

Effect of Educational Program on Pediatric Nurses' Knowledge and Practice Regarding Assessment of Body Fluid Balance for Critically Ill Children

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Abstract:

Background: Body fluid balance assessment for critically ill children is vital for pediatric nurses. **Aim** of the present study was to evaluate the effect of educational program on pediatric nurses' knowledge and practice regarding assessment of body fluid balance for critically ill children. **Subjects and Method:** A quasi-experimental (pre-post-test) research **design** was applied at Emergency and Rehydration units of Assiut University Children Hospital. **Two tools** were used to collect the data: **Tool (1):** A structured interview questionnaire for nurses. It consisted of **two parts:** personal characteristics of the studied nurses and nurses' knowledge questionnaire. **Tool (2):** Nurses' practice for assessing body fluid balance observation checklist. **Results:** It was noticed that more than two-thirds of nurses had good score of knowledge after the program application. Also, the majority of nurses had a satisfactory practice level after the program application. Statistically significant differences were found between pre and post-program as regards nurses' knowledge and practice. Moreover, it was found a positive correlation regarding total nurses' knowledge and practice scores before and after program application. **Conclusion:** There was a significant improvement in pediatric nurses' knowledge and practice regarding assessment of body fluid balance for critically ill children after educational program implementation compared to before the program. **Recommendations:** Continuous educational training programs regarding assessment of body fluid balance of critically ill children will help pediatric nurses to update their knowledge and improve their practice.

Keywords: *Assessment of Body Fluid Balance, Critically Ill Children, Educational Program, Knowledge & Practice, Pediatric Nurses.*

Introduction:

Children vary in required fluid intake due to increased metabolic rates, which cause increased fluid loss (Feld et al., 2018). Fluid balance (FB) monitoring is essential for pediatric nurses in the intermediate and intensive care unit to identify fluid overload. Which can harmfully impact the child outcomes (Flori et al., 2011). A study by Arikani et al. (2012) who revealed that fluid overload may deleteriously affect the prognosis of children (especially in the intermediate and intensive care unit) who did not receive continuous renal replacement therapy. Despite this, the best method for measuring FB at the bedside in the intermediate intensive care unit is unclear.

FB is an expression that typically explains balance between the input and output of fluids that allows metabolic processes to function properly (Welch, 2010). It has a significant function in managing patients who have severe disorders which impact their body function. Therefore, it is very important to accurately assess FB as baseline information of ill children. It directs their interventions both medical

and nursing to stabilize the physiological status of the child and thwart complications (AbdElaleem; Fouad, 2018 & Asfour, 2016).

Furthermore, evaluating and documentation of a child's FB is important. It is used in managing the clinical condition of critically ill patients who have diseases leading to body fluid accumulation such as hypertension, peripheral and tissue edema, respiratory failure, and increased cardiac demand (AbdElaleem; Fouad, 2018 & Asfour, 2016).

Effective management needs an accurate assessment of the FB status of critically ill cases. This involves proper monitoring of fluid intake and output. Therefore, it is necessary for pediatric nurses to perform suitable FB monitoring, accurate calculation, and documentation to provide high quality of patient care (Asfour, 2016; Diacon & Bell, 2012).

Timby & Smith (2013) who emphasized that pediatric nurses play an important role in caring for critically ill children. So, pediatric nurses should have the knowledge and skills required for optimal maintenance of hydration status and FB of patients.

Monitoring of FB is a part of the nurses' scope practice. Thus, pediatric nurses must have knowledge and skills to assess and monitor body fluids. As nurses are accountable and responsible for the careful recording and calculation of FB while caring for seriously ill children (AbdElalem & Fouad, 2018).

Therefore, pediatric nurses need to properly monitor and evaluate fluids in the child's body to boost the child's safety. Also, FB management of patients is just as important as performing any other patient care activity for critically ill patients (AbdElalem & Fouad, 2018, Abdullah, 2014, & Boyd et al., 2011).

Significance of the study:

Fluid management is critical when providing acute care in the emergency department or hospitalized children. Early and appropriate fluid administration improves outcomes and reduces mortality in children. The human body has strict physiologic control to maintain a balance of fluid and electrolytes. However, in disease states, these mechanisms may be overwhelmed. Dehydration occurs due to the significant depletion of water and electrolytes. It commonly increases morbidity and mortality in children (Benjamin & Muhammad, 2021).

Current publications and nursing best practices emphasize the significance of careful and correct monitoring of FB in critically ill patients, including recording fluid intake and output on a purpose-designed FB chart (AbdElalem & Fouad, 2018 and Diacon & Bell, 2014).

Aim of the study:

The aim of this study was to evaluate the effect of educational program on pediatric nurses' knowledge and practice regarding assessment of body fluid balance for critically ill children.

Research hypothesis:

Pediatric nurses' knowledge and practice regarding assessment of body fluid balance will be expected to be improved after program Implementation.

Subjects and Method

Study design:

A quasi-experimental (pre-post-test) research design was used in the present study.

Setting of the study:

This study was conducted at Emergency and Rehydration units in Assiut University Children Hospital. The Emergency and Rehydration units have received nearly 7345 and 4693 cases of children during the year 2020 with an average of 612 and 496 child/month respectively. Also, each Emergency and Rehydration units have an intermediate intensive care unit to treat the critically ill cases of admitted children.

Study subjects:

Purposive sampling technique of sixty pediatric nurses at the Emergency and Rehydration units was used with the following inclusion criteria:

Inclusion criteria: The study included pediatric nurses in the mentioned setting who have/were:

- 1- Qualifications (diploma and baccalaureates degree in nursing).
- 2- Not less than a year of experience at the Emergency and Rehydration units.
- 3- Responsible and accountable for giving nursing care for critically ill children in the mentioned above setting.
- 4- Accepting to take part in this study.
- 5- The study included all nurses who were giving nursing care for critically ill children who were admitted and received intravenous fluids and monitored their fluids intake and output during the study period in the mentioned setting.

Study tools:

Two tools were utilized to gather the study data. The researchers developed the tools through reviewing the relevant scientific literature and references. Also, it was based on relevant previous literature by Sheta & Mahmoud (2018), Waqas et al. (2017), and Ruth & Mogileeswari (2016).

Tool (1): A structured interview sheet for nurses; it involved of two parts as the following:

Part (1): It was included nurses' characteristics such as: Age, education, unit's experience, and the training programs which previously attended.

Part (2): Knowledge questionnaire of pediatric nurses: The questionnaire was aimed to assess knowledge of pediatric nurses regarding body fluid balance for critically ill children at the Emergency and Rehydration units. It has consisted of 16 questions; definition of FB, body fluid importance, fluid compartments, pediatric differences related to fluid and electrolyte balance, types of fluid, percent distribution of body fluid, definition of fluid imbalance, dehydration's causes, signs and symptoms, & complications, definition of over hydration or water intoxication, over hydration, causes, clinical manifestations, & complications, fluid input & output measuring methods, and accurate FB chart's indications.

Tool (1) scoring: Each correct answer was given one mark and the incorrect answer was given zero marks. The nurses' knowledge was considered accurate according to the literature. The maximum score was 16 and the minimum score was zero. According to Sheta & Mahmoud (2018) the nurses' knowledge was scored as follows: Good >75% (12 -16), average 50 – 75% (<8-12), and poor <50% (<8).

Tool (2): Nurses' practice for assessing body fluid balance by using observation checklist. It has

consisted of 23 items divided into three parts as the following:

Part (1): Child's fluid assessment: It consisted of 6 items: Child's weight, vital signs, abnormal breathing sound, peripheral edema, postural hypotension, laboratory findings such as; complete blood count, etc...

Part (2): Fluid input measuring: It consisted of 8 items: All drinks via the mouth. Drinks were measured using standardized-sized cups, liquid food. Intravenous fluids such as blood transfusion, nasogastric tube feeding, water, flushes/boluses, total parenteral nutrition, and fluid input items recorded.

Part (3): Fluid output measuring: It consisted of 9 items: Urine, stool/stoma output, vomiting, nasogastric tube aspiration, perspiration/insensible losses, drainage from surgical drains, chest drains, weighing pads, and fluid output items recorded to estimate the balance between input and output.

Tool (2) scoring: The items which were observed done completely scored "2", the items which were observed done incompletely scored "1", while the items which were observed not done scored "0". The total practice score was considered satisfactory practice if $\geq 75\%$ (17-23), while a score $< 75\%$ (< 17) was considered unsatisfactory practice (Sheta & Mahmoud, 2018).

Method of Data collection:

Ethical approval was accomplished by the Ethical Committee at the Faculty of Nursing at Assiut University. The aim of the study was explained to the nurses at the Emergency and Rehydration units. Written consent was obtained from the studied participants. The researchers have informed the nurses whether they had the right to contribute to the study or not. Also, the collected data would be confidential and used only for the study purpose.

Official permission was attained from the Chairmen of the Emergency and Rehydration units of Assiut University Children Hospital. It was done to collect the data after explaining the study's aim.

Validity & reliability of the study tools: **The content validity index** of tools were evaluated by five Pediatric Nursing experts (tool one was 0.87 & tool two was 0.80). **Tools reliability** was done using **Cronbach's α test** to measure the internal consistency of the tools (tool one; $R= 0.79$ & tool two; $R=0.77$).

The pilot study: It was carried out for 10% of nurses (6). It was implemented to examine the clarity and applicability of the study tools. Also, to determine the time required for filling the sheet. The pilot study nurses were involved in the total sample because no necessary modifications were done to the sheet.

Structured educational program:

It had been designed by the researchers based on the pertinent literary text. The researchers used lecture and discussion as a method of teaching and giving booklet handouts presented into Arabic language. The booklet was contained an illustrated colored pictures and photos. It was included the knowledge of pediatric nurses concerning body FB assessment for critically ill children i.e. FB's definition, etc.... as mentioned in tool one. Also, nurses' practice for assessing body fluid balance as assessing child's fluid status, fluid input and output measuring, etc.... as mentioned in tool two.

Field of the study:

The researchers were collected the data from December 2020 to May 2021. Each nurse was interviewed separately by the researchers at the Emergency and Rehydration units in the pretest in the morning shift, during the working time. Then the researchers clarified the study aim after introducing themselves. Three sessions were implemented for studied nurses: In the first session; a pretest was completed by using tool (1) during an interview and an indirect observational checklist was applied by using tool (2) through observing nurses' practice (assessing body FB of critically ill children). About two to three nurses were interviewed two days/week. The first session's duration was variable and ranged between 60 and 90 minutes for each nurse. In the second session; the educational program was applied through 10 classes each class involved 6 nurses according to their unit's schedule. The program's contents were presented through lectures and distributed in a printed colored booklet. The session was taking from 45-60 minutes. It was implemented immediately after finishing the first session for all nurses (two months) and finished during one month. In the third session; the researchers had applied the posttest after one month of the second session using the study tools. It was finished within two months for all nurses.

Statistical Analysis:

The data were tested for normality using the Anderson-Darling test and for homogeneity variances prior to further statistical analysis. Categorical variables were described by **number and percent (N, %)**, where continuous variables were described by the mean and standard deviation (**Mean, SD**). **Chi-square test** and Fisher exact test used to compare between categorical variables where compare between continuous variables by **t-test** and **ANOVA TEST**. The person Correlation was used to appear the association between scores. **A two-tailed $p < 0.05$** was considered statistically significant. All analyses were performed with the **IBM SPSS 20.0** software.

Results

Table (1): Percentage distribution of studied nurses related to personal characteristics (n=60)

Personal characteristics	No	%
Age/ years		
▪ Less than 25 years	15	25.0
▪ From 25-30 years	27	45.0
▪ More than 30 years	18	30.0
Mean ±SD (range)	30.07±6.62 (22-49)	
Education Level		
▪ Bachelor's degree in Nursing	15	25.0
▪ Technical Institute of Nursing	24	40.0
▪ Secondary School of Nursing	21	35.0
Years of experience		
▪ Less than 5 year	24	40.0
▪ From 5-10 year	20	33.3
▪ More than 10 year	16	26.7
Mean ±SD (range)	8.04±6.30 (0.6-24)	
Previous training programs		
▪ No	55	91.7
▪ Yes	5	8.3

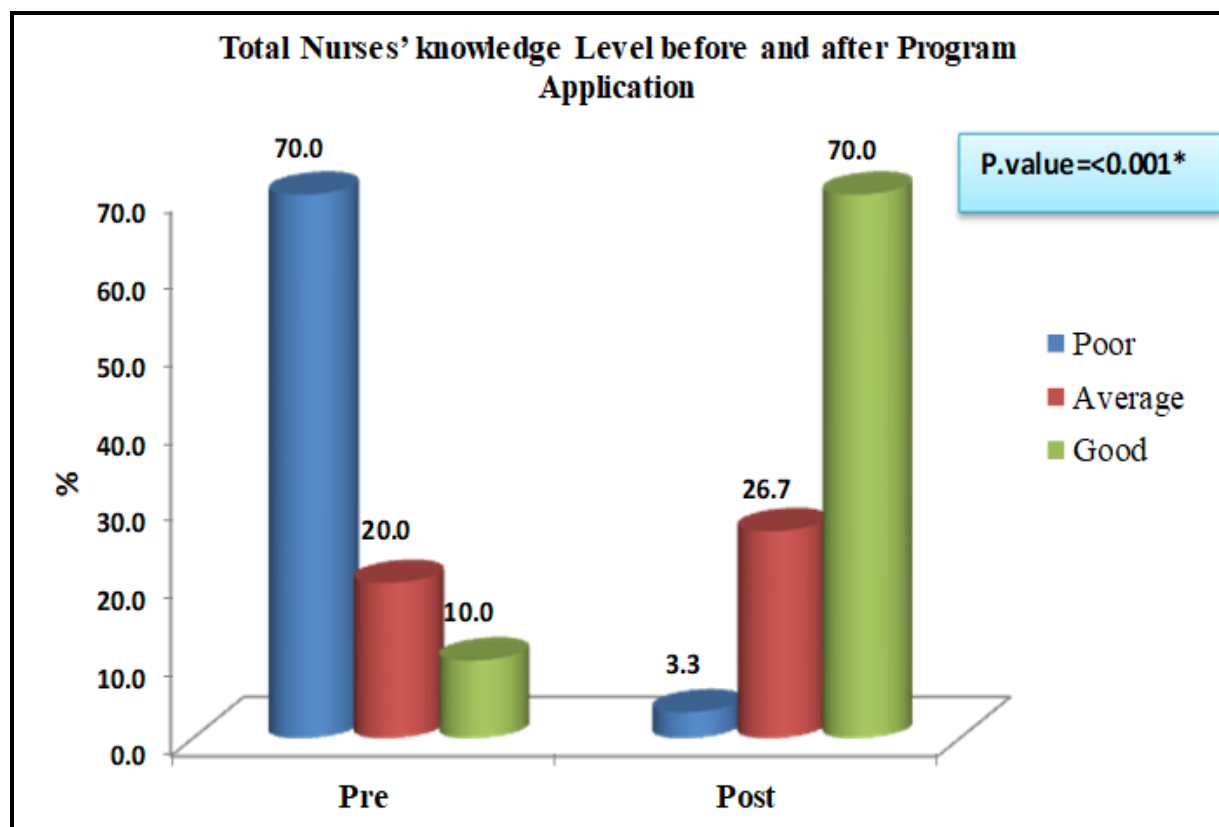


Figure (1): Total nurses' knowledge level before and after educational program implementation

Table (2): Mean score of nurses' practice before and after educational program implementation (n=60).

Nurses' practice	Before (n=60)	After (n=60)	T	P. value
	Mean ±SD	Mean ±SD		
• Assessing patients' fluid status	6.28±2.85	9.13±1.96	-6.386	<0.001**
• Measuring of fluid input	12.77±3.53	14.77±1.81	-3.903	<0.001**
• Measuring of fluid output	10.23±3.88	13.53±3.19	-5.094	<0.001**
Total Score	29.28±8.81	37.43±5.07	-6.210	<0.001**

Independent T-test quantitative data between the Tow group

**Significant level at P-value ≤ 0.01

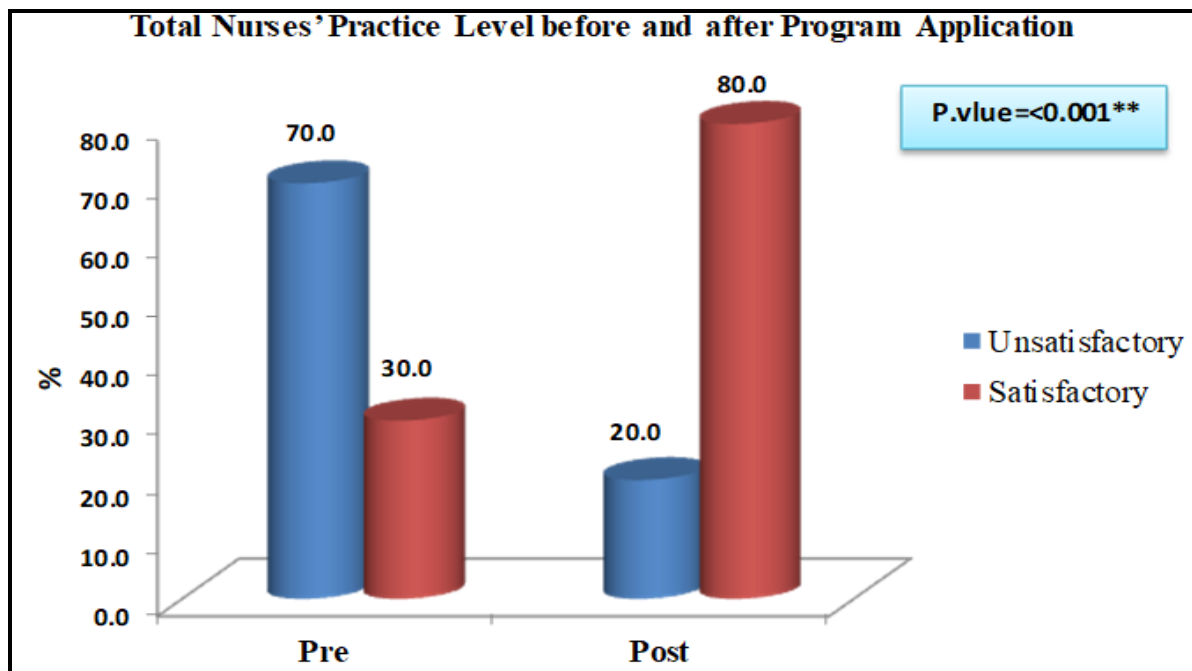


Figure (2): Total nurses' practice level before and after program application

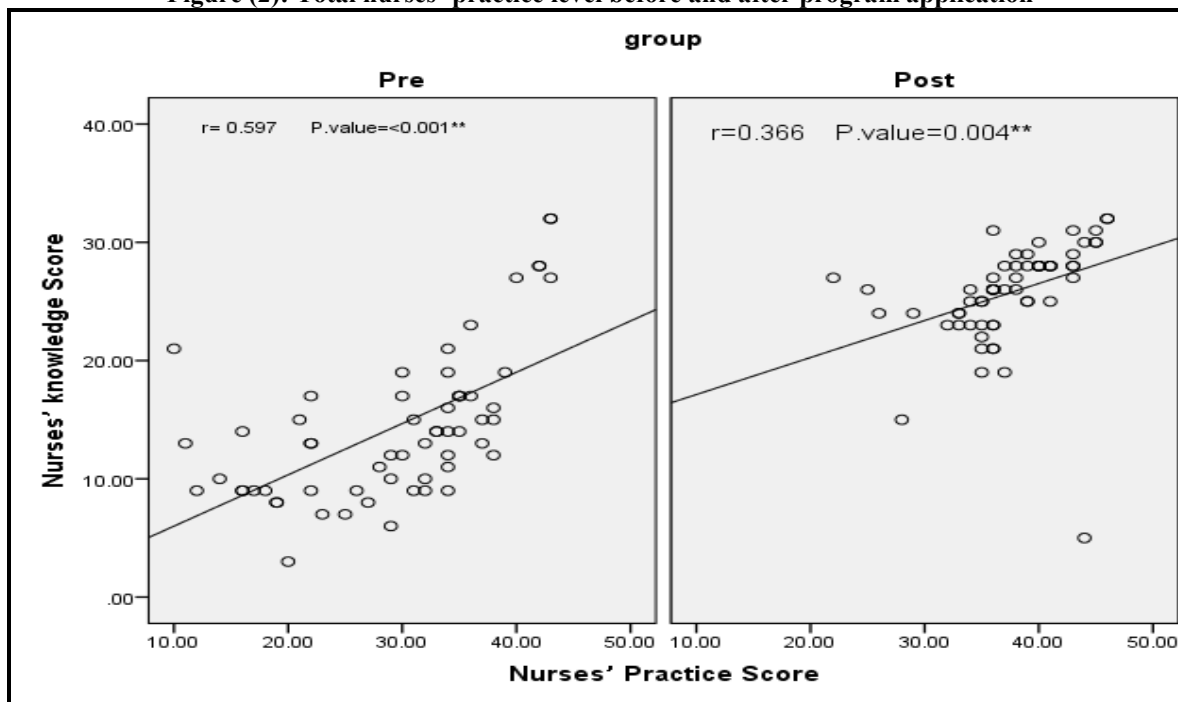


Figure (3): Correlation coefficient between total nurses' knowledge score and their total practice score before and after educational program implementation.

Table (3): Relation between total nurses' knowledge and personal characteristics before and after educational program implementation (n=60)

Personal characteristics	Total 'knowledge before			P1	Total knowledge after			P2
	Poor (n=42)	Average (n=12)	Good (n=6)		Poor (n=2)	Average (n=16)	Good (n=42)	
	No (%)	No (%)	No (%)		No (%)	No (%)	No (%)	
Age/ years								
▪ Less than 25 years	14(33.3)	1(8.3)	0(0.0)	0.055	0(0.0)	7(43.8)	8(19)	0.157
▪ From 25-30 years	19(45.2)	4(33.3)	4(66.7)		2(100)	6(37.5)	19(45.2)	
▪ More than 30 years	9(21.4)	7(58.3)	2(33.3)		0(0.0)	3(18.8)	15(35.7)	
Education Level								
▪ Bachelor's degree in nursing	5(11.9)	4(33.3)	6(100)	<0.001**	0(0.0)	1(6.3)	14(33.3)	0.133
▪ Technical institute of nursing	18(42.9)	6(50)	0(0.0)		1(50)	10(62.5)	13(31)	
▪ Secondary school of nursing	19(45.2)	2(16.7)	0(0.0)		1(50)	5(31.3)	15(35.7)	
Years of experience								
▪ Less than 5 year	20(47.6)	4(33.3)	0(0.0)	0.048*	0(0.0)	9(56.3)	15(35.7)	0.181
▪ From 5-10 year	14(33.3)	2(16.7)	4(66.7)		2(100)	4(25)	14(33.3)	
▪ More than 10 year	8(19)	6(50)	2(33.3)		0(0.0)	3(18.8)	13(31)	
Previous training program								
▪ No	40(95.2)	11(91.7)	4(66.7)	0.060	2(100)	15(93.8)	38(90.5)	0.839
▪ Yes	2(4.8)	1(8.3)	2(33.3)		0(0.0)	1(6.3)	4(9.5)	

Chi square test for qualitative data between the two groups or More

*Significant level at P-value ≤ 0.05 ,

** at P-value ≤ 0.01

Table (4): Relations between nurses' total practice and their nurses characteristics before and after educational program implementation (n=60)

Personal Characteristics	Total practice before		P1	Total practice after		P2
	Unsatisfactory (n=42)	Satisfactory (n=18)		Unsatisfactory (n=12)	Satisfactory (n=48)	
	No (%)	No (%)		No (%)	No (%)	
Age/ years						
▪ Less than 25 years	15(35.7)	0(0)	0.014*	6(50)	9(18.8)	0.078
▪ From 25-30 years	16(38.1)	11(61.1)		4(33.3)	23(47.9)	
▪ More than 30 years	11(26.2)	7(38.9)		2(16.7)	16(33.3)	
Education level						
▪ Bachelor's degree in nursing	3(7.1)	12(66.7)	<0.001**	0(0)	15(31.3)	0.003**
▪ Technical institute of nursing	19(45.2)	5(27.8)		3(25)	21(43.8)	
▪ Secondary school of nursing	20(47.6)	1(5.6)		9(75)	12(25)	
Years of experience						
▪ Less than 5 year	19(45.2)	5(27.8)	0.443	6(50)	18(37.5)	0.626
▪ from 5-10 year	13(31)	7(38.9)		4(33.3)	16(33.3)	
▪ More than 10 year	10(23.8)	6(33.3)		2(16.7)	14(29.2)	
Previous training program						
▪ No	40(95.2)	15(83.3)	0.126	11(91.7)	44(91.7)	1.000
▪ Yes	2(4.8)	3(16.7)		1(8.3)	4(8.3)	

Chi square test for qualitative data between the two groups or More

*Significant level at P-value ≤ 0.05 ,

** at P-value ≤ 0.01

Table (1): It was observed that 45.0 % of the studied nurses were in the age group ranged from 25-30 years with a mean age (range) of 30.07 ± 6.62 (22-49). Also,

40.0 % of them graduated from Technical Institute of Nursing. Moreover 40.0 of the nurses had less than 5 years of experience at emergency and rehydration

units. Finally, only 8.3 % of studied nurses had attended training educational programs regarding assessment of body fluid balance for extremely sick children.

Figure (1): It was noticed from this figure that 70% of the nurses had a poor score of knowledge before the program decreased to 3.3% after educational program implementation. On the other hand, 10% of nurses had a good score before educational program increased to 70% after educational program implementation. A statistically significant difference was found between pre and post-educational program implementation ($P < 0.001^{**}$).

Table (2): Present table demonstrated a statistically significant difference in respect of assessing patients' fluid status, measuring fluid input and output before and after educational program implementation ($p < 0.001^{**}$, $< 0.001^{**}$ and $< 0.001^{**}$ respectively).

Figure (2): This figure illustrated that 70% of the studied nurses had unsatisfactory practice levels which lowered to 20% after program application. On the other hand, 30% of nurses had a satisfactory practice level before educational program implementation which was reached 80% after educational program implementation with a statistically significant difference between pre and post-program ($p\text{-value} = < 0.001^{**}$).

Figure (3): It was clear from the figure that a positive correlation was found as regards total nurses' knowledge and practice scores before and after educational program implementation ($r = 0.597^{**}$ $p = < 0.001^{**}$ and $r = 0.366^{**}$ $p = 0.004^{**}$ respectively).

Table (3): The present table revealed a statistically significant difference between nurses' total knowledge and their personal characteristics before educational program implementation regards their educational level and the years of experience ($P < 0.001^{**}$, and 0.048^{*}) respectively.

Table (4): The results found that statistically significant differences were detected between nurses' total practice and their nurses characteristics before educational program implementation as regards their age and educational level ($p = 0.014^{*}$ and $< 0.001^{**}$) respectively. While a statistically significant difference was detected as regards the nurses educational level only after educational program implementation ($p = 0.003^{**}$).

Discussion

The accurate monitoring of FB activities is a vital part of patient's baseline information, which guides medical and nursing interventions to achieve physiological stability. While inaccurate monitoring of FB especially in critically ill children can deteriorate children conditions. Therefore, FB should be monitored and recorded accurately for patients in

intermediate and intensive care units (Asfour, 2016). The aim of this study was to evaluate the effect of educational program on pediatric nurses' knowledge and practice regarding assessment of body fluid balance for critically ill children.

The current research exhibited that near half of the studied nurses were in the age group ranged from 25-30 years. This was in agreement with Sheta & Mahmoud (2018) and Abd Elalem & Fouad (2018). Also, two-fifth and more than one-third of nurses were obtained technical institute of nursing and secondary school of nursing. Most of the nurses were not highly qualified so they should seek to obtain a more advanced qualification and training. In this respect, the American Association of Colleges of Nursing (AACN) encourages lifelong learning and offers motivations for nurses seeking to advance their education (AACN, 2014). Regarding years of experience; it was found that two-fifth had less than 5 years of experience at emergency and rehydration units. This meant that these nurses were new graduates. Moreover, less than one-tenth of studied nurses had attended training programs regarding body FB assessment for extremely sick children. This result was concurrent with Sheta & Mahmoud (2018) who indicated that the majority of nurses had no training program.

Moreover, more than two-thirds of the studied nurses had poor score of knowledge before the program which significantly improved to a good score after the program application as presented in the study results. The present findings were in agreement with Hassan et al., (2021), Abd Elalem & Fouad (2018), Aslam et al., (2017), and Asfour (2016). Also, similar to Sheta & Mahmoud (2018) who concluded that the nurses' knowledge was significantly enhanced after program application. The result could be explained that the planned educational program would positively increase the pediatric nurses' awareness and knowledge about body fluid balance assessment.

In addition, the present findings illustrated that there were statistically significant differences between the total mean pediatric nurses' practice score pre and post program application concerning body FB assessment for critically ill children. Similarly, the majority of nurses had satisfactory practice levels after program application with a statistically significant difference between pre and post-program application. These results were synchronized with Sheta & Mahmoud (2018), Eldsok et al., (2016), and Diacon & Bell (2014) who revealed that the nurses' practices about fluid and electrolyte balance were enhanced after implementing the educational program. Likewise, these results were continuous with Kol et al. (2017) who determined that continuous training programs for nurses are highly

important concern that helps the nurses to be aware and updated with the novel in the nursing sciences which enhances the nursing practice.

Moreover, the present study indicated that a positive correlation was found as regards total nurses' knowledge and practice scores before and after program application. These results were consistent with **Arrar & Mohammed (2020)**, **Sheta & Mahmoud (2018)**, and **Aslam et al., (2017)**. Furthermore, **Abd Elalem & Fouad (2018)** found a significant relation between knowledge and practice of studied nurses concerning body assessment of FB after program application. This could be explained by every nurse needs to acquire theoretical and technical information, that is necessary to develop her skills in clinical practice. Technical skills cannot be separated from intellectual and interpersonal skills. Intellectual skills related to technical skills include the nurses' knowledge of the principles and steps of the procedure. Also, the educational program assisted the nurses in completing the professional tasks competently and correctly.

Likewise, the present study revealed that a statistically significant difference between nurses' total knowledge and their personal characteristics before program application as regards their educational level and years of experience. This finding was in the same line with **Hamed, (2009)** who reported that the Bachelor's degree nurses scores were significantly better than nurses who graduated from the Technical Institute of Nursing and Secondary School of Nursing. This could be explained possibly because of the basic knowledge received during academic years, which is different than that knowledge received by the Technical Institute of Nursing and Secondary School of Nursing Students. On the other hand, these results were not in agreement with **Hassan et al., (2021)** who illustrated that, there was no statistically significant relation between nurses' total knowledge score and their demographic characteristics.

The study found that a statistically significant difference between nurses' total practice and their personal characteristics as regards age and educational level. This result was unpredictable with **Kaya & Dogu (2018)** who found that the nurses' characteristics didn't affected their practice. These findings were inconsistent with the study conducted by **Hassan et al., (2021)** & **Mohamed et al., (2019)** who revealed that there was no statistically significant relation between nurses' characteristics and their practice.

Conclusion:

There was a significant improvement in pediatric nurses' knowledge and practice regarding assessment

of body fluid balance for critically ill children after educational program implementation compared to before the program.

Recommendations:

In the light of the study results' findings, the following recommendations are suggested:

- Continuous educational training programs regarding assessment of body fluid balance of critically ill children help pediatric nurses to update their knowledge and improve their practice.
- A provision of periodic training workshops and seminars for pediatric nurses at the emergency and rehydration units about assessment of body fluid balance.
- A designed protocol for assessment of body fluid balance should be provided to all pediatric nurses and be available at the units.

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References:

- **Abd Elalem S., & Fouad N. (2018):** Effect of an instruction intervention about body fluid balance assessment on knowledge and practice among nurses in intensive care unit. *International Journal of Novel Research in Healthcare and Nursing*, 5 (1): 94-105.
- **Abdullah M. (2014):** Nurses' knowledge and practices about administration of medications via nasogastric tube among critically ill patients. *Journal of Education and Practice*, 5(1): 147-59. Retrieved from <http://www.iiste.org/Journals/index.php/JEP/article/view/10736>. Accessed on 20 August 2021.
- **American Association of Colleges of Nursing (AACN) (2014):** 2013-2014 enrollment and graduations in baccalaureate and graduate programs in nursing. Washington, DC: Author.
- **Arikan A.A., Zappitelli M., Goldstein S.L., Naipaul A., Jefferson L.S., & Loftis L.L. (2012):** Fluid overload is associated with impaired oxygenation and morbidity in critically ill children. *Pediatr Crit Care Med Journal*, 13(3):253-58. <https://doi.org/10.1097/PCC.0b013e31822882a3>
- **Arrar A., & Mohammed S.J. (2020):** Effectiveness of an educational program on nurses' knowledge and practices concerning nursing care for critically ill patients at critical care units in Misan Governorate Hospitals. *Medico-legal Update*, July-September, 20 (3): 1236-47.
- **Asfour I. (2016):** Fluid balance monitoring accuracy in intensive care units. *IOSR Journal of Nursing and Health Science*, 5 (4): 53-62.

- **Aslam S., Afzal M., Kousar R., Waqas A., & Gilani S. (2017):** Assessment of nurses' knowledge and practices about fluid and electrolytes monitoring and administration among cardiac surgery patients: A case of Punjab Institute of Cardiology, *Int. J. Appl. Sci. Biotechnol*, 5(2): 208-15.
- **Benjamin P., & Muhammad K.W. (2021):** Pediatric fluid management. Stat pearls publishing LLC. Bookshelf ID: NBK560540PMID: 32809375.
- **Boyd J., Forbes J., Nakada T., Walley K., & Russell J. (2011):** Fluid resuscitation in septic shock: A positive fluid balance and elevated central venous pressure are associated with increased mortality. *Crit Care Med Journal*, 39(2):259-65.
- **Diacon A., & Bell J. (2012):** Fluid balance monitoring in critically ill patients. Faculty of medicine and health sciences at Stellenbosch University.
- **Diacon A., & Bell J. (2014):** Investigating the recording and accuracy of fluid balance monitoring in critically ill patients. *S Afr J Crit Care Journal*, 30(2):55- 7.
- **Eldsouk E., Taha N., & Saleh M. (2016):** Nurses' knowledge and practice concerning fluid and electrolyte balance among patients with congestive heart failure, *Zagazig Nursing Journal*, 12(1): 114-21.
- **Feld L.G., Neuspiel D.R., Foster B.A., & Leu M.G., (2018):** Subcommittee on fluid and electrolyte therapy. Clinical practice guideline: Maintenance intravenous fluids in children. *Journal of Pediatrics*, 142(6). Article e20183083. <https://doi.org/10.1542/peds.2018-3083.e20183083>.
- **Flori H.R., Church G., Liu K.D., Gildengorin G., & Matthay M.A. (2011):** Positive fluid balance is associated with higher mortality and prolonged mechanical ventilation in pediatric patients with acute lung injury. *Critical Care Res Pract Journal*: 854142. <https://doi:10.1155/2011/854142>. PMID: PMC3114079.
- **Hamed S.M. (2009):** Nurses performance during cardiopulmonary resuscitation in intensive care unit and cardiac care unit at Benha University hospital, Unpublished Master thesis, Faculty of Nursing, Benha University.
- **Hassan H.M., El-sayed E.E., Mohammad S.Y., & Sobh D.E. (2021):** Effect of applying guidelines on nurses' performance regarding fluid and electrolyte imbalance, *Port Said Scientific Journal of Nursing*, 8 (2): 14 -36.
- **Kaya H., & Dogu O. (2018):** Intensive care unit nurses' knowledge, attitudes and practices related to using physical restraints, *International Journal of Caring Sciences*. 11(1):61-70.
- **Kol E., Ilaslan E., & Turkay M. (2017):** Training needs of clinical nurses at university hospital in Turkey, *Nurse Education in Practice*, 22, 15-20.
- **Mohamed M.A., EL-Dakhakhny A.M., & Mohamed B.M. (2019):** Nurses knowledge and practice regarding care of comatose children at pediatric intensive care units. *Zagazig Nursing Journal*, 15 (2): 54-70.
- **Ruth M. & Mogileeswari P. (2016):** Knowledge and practice regarding fluid and electrolyte replacement therapy for patient with burns. *International Journal of Multidisciplinary Research and Development*, 4(3):217-20.
- **Sheta H.A., & Mahmoud M.H. (2018):** "Effectiveness of structured educational program on knowledge and practice among nurses regarding body fluid balance assessment for critically ill patients." *Journal of Nursing and Health Science* 7(5): 74-83.
- **Timby B.K., & Smith N.E. (2013):** Caring for Clients with Fluid, Electrolyte and Acid Base Imbalance. *Introductory Medical-Surgical Nursing 11th ed.* Philadelphia: Lippincott Williams & Wilkins Co.
- **Welch K. (2010):** Fluid balance. *Learning disability practice*; 13: 6, 33-38.
- **Waqas A., Gilani S., & Kousar R. (2017):** Assessment of nurses' knowledge and practices about fluid and electrolytes monitoring and administration among cardiac surgery patients: A case of Punjab Institute of Cardiology, *Int. J. Appl. Sci. Biotechnol*. 5(2): 208-15.