Nurses' Performance in Operating Life-saving Medical Devices at Pediatric Intensive Care Unit.

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Abstract

Background: *The life-saving medical devices can be define as are machines, apparatuses or technologist which used to ensure the optimal level of physiological functions. In case that the organ or organs failed to function well.* ***Aim:*** *The study aimed to assess nurses' performance in operating life-saving medical devices at Pediatric Intensive Care Unit* ***Research Question:*** *What is the level of nurses' performance in operating life-saving medical devices at Pediatric Intensive Care Unit?* ***Operational Definition:*** *Life-saving devices in this study refer to mechanical ventilator, cardiac monitor, and infusion and syringe pumps.* ***Settings:*** *The study was conducted at the Pediatric Intensive Care Units (PICUs) of Alexandria University Children's Hospital (AUCH) at Elshatby and Alanfoshy Children's Hospital (ACH) at Bahari.* ***Subjects****: 50 nurses worked on the life-saving medical devices in the previously mentioned settings were included.* ***Tools:*** *One tool named "Assessment of Nurses' Performance in Operating Life-saving Medical Devices" used to collect the necessary data in this study. It included two parts. Part One: The Characteristics of Nurses. Part Two: Nurses' Performance in Operating Life-saving Medical Devices Observational Checklist.* ***Results:*** *nurses performance regarding the operating studied four lifesaving medical devices was satisfactory level in 60 % studied nurses, as regarding interoperating maintenance nurses performance was unsatisfactory level (98%) for the same medical devices in pediatric intensive care unit* ***Conclusion:*** *It was concluded that nurses' performance was satisfactory in operating the studied four lifesaving medical devices at in pediatric intensive care unit.* ***Recommendation*** *It was recommended that nurses should receive a continuous training programs concerning interoperating maintenance of lifesaving medical devices.*

Keywords: ***Nurses Performance, Operating Life-saving Medical Devices, Pediatric Intensive Care Unit.***
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INTRODUCTION

Medical devices are ubiquitous, technologies in modern pediatric intensive care unit. The number of available types of the medical devices is 1.5 million worldwide. They are integral part of providing safe and high quality care of hospitalized children. The profusion of intensive care as heavily relies on technical resources. The use of ventilators, vital sign monitors, infusion, and syringe pumps, is fundamental to functioning of the PICUs. The safe operation of devices requires the availability of procedures manuals for operation and maintenance (Battini et al., 2022; de Oliveira et al., 2017).

The life-saving medical devices can be define as are machines, apparatuses or technologist which used to ensure the optimal level of physiological functions. In case that the organ or organs failed to function well. They enable nurses to provide high quality nursing care. Another cause is the insufficient and inconsistent training of the nursing staff. The last reason is the financial constraints. As any operating machine the life-saving medical devices as expected lifespan.so this devices needs periodic evaluation of their performance (Alsohime et al., 2019; Deep, 2022).

The aim of PICU admission is to support of vital system functions and restore health of critically ill or injured children. The PICU is a highly demanding environment due to the of the admitted children conditions. Raise critical conditions requires highly efficient medical life saving devices to support and monitor children's condition. Therefore, the nursing staff must pay attention to the variations different models of the device and their way of operation adjustment. Nursing staff must be alert to the alarming system and proper functioning of different life saving medical devices be. (Lee et al., 2023; Slusher et al., 2018).

The lifesaving medical devices are continuously used for all critically ill children, so it is essential so they must be properly maintained to ensure their functioning particularly in all devices used for supporting life and resuscitation. Nursing staff in the PICU must perform daily checks on medical devices and inform biomedical engineering staff about the need for replacement and maintenance. Preventive Maintenance is used to reduce the cause of a potential harms or non- functioning. The satisfactory operating condition is grantee by systematic inspection, detection, and correction of incipient failures either before and after they occur. (Corciova et al., 2024; Daniel, 2024; Wheeler et al., 2018).

The inter hospital handling of medical devices require careful operation, cleaning, sterilization and transportation. In deploying a medical equipment management system, it is important to consider the services to be executed and their specific characteristics required for the operation and handling .Nurses are the largest group using the medical devices at PICU. They play significant roles in the appropriate use and maintenance of all health resources including the lifesaving medical devices (Chaminda et al., 2023; Wu et al., 2022).

The pediatric critical care nurse's intricate role involves continuously monitoring physiologic indicators and medical equipment, as well as

assessing the child's condition. The nurse must promptly assess any abnormalities and take appropriate action, while also ensuring the safe and efficient operation of medical devices. Additionally, she plays a key role in creating a supportive environment for the child and their family to adapt to the situation. Lastly, the nurse acts as a coordinator of patient information (Adly et al., 2020).

Accordingly, it is very critical to study the competency of PICU nurses in dealing with the medical devices during their caring of critically ill infants and children

AIM OF THE STUDY

The aim of the present study was to assess nurses' performance in operating life-saving medical devices Pediatric Intensive Care Unit.

RESEARCH QUESTION

What is the level of nurses' performance in operating life-saving medical devices at Pediatric Intensive Care Unit?

Materials and Method

Research Design:

Descriptive research design was used to accomplish this study.

Settings:

The study was conducted at the Pediatric Intensive Care Units (PICUs) of Alexandria University Children's Hospital (AUCH) at Elshatby and Alanfoshy Children's Hospital (ACH) at Bahari.

Settings' Description:

- Pediatric intensive care unit at Alexandria University Children's Hospital (AUCH): it has 3 rooms with 12 beds. Each bed has all the basically needed critical care medical equipment as follows: ventilator, cardiac monitor, syringe pump, infusion pump and air mattress as needed. It has also 3 defibilirators and 2 dialysis machines. The hospital provides pediatric medical and surgical tertiary care services to 4 governorates; Alexandria, Albuhairah, Kafr-Elsheik and Matrouh.
- Pediatric intensive care unit at Alanfoshy Children's Hospital (ACH): it has 2 rooms with 9 beds. As for the critical care equipment; the unit has the following: 3 ventilators, 6 syringe pumps, 6 infusion pumps, 9 monitors and 2 defibrillators. The hospital provides pediatric medical and surgical tertiary care services mainly for the West and Elgomrok districts of Alexandria governorate.

Subjects:

The subjects of the current study comprised all nurses who were working on the life-saving medical devices in the previously mentioned settings (50 nurses).

Tools:

One tool used to collect the necessary data in this study.

Tool: Assessment of Nurses' Performance in Operating Life-saving Medical Devices:

This tool was developed by the researcher after thorough review of the related literature (Adly et al., 2020; Alsohime et al., 2019). It included two parts as follows:

Part One: The Characteristics of Nurses:

This part comprised the characteristics of nurses which are age, level of education, years of experience and attending special training on the operation of life-saving medical devices.

Part Two: Nurses' Performance in Operating Life-saving Medical Devices Observational Checklist:

It included data related to the nurses' performance in operating and interoperating maintenance of life-saving medical devices as follows:

- Mechanical ventilator's operation data: connecting air and oxygen extensions, connecting circuit, turning on and off, calipering flow sensor, adjusting ventilator settings and responding to alarming system.
- Cardiac monitor's operation data: connecting probes and blood pressure extensions, applying chest electrodes, entering new case's data and printing ECG waveforms as needed.
- Infusion pump's operation data: connecting flow set, regulate the flow rate, apply flow sensor, priming fluids double check the rate by manual counting.
- Syringe pump's operation data: connecting appropriate syringe size, connecting proper sized extension, regulate flow rate of medication, priming extension line and giving bolus doses as prescribed.
- Interoperating maintenance:
  - Mechanical ventilator's maintenance data such as: changing filters and circuits, sterilizing autoclavable parts and replacing flow sensors before expiration.
  - Cardiac monitor's maintenance data such as: keeping electrical extensions straight and non-kinked, proper disinfection during and after use and keeping monitor on a proper sized holder to prevent falling.
  - Infusion pump's maintenance data such as: maintaining pump charged, proper final disinfection, keeping pump well fixed to prevent falling and keeping pump's door closed.
  - Syringe pump's maintenance data such as: maintaining pump charged, keeping plunger closed if it is not used and keeping clips closed as far as syringe is turned off.

Scoring System:

Nurses' performance was assessed and scored as follow;

- Not done items scored as one.
- Done items scored two.

The total score of items were summed up and converted into percent score as:

- Unsatisfactory performance was scored as < 100%.
- Satisfactory performance was scored as = 100 %.

METHOD

1. Approval from the Research Ethics Committee, Faculty of Nursing, and Alexandria University was obtained before starting the study
2. The developed tool was tested for its content validity by five experts in Pediatric Nursing field. The validity of the tool was 90 %. Based on their comments, necessary modifications were done.
3. A pilot study was conducted on 10% of the study subjects to test the feasibility of research and the applicability of the tool. Necessary modifications were done accordingly and this number was excluded from total study sample.
4. The reliability of the tools was done by measuring the internal consistency of its items using Cronbach Coefficient Alpha ,where r = 0.797 .interrater reliability was done two time before &

after pilot study the result before pilot was 0.797& after pilot was = 0.818 reliability .

5. Nurses' characteristics were obtained from every nurse using part one of the tool.
6. Every nurse was interviewed individually by researcher to obtain her/ his characteristics. This interviewing was held during the break time .each interview session least about10 minutes.
7. Every nurse in the Pediatric Intensive Care Unit was observed individually by the researcher to assess nurse's performance in operating the life-saving medical devices using part two of the tool. The observation was performed two times during the working hours; one time in the morning and the other one was done in the evening shift.
8. Data collection of the study over a period of three months from the first of august 2021 to the end of January 2022.
9. After completion of the data collection, the necessary statistical analysis was done.

Ethical Considerations

- Witness written consent for all nurses will be obtained from the nursing director of the unit after providing appropriate explanation about the purpose of the study.
- Confidentiality of data of pediatric intensive care unit nurses will be maintained throughout the implementation of the study.

Statistical analysis

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0**. (**Armonk, NY: IBM Corp**).** Qualitative data were described using number and percent. The **Shapiro-Wilk test** was used to verify the normality of distribution. Quantitative data were described using range (minimum and maximum), mean, and standard deviation, median. Significance of the obtained results was judged at the 5% level.

Results

Table (I) presents the characteristic of nurses. It was noticed that 42% of nurses' ages ranging from 25 to less than 30 years. The ages of equal percent of them (20%) were less than 25 years and 35 years and more with mean and standard deviation 28.540 ± 4.77.

Concerning the nurses' education level, it was found that the majority of nurses had bachelor degree (78%).furthermore 18 % of them had diploma of secondary school or technical institute. Only 4% of studied nurses attained postgraduate degree.

It was observed from the same table that 54% of nurses had less than 5 years of experience in PICU, while 20 % of them had 10 years & more. Unfortunately, it was observed that 98 % of nurses did not attend special training regarding the operation of life saving medical devices.

Table (II) presents the level of nurses' performance regarding mechanical ventilator device at PICU.it was found that the nurses' performance in operating the mechanical ventilator device was in satisfactory level for 60% &62% of them during first & second observations respectively.

Unfortunately, it was shows that the majority of nurses' performance was in unsatisfactory level (98% &94%) regarding interoperating maintenance the mechanical ventilator device during first & second observations respectively

Table (III) illustrates the level of nurses' performance regarding cardiac monitor device

at PICU.it was noticed that the nurses' performance in operating the cardiac monitor device was in satisfactory level for 84% &90% of them during first & second observations respectively.

Unfortunately, it was shows that the majority of nurses' performance was in unsatisfactory level (84% &82%) regarding interoperating maintenance of cardiac monitor device during first & second observations respectively

Table (IV) Presents the level of nurses' performance regarding infusion pump device at pediatric intensive care unit. It was clarified that the nurses' performance in operating the infusion pump device was in satisfactory level for 58% &52% of them during first & second observations respectively.

Unexpectedly, it was found that the majority of nurses' performance was in unsatisfactory level (90% &100%) regarding interoperating maintenance infusion pump device during first & second observations respectively.

Table (V) Portrays the level of nurses' performance regarding syringe pump devices at pediatric intensive care unit. It was clarified that the nurses' performance in operating the syringe pump device was in satisfactory level for 60% &62% of them during first & second observations respectively.

Regrettably, it was found that the performance for all nurses was in unsatisfactory level (100%) regarding interoperating maintenance of syringe pump device during first & second observations respectively

Table (VI) illustrates the level of nurses' performance regarding the four lifesaving medical devices at pediatric intensive care unit. It was found that the nurses' performance in operating the studied four lifesaving medical devices was in satisfactory level for 62% &60% of them during first & second observations respectively.

Unlikely, it was noticed that the majority of nurses' performance was in unsatisfactory level (98% &100%) regarding interoperating maintenance for the studied four lifesaving medical devices during first & second observations respectively.

Table (VII) portrays the relationship between nurses' performance and their characteristics regarding the operating of lifesaving medical devices at pediatric intensive care unit. It was showed that the nurses' performance who their ages ranging from 25 to less than 30 years was in satisfactory level (41.9 % & 43.3%) during first & second observations respectively.

Regrettably, it was clarified that the performance of nurses' who years of experience in PICU less than 5 years was in unsatisfactory level in first (63.2%) and second observations (55%) regarding operating of lifesaving medical devices.

It was noticed that high percent of nurses' performance who had bachelor of nursing degree was in satisfactory level in first (80 .6%) and second (83.3%) observations regarding the operating of lifesaving medical devices.

Unfortunately, it was found that the majority of nurses performance who not attend the special training program was did in unsatisfactory level during first (96.8%) and second (95%) observations regarding the operating of lifesaving medical devices. In

addition the significant differences were not illustrated.

Discussion

Nurses' performance in operating of lifesaving medical devices at pediatric intensive care unit (PICU) is crucial, compound and dynamic for patient care .Nurses require an enormous number of practical skills, effort, and competency in managing technologies pleasantly toward positive human health perspectives in the ICUs. Therefore, they should update their knowledge and practice through continuing training educational programs and workshops. (El-Garhy, S. H. A. et al 2020).

Nowsdays, equipment lifesaving medical devices become more sophisticated and complex, so hospitals must ensure that these critical devices are safe, accurate, reliable and operational at a required level of performance. Many performance measurement frameworks have been developed and widely used to achieve the excellence of maintenance service, namely the balance of performance, risks and cost.(Mahfoud,H., 2017)

Nursing staff has an important role in understanding and applying the safety standard precautions goals for children safety to minimize the hazards and errors (Adly.R., 2020).The findings of the present study revealed that two third of the studied nurses had satisfactory level in operating lifesaving medical devices [first &second observations (62% &60%) respectively] as clarified in table (VI). These findings could be related to certain factors, such as education, where the high percent of nurses in this study who were in satisfactory level had either bachelor or master degree as clarified in table (VII). These results were congruent with many authors. Nguyen, 2021 in his study regarding the relationship between critical thinking and job performance among nurses cited that the high level of education emphasizing the critical thinking, enhancing knowledge &problem solving approaches as well as encouraging the application of evidence based practice in updating the nurses' skills that are influencing on their performance. Swingwood et al. 2019 also supported the same issue, where they illustrated that working in ICUs requires special skills &strong working endurance that will be achieved by high qualification of nurses.

On other hand, the results of the present study elaborated that the performance of nurses who had diploma degree in nursing were in unsatisfactory level regarding the lifesaving medical devices. This findings were parallel with El-sayed,S. (2019**)** who cited that 30% of nurses got secondary school or technical institute in nursing had unsatisfactory.

The nurses' age could be another factor which effect for performance. It was showed from the result of the current study that high percent of nurses who were 25 to less than 30 years of age had satisfactory level in operating lifesaving medical devices first & second observations (41.9 % & 43.3 %) respectively s as clarified in table (VII).This was confirmed by Guven,S.D.(2023) who stated that middle age of nurses often bring a wealth of experience to the workplace and have typically developed strong critical thinking abilities, making sound judgments and decisions in complex patient

The years of nurses' experience have a significant impact on their performance. The nurses gained experiences tend to become confident, efficient and skilled in operating of medical devices.

Regrettably ,the result of the present study revealed that high percent of nurses who experienced less than 5 years in had unsatisfactory level in first & second observations (63.2% & 55%)] regarding the operating lifesaving medical devices in PICU as observed in table (VII).

In addition, **_Nagai,** et al, (2023) mentioned that the availability of knowledge base that acquired through years of experience enable nurses prioritize tasks and subsequently improve their performance.

The maintenance of medical devices has a direct impact on nurses' performance in terms of patient safety, efficiency, reliability, training, and cost management. The prioritizing of maintenance devices, enhancing the nurses' ability to provide high-quality of care and improve overall healthcare outcomes. (Badnjević,A.,.2020).Unfortunately, the findings of the present study were not parallel with the mentioned such issue, where all nurses(100%) in their performance of interoperating maintenance had unsatisfactory level either in first (98%) or second (100%) observation as clarified in table (VI).

Furthermore, it was mentioned by Lane-Cordova et al., (2020) that nurses need to be familiar with the operating, cleaning, and maintenance procedure of different medical devices where regular training and updates on devices maintenance help nurses stay proficient in using the equipment and ensure that they can troubleshoot common issues also reported that frequent attendance of training courses will enhance the nurses' knowledge and it gated them the chance of update their practices. Ali,S., et al, (2023).

Unfortunately, the result of present congruent with such issue, where the majority of studied nurses who had unsatisfactory level did not attend training program & workshops in first 96.8% & second 95% observations as clarified in table (VII).

The nurses' incompetency that were portrayed in this study regarding their performance in interoperating maintenance of medical devices might be related to the lack of nurses' attendance for their special training & workshops that enhancing their level of competencies. Plus shortage of nursing staff that exceeding the nurses / patients ratio in PICU which is reflecting negatively on their patient's care, safety measures as well as disinfection and sterilizing.

CONCLUSION

Based on the findings of the present study, it could be concluded that the performance of two thirds of nurses' in operating the studied four lifesaving medical devices was satisfactory. Unfortunately, the all nurses' performance regarding interoperating maintenance for the same studied devices in PICU was unsatisfactory.

RECOMMENDATIONS

Based on the previous findings and conclusion, the following recommendations were suggested:

1. Nurses should receive continuous training on the setup, operation, and maintenance of medical devices to ensure they are proficient in their use.
2. Implementing standardized procedures for device use can reduce errors and improve

performance. This includes standardized workflows and checklists for device setup and monitoring.

3. Nurses should have adequate knowledge and practice regarding the use of medical devices. This can be achieved through self-learning packages and in-service training

4. Regular monitoring and feedback mechanisms should be in place to assess and improve nurses' performance regarding the use of medical devices.

Table (I): The Characteristics of Nurses.

Characteristics of Nurses	No. = 50	%
Age		
• <25 years	10	20.0
• 25 -	21	42.0
• 30 -	9	18.0
• 35 years & more	10	20.0
Min. – Max.	23.0 – 40.0	
Mean ± SD.	28.54 ± 4.77	
Median	26.0	
Level of Education		
• Diploma of Secondary School or Technical Institute Diploma	9	18.0
• Bachelor of Nursing	39	78.0
Post graduate		
• Diploma or Master degree	2	4.0
Years of Experience in PICU		
• < 5 Years	27	54.0
• 5 -	13	26.0
• 10 Years & more	10	20.0
Attendance of Special Training regarding the Operation of Life-saving Medical Devices		
• No	49	98.0
• Yes	1	2.0

Table (II): Level of nurses' performance regarding mechanical ventilator device at pediatric intensive care unit (PICU).

Level of nurses' performance regarding mechanical ventilator device	First Observation		Second Observation	
	No. = 50	%	No. = 50	%
❖ **operating:**				
➢ Satisfactory	30	60.0	31	62.0
➢ Unsatisfactory	20	40.0	19	38.0
❖ **Interoperating maintenance:**				
➢ Satisfactory	1	2.0	3	6.0
➢ Unsatisfactory	49	98.0	47	94.0

Table (III): Level of nurses' performance regarding cardiac monitor device at pediatric intensive care unit (PICU).

Level of nurses' performance regarding mechanical ventilator device	First Observation		Second Observation	
	No. = 50	%	No. = 50	%
❖ **operating:**				
➢ Satisfactory	30	60.0	31	62.0
➢ Unsatisfactory	20	40.0	19	38.0
❖ **Interoperating maintenance:**				
➢ Satisfactory	1	2.0	3	6.0
➢ Unsatisfactory	49	98.0	47	94.0

Table (IV): Level of nurses' performance regarding infusion pump device at pediatric intensive care unit (PICU).

Level of nurses' performance regarding infusion pump device	First Observation		Second Observation	
	No. = 50	%	No. = 50	%
❖ **operating:**				
➢ Satisfactory	29	58.0	26	52.0
➢ Unsatisfactory	21	42.0	24	48.0
❖ **Interoperating maintenance:**				
➢ Satisfactory	5	10.0	0	0.0
➢ Unsatisfactory	45	90.0	50	100.0

Table (V): Level of nurses' performance regarding syringe pump device at pediatric intensive care unit (PICU).

Level of nurses' performance regarding syringe pump device	First Observation		Second Observation	
	No. = 50	**%**	**No.** = 50	**%**
❖ **operating:**				
➢ Satisfactory	30	60.0	31	62.0
➢ Unsatisfactory	20	40.0	19	38.0
❖ **Interoperating maintenance:**				
➢ Satisfactory	0	0.0	0	0.0
➢ Unsatisfactory	50	100.0	50	100.0

Table (VI): Level of nurses' performance regarding four lifesaving medical devices at pediatric intensive care unit (PICU).

Level of nurses' performance regarding four lifesaving medical devices	First Observation		Second Observation	
	No. = 50	**%**	**No.** = 50	**%**
❖ **operating:**				
➢ Satisfactory	31	62.0	30	60.0
➢ Unsatisfactory	19	38.0	20	40.0
❖ **Interoperating maintenance:**				
➢ Satisfactory	1	2.0	0	0.0
➢ Unsatisfactory	49	98.0	50	100.0

Table (VII): The relationship between nurses' performance and their characteristic regarding the operating of life saving medical devices at pediatric intensive care unit (PICU).

Nurses characteristics	First observation				Second observation			
	Satisfactory (n = 31)		Unsatisfactory (N = 19)		Satisfactory (N =30)		Unsatisfactory (N = 20)	
	No.	%	No.	%	No.	%	No.	%
Age								
•< 25 years	6	19.4	4	21.1	6	20.0	4	20.0
•25 -	13	41.9	8	42.1	13	43.3	8	40.0
•30 -	4	12.9	5	26.3	5	16.7	4	20.0
•35 years & more	8	25.8	2	10.5	6	20.0	4	20.0
χ^2 (^{MC}p)	**2.553 (0.477)**				**0.293 (1.000)**			
Level of Education								
• Diploma of Secondary School or Technical Institute Diploma	4	12.9	5	26.3	3	10.0	6	30.0
• Bachelor of Nursing	25	80.6	14	73.7	25	83.3	14	70.0
• Diploma or Master Degree	2	6.5	0	0.0	2	6.7	0	0.0
χ^2 (^{MC}p)	**2.118 (0.375)**				**3.769 (0.121)**			
Years of Experience in PICU								
• < 5 Years	15	48.4	12	63.2	16	53.3	11	55.0
• 5 -	9	29.0	4	21.1	8	26.7	5	25.0
• 10 Years & more	7	22.6	3	15.8	6	20.0	4	20.0
χ^2 (p)	**0.994 (^{MC}p=0.585)**				**0.019 (0.991)**			
Attendance of Special Training regarding the Operation of Life-saving Medical Devices								
• Yes	1	3.2	0	0.0	0	0.0	1	5.0
• No	30	96.8	19	100..0	30	100.0	19	95.0
χ^2 (^{FE}p)	**0.625(1.000)**				**1.531 (0.400)**			

χ^2: **Chi square test** MC: **Monte Carlo** FE**: Fisher Exact**

p: p value for comparison between the studied categories

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