

Effect of Implementing Early Warning Scoring Tools on Early Detection of Abnormal Signs in Pediatric Oncology Units

Fatma Ismail Mohammed¹, Doaa E, Abo zaid² and Samah Abdallah Mohamed Amer³

(1) Lecturer of Pediatric Nursing, Faculty of Nursing, Benha University, Egypt, (2) Lecturer of Pediatric Nursing, Faculty of Nursing, Menoufia University, Egypt and (3) Assistant Professor of Pediatric Nursing, Faculty of Nursing, Benha University, Egypt.

Abstract:

Background: Pediatric early warning score is instrument have been developed for early identification of warning signs in pediatric oncology. Pediatric oncology nurses are involved in all aspects of cancer care, from initial detection to providing physical and emotional support throughout treatment. **Aim of the study** was to evaluate the effect of implementing early warning scoring tools on early detection of abnormal signs in pediatric oncology unit. **Setting:** This study was conducted in oncology unit at Benha specialized pediatric hospital affiliated to general secretariat of specialized medical centers in Benha city. **Design:** A quasi experimental design was utilized for conducting the current study (pre /immediate post and follow up). **Sampling:** All available nurses (40) who work in oncology unit from the previous mentioned setting. **Data collection Tools: Tool I:** A structured interview questionnaire for assessing nurses' characteristics and knowledge about pediatric early warning scoring tools. **Tool II:** Observational checklist for nurse's practice regarding application of warning signs scale. **Tool III:** Pediatric Early warning scoring tool. **Results:** There was a highly statistically significant improvement in nurses' knowledge, and practice regarding early detection of abnormal signs in oncology unit post and follow-up implementation of pediatric early warning scoring tools. **Conclusion:** Pediatric early warning score implementation improved nurses' knowledge, and practice regarding early detection of abnormal pediatric signs in oncology unit. **Recommendation:** In-service training programs about pediatric early warning score should be continuously implemented in pediatric oncology units to enhance nurses' knowledge and practice regarding early detection of abnormal signs.

Keywords: Abnormal signs. Early warning scoring tools. Early Detection. Pediatric oncology

Introduction:

Globally, cancer is one of the main causes of death for children. Eighty percent of children diagnosed with cancer each year come from low- or middle-income countries (WHO, 2022). The most prevalent cancers in children are solid tumors such as osteosarcoma, Wilms tumor, neuroblastoma, brain tumors, as well as leukemia and lymphomas (Jagannath, 2024).

Detecting cancers in children early can be challenging because initial symptoms often resemble those of more common illnesses or injuries. Children frequently become ill or

sustain bumps or bruises that may obscure the early signs of cancer. If any unusual signs or symptoms are observed in a child, it is crucial to have a doctor examine them. These signs can includes an unusual lump or swelling, pallor and fatigue, bleeding or bruising, localized pain, limping, fever, recurring headache often accompanied by vomiting, sudden changes in vision or eyes, and weight loss (American Cancer Society, 2019).

Timely identification of pediatric cancer is crucial for multiple reasons. It not only results in better treatment outcomes, decreased morbidity, and fewer treatment-related side

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effects, but it also hinders disease advancement and provides essential emotional support for impacted families. Increasing awareness of children's cancer symptoms is the first step toward early diagnosis, ensuring that children receive prompt intervention and thereby improving their survival chances and quality of life (**Pjagandath, 2024**).

The prompt identification of cancer includes two components: early screening and diagnosis. Early diagnosis aims to detect symptomatic children quickly, while screening entails testing healthy children to identify those with cancers prior to the appearance of symptoms to enhanced the availability and cost-effectiveness of diagnostic and treatment services, also easing referrals from primary to secondary and tertiary care facilities (**WHO, 2024**).

The Pediatric Early Warning Score (PEWS) is a scoring system designed to monitor and alert personnel to rapid declines in the health condition of hospitalized children (**Agulnik et al., 2019**). PEWS contributes to the overall improvement of safety in healthcare, where the standardization of nursing has proven to reduce the likelihood of health care team errors and subjective assessments (**Iso-Somppi et al., 2019**). Furthermore, PEWS has been emphasized as a global research focus to enhance pediatric oncology treatment (**Soeteman et al. 2019**).

The Pediatric Early Warning scores offer a structure for evaluating various parameters and observational information to detect early decline in pediatric patients and establish a unified label for the level of deterioration. Common parameters consists of heart rate, respiratory rate, oxygen saturation, changes in consciousness, effort of breathing, systolic blood pressure, and oxygen delivery. Some PEWS use different scoring systems

depending on the age of the child (**Ball et al., 2021**).

The World Health Organization (2021) highlights the significance of severe health conditions in children and calls for support in all medical aspects to enhance the early identification of critical cases and children requiring urgent treatment and hospitalization. Timely detection and recognition of changes in vital signs and physiological parameters in pediatric patients in hospitals are crucial to lower the chances of avoidable death and prevent unexpected admissions to critical care units (**Kurita et al., 2020**).

Determine the physical signs that best identify a child at risk of decline. Changes in vital signs may show a deterioration or may simply suggest that a child is ill and at risk. However, when clinical observations are scored and connected to bedside concerns by nurses or family, this information can help physicians identify and rescue ill children before their condition deteriorates (**Fitzsimons et al., 2023**).

Nurses are vital in the treatment of children with cancer and greatly influence the achievements in curing children in oncology units. Developing effective communication with the family and child battling cancer is essential for proper care (**Gunter and Duke, 2018**). The nursing role in the pediatric early warning system begins with the nurse conducting a physical examination and measuring the child's vital signs, then utilizing a scoring chart to assess the child's health status. Furthermore, the nurse employs an algorithm to evaluate the appropriate level of care required for the child. The scores are linked to a color system that enhances communication with other staff members (**National Cancer Institute, 2024**).

Significance of the study:

The Pediatric Early Warning Score (PEWS) is a child safety initiative designed for early detection of abnormal signs and deterioration in children, enhancing their care and improving outcomes (Trubey et al., 2019). Timely identification of worsening pediatric patients in oncology units is crucial for decreasing morbidity and mortality, as well as enhancing long-term outcomes. Additionally, PEWS aims to enhance the skills and self-assurance of oncology nurses in their triage abilities (Nagarajah et al., 2022). Consequently, this research was conducted to assist oncology nurses in recognizing children who are at higher risk of deterioration by assigning a score based on vital signs and clinical condition, while directing interventions to improve children outcomes.

Aim of the study:

The present study aimed to evaluate the effect of implementing early warning scoring tools on early detection of abnormal signs in pediatric oncology unit through the following:

1. Assessing nurses' knowledge and practice regarding the implementation of early warning scoring tools for the early detection of abnormal signs in pediatric oncology unit.
2. Designing and implementing early warning scoring tools for nurses regarding early detection of abnormal signs in pediatric oncology unit.
3. Evaluating the effect of early warning scoring tools on nurses' knowledge and practice in relation to the early detection of abnormal signs in pediatric oncology unit.

Research hypothesis:

Nurses who attended the early warning scoring tools will have a higher level score of knowledge and practice regarding the implementation of early warning scoring tools on post- and follow-up tests than on the pretest, which will contribute to the early

detection of abnormal signs in pediatric oncology unit on post- and follow-up tests.

Research design: A quasi-experimental research design was utilized to fulfill the aim of this study (pre / immediate post and follow-up tests).

Setting: The current study was carried out at the oncology unit at Benha specialized pediatric hospital which affiliated to general secretariat of specialized medical centers in Benha city it located in fourth floor of medical building and consist of three rooms each room have three beds and one room for isolation. It received children from all over Qaluobia governorate.

Subject: All available nurses (40) who work in the previously mentioned setting, regardless of their characteristics.

Data collection tools: This study had three data collection tools, which included the following.

Tool I: A structured interviewing questionnaire: It was created by the researchers after reviewing the relevant literatures, written in Arabic and divided into two parts:

Part (1): Nurses' characteristics: Included age, gender, academic qualifications, years of experience at pediatric oncology unit, and attendance of training courses regarding implementation of early warning scoring tools in oncology unit.

Part (2): Oncology nurses' knowledge which divided into three categories.

First category: Nurses' knowledge regarding pediatric cancer. It was designed by the researchers after reviewing related literatures (American Society of Clinical Oncology, 2023), & (National Cancer Institute, 2023). It was used to evaluate nurses' knowledge regarding cancer. It encompassed (10) multiple-choice questions and (9) open-ended questions includes; definition of cancer, common types of cancer

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among children, manifestation of leukemia, manifestation of lymphoma, definition of solid tumors, signs and symptoms of Wilms tumor, cancers of soft tissues and bones, factors that causes cancer, diagnostic evaluation of cancer, methods of cancer treatment, definition of chemotherapy, aim of chemotherapy, precautions that nurses do during chemotherapy administration, side effects of chemotherapy, definition of radiation therapy, side effects of radiation therapy, definition of immunotherapy, definition of hematopoietic stem cell transplantation and psychological effect of cancer.

Second category: Nurses' knowledge about pediatric early warning scoring tools and clinical deterioration. It was designed by the researchers after reviewing related literatures (Hester et al., 2021), & (Singkwang, 2020). It contained (10) multiple-choice questions and (7) open-ended questions includes; definition, purpose, domains, scores, manifestation of clinical deterioration, risk factor of clinical deterioration, definition of triage, manifestation of respiratory distress, degree of fever, differentiate between tachycardia and bradycardia, assessment of skin color, assessment level of consciousness, assessment blood pressure, assessment heart rate, assessment respiratory rate, importance of documentation and application of early warning scoring tools.

Third category: Nurses' knowledge regarding nursing management of cancer related problems. It was designed by researchers after reviewing related literature. (National Cancer Institute, 2023). It encompassed (7) multiple-choice questions and (7) open-ended questions includes ; pain management, management of poor appetite, management of nausea and vomiting/emesis, management of dry mouth or thick saliva, management of stomatitis and mucositis, management of digestive disorders (constipation and diarrhea), anal hygiene,

management of hair loss/alopecia, management of myelo-suppression, management of thrombocytopenia, management of anemia, management of fatigue, emergency treatment of the children and nurses role for child with clinical deterioration.

Scoring system of nurses' knowledge: Two scores were given for complete correct answer, one score was given for incomplete correct answer and zero score was given for wrong answer / unknown answer. According to the nurses' responses, their total level of knowledge (50 questions and total scores 100 point) classified to; low level; if the obtained total scores was less than 50% (less than 50 point), and moderate level, if the obtained total scores was (50% to less than 75%) 50 to less than 75 point, and high level if the obtained total scores was (75% to 100%).75 to 100 point

Tool II: Observational checklist. It was Adopted from (Hockenberry, and Wilson, 2015), (Johnson, 2023), (Bhutta et al., 2024), & (Brinkman et al., 2024). It includes 11 nursing procedures for assessment of nurse's practice regarding application of pediatric early warning scoring tool in oncology unit. It includes behavioral assessment, cardiovascular assessment, respiratory rate assessment, heart rate measurement, blood pressure measurement, axillary temperature measurements, measurement of oxygen saturation by pulse oximeter, capillary refill time measurement, assess child alertness, skin color assessment and measuring intake and output.

Scoring system of nurses' practice: where one score was given for each step done correctly and zero score for step done incorrectly or not done. The total level of practice was considered incompetent level if the obtained total means scores were less than 90% and competent level if the obtained total mean scores were $\geq 90\%$.

Tool III: part (1): Children' characteristics: age, gender, and type of cancer (3 questions).

Part (2): Application of pediatric early warning scoring tool; based on (Monaghan 2005), and was modified by (Akre et al. 2010). This tool was adapted for detecting clinical deterioration and level of abnormal signs in pediatric oncology units post and follow up PEWST implementation. PEWST divided into three parameter; respiratory, circulatory, and behavioral signs of clinical deterioration, which are scored on a scale from 0 to 3 for each parameter.

Total scoring system: Every domain was assigned a score between 0 and 3 as clarified;

Domains/ score			
Behavior assessment			
Playing Score (0)	Sleeping Score (1)	Irritable Score (2)	Lethargic/disoriented or diminished sensitivity to pain Score (3)
Cardiovascular assessment			
Pink or capillary refill was 1-2 seconds Score (0)	3 seconds of capillary refill / pale or dusky Score (1)	Capillary refill 4 seconds / grey or cyanotic or tachycardia of 20 b/min above normal rate Score (2)	5 seconds or more for capillary refill /grey or cyanotic and mottled or Tachycardia of 30 b/min above normal rate or brady cardia Score (3)
Respiratory assessment			
No retractions within normal respiratory rates Score (0)	Using accessory muscles during respiration or retractions and greater than 10 c/min over normal respiratory rate Score (1)	Retractions or more than 20 c/min over normal respiratory rate Score (2)	Retractions / grunting Score (3)

The scoring system: spans from 0 to 9, with zero indicating a normal physiological condition, two extra 'points' may be granted if either ongoing inhalation medications or Continuous Positive Airway Pressure (CPAP)

are in use. **The total scoring system** is categorized as the following; 0-2 scores mean none, 3 scores mean mild, 4 scores mean moderate, > 5 scores mean sever degree of deterioration .

Methods:

The research was conducted through performing the subsequent steps:

Preparatory phase: involved developing the study tools using books, periodicals, magazines of line reference, and evidence-based articles, as well as reviewing recent studies and related material from both domestic and international sources to become familiar with a variety of research-related topics. Based on their recognized needs, the researchers created the training materials for oncology nurses during this phase.

Tools validity and reliability: The study tools' content validity was assessed and reviewed by a panel of three experts of pediatric nursing field in faculty of nursing; Benha University to test its applicability, relevance, sequence of items and clarity. Cronbach's alpha was used to test the reliability of the study tools. The reliability score for knowledge, and practices, were 0.88 and 0.83 respectively, indicates an internal consistency.

Ethical Considerations:

The researchers obtained ethical approval from the scientific research ethical committee at Benha University’s faculty of nursing code; REC-PN-P 53 on 3 April, 2024 and from the directors of the oncology unit at Benha specialized pediatric hospital. Prior to data collection, informed written consent was obtained from the oncology nurses involved in the study. Oncology nurses were briefed on the study's objectives and anticipated outcomes. Additionally, nurses were reassured about the study's harmlessness. After

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presenting the nature and objectives of the research, each nurse had the withdrawal right from the study any time. Also, all the studied nurses assured about the privacy, confidentiality, safety of obtained data.

The pilot study:

A preliminary research was conducted on 10% of study subjects (4) nurses along one month (during April 2024), to test the applicability and clarity of tools and estimate the required time to fulfill the study tools. According to the findings of the pilot study, no radical modifications were made to study tools. Therefore, the nurses include pilot study were added to the sample of the study.

Field of Work:

The pediatric early warning scoring tool actually done over six months from the beginning of the month of May 2024 to the end of October 2024. The researchers available in the study setting three days/ week (Sunday, Tuesday, and Thursday) by rotation between researchers during morning shift from 11.00 AM and extended to 1.30 PM and for gathering data through the previous data collection tools.

Assessment phase:

Each nurse was met by the researchers individually in the oncology unit. The researchers introduced themselves and explained the study aim and duration and obtained nurses' written consent to participate. Then, each nurse filled out the structured interview questionnaire sheet individually to obtain baseline data and to assess knowledge about early warning scoring tools to assess learning needs. The researchers clarify and interpret any vague issues. The average time needed 20-30 minutes. The researcher observed practice of nurses towards early warning scoring tools during their shifts by using an observational checklist. Each direct

observation took an average of 30-45minutes to complete. The researchers fill the children' characteristics from medical record

Planning phase:

The researchers reviewed the literatures based on oncology nurses' needs identified through assessment phase. Using various methods including a booklet contained major headlines of early warning scoring tools, which was designed by the researchers ensure accurate, clear, precise, updated, systematically organized, and simple contents were manipulated.

General objective: improve oncology nurses knowledge and practice regarding early detection of abnormal signs in pediatric oncology units

Specific objectives: At the end of PEWST implementation, the oncology nurses should be able to:

A-Nurses' knowledge regarding pediatric cancer:

- List common types of cancer among children,
- Illustrates manifestation of leukemia,
- List signs and symptoms of Wilms' tumor
- Differentiate between cancers of soft tissues and bones
- Mention diagnostic evaluation methods of cancer
- List methods of cancer treatment
- Discuss precautions that nurses do during chemotherapy administration,
- Discuss side effects of radiation therapy
- Define immunotherapy
- Define hematopoietic stem cell transplantation
- Discuss psychological effect of cancer.

B-Nurses' knowledge about pediatric early warning scoring tools and clinical deterioration:

- Define pediatric early warning scoring tools

- List purpose of pediatric early warning scoring tools
- Discuss domains of pediatric early warning scoring tools
- Illustrates scores of pediatric early warning scoring tools
- List manifestation of clinical deterioration
- Discuss application of pediatric early warning scoring tools

C- Nurses' knowledge regarding nursing management of cancer related problems:

- Discuss methods of pain management,
 - Explains management of poor appetite
 - Illustrates management of nausea and vomiting/emesis
 - Discuss management of dry mouth or thick saliva
- Identify management of fatigue
Identify emergency treatment of the children
Discuss nurse's role for child with clinical deterioration.

Practical skills

- Apply behavioral assessment
- Perform cardiovascular assessment
- Demonstrate respiratory rate assessment
- Apply heart rate measurement
- Perform blood pressure measurement
- Apply axillary temperature measurements
- Perform measurement of oxygen saturation by pulse oximeter
- Demonstrates capillary refill time measurement
- Assess child alertness
- Assess skin color
- Measure intake and output.

The pediatric early warning scoring tool implementation phase

The oncology nurses were informed about the time and place of PEWST sessions which were carried out at pediatric oncology unit at the fourth floor. They divided into 8 groups,

each group consisting of 5 nurses. The program lasted 8 hours for each group and was conducted according to the nurses' readiness, distributed as follows: (3) sessions for the theoretical component, each lasting 30-45 minutes, and (5) sessions for the practical component, each lasting 1 hour, held 3 days a week during the morning shift.

Theoretical sessions; the **first session** included nurses' knowledge regarding pediatric cancer, **the second session** included nurses' knowledge about pediatric early warning scoring tools and clinical deterioration, **the third session** concerned with nurses' knowledge regarding nursing management of cancer related problems. **Practical sessions;** concerned with implementation of paediatric early warning scoring tool through; **The first session** includes; behavioural and cardiovascular assessment, **The second session** includes ; respiratory rate, heart rate and blood pressure measurement, **The third session** includes; axillary temperature measurements, measurement of oxygen saturation by pulse oximeter and capillary refill time measurement, **The fourth session** includes; assess child alertness, assess skin colour and measure intake and output, then **The fifth session includes:** application of pediatric early warning scoring tool. These sessions were repeated to each subgroup of participated oncology nurses.

Evaluation phase

Posttest was completed immediately after implementation of early warning scoring tools. The post-tests were conducted using the same pretest data collection tools. Follow up was conducted after one month.

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Statistical analysis:

The gathered data was structured, arranged in tables, and analyzed statistically with Statistical Package for Social Science (SPSS) version 21 for Windows, operating on an IBM compatible computer. Data were shown with descriptive statistics represented as numbers and percentages for qualitative variables, and mean and standard deviation for quantitative variables. Qualitative variables were analyzed using the Chi-square test. Whenever the anticipated values in one or more of the cells fell below 5, the Fisher exact test was applied instead. Pearson correlation analysis was done for assessment of the interrelationship among quantitative variables. Statistical significance was defined as a p-value < 0.05, while a highly significant result was defined as p < 0.001.

Results:

Table (1): Reveals that; half (50%) of nurses are in the age group 35- <40 years with a mean age of 33.37 ± 6.53 years. The majority (90%) of them are females. In relation to academic qualifications, less than two-thirds (62.5%) of nurses had technical institute of nursing, and less than half (40%) of them had 5- <10 years of experience at the pediatric oncology unit with a mean experience of 10.30 ± 3.93 years. None of them had training courses regarding the implementation of early warning scoring tool in oncology units.

Table (2): It's clear from this table that; less than three quarters (72.5%) of nurses under study had wrong answers /or don't know regarding definition of solid tumors pre PEWST implementation which improved to majority (87.5% & 70%) of them had complete correct answers post and follow-up PEWST implementation respectively. Moreover, there was a highly statistical significant difference (p <0.000) in favor of immediate post and follow- up PEWST implementation.

Table (3): Represents that; more than half 55% of nurses under study had wrong answers /or don't know regarding assessment heart rate pre PEWST implementation which improved to 90% & 77.5 of them had complete correct answers immediate post and follow-up PEWST implementation respectively. Moreover, there was a highly statistical significant difference (p <0.000) in favor of post and follow-up PEWST implementation.

Table (4): Clarifies that; 70% of nurses under study had incomplete correct answers regarding management of nausea and vomiting/emesis pre PEWST implementation which improved to 97.5% and 77.5 of them had complete correct answers post and follow- up PEWST implementation respectively. Moreover, there was a highly statistical significant difference (p <0.000) in favor of post and follow- up PEWST implementation.

Figure (1): Clarifies that, less than two third (62.5%) of the studied nurses had low level of knowledge at pre PEWST implementation. Which improved to, majority (95% & 80%) of them had high level of knowledge post and follow-up PEWST implementation respectively.

Table (5): Reveals that; 65.0% of nurses under study had incompetent practice regarding cardiovascular assessment pre PEWST implementation which improved to 85% and 70.0 of them had competent level post and follow-up PEWST implementation respectively. Moreover, there was a highly statistical significant difference (p <0.000) in favor of post and follow-up PEWST implementation.

Figure (2): Clarifies that, majority (80%) of nurses under study had incompetent practice level regarding pediatric early warning scoring tool pre implementation.

Which improved to majority 90.0 & 82.5 of them had competent level of practice immediate post and follow-up PEWST implementation respectively

Figure (3): Shows that, more than half 57.5% of children under study were male

Figure (4): It explains that less than half 40% of children under study were diagnosed with leukemia and less than one third 30% of them had lymphomas. Also, a minority 12.5, 10% & 7.5 of them were diagnosed with brain and spinal tumors, kidney tumors, and bone tumors, respectively.

Figure (5): Shows that less than half (42.5%) of children under study had mild abnormal signs on post PEWST implementation while less than one third (30% & 22.5) of them had moderate and sever abnormal signs during follow up PEWST implementation respectively.

Table (6): Clarified that there were significant positive correlations found between nurses' total knowledge and total practice scores through PEWST implementation phases.

Table (1): Distribution of the studied nurses regarding their characteristics (n= 40)

Items	No.	%
Age/ years		
25- <30 year	3	7.5
30- <35 year	10	25.0
35- <40 year	20	50.0
≥ 40 year	7	17.5
Mean ± SD 33.37±6.53 years		
Gender		
Male	4	10.0
Female	36	90.0
Academic qualifications		
Secondary school of nursing	7	17.5
Technical institute of nursing	25	62.5
Bachelor in nursing science	5	12.5
Post graduate studies	3	7.5
Years of experience at pediatric oncology unit		
< 5 year	3	7.5
5- <10 year	16	40.0
10- <15 year	11	27.5
≥ 15 year	10	25.0
Mean ± SD 10.30±3.93 years		
Attendance of training courses regarding implementation of early warning scoring tools (EWST) in oncology unit		
No	40	100.0

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Table (2): Distribution of studied nurses' knowledge regarding pediatric cancer through PEWST implementation phases (n =40)

Items	Pre PEWST implementation						Immediate post PEWST implementation				X ² FET	P value (1)	Follow-up PEWST implementation				X ² FET	P value (2)
	Complete correct answers		Incomplete correct answers		Wrong answers /or don't know		Complete correct answers		Incomplete correct answers				Complete correct answers		Incomplete correct answers			
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%			NO.	%	NO.	%		
Definition of cancer.	2	5.0	19	47.5	19	47.5	36	90.0	4	10.0	63.53	0.000**	29	72.5	11	27.5	55.30	0.000**
Common types of cancer among children	3	7.5	14	35.0	23	57.5	34	85.0	6	15.0	53.97	0.000**	28	70.0	12	30.0	52.2	0.000**
Manifestation of leukemia	1	2.5	14	35.0	25	62.5	35	87.5	5	12.5	62.77	0.000**	29	72.5	11	27.5	61.11	0.000**
Manifestation of lymphoma	2	5.0	13	32.5	25	62.5	36	90.0	4	10.0	61.34	0.000**	29	72.5	11	27.5	58.04	0.000**
Definition of solid tumors	2	5.0	9	22.5	29	72.5	35	87.5	5	12.5	62.43	0.000**	28	70.0	12	30.0	60.79	0.000**
Signs and symptoms of Wilms tumor	1	2.5	11	27.5	28	70.0	35	87.5	5	12.5	64.44	0.000**	28	70.0	12	30.0	62.11	0.000**
Cancers of soft tissues and bones	2	5.0	12	30.0	26	65.0	34	85.0	6	15.0	60.45	0.000**	26	65.0	14	35.0	58.08	0.000**
Factors that cause cancer.	1	2.5	20	50.0	19	47.5	33	82.5	7	17.5	57.45	0.000**	26	65.0	14	35.0	52.79	0.000**
Diagnostic evaluation of cancer	2	5.0	21	52.5	17	42.5	35	87.5	5	12.5	56.27	0.000**	28	70.0	12	30.0	49.29	0.000**
Methods of cancer treatment	1	2.5	29	72.5	10	25.0	35	87.5	5	12.5	59.44	0.000**	27	67.5	13	32.5	51.87	0.000**
Definition of chemotherapy	3	7.5	29	72.5	8	20	37	92.5	3	7.5	58.14	0.000**	30	75.0	10	25.0	49.47	0.000**
Aim of chemotherapy.	3	7.5	23	57.5	14	35.0	36	90.0	4	10.0	55.29	0.000**	29	72.5	11	27.5	47.53	0.000**
Precautions that nurses take during chemotherapy administration.	5	12.5	20	50.0	15	37.5	37	92.5	3	7.5	52.27	0.000**	32	80.0	8	20.0	49.63	0.000**
Side effects of chemotherapy	8	20.0	22	55.0	10	25.0	36	90.0	4	10.0	41.37	0.000**	29	72.5	11	27.5	37.29	0.000**
Definition of radiation therapy	6	15.0	15	37.5	19	47.5	34	85.0	6	15.0	45.88	0.000**	29	72.5	11	27.5	43.78	0.000**
Side effects of radiation therapy	7	17.5	13	32.5	20	50.0	38	95.0	2	5.0	49.95	0.000**	33	82.5	7	17.5	45.89	0.000**
Definition of immunotherapy	2	5.0	26	65.0	12	30.0	35	87.5	5	12.5	56.00	0.000**	31	77.5	9	22.5	50.99	0.000**
Definition of hematopoietic stem cell transplantation	3	7.5	18	45.0	19	47.5	37	92.5	3	7.5	58.90	0.000**	32	80.0	8	20.0	53.94	0.000**
Psychological effect of cancer	6	15.0	24	60.0	10	25.0	38	95.0	2	5.0	52.07	0.000**	33	82.5	7	17.5	46.33	0.000**

**** A highly statistically significant difference (P <0.001)**

- Fisher exact test "FET"

-P (1): between pre and post PEWST implementation -- P (2): between pre and follow-up PEWST implementation

Table (3): Distribution of the studied nurses' knowledge about pediatric early warning scoring tools and clinical deterioration through PEWST implementation phases (n =40)

Items	Pre PEWST implementation						Immediate post PEWST implementation				X ² FET	P value (1)	Follow-up PEWST implementation				X ² FET	P value (2)
	Complete correct answers		Incomplete correct answers		Wrong answers / don't know		Complete correct answers		Incomplete correct answers				Complete correct answers		Incomplete correct answers			
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%			NO.	%	NO.	%		
Definition of early warning scoring tools	0	0.0	17	42.5	23	57.5	35	87.5	5	12.5	66.25	0.000**	29	72.5	11	27.5	64.47	0.000**
Purpose of early warning scoring tools	6	15.0	11	27.5	23	57.5	33	82.5	7	17.5	44.75	0.000**	27	67.5	13	32.5	43.78	0.000**
Domains of early warning scoring tools	0	0.0	15	37.5	25	62.5	34	85.0	6	15.0	64.47	0.000**	28	70.0	12	30.0	61.47	0.000**
Scores of early warning scoring tools	0	0.0	13	32.5	27	67.5	33	82.5	7	17.5	63.52	0.000**	28	70.0	12	30.0	61.05	0.000**
Manifestation of clinical deterioration	2	5.0	28	70.0	10	25.0	36	90.0	4	10.0	59.62	0.000**	32	80.0	8	20.0	54.99	0.000**
Risk factor of clinical deterioration	3	7.5	16	40.0	21	52.5	35	87.5	5	12.5	54.83	0.000**	32	80.0	8	20.0	52.97	0.000**
Definition of triage	3	7.5	19	47.5	18	45.0	32	80.0	8	20.0	48.66	0.000**	30	75.0	10	25.0	47.14	0.000**
Manifestation of respiratory distress	7	17.5	18	45.0	15	37.5	37	92.5	3	7.5	46.70	0.000**	34	85.0	6	15.0	44.32	0.000**
Degree of fever	9	22.5	24	60.0	7	17.5	34	85.0	6	15.0	32.86	0.000**	32	80.0	8	20.0	30.71	0.000**
Differentiate between tachycardia and brady cardia	8	20.0	20	50.0	12	30.0	36	90.0	4	10.0	59.32	0.000**	32	80.0	8	20.0	56.97	0.000**
Assessment of skin color	8	20.0	19	47.5	13	32.5	34	85.0	6	15.0	52.17	0.000**	30	75.0	10	25.0	48.66	0.000**
Assessment level of consciousness	5	12.5	12	30.0	23	57.5	31	77.5	9	22.5	56.20	0.000**	26	65.0	14	35.0	55.37	0.000**
Assessment blood pressure	7	17.5	30	75.0	3	7.5	31	77.5	9	22.5	43.85	0.000**	27	67.5	13	32.5	41.99	0.000**
Assessment heart rate	6	15.0	12	30.0	22	55.0	36	90.0	4	10.0	64.42	0.000**	31	77.5	9	22.5	62.84	0.000**
Assessment respiratory rate	5	12.5	25	62.5	10	25.0	36	90.0	4	10.0	59.46	0.000**	32	80.0	8	20.0	56.97	0.000**
Importance of documentation	6	15.0	13	32.5	21	52.5	35	87.5	5	12.5	48.60	0.000**	31	77.5	9	22.5	47.60	0.000**
Application of early warning scoring tools	0	0.0	14	35.0	26	65.0	33	82.5	7	17.5	63.52	0.000**	28	70.0	12	30.0	61.05	0.000**

**** A highly statistically significant difference (P <0.001) - Fisher exact test "FET"**

-P (1): between pre and post PEWST implementation - P (2): between pre and follow-up PEWST implementation

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Table (4): Distribution of the studied nurses' knowledge regarding nursing management of cancer related problems through PEWST implementation phases (n =40)

Items	Pre PEWST implementation						Post PEWST implementation				X ² FET	P value (1)	Follow up PEWST implementation				X ² FET	P value (2)
	Complete correct answers		Incomplete correct answers		Wrong answers / don't know		Complete correct answers		Incomplete correct answers				Complete correct answers		Incomplete correct answers			
	NO.	%	NO.	%	NO.	%	NO.	%	NO.	%			N O.	%	NO.	%		
Pain management	14	35.0	24	60.0	2	5.0	36	90.0	4	10.0	40.48	0.000**	30	75.0	10	25.0	35.63	0.001**
Management of poor appetite	10	25.0	19	47.5	11	27.5	33	82.5	7	17.5	37.77	0.000**	29	72.5	11	27.5	35.61	0.000**
Management of nausea and vomiting/emesis	7	17.5	28	70.0	5	12.5	39	97.5	1	2.5	62.22	0.000**	31	77.5	9	22.0	29.19	0.000**
Management of dry mouth or thick saliva	7	17.5	26	65.0	7	17.5	38	95.0	2	5.0	55.39	0.000**	30	75.0	10	25.0	28.40	0.000**
Management of stomatitis and mucositis	9	22.5	23	57.5	8	20.0	36	90.0	4	10.0	43.92	0.000**	32	80.0	8	20.0	28.66	0.000**
Management of digestive disorders (constipation and diarrhea)	6	15.0	27	67.5	7	17.5	38	95.0	2	5.0	55.08	0.000**	31	77.5	9	22.5	32.01	0.000**
Anal hygiene	8	20.0	22	55.0	10	25.0	39	97.5	1	2.5	58.55	0.000**	32	80.0	8	20.0	30.42	0.000**
Management of hair Loss/alopecia	7	17.5	19	47.5	14	35.0	35	87.5	5	12.5	45.39	0.000**	30	75.0	10	25.0	32.21	0.000**
Management of myelosuppression	8	20.0	16	40.0	16	40.0	38	95.0	2	5.0	46.89	0.000**	30	75.0	10	25.0	30.63	0.000**
Management of thrombocytopenia	10	25.0	17	42.5	13	32.5	35	87.5	5	12.5	40.62	0.000**	31	77.5	9	22.5	26.21	0.000**
Management of anemia	8	20.0	18	45.0	14	35.0	37	92.5	3	7.5	49.46	0.000**	30	75.0	10	25.0	29.98	0.000**
Management of fatigue	11	27.5	21	52.5	8	25.0	36	90.0	4	10.0	36.25	0.000**	28	70.0	12	30.0	24.15	0.000**
Emergency treatment of the children	8	20.0	23	57.5	9	22.5	35	87.5	5	12.5	41.42	0.000**	32	80.0	8	20.0	30.65	0.000**
Nurses role for child with clinical deterioration	8	20.0	26	65.0	6	15.0	36	90.0	4	10.0	52.50	0.000**	29	72.5	11	27.5	29.98	0.000**

**** A highly statistically significant difference (P <0.001)**

- Fisher exact test "FET"

P (1): between pre and post PEWST implementation -- P (2): between pre and follow-up PEWST implementation

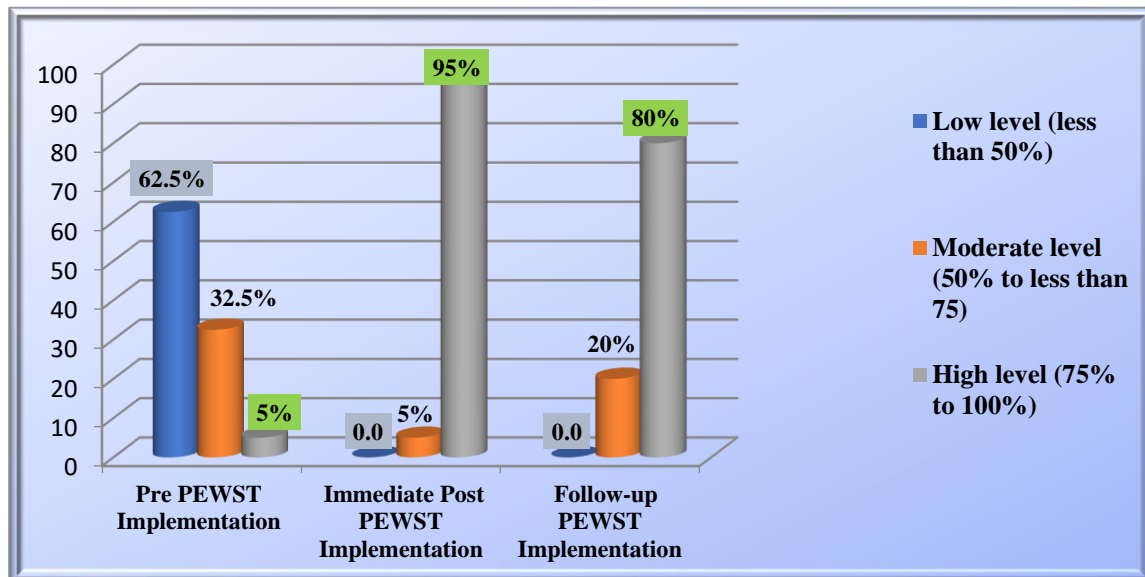


Figure (1): Distribution of total level of the studied nurses' knowledge through PEWST implementation phases (n =40)

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Table (5): Distribution of total level of the studied nurses' practice through PEWST implementation phases (n =40)

Procedure	Pre PEWST implementation				Post PEWST implementation				X2 FET	P value	Follow up PEWST implementation				X2 FET	P value
	Competent practice ≥90%		Incompetent practice < 90 %		Competent practice ≥90%		Incompetent practice < 90 %				Competent practice ≥90%		Incompetent practice < 90 %			
	No.	%	No.	%	No.	%	No.	%			No.	%	No.	%		
Behavioral assessment	12	30.0	28	70.0	35	87.5	5	12.5	48.08	0.000**	29	72.5	11	27.5	22.28	0.000**
Cardiovascular assessment	14	35.0	26	65.0	34	85.0	6	15.0	61.28	0.000**	28	70.0	12	30.0	15.71	0.002**
Respiratory rate assessment	16	40.0	24	60.0	38	95.0	2	5.0	51.71	0.000**	32	80.0	8	20.0	18.32	0.001**
Heart rate measurement	13	32.5	27	67.5	37	92.5	3	7.5	54.48	0.000**	30	75.0	10	25.0	14.53	0.000**
Blood pressure measurement	15	37.5	25	62.5	38	95.0	2	5.0	51.71	0.000**	31	77.5	9	22.5	18.32	0.000**
Axillary temperature measurements	17	42.5	23	57.5	39	97.5	1	2.5	46.87	0.000**	32	80.0	8	20.0	13.37	0.001**
Measurement of oxygen saturation by pulse oximeter	19	47.5	21	52.5	37	92.5	3	7.5	37.06	0.000**	33	82.5	7	17.5	14.57	0.002**
Capillary refill time measurement	13	32.5	27	67.5	39	97.5	1	2.5	61.59	0.000**	31	77.5	9	22.5	16.48	0.000**
Assess child alertness	14	35.0	26	65.0	36	90.0	4	10.0	48.08	0.000**	28	70.0	1	30.0	12.07	0.002**
Skin color assessment	12	30.0	28	70.0	36	90.0	4	10.0	61.28	0.000**	29	72.5	11	27.5	18.32	0.000**
Measuring intake and output	17	42.5	23	57.5	37	92.5	3	7.2	45.45	0.000**	31	77.5	9	22.5	19.29	0.001**

**** A highly statistically significant difference (P <0.001) --- Fisher exact test "FET"**

P (1): between pre and post PEWST implementation -- P (2): between pre and follow-up PEWST implementation

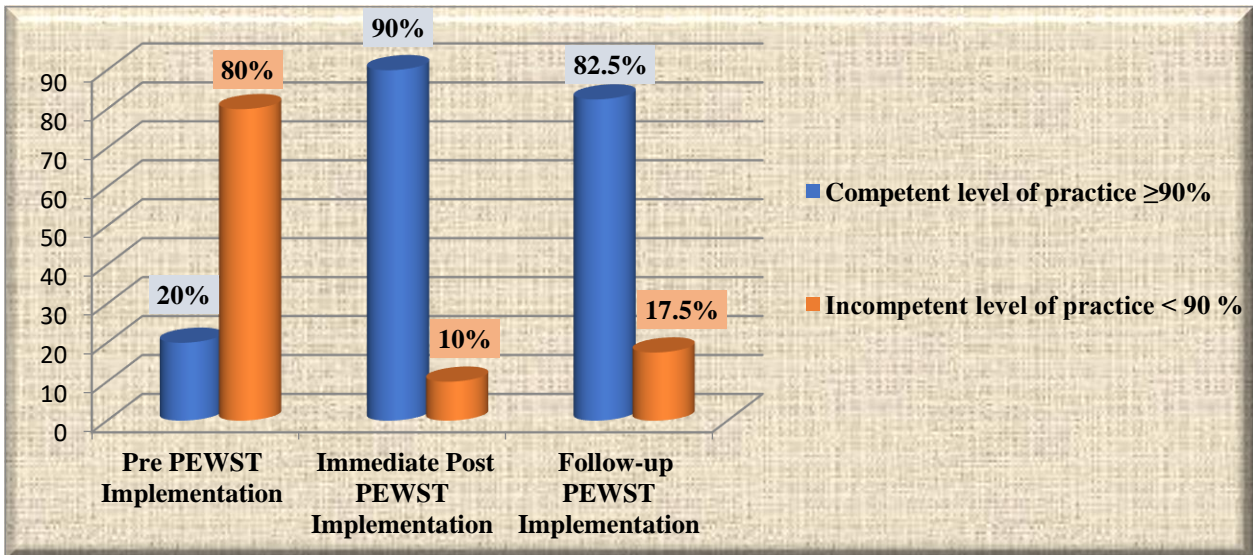


Figure (2): Distribution of total level of studied nurses' practice regarding pediatric early warning scoring tool through PEWST implementation phases (n =40)

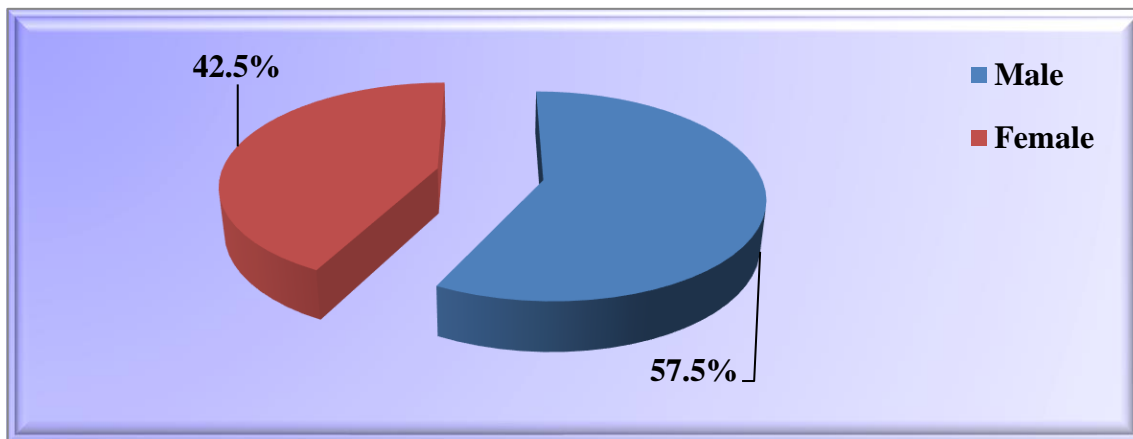


Figure (3): Distribution of studied children based on their gender (n =40)

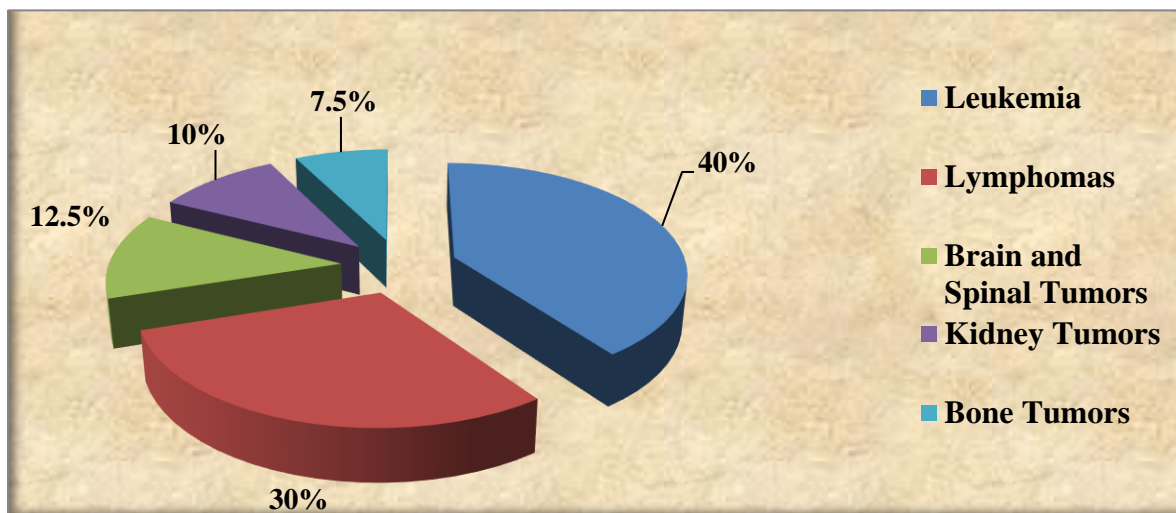


Figure (4): Distribution of studied children according to type of cancer (n =40)

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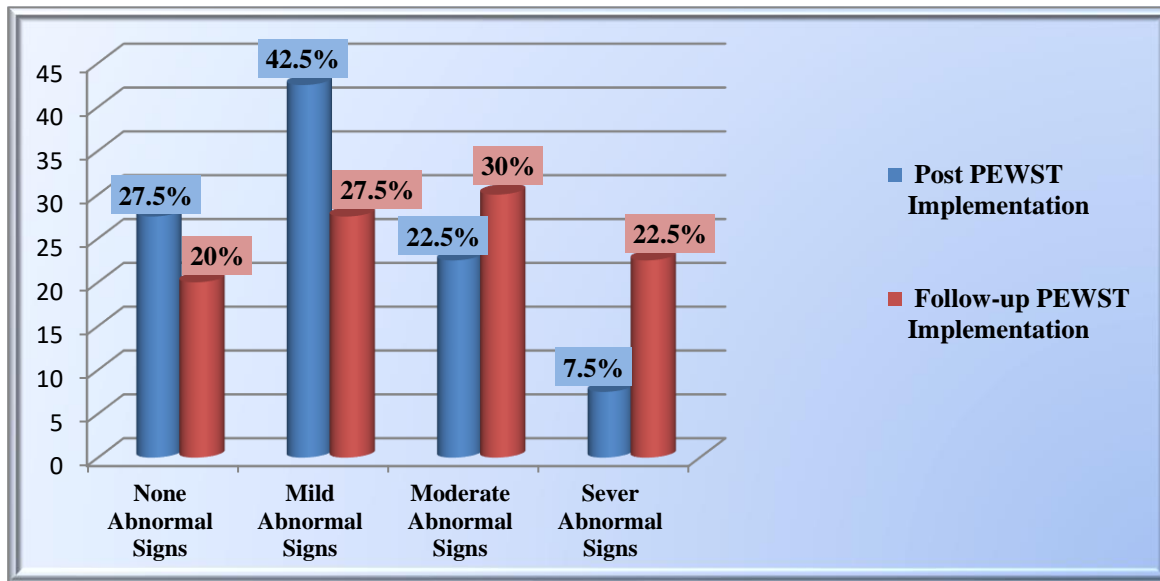


Figure (5): Classification of children under study based on the level of abnormal signs in pediatric oncology units using early warning scoring tools, post and follow up PEWST implementation (n =40)

Table (6): Correlation coefficient between studied nurses' total knowledge and total practice scores through PEWST implementation phases (n=40)

Total scores	Pearson correlation coefficient					
	Total practice score					
	Pre PEWST implementation		Immediate post PEWST implementation		Follow up PEWST implementation	
	r	P-value	r	P-value	r	P-value
Total knowledge score	0.851	0.000**	0.824	0.000**	0.769	0.000**

**** Correlation is significant at the 0.01 level (2- tailed).**

Discussion:

Clinical deterioration in children with cancer can occur for a variety of reasons, such as treatment-related toxicities and problems connected to the disease. During their treatment, up to 30% of children with cancer may require frequent admission to intensive care unit. Poorer outcomes that include organ failure and increased death rates which are linked to delays in transferring critically sick

children to the intensive care unit (Graetz et al., 2021).

The application of PEWS led to a decrease in the mortality rate of oncology children in 32 low-resource hospitals in Latin America. This information backs PEWS as successful evidence-based strategies for decreasing disparities in worldwide survival rates for children with cancer (Agulnik et al., 2023).

Regarding characteristics of oncology nurses, the study results mentioned that; half of them were in the age group 35- <40 years with a mean age of 33.37 ± 6.53 years, majority of them were females and less than two-thirds of oncology nurses had technical institute of nursing. These results congruent with **Abo El-Fadl, N. (2020)** who implement educational program on nurses' ability to prevent and manage chemotherapy extravasation via intravenous administration and reported that, less than half of studied nurses age ranged from 20 to less than 30 years with a mean age of 30.87 ± 5.59 years, and all of them were females. Also, less than two thirds of oncology nurses had a technical nursing institute certification.

Toward oncology nurses' knowledge level, the study findings clarified that; less than two third of them had low level of knowledge at pre PEWST implementation. This could be interpreted to none of them had training courses regarding the implementation of pediatric early warning scoring tools in oncology units. Which improved to, majority of them had high level of knowledge post and follow-up PEWST implementation. From the researcher's point of view, nevertheless, it can be inferred that the application of the PEWST program helped oncology nurses improve their knowledge and skills in using pediatric early warning scoring tools in pediatric oncology units. Also, this might be justified by the fact that the researchers employed various educational techniques such as giving oral presentations, discussion in a group, receiving feedback, and providing explanations and small books. These findings supported by **Abdala1 et al., (2018)** who design nursing intervention based on evidence based for identifying pediatric warning signs early and displayed average scores before the intervention were 14.18 ± 1.38 , improved to

be 17.81 ± 0.39 and 17.33 ± 1.19 on post-intervention and follow-up assessments. There were clearly significant differences in nurses' knowledge at the 0.001% level of statistical significance.

Moreover, these finding supported by **Sridhar et al., (2020)** who utilizing a pediatric early warning score to enhance communication and empower nursing staff in a rural hospital in Rwanda and reported that, all nurses passed skill testing with >80% accuracy.

In relation to total level of the studied nurses' practice regarding pediatric early warning scoring tools through PEWST implementation phases; the current study clarified that, majority of nurses under study had incompetent practice level regarding pediatric early warning scoring tool pre implementation. Which improved to majority of them had competent level post and follow-up PEWST implementation. This results supported by **Bubphamalo et al., (2023)** who design nursing practice guidelines for early warning system on nurses' knowledge, practice and abnormal signs detection in at-risk neonates and reported that; practice scores higher after the program implementation in the experimental group than that in the control group ($p = .008$). The detection rate of abnormalities in at-risk neonates reported by the experimental group was significantly higher than that by the control group ($p < .001$). From the researcher's point of view, the application of PEWST helps oncology nurses in identifying critically ill children through detection of abnormal signs.

Regarding characteristics of children under study, the current research findings demonstrated that, more than half of them were male and less than half of children under study were diagnosed with leukemia and less

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than one third of them had lymphomas. Also, a minority of them were diagnosed with brain and spinal tumors, kidney tumors and bone tumors. These findings go in the same line with **Zaky et al., (2022)** who investigate manner of childhood cancers in Minia Governorate and reported that, the most frequent type of cancer in children was leukemia followed by lymphoma.

Moreover, these results supported by **Ibrahim and Shash (2022)** they conducted research on overall cancer treatment in Egypt and found that out of 57,357 hospitals, more than half of children were diagnosed with solid tumors while less than half were diagnosed with hematopoietic cancers. Also, the predominant types of cancer included leukemia, lymphoma, CNS tumors, and neuroblastoma.

Regarding application of PEWST on oncology children, the present study showed that less than half of children under study had mild abnormal signs on post PEWST implementation while less than one third of them had moderate and severe abnormal signs during follow up PEWST implementation. From the researchers' point of view, PEWST implementation assisted oncology nurses in enhancing their skills for early detection signs of deterioration and documenting warning signs in pediatric oncology units at an early stage. These results congruent with **Chong et al., (2022)** Who conducted a systematic review and meta-analysis research to study the effect of pediatric early warning systems on reducing mortality rates and critical deterioration among children and found that, among 10 studies analyzed for the incidence of mortality rates, there was an increased mortality risk found in the group not implementing PEWS compared to the group implementing PEWS.

Moreover, this results supported by **Phuaksaman, and Sukboonthong, (2022):** who apply modified pediatric early warning score in general medical ward and reported that; PEWS is an effective tool at detecting pediatric patients who have deteriorated.

Regarding correlation between studied nurses' knowledge and practice the present study clarified that there were significant positive correlations found between nurses' total knowledge and total practice scores through PEWST implementation phases. This finding was in the same line with results of **Ebraheim et al., (2023)** who study the effect of early warning scores teaching on nurses' performance to recognize and react to clinical deterioration and explains that the practice of the nurses under study and their knowledge at the pre and post intervention phase have a positive, significant correlation ($p < 0.001$).

Conclusion:

Nurses who attended the PEWST have a higher level of knowledge and practice regarding the implementation of pediatric early warning scoring tools on immediate post- and follow-up tests than on pretest, which contributed to early detection of abnormal signs in pediatric oncology unit on immediate post- and follow-up tests.

Recommendations:

1-In-service training programs about PEWST should be continuously implemented in pediatric oncology units to enhance nurses' knowledge and practice regarding early detection of abnormal signs

2-The PEWST needs to be incorporated into the recently developed pediatric patient protocol observation chart present in oncology units.

3-Further researches; the PEWST study should be replicated on a larger random sample in different oncology units for the generalization of the obtained results.

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تأثير تطبيق أدوات تسجيل الإنذار المبكر على الاكتشاف المبكر للعلامات الغير طبيعية في وحدات أورام الأطفال

فاطمة إسماعيل محمد ابوالعلا - دعاء السيد محمد ابوزيد - سماح عبدالله محمد عامر

تم تطوير أداة تسجيل الإنذار المبكر للأطفال للتعرف المبكر على العلامات التحذيرية في أورام الأطفال حيث يشارك ممرضين أورام الأطفال في جميع جوانب رعاية الاطفال مرضى السرطان، من الاكتشاف الأولي إلى تقديم الدعم البدني والعاطفي طوال فترة العلاج. لذا هدفت الدراسة إلى تقييم تأثير تطبيق أدوات تسجيل الإنذار المبكر على الاكتشاف المبكر للعلامات الغير طبيعية في وحدات أورام الأطفال. و تم استخدام تصميم شبه تجريبي لإجراء الدراسة (اختبار قبلي وبعدي ومتابعه). وقد أجريت هذه الدراسة في وحدة الأورام في مستشفى الأطفال التخصصي بنها التابع للأمانة العامة للمراكز الطبية المتخصصة على جميع الممرضين المتاحين (٤٠) العاملين في المكان المذكور أعلاه. وتم جمع البيانات باستخدام الأدوات التالية: الأداة (الأولى): استمارة استبيان المقابلة الشخصية. الأداة الثانية: استمارة الملاحظة لتقييم مهارات الممرضين تجاه الاكتشاف المبكر للعلامات الغير طبيعية في وحدات أورام الأطفال و الاداة الثالثة: الخاصه بالمعلومات الطبيه للاطفال المشاركين في الدراسة و بتطبيق أدوات تسجيل الإنذار المبكر. و اظهرت النتائج بان كان هناك تحسن إحصائيًا كبيراً في معلومات وممارسات الممرضين فيما يتعلق بالكشف المبكر عن العلامات غير الطبيعية في وحدة الأورام بعد تنفيذ أدوات تسجيل الإنذار المبكر للأطفال. كما أدى تنفيذ ادوات تسجيل الإنذار المبكر للأطفال إلى تحسين معلومات وممارسات الممرضين فيما يتعلق بالكشف المبكر عن العلامات غير الطبيعية للأطفال في وحدة الأورام. و اوصت الدراسة بأنه يجب تنفيذ برامج تدريبية عن ادوات تسجيل الإنذار المبكر للأطفال بشكل مستمر في وحدات أورام الأطفال لتعزيز معلومات وممارسات الممرضين فيما يتعلق بالكشف المبكر عن العلامات غير الطبيعية.