

Relationship between Nursing Care Provided for Children Post-Extubated from Mechanical Ventilation and their Reventilation.

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Abstract

Background: Respiratory failure requires mechanical ventilation to maintain gas exchange. Extubation means endotracheal tube removal, where ventilated children maintain an efficient gas exchange without ventilatory support. If extubation fails, the children will need reventilation. Therefore, after extubation, children must receive proper nursing care to prevent reventilation. **Aim:** This study aims to identify the relationship between nursing care provided for children post-extubated from mechanical ventilation and their reventilation. **Settings:** The study was conducted at the Pediatric Intensive Care Unit of Alexandria University Children's Hospital at El-Shatby. **Subjects:** A convenient sample of 50 extubated children and all nurses provided care to these children. **Tools:** Three tools were used to collect the necessary data: Characteristics of Child and their Medical Data Assessment Sheet, Nursing Care Provided for Children Post-Extubated from Mechanical Ventilation Observational Checklist, and Reventilation Assessment Sheet. **Results:** Only 14% of the extubation children were reventilated. Apnea was the cause of reventilation in 57.1% of children, low oxygen saturation was the cause for 42.9 %, and 28.6% for bradycardia, while tachypnea and aspiration were the cause for 41.3% of reventilation. There was a relationship between nursing care provided to children and their reventilation, where 93% of nurses had a satisfactory level of total care for not-reventilated children compared to 57.1% for reventilated ones. **Conclusion:** It was concluded that there is a relationship between the care provided to extubated children and their reventilation. **Recommendations:** Develop a bundle of care for extubated children to prevent their reventilation and encourage nurses to attend conferences and workshops to be up to date in their knowledge.

Keywords: Relationship, Nursing Care, Children, Post-Extubated, Mechanical Ventilation, Reventilation.

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INTRODUCTION

Respiratory failure is defined as the inability of the lungs to establish or maintain adequate gas exchange. Infants and children experiencing respiratory distress can present with clinical manifestations as impaired gas exchange, tachypnea, respiratory distress, retraction and grunting which will required Mechanical Ventilation (**Eber & Midulla, 2021**). More than 40% of Pediatric Intensive Care Units (PICU) admissions receive MV (**Tripathi et al., 2021**). In Alexandria, it was found in 2020 that 154 children (37.8%) received MV out of 407 children admitted to PICU, where 44 cases were reventilated (28.6%) (**Unpublished Statistics of Alexandria University Children's Hospital,2020**).

Extubation from mechanical ventilation is defined as the removal of the endotracheal tube. Extubation failure occurs when children need reventilation within 48 hours following a planned extubation. In the pediatric population, it is estimated that the failure rate ranges from 16% to 22%. A failed extubation may be secondary to the inability to maintain adequate oxygenation, alveolar ventilation, airway patency, or any combination of them. (**Moura et al., 2021**).

The onset of respiratory distress following extubation should alert the healthcare team that the children have failing extubation. Hypercapnia, hypoxia, and abdominal breathing are alarming signs that reventilation may be necessary. (**Egbuta & Evens, 2022; Glover & Glossop, 2017; Nugent, 2016**).

In post extubation the pediatric nurses should pay special attention to the effectiveness of gagging and swallowing reflexes. Gentle suction of any secretion from the oropharynx and nasopharynx should be performed. She should give feeds either orally or through a gavage feeding according to the planned schedule, with particular attention to signs of aspiration. The position should be changed frequently. Postural drainage and chest physiotherapy should be performed with proper techniques. Nurses should be able to interpret the blood gas results (**Bose et al., 2023**).

The post-extubation clinical outcomes are strongly related to the provided nursing care. Effective and efficient nursing care will lead to a safe post-extubation period with a decreased need to reventilate children again. Therefore, this study **aimed** to find out the relationship between nursing care provided for children post-extubated from mechanical ventilation and their reventilation.

Research Question

What is the relationship between nursing care provided for children post-extubated from mechanical ventilation and their reventilation?

Materials and Method

Research Design

A descriptive correlational research design was used to accomplish this study.

Setting

The study was conducted at the Pediatric Intensive Care Unit of Alexandria University Children's Hospital at Elshatby in Alexandria.

Subjects

A Convenient sample of 50 children who fulfilled the following criteria: Age ranged from 1 month to 6 years; not reventilated in the 1st 24 hours post-extubation from mechanical ventilation and free from Guillain-Barre and Mythania Gravis.

EPI Info 7 program was used to estimate the children's sample size applying the following information:

- Occlusion size = 100 over 3 months
- Expected frequency =50%
- Acceptance error =10%
- Confidence coefficient =50
- Minimum sample size =25

All nurses who were working in the previously mentioned setting and provided care to the post-extubated children regardless of their level of education and years of experience (N =50 nurses) are included in the subjects.

Tools

Three tools were used to collect the necessary data, which were developed by the researcher after reviewing recent and relevant literature ASNJ Vol.26 No.4, Dec 2024

(Garrahan et al. 2018 & Gattinoni et al. 2017).

Tool I: Characteristics of Children and their Medical Data Assessment Sheet

It included children's characteristics such as age, gender, and birth order as well as their medical data as diagnosis and data about reventilation.

Tool II: Nursing Care Provided for Children Post-Extubated from Mechanical Ventilation Observational Checklist

It included data that assessed the provided nursing care after extubation from mechanical ventilation. This data comprised two main parts as follows:

I-Extra-Pulmonary Care:

Measuring physiological parameters (Temperature, pulse, respiration, blood pressure and Oxygen saturation), changing position to supine, semi-prone and prone positions, and feeding (Gavage and bottle feeding).

II-Pulmonary Care:

Oropharyngeal or nasopharyngeal suction of children, and postural drainage and chest physiotherapy

The nurses' care was assessed as done or not done.

Characteristics of nurses were attached to tool II as age, level of education, years of experience, & attendance of educational courses on mechanical ventilation.

Tool III: Reventilation assessment sheet

- Reventilation assessment sheet included assessment of reventilation: reventilated or not reventilated and causes of reventilation.

METHOD

1. The Approval of the Research Ethics Committee, of Faculty of Nursing, Alexandria University was obtained before conducting the study.
2. Written approval was obtained from the responsible authorities of the previously mentioned setting to obtain their permission to conduct the study after explaining its aim.
3. Tools were developed and tested for their content validity by five experts in the pediatric nursing field, where the value was 90% for each of the three tools.
4. A pilot study was carried out on 5 children and nurses to test the feasibility of the study and the applicability of the tools. No modification was done, and they were excluded from the sample.
5. Reliability of tools was ascertained using the Cronbach alpha Coefficient test and the result of the observational checklist was 0,961.
6. The researcher obtained a list of the cases planned for extubation to assess the nursing care provided to them.
7. Every child extubated from mechanical ventilation was observed three times as follows:
 - a. First observation: Morning shift of the 1st day post-extubation.
 - b. Second observation: Evening shift of the 2nd day post-extubation.
 - c. Third observation: Night shift of the 3rd day post-extubation,
8. Nurses' characteristics were obtained as attached to Tool II.
9. Characteristics of children and their medical data were obtained from children's medical records.

10. Every child was assessed for the occurrence of reventilation using **Tool III**.
11. After completion of the data collection, the necessary statistical analysis was done to find out the relationship between nursing care provided for children and their reventilation.
12. Data was collected between September 2020 to January 2021.

Ethical Considerations

- Witness written consent for all nurses was obtained from the nursing director of the unit after providing an appropriate explanation about the purpose of the study.
- Written consent from children's parents was obtained after explaining the aim of the study, their participation was on voluntary base and their right to withdraw their children from the study at any time.
- Confidentiality of data was maintained throughout the implementation of the study.

Statistical Analysis

- The collected data were coded and entered in special format to be suitable for computer feeding. Following data entry, checking and verification process were carried out to avoid any errors. Data were analyzed using the statistical package for social science SPSS (version 20).

Scoring of Nurses' Care was as follows:

Each item of care was done = 1 mark and not done = zero

Total score of care provided by nurses was 154 marks distributed as follows:

Measuring temperature (9), Pulse (11), Blood Pressure (21), Respiration (3), Oxygen Saturation (8), Change position (22), Feeding (35), Oropharyngeal Care (15) and Postural Drainage (30).

- The following statistical analysis measures were used:
 - **Descriptive statistical measures**, which included: numbers, percentages, and averages (Minimum, Maximum, Arithmetic mean (\bar{X}), Standard deviation (SD).
 - **Statistical analysis tests** included: Chi square, student T test and paired T test.
 - **Graphical presentation** included: Bar graph was done for data visualization.

Results

It is clear from **Table.1** that 70 % of the children were less than 1 year of age with a mean age of 10.41+ 11.13 years and 54% of the children were females. Half of the children were first-born, and 48% were second. It was found from **Table 2** that only 14% of the children were reventilated. Apnea was the cause of reventilation for slightly more than half of the reventilated children (57.1%). Low oxygen saturation was the cause for 42.9% of the children, and 28.6% for bradycardia.

Characteristics of studied nurses illustrated in **Table 3**, where slightly less than half of nurses were less than 30 years of age (46%) and 30% were at the age between 30 years to less than 40 years with a mean age of

31.76 ± 6.669. Furthermore, it was found that 64% of the nurses have bachelor's degrees in nursing and 20% have secondary school of nursing. Slightly less than half (48%) of nurses have less than 5 years of experience and most of the nurses (90%) did not attend training workshops about mechanical ventilation.

Figure (1) presents nurses' level of total practices of pulmonary and extrapulmonary care. It is clear from the figure that 93% of the total care nurses provided to not-reventilated children was satisfactory compared to 57.1% for reventilated ones.

It is revealed from **Table 4** that there was a significant relationship between nurses' level of extrapulmonary, pulmonary care and the reventilation of the children in changing children's position to semi-prone position ($P= 0.016$). Additionally, there was a significant relationship between nurses' level of extrapulmonary, pulmonary care and postural drainage especially in percussion and vibrations of the children ($P = 0.000$ and $P = 0.001$ for percussion and vibration respectively), where they were done for not-reventilated more than the reventilated ones.

Regarding the relationship between nurses' level of care and their characteristics, it is clear from **Table 5** that there is no significant difference between nurses' level of care and their characteristics, where P Value was $P=0.643$ for years of experience and $P=0.487$ for attending previous training on mechanical ventilation.

Discussion

The ability to tolerate spontaneous breathing without mechanical ventilatory support and the ability to maintain a patent airway once the ETT is removed are both required for successful extubation from mechanical ventilation. It takes specific skills to successfully extubate someone, such as managing secretions and maintaining airway protection (**Abu-Sultaneh et al. 2022**).

Extubation failure is frequently described as the requirement for reventilation within 24-72 hours of a scheduled extubation. (**Elisa et al. 2022**). Extubation failure and reventilation can be caused by a variety of causes, including unrecruited muscles, upper airway edema, an inability to remove secretions, and a decreased level of consciousness because of the long-term effects of sedatives and analgesics (**Abu-Sultaneh et al. 2022**).

Reventilation after extubation failure occurs in 2% - 20% of pediatric patients depending on the quality of care given and the children's pathophysiological factors (**Heubel et al. 2020**). According to the present study, reventilation occurred in less than one fifth of children after extubation (**Table 4.**), which matches the percentage of extubation failure and restarting mechanical ventilation in international studies (**Beshish et al. 2022 & Poeira et al. 2020**). **Kilba, Salie & Morrow (2022)** who conducted research about the risk factors and outcomes of extubation at a pediatric intensive care units in South Africa, reported that 11.4% of extubated children were reventilated. On the other hand, **Ishak et al., (2022)** who performed research about the predictors of

failed extubation in mechanically ventilated children found that the rate of extubation failure and mechanically reventilated children in their study was 46.2%.

The rate of reventilation in the current study may be justified by the provision of high-quality nursing care provided by a well-trained nursing staff. Additionally, about two thirds of the nursing staff were faculty graduates whose place of work is the critical care units in most instances (**Table 4.3**). These nurses work in different intensive care units which gives them the opportunity to care for mechanically ventilated cases from the initiation till termination of ventilatory support.

The causes of pediatric extubation failure and reinitiating mechanical ventilation are diverse (**Egbuta and Evans 2022**). In the current study the causes of reventilation were apnea, desaturation, bradycardia, tachypnea, and aspiration respectively (**Table 2**). The reasons behind the occurrence of reventilation in the present study may be related to the age of the studied children, where about two thirds of the sample were less than one year of age i.e. infants (**Table 1**). The findings of current study about reventilated data of the studied children are supported by similar results reported by **Abdelnaser et al., (2022)**, who reported that more than half of their studied subjects were less than one year of age and the respiratory problems were the cause of reinitiating mechanical ventilation. On the contrary, **Khemani et al., (2017)** found that the first cause of reventilating their subjects

was upper airway obstruction followed by neurological causes.

The results of the current study may be explained in the light of the fact that infants have smaller airways, more horizontal ribs and less compliant respiratory muscles which make them more susceptible to lung incompliance, respiratory distress, and apnea. They also have larger heads which with neck flexion easily obstruct the airways leading to desaturation and apnea (**Diganta & Saikia 2019**).

The aim of the current study was to find out the relationship between nursing care provided for children post-extubated from mechanical ventilation and their reventilation. It was found that there is a significant relation between the total mean score of nurses' performances and the occurrence of reventilation among children (**Table 4**). These results can be explained by the fact that the nurses' performance was satisfactory in more than ninety percent in the non-reventilated cases. This is also confirmed by the high mean total percent scores across all procedures in the not-reventilated cases as it reached hundred percent in the preparatory steps of different procedures (**Table 4**). These results were supported by **Mostafa et al., (2016)** who found that almost all studied nurses had satisfactory practice regarding nursing care given to children receiving mechanical ventilation. On the contrary, **Ebrahim, El-Dakhkhny & AbdElnabi (2023)** found that about two thirds of their studied nurses had insufficient practice regarding nursing care provided for children undergoing mechanical ventilation. **Moreover, El-Garhy et al.,**

(2020) found that more than two thirds of studied nurses provided incompetent nursing care for neonate infants undergoing mechanical ventilation with significant statistical tests.

The personal characteristics of nurses may or may not affect their level of performance in intensive care units **Ullah et al. 2023**). In the current study findings, there was an insignificant relation between the nurses' age, years of experience or receiving special training programs on mechanical reventilation and their level of performance (**Table 3**). This may be contributed to the intensified orientation period that is given to all nurses working at the PICU in the children's university hospital. Moreover, all nursing staff may be closely observed and supervised by the head nurse and the seniors of each working shift, and the majority attended workshops about MV. This result was supported by Comparable results were reported by **Mustafa et al., (2019)**, who found that there is an insignificant relation between nurses' age, level of education and years of experience and their level of performance regarding mechanically ventilated neonates. These results were incongruent with **Tawfeeq, Abd-Elmoaty & Ahmed (2023)** who reported that there is a significant relation between education level, years of experience, attending training programs and nurses' knowledge and practice regarding mechanically ventilated children.

Conclusion

According to the findings of the present study, it can be concluded that there was a relationship between care provided to extubated children and their reventilation,

where the means of satisfactory care of not-reventilated children were higher than the means of reventilated children and the differences were statistically significant. Furthermore, nurses' practices were satisfactory in almost all the care provided to extubated children, which reflected on children's reventilation where less than one sixth of extubated children were reventilated.

Recommendations

Based on the results of the present study, the following recommendations are suggested:

1. Developing a bundle of care for extubated children to prevent their reventilation is mandatory and be included in hospital policies.
2. Designing suitable booklets, handouts, and boosters about proper care of extubated children to prevent reventilation to be available for nurses in all intensive care units.

Further Studies

Develop, implement, and evaluate a bundle of care for extubated children to prevent their reventilation.

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Table (1): Characteristics of Children

Characteristics	Total N=50	
	No.	%
Age (months)		
- <12-	35	70.0
- 12-	10	20.0
- ≥24	5	10.0
Min – Max	1.0-47	
Mean ± SD	10.41 ± 11.13	
Sex		
- Boys	23	46.0
- Girls	27	54.0
Birth order		

- First	25	50.0
- Second	24	48.0
- Third and more	1	2.0

Table (2) Children’s Reventilation Data

Reventilation Data	Total N=50	
	No.	%
Occurrence of reventilation		
- Not-reventilated	43	86.0
- Reventilated	7	14.0
Causes of reventilation*	n = 7	
- Apnea	4	57.1
- Tachypnea	1	14.3
- Bradycardia	2	28.6
- Low oxygen saturation	3	42.9
- Aspiration	1	14.3

Table (3): Characteristics of Studied Nurses

Nurses’ Characteristics	Total N=50	
	No.	%
Age (years)		
- <30	23	46.0
- 30-	15	30.0
- ≥40	12	24.0
Min – Max 23.0-50.0	Mean ± SD	31.76 ± 6.669
Level of education		
- Diploma of Secondary School of Nursing	10	20.0
- Diploma of Technical Institute of Nursing	8	16.0
- Bachelor’s degree in nursing	32	64.0
Years of experience		
- <5	24	48.0
- 5-	13	26.0
- 10-	5	10.0
- ≥15	8	16.0
Attendance of training workshops about mechanical ventilation		

- No	45	90.0
- Yes	5	10.0

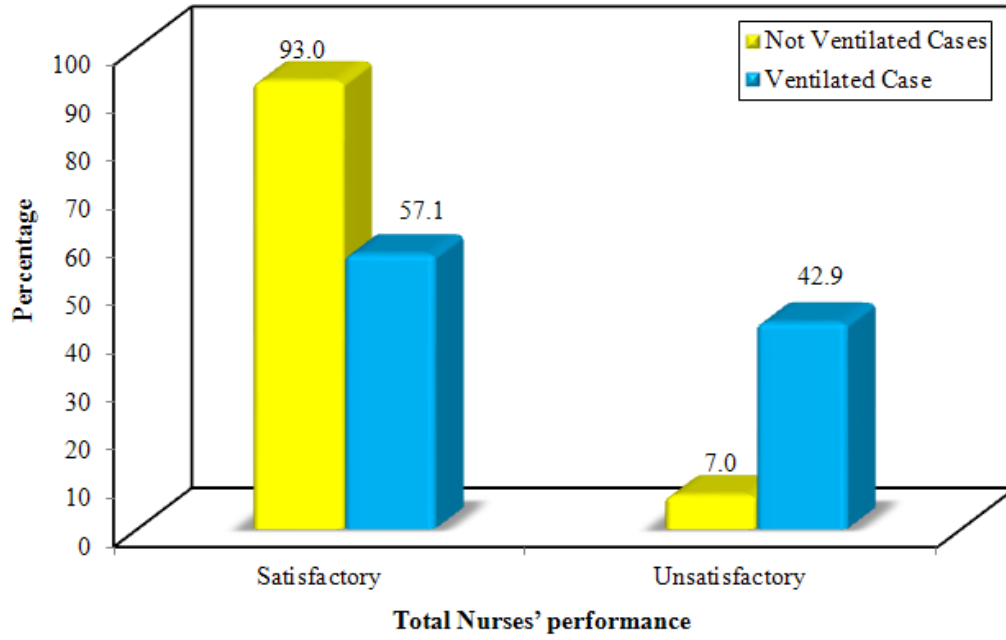


Fig. 1. Nurses' Level of Total Practices of Pulmonary and Extrapulmonary Care

Table (4): Mean Score of Nurses’ Practices of Pulmonary and Extrapulmonary Care in Relation to Reventilation of Children

Items	Not Ventilated Cases N= 129			Ventilated Case N= 21			Test of Significance
	Min- Max	Mean ± SD	Mean Percent Score	Min- Max	Mean ± SD	Mean Percent Score	
1. Extra pulmonary Care	56.0-85.0	66.80±7.019	77.37%	58.0-70.0	62.71±3.423	72.87%	t= 6.816 P= 0.010*
A. Physiological Measures	29.0-52.0	37.40±6.486	79.16%	31.0-40.0	34.67±2.763	73.37%	t= 3.594 P= 0.060
– Before measurement (N=150)	3.0-3.0	3.000±0.000	100.0%	3.0-3.0	3.000±0.000	100.0%	NA
– Mercury temperature (N=150)	4.0-6.0	5.910±0.331	98.50%	5.0-6.0	5.710±0.463	95.17%	t= 5.853 P= 0.017*
– O ₂ Saturation (N=150)	5.0-8.0	7.600±0.795	95.00%	6.0-8.0	7.330±0.856	91.63%	t= 2.060 P= 0.153
– Electronic BP (N=150)	7.0-9.0	8.950±0.276	99.44%	9.0-9.0	9.00±0.000	100.0%	t= 0.595 P= 0.442
– Mercury BP (N=30)	11.0-12.0	11.92±0.282	99.33%	0.0-0.0	0.000±0.000	0.000%	NA
– Apical pulse (N= 150)	4.0-5.0	4.970±0.174	99.40%	4.0-5.0	4.900±0.301	98.00%	t= 1.940 P= 0.166
– Peripheral pulse (N=150)	0.0-6.0	1.810±2.756	22.639%	0.0-6.0	1.710±2.777	21.37%	t= 0.020 P= 0.888
– Respiration (N=150)	0.0-3.0	2.930±0.454	97.67%	3.0-3.0	3.000±0.000	100.0%	t= 0.493 P= 0.484
B. Change Position	8.0-14.0	11.82±2.086	56.63%	9.0-15.0	10.76±2.143	51.24%	t= 4.628 P= 0.033*
– Before positioning (N=150)	4.0-4.0	4.000±0.000	100.0%	4.0-4.0	4.000±0.000	100.0%	NA
– Supine position (N=150)	4.0-5.0	4.810±0.391	96.40%	4.0-5.0	4.860±0.359	97.20%	t= 0.226 P= 0.636
– Semi prone position (N=150)	0.0-4.0	2.570±1.932	60.25%	0.0-4.0	1.480±1.940	37.00%	t= 5.933 P= 0.016*
– Prone position (N=150)	0.0-1.0	0.440±0.499	5.50%	0.0-3.0	0.430±0.746	8.60%	t= 0.011 P= 0.917
C. Gavage feeding (N=99)	15.0-19.0	18.50±0.907	97.63%	19.0-19.0	19.00±0.000	100.0%	t= 2.528 P= 0.115
D. Bottle feeding (N=51)	13.0-16.0	15.46±0.756	96.62%	16.0-16.0	16.00±0.000	100.0%	t= 6.010 P= 0.018*
2. Pulmonary Care	32.0-42.0	38.37±2.848	79.94%	31.0-42.0	35.76±4.073	74.50%	t= 13.29 P= 0.000*
A. Oropharyngeal care	11.0-16.0	15.14±0.908	94.53%	12.0-16.0	15.00±1.342	93.75%	t= 0.368 P= 0.545
B. Postural drainage	17.0-26.0	23.23±2.771	72.59%	16.0-26.0	20.76±3.239	64.88%	t= 13.68 P= 0.000*
– Preliminary steps (N=150)	3.0-6.0	5.220±0.684	87.00%	5.0-6.0	5.330±0.483	88.83%	t= 0.560 P= 0.456
– Postural pre-step (N=150)	5.0-11.0	7.643±0.808	54.59%	7.0-8.0	7.430±0.507	53.07%	t= 1.390 P= 0.240
– Percussion (N=150)	0.0-3.0	2.942±0.421	98.06%	0.0-3.0	2.570±1.076	85.67%	t= 21.21 P= 0.000*
– Vibration (N=150)	0.0-5.0	3.370±2.435	67.40%	0.0-5.0	1.430±2.315	28.60%	t= 12.38 P= 0.001*
– After care (N=150)	4.0-4.0	4.000±0.000	100.0%	4.0-4.0	4.000±0.000	100.0%	NA
Total Nurses’ Performance	92.0-124.0	105.17±6.901	78.46%	92.0-106.0	98.48±4.686	73.37%	t= 18.328 P= 0.000*

t= Student T test * Statistically significant at p ≤ 0.05 NA = not applicable test of significance

Table (5): Relationship between Nurses’ Level of Care and their Characteristics (N=50)

Characteristics	Unsatisfactory (N= 4)		Satisfactory (N= 46)		Total N=50		Test of Significance
	No.	%	No.	%	No.	%	
Age (years)							
- <30	1	4.3	22	95.7	23	46.0	X ² = 0.998
- 30-	2	13.3	13	86.7	15	30.0	P= 0.607
- ≥40	1	8.3	11	91.7	12	24.0	
Level of education							
- Bachelor Degree of Nursing	3	9.4	29	90.6	32	64.0	X ² = 1.172
- Technical Institute of Nursing	1	12.5	7	87.5	8	16.0	P=0.557
- Secondary School of Nursing	0	0.0	10	100.0	10	20.0	
Years of experience							
- <5	2	8.3	22	91.7	24	48.0	X ² =1.679
- 5-	1	7.7	12	92.3	13	26.0	P=0.642
- 10-	1	20.0	4	80.0	5	10.0	
- ≥15	0	0.0	8	100.0	8	16.0	
Previous training on mechanical ventilation							
- No	4	8.9	41	91.1	45	90.0	X ² = 0.483
- Yes	0	0.0	5	100.0	5	10.0	P=0.487