessment.	3.314	0.8	0.001*	1. Recognition of febrile neutropenia as pediatric oncological emergency.	3.384	0.82	0.001*

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2. Understanding the core principles of multimodal and individualized pain management.	3.126	0.76	0.002*	2. Timely management of febrile neutropenia.	3.448	0.83	0.001*
3. Knowing the significance of timely pain management interventions.	3.397	0.82	0.001*	3. Potential complications of febrile neutropenia.	3.397	0.82	0.001*
4. Understanding the importance of collaboration among healthcare providers in providing comprehensive and effective pain management.	3.115	0.76	0.002*	4. Importance of optimal nutrition in pediatric oncology patients undergoing treatment.	3.372	0.81	0.001*
5. Role of effective communication and empathy in breaking bad news.	2.362	0.57	0.018*	5. Prevalence, risk factors, pathophysiology of mucositis.	3.416	0.82	0.001*
6. Awareness of the challenges in breaking bad news to pediatric cancer patients and their families.	2.738	0.66	0.006*	6. Supportive care measures in improving nutritional intake and reducing mucositis related discomfort.	3.372	0.81	0.001*
7. Importance of having open and honest discussions with pediatric patients and their families.	2.96	0.72	0.003*	7. Importance of early intervention and timely adjustments to nutritional support plans.	3.589	0.87	<0.001*
8. Importance of using clear and age-appropriate language when breaking bad news.	2.818	0.68	0.005*	8. Identification of the appropriate blood products for transfusion, based on clinical needs.	3.64	0.82	<0.001*
9. Understanding the importance of collaborative and multidisciplinary approach during difficult conversation.	3.36	0.82	0.001*	9. Understand the indications and different thresholds for blood products transfusion.	3.602	0.87	<0.001*
				10. Recognition of potential risks and complications associated with blood transfusions.	3.508	0.85	<0.001*

*Significant value, $r \leq 0.10$ = Small effect, $r \leq 0.30$ = Medium effect, $r = 0.50$ = Large effect or higher.

Effect size calculated by the formula: $r = Z / \sqrt{N}$

The Wilcoxon signed-rank test calculated a significant p-value. This test is used because of an ordinal data.

DISCUSSION

The findings of the study show that the inaugural physician-focused pediatric oncology course was effective in improving participants' self-perceived knowledge and was well-received in terms of content, structure and delivery. This is particularly relevant in the context of low-and -middle-income countries (LMIC), where survival outcomes remain significantly lower than in high-income countries (HICs), largely due to delay in diagnosis and inadequate early stabilization and referral of children with cancer [14]. A major contributor to these challenges is the lack of knowledge and training among healthcare professionals, particularly physicians [15-17] The improvement in self-perceived knowledge, along with satisfactory performance in end of module assessments, suggests effective knowledge acquisition and reinforces the potential of blended programs to address the gaps in pediatric oncology.

This study observes a substantial enhancement in the perceived knowledge of the participants in all six modules, with large effect sizes ($r \geq 0.50$) for each learning objective. The clinical relevance of topics such as febrile

neutropenia, transfusion guidelines and nutritional support for frontline physicians was reflected in the supportive care module, which exhibited the highest average effect size (r=0.83). Furthermore, palliative care module demonstrated relatively lower learning gain (r=0.73), which highlights the need for more structured training in communication, pain management and multidisciplinary care within pediatric oncology. Evidence from South Asia highlights that Project ECHO'S pediatric palliative care model effectively improved provider knowledge, clinical decision making, and peer learning via case-based presentations and discussions and structured mentorship. Incorporating similar elements will likely improve our palliative care module outcomes [18].

The palliative care and leukemia modules had the highest average score while the solid tumor recorded relatively lower performance. This suggests that there is limited exposure to rare tumors and emphasizes the need for more case-based discussions in this domain. The satisfactory performance observed in end of module exam suggests effective knowledge acquisition and retention, supporting the ability of the course to deliver and reinforce core pediatric oncology concepts. Our results are in accordance with the increasing number of international evidence that illustrates the feasibility and efficacy of online courses in oncology [19-21]. Similarly, a virtual pediatric radiation oncology course conducted in sub-Saharan Africa showed improvement in participant's knowledge and self-reported confidence, highlighting the significance of online platforms in capacity building [22].

Locally, a 13-week online course was conducted for physicians at IHHN with similar topics, the course showed an increase from a score of 56.2% in pre-test to a score of 71.9% in the post-test, which further demonstrates that enhancement of knowledge in pediatric oncology can be achieved using virtual teaching [23]. In Pakistan, hybrid pediatric neuro-oncology educational initiatives, which included virtual tumor boards and interactive lecture series, were successful in improving collaboration and specialist training across institutions [24]. Nevertheless, systemic reviews underscore that e-learning initiatives are underutilized in LMIC, with majority of oncology training programs still adapting to in-person methods, despite the apparent benefits of virtual training in scalability, cost-effectiveness and accessibility [25].

LIMITATIONS

This was a single-center study with no comparison groups and also had a small sample size which limits the generalizability of results. The study assessed short-term knowledge improvement and long-term retention of knowledge and impact on clinical practice was not evaluated.

STRENGTHS

This study provides preliminary evidence of the efficacy of a structured blended-learning pediatric oncology course in a resource-constrained environment. Pre- and post-module assessments, exam performance, and participant feedback indicate its potential influence on physician learning.

CONCLUSION

To summarize, this study highlights that a structured blended-learning model can effectively enhance physician knowledge, confidence and engagement in pediatric oncology in resource-limited settings. Our results suggest that similar digital training interventions should be more widely implemented, with a goal of enhancing early diagnosis, referral practices and overall treatment outcomes by integrating it into multidisciplinary educational frameworks.

LIST OF ABBREVIATIONS

LMICs: Low and Middle-income Countries.

LMS: Learning Management System.

AUTHORS' CONTRIBUTION

Anushe Mohsin Feroze: Conceptualization, Study Design, Methodology, Data analysis and interpretation, and Writing draft.

Naeem Jabbar: Conceptualization, Methodology, Data analysis and interpretation, and Writing draft.

Shafaq Sultana: Conceptualization, Study Design, and Writing draft.

Sadia Muhammad: Writing draft and Critical review and revision of the manuscript.

Syed Ahmer Hamid: Final approval, final proof to be published.

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ETHICAL DECLARATIONS

Data Availability Statement

The data will be available from the corresponding author upon request.

Ethical Approval

The study was reviewed by the Institutional Ethical Review Committee of Indus Hospital and Health Network (IHHN_IRB_2025_08_004) (18-Aug-25) and was granted exemption.

Consent to Participate

Participants were informed about the study, confidentiality, and intended use of data. Informed consent was implied through voluntary completion of the forms.

Consent for Publication

All authors provided consent for the publication.

Conflict of Interest

Declared none.

Competing Interest / Funding

Declared none.

Use of AI-Assisted Technologies

The manuscript underwent language editing with QuillBot AI tools to improve clarity. All scientific content was reviewed and verified by the authors.

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