The Effect of Applying Patients' Acuity Score during Assigning Nurses to Patients on the Quality of Care of Mechanically Ventilated Patients

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Abstract

Applying acuity scores is an important basis for standardized assignment which allows nurses to perform the care of mechanically ventilated patients correctly. The aim of study was to explore the effect of applying acuity score on the quality of care of mechanically ventilated patients the study was conducted at the critical areas of a JCI accredited hospital in Egypt. The study subjects included two groups. Firstly, a convenience sample of staff nurses working in critical areas at the time of the study and having at least one year of work experience in ICU. Secondly, Convenience sample of ventilated patients who admitted in the ICU during the time of the study. A quasi-experimental study design was used in the study. The study tools were 3 tools including; firstly, nurses' demographic characteristics assessment sheet in which the personal interview was used. Secondly, nurses' practice regarding ventilated patient observational checklist which was used to assess the quality of nursing care of mechanically ventilated patients. Thirdly, patients' outcome assessment sheet which was used to measure ventilated patients' outcome. It calcifies that applying patients' acuity score had positive large effect size on total nursing practice regarding care of mechanically ventilated patients during pre, post & three months follow up. There is a significant relation between applying the acuity score and the quality of care of mechanically ventilated patients and thus patients' outcomes. The acuity score should be used in the critical cares.

Keywords: mechanically ventilated, healthcare, ICU, clinical patient criteria, ventilated patients

1. Introduction

The well-being of nurses is an important topic in healthcare because it has a significant impact on the quality of care and job performance [1]. Nurses strive to provide high-quality care, but there are various factors that hinder their ability to effectively carry out their tasks. It is believed that increased workloads and stressful patient assignments result in inadequate quality of care for patients [2]. Assigning and distributing nurses to patients in a dynamic clinical environment is challenging in the field of nursing. The traditional approach to organizing nurse distribution for optimal patient care is based on nurse-to-patient ratios [3]. While this method is somewhat practical, it is difficult to determine with certainty how many patients a nurse can effectively care for due to unforeseen patient needs [4]. Nurse assignment is a complex process due to the constantly changing health status and care requirements of patients. Several factors are taken into account when creating nurse-patient assignments, as they play a crucial role in workload evaluation. The assignment process involves matching nurses with patients based on individual characteristics and specific care needs [5]. Patient acuity, which measures the intensity of nursing care required, is also considered in the assignment process. Patients with higher acuity ratings require more intensive nursing care compared to those with better health [6]. Patient acuity score (PAS) is a method used to classify and categorize patients based on their nursing care requirements and needs [7]. It is an evidence-based tool that utilizes clinical patient criteria and workload indicators to assign a numeric value reflecting the complexity and intensity of nursing care required by each patient. Assignments based on acuity scores help ensure that the number of nurses on a shift aligns with patient needs rather than simply focusing on numbers [8]. Patient needs can vary significantly, with medical/surgical ward patients requiring basic care compared to mechanically ventilated patients in critical care units who need complex nursing care for advanced cases. By identifying each patient's needs, nurses can prioritize and provide individualized care, resulting in high-quality care [9].

Nurse-patient assignment is a critical aspect of care delivery, involving the pairing of nurses and patients based on individual characteristics and specific care requirements. It affects both patient safety and the quality of care, as well as nurses' job satisfaction [7]. Nurse leaders use evidence-based practices to collect and analyze outcome data, allowing them to modify assignment practices based on unit demands. Understanding the capabilities of the staff and involving them in the process improves the work environment and promotes acceptance among the staff. Balanced assignments have an impact on patient outcomes and workload [10]. In order to provide high-quality care, it is necessary to differentiate between patients in hospitals. Each patient has unique needs based on their medical condition and personal criteria. Classifying patients has become a common practice to ensure appropriate care [11]. Nurse-to-patient assignment is crucial as it affects daily nurse workload and patient flow, allowing nurses to assess the level of patient safety risks. Assigning several critical cases to a single nurse can have negative impacts on professional practice and healthcare services, including increased patient waiting times, overtime, unfair distribution of assignments, nurse dissatisfaction, retention issues, nurse burnout, and patient safety problems [12]. Maintaining a balance between the supply of qualified providers and patient care demands is crucial for ensuring quality care in hospitals. This requires continuous efforts to improve quality and achieve a balance between supply and demand [13]. The nursing care of mechanically ventilated patients presents various challenges, including the need for highly technical skills, expertise in invasive monitoring, and the implementation of interventions. Each critically ill patient brings unique complexities associated with their illness and the rationale for mechanical ventilation [8]. The nursing care and management of critically ill mechanically ventilated patients require therapeutic interventions and come with potential complications. Equitable patient-nurse assignments are crucial for these patients. Evidence-based nursing care plays a pivotal role in achieving quality health outcomes for mechanically ventilated patients [3]. Patients in critical care units are vulnerable and require increased nursing care due to the complexity of their care, patient acuity, and co-morbidities. Inconsistent, subjective, and unquantifiable nurse assignments can result in nurse dissatisfaction, which poses barriers to adaptation and threatens patient care outcomes, which are crucial for quality care [15]. Patient acuity is a fundamental concept in critical care units as it can impact outcomes and safety for mechanically ventilated patients, including issues such as pressure ulcers, mortality rate, length of stay, falls, medication errors, nosocomial infections, and pain management. Nursing workload acuity affects nurses' ability to assess patient status and promote excellent patient outcomes, as patient outcomes are significantly influenced by nurse staffing ratios. When assignments are not equitable, nurses may feel disappointed and frustrated, hindering their ability to perform their work effectively for the well-being of patients [16]. When nurses' assignments were made according to traditional method Evidence-based nursing care plays a pivotal role in achieving quality health outcomes for mechanically ventilated patients by assigning blocks of rooms to nurses usually in sequential order or distributing equivalent number of patients among nurses, this may lead to group patients with high needs together thus, misbalancing workloads. Additionally, nurses

are overburdened by the care requirements for multiple patients which decrease the ability to recognize subtle changes or meet all the needs for care. When nurse-patient ratios decreased and patient acuity increased, nurse workload increases and care quality deteriorated and vice versa [14]. It is assumed that there are 10 JCI accredited hospitals in Egypt which is the first-class hospitals. All of them don't apply the patient acuity score-based nurse-patient assignment and indeed the lower-level hospitals. In the light of previous researches and many others such a study would be crucial to emphasize the role of applying patient acuity score as a necessary tool for fair distribution of work load. This could be a very effective factor in improving nursing care generally and especially for the mechanically ventilated patients [17]. The significance placed on that healthcare organizations need applying patient acuity score and able to lead change positively in the way to perform assigned duties perfectly to keep up with updates and development which inspired by satisfaction of nurses toward high quality of patient care. So, this study was done to assess the effect of applying patients' acuity scoring on the level of care of mechanically ventilated patients in the selected setting. This study aimed to assess the effect of applying patients' Acuity scoring on the level of care of mechanically ventilated patients through; assessing the quality of care of ventilated patient before applying the patients' acuity scoring, applying developed acuity scoring in the chosen critical area, assessing quality of care of ventilated patient after applying the patients' acuity scoring, and evaluating effects of applying the patients' acuity scoring on the quality of care of ventilated patients.

2. Materials and methods

This study was conducted in the critical areas of one of the JCI accredited hospitals in Cairo, Egypt. The study tools were used with two samples (n=336) divided into 84 nurses and 252 patients. The study tools were 3 tools including; firstly, nurses' demographic characteristics assessment sheet in which the personal interview was used. Secondly, nurses' practice regarding ventilated patient care observational checklist which was used to assess the quality of nursing care provided by nurses to mechanically ventilated patients. Thirdly, patients' outcome assessment sheet which was used to measure ventilated patients' outcome in critical care units.

3. Results

Table 1 shows demographic characteristics among the studied nursing staff, it shows that about two thirds (58.3%) of the age range of the studied nursing staff was ranged from $31-\leq 40$ years old, with a mean age of 31.86 ± 3.78. considering gender, more than two thirds (66.7%) of them were male with a male to female ratio is 2:1. In relation to educational level, more than three thirds (94.0%) of them holding bachelor nursing degree. Considering years of experience, about two thirds (59.5%) of them had an experience lasting for $6-\leq 10$ Yrs. with a mean age of 9.25 ± 3.92. Table 2 shows demographic characteristics among the studied mechanically ventilated patients, it shows that more than half of the age range of the studied mechanically ventilated patients was more than 60 years old years old.

They have percentages (52.4%, 53.6% and 53.6%) respectively during pre, post & three months follow up test with a mean age of 59.7 ± 15.9, 62.0 ± 3.6 & 60.3 ± 12.6

respectively. considering gender, more than half of them were male with the percentages (59.5%, 54.8% and 57.1%) respectively with Male to Female Ratio is 1.5:1, 1.2:1 & 1.3:1 respectively during pre, post & three months follow up test. Table 3 clarifies Effect size and η2 of applying patients' acuity score on total practice regarding care of mechanically ventilated patients during pre, post & three months follow up among the studied nursing staff. It calcifies that applying patients' acuity score had positive large effect size on total practice regarding care of mechanically ventilated patients during pre, post & three months follow up among the studied nursing staff as η2= 0.561. When Eta-square value = 0.01 to < 0.06, the effect is considered weak, when it = 0.06 to < 0.14, the effect is considered medium and when it ≥ 0.14 the effect is large. Therefore, this provides enough evidence to support research hypothesis. Moreover, there was a highly statistically significant difference between the total mean score of practice regarding the care of mechanically ventilated patients during pre, post, and three-month follow up among the studied nurses at F = 158.9 & P = 0.000. Table 4 summarizes outcomes during pre, post & three months follow up among the studied mechanically ventilate patients. In relation to length of hospital stay, it denotes that, during the post-test phase, the studied mechanically ventilated patient gained a lower mean of length of hospital stay ($\bar{x} \pm$ SD = 4.37 ± 2.42) followed by the phase of follow-up test ($\bar{x} \pm$ SD = 4.58 ± 2.41) as compared with the phase of pre-test ($\bar{x} \pm$ SD = 5.61± 4.25) during pre, post, and three-month follow up. In addition to, there isn't difference between observed and expected values at $\chi2$= 5.19 & P Value= 0.519. In relation to ventilator days, it denotes that, during the post-test phase, the studied mechanically ventilated patient gained a lower mean of ventilator days ($\bar{x} \pm$ SD = 2.92± 2.17) followed by the phase of follow-up test ($\bar{x} \pm$ SD = 3.12 ±2.17) as compared with the phase of pre-test ($\bar{x} \pm$ SD = 3.93± 3.52) during pre, post, and three-month follow up. In addition to presence of difference between observed and expected values with a significant statistical difference at $\chi2$=12.3, P=0.05. Concerning acquire CAUTI and mortality, there isn't difference between observed and expected values at P Value= 0.366 & 0.969 respectively. While, regarding to acquire VAB, there is a difference between observed and expected values with a significant statistical difference at P=0.04. Figure 1 clarifies cumulative total practice regarding the care of mechanically ventilated patients among the studied nursing staff. It denotes that more than three quarters (92.9%) of the studied nursing staff had a competent level of practice regarding the care of mechanically ventilated patients with a total mean score of practice= 316.64 ± 29.91. In addition to presence of difference between observed and expected values with a significant statistical difference at $\chi2$=61.71 P=0.000. moreover, competent to in competent ratio is 13:1.

4. Discussion

The current study discussed that the majority of the nursing staff (about two thirds) were aged between 30 to 40 years old, with a mean age of 31.86 ± 3.78. These findings were in line with the hospital's recruitment policy, which aims to select knowledgeable and skilled staff. The gender distribution of the nurses was predominantly male (more than two thirds), which was attributed to the physically demanding nature of the work in the intensive care department. With regards to education, more than three thirds of the nurses held

a bachelor's degree in nursing, while the remaining nurses had a master's degree, which reflects the hospital's emphasis on highly educated staff, particularly for ICU nurses. In terms of experience, approximately two thirds of the nurses had six to ten years of experience. It is worth noting that the hospital was accredited by the Joint Commission International (JCI), and as part of the standardized recruitment process, highly qualified staff nurses were selected to work in the ICU. On the one hand these results were supported by Ageiz and Abd El-Mageed (2020), who explained that the highest percentage of studied nurses aged between 30-40 years old, had a bachelor degree in nursing, and regarding their years of experience the highest percentage were ranged between five to ten years [18]. On the other hand, the previous study was contradicted in regards to the gender as it illustrates that the majority of studied nurses were females. Concerning the demographic characteristics among the studied mechanically ventilated patients, it shows that more than half of the age range of the studied mechanically ventilated patients was more than sixty years old. Considering gender, more than half of them were male. The results associated with old age could be explained as normal physiological changes of aging which makes the human body more susceptible to many complications that could lead to mechanical ventilation. This finding is supported by Soo Jung Cho and Heather W. Stout-Delgado (2020), who reported in a study titled "Aging and Lung Disease" that Natural lung aging is associated with molecular and physiological changes that cause alterations in lung function, diminished pulmonary remodeling and regenerative capacity, and increased susceptibility to acute and chronic lung diseases [19]. Also, Murtha et al., (2019) stated in a study titled "The role of aging in cardiac and pulmonary fibrosis" that Aging promotes a range of degenerative pathologies characterized by progressive losses of tissue and/or cellular function [20]. Fibrosis is the hardening, overgrowth and scarring of various tissues characterized by the accumulation of extracellular matrix components. Aging is an important predisposing factor common for fibrotic respiratory disease. Concerning effect size and η2 of applying patients' acuity score on total practice regarding care of mechanically ventilated patients during pre, post & three months follow up among the studied nursing staff. It calcifies that applying patients' acuity score had positive large effect size on total practice regarding care of mechanically ventilated patients during pre, post & three months follow up among the studied nursing staff. Therefore, this provides enough evidence to support research hypothesis. Furthermore, Applying the acuity score is the basis for controlling nurse to patient ratio specially with the complicated cases such as the mechanically ventilated patients. That will provide the critical care nurse with the ability to apply the guidelines of caring the mechanically ventilated patients. Moreover, there was a highly statistically significant difference between the total mean score of practice regarding the care of mechanically ventilated patients during pre, post, and three-month follow up among the studied nurses.

These findings are supported by Cho et al., (2019) in a study titled "Nurse staffing, nurses' prioritization, missed care, quality of nursing care, and nurse outcomes" which stated that inappropriate assignment is associated with increased missed care and vice versa [21]. Also, Sadeem et al., (2019) in a study titled "Predicting the effect of nurse–

patient ratio on nurse workload and care quality using discrete event simulation" which explained that as nurse to patient ratio increases, care quality deteriorated, missed care, and nursing workload increased [22]. Regarding patient outcomes during pre, post & three months follow up among the studied mechanically ventilated patients. In relation to length of hospital stay, it denotes that, during the post-test phase, the studied mechanically ventilated patient gained a lower mean of length of hospital stay followed by the phase of follow-up test as compared with the phase of pre-test during pre, post, and three-month follow up. In addition, there is no difference between observed and expected values. In relation to ventilator days, it denotes that, during the post-test phase, the studied mechanically ventilated patient gained a lower mean of ventilator days followed by the phase of follow-up test as compared with the phase of pre-test during pre, post, and three-month follow up. In addition to presence of difference between observed and expected values with a significant statistical difference. Concerning acquired CAUTI and mortality, there is no difference between observed and expected values. While, regarding to acquired VAB, there is difference between observed and expected values with a significant statistical difference. These results are in concordance with McHugh et al., (2021) in the study titled "Effects of nurse-to-patient ratio legislation on nurse staffing and patient mortality, readmissions, and length of stay: a prospective study in a panel of hospitals" which found that the length of stay were significantly decreased after controlling the nurse-to-patient ratio and assignment [24]. But the same study found that the mortality rates were significantly decreased after intervention which oppose the results of the current study. In addition, Aloush (2018) in the study titled "Nurses' implementation of ventilator-associated pneumonia prevention guidelines: an observational study in

Jordan" found that Nurses' compliance with ventilator-associated pneumonia prevention guidelines which directly affect the average ventilator days was insufficient, and this knowledge can be used by health professionals to guide clinical practice and improve the quality of care, especially in units with a 1:2 nurse to patient ratio and higher beds' capacity [25]. Moreover, McHugh et al., (2019) stated that controlling the assignment and nurse-to-patient ratio leads to more adherence for sepsis bundles and as a result the rate of infection decreased in the study titled "Evaluation of hospital nurse-to-patient staffing ratios and sepsis bundles on patient outcomes" [23]. Concerning cumulative total practice regarding the care of mechanically ventilated patients among the studied nursing staff. It denotes that more than three quarters of the studied nursing staff had a competent level of practice regarding the care of mechanically ventilated patients with a total mean score of practice. In addition to presence of difference between observed and expected values with a significant statistical difference. These results are in concordance with Alsharari et al., (2020) in the study titled "Critical Care Nurses' Perception of Care Coordination Competency for Management of Mechanically Ventilated Patients" who stated that There was a high overall score and subscale scores of nurses' care coordination competence for mechanically ventilated patients for the majority of critical care nurses, but few gaps were identified in some of the items [17]. Moreover, Ali and Ahmed (2023) in the study titled "Effectiveness of In-Service Training Module on Intensive Care Nurses' Performance Regarding Mechanical Ventilator Patients' Skillful Handling" proved that the majority of studied nurses get promoting the achievement of level of practice after intervention during pre, post & three months follow-up phases [26].

Table 1: Number and percentage of distribution of demographic characteristics among the studied nursing staff (n=84).

Items		No.	%
Age (year)	▪ 20-≤30	31	36.9
	▪ 31-≤40	49	58.3
	▪ 41-≤50	4	4.8
	▪ **Mean± SD**	**31.86 $\pm$ 3.78**	
Gender	▪ Male	56	66.7
	▪ Female	28	33.3
	▪ **Male to female ratio**	**2:1**	
Educational level	▪ Bachelor nursing degree	79	94.0
	▪ Master's degree	5	6.0
Years of experience	▪ 1 -≤ 5 Yrs.	11	13.1
	▪ 6 -≤ 10 Yrs.	50	59.5
	▪ 11 -≤ 15 Yrs.	16	19.0
	▪ > 15 Yrs.	7	8.3
	▪ **Mean± SD**	**9.25 $\pm$ 3.92**	

Table 2: Number and percentage of distribution of demographic characteristics during pre, post & three months follow up among the studied mechanically ventilated patients (n=252).

Items		Pre-test n=84		Post-test n=84		Follow up - test n=84		χ2	P Value
		N	%	N	%	N	%		
▪ Age	20-≤30 years old	4	4.8	2	2.4	2	2.4	6.81	0.557
	21-≤40 years old	10	11.9	3	3.6	5	6.0		
	41-≤50 years old	8	9.5	11	13.1	12	14.3		
	51-≤60 years old	18	21.4	23	27.4	20	23.8		
	> 60 years old	44	52.4	45	53.6	45	53.6		
	Mean ± SD	59.7 ±15.9		62.0± 3.6		60.3±12.6			
▪ Gender	Male	50	59.5	46	54.8	48	57.1	0.389	0.823
	Female	34	40.5	38	45.2	36	42.9		
	Male to Female Ratio	1.5:1		1.2:1		1.3:1			

Table 3: Effect size and η2 of applying patients' acuity score on total practice regarding care of mechanically ventilated patients during pre, post & three months follow up among the studied nursing staff (n=84).

Variables	Interval	Mean	SD	F Test	P value	η	η2	Effect size
▪ Primary assessment	Pre-test	16.0	4.10	135.4	0.000***	0.722	0.521 ***	Large effect
	Post-test	22.9	1.56					
	Follow up	22.3	2.85					
▪ Secondary assessment	Pre-test	21.2	4.79	224.7	0.000***	0.802	0.643 ***	Large effect
	Post-test	31.5	1.99					
	Follow up	31.0	3.35					
▪ Intervention phase	Pre-test	24.0	4.36	114.2	0.000***	0.692	0.479 ***	Large effect
	Post-test	31.1	2.13					
	Follow up	30.6	3.30					
▪ VAB bundle	Pre-test	9.85	1.20	62.4	0.000***	0.578	0.334 ***	Large effect
	Post-test	11.4	0.828					
	Follow up	11.3	1.02					
▪ CLABSI bundle	Pre-test	6.83	1.37	216.9	0.000***	0.797	0.635 ***	Large effect
	Post-test	9.89	0.581					
	Follow up	9.70	1.08					
▪ CAUTI Bundle	Pre-test	7.81	1.18	87.8	0.000***	0.643	0.414 ***	Large effect
	Post-test	9.51	0.668					
	Follow up	9.38	0.849					
Total	**Pre-test**	**85.74**	**16.35**	**158.9**	**0.000*****	**0.749**	**0.561 *****	**Large effect**
	Post-test	**116.48**	**7.29**					
	Follow up	**114.43**	**12.14**					

*Significant p ≤ 0.05　　　**Highly significant p ≤ 0.01　　　F: ANOVA Test
*Small effect size (0.01 to < 0.06)　　**Medium effect size (0.06 to < 0.14)　　***Large effect size ≥ (0.14)

Table 4: Number and percentage distribution of outcomes during pre, post & three months follow up among the studied mechanically ventilate patients (n=252).

Items		Pre-test n=84		Post-test n=84		Follow up - test n=84		χ2	P Value
		N	%	N	%	N	%		
▪ Length of Stay	1≥ 2 days	26	31.0	29	34.5	26	31.0	5.19	0.519
	3 ≥ 5 days	29	34.5	33	39.3	31	36.9		
	6 ≥ 7 days	12	14.3	14	16.7	17	20.2		
	> 7 days	17	20.2	8	9.5	10	11.9		
	$\overline{x} \pm SD$	5.61± 4.25		4.37 ± 2.42		4.58 ± 2.41			
▪ Ventilator Days	1≥ 2 days	41	48.8	47	56.0	42	50.0	12.3	0.05*
	3 ≥ 5 days	26	31.0	28	33.3	31	36.9		
	6 ≥ 7 days	6	7.1	7	8.3	9	10.7		
	> 7 days	11	13.1	2	2.4	2	2.4		
	$\overline{x} \pm SD$	3.93± 3.52		2.92± 2.17		3.12 ±2.17			
▪ Acquire pressure injury	Yes								
	No								
▪ Acquire VAP	Yes	3	3.6	0	0.0	0	0.0	6.16	0.04*
	No	81	96.4	84	100.0	84	100.0		
▪ Acquire CLABSI	Yes	0	0.0	0	0.0	0	0.0	NC	
	No	84	100.0	84	100.0	84	100.0		
▪ Acquire CAUTI	Yes	1	1.2	0	0.0	0	0.0	2.0	0.366
	No	83	98.8	84	100.0	84	100.0		
▪ Mortality	Died	13	15.5	12	14.3	12	14.3	0.06	0.969
	Discharged alive	71	84.5	72	85.7	72	85.7		

*Significant p ≤ 0.05   **Highly significant p ≤ 0.01
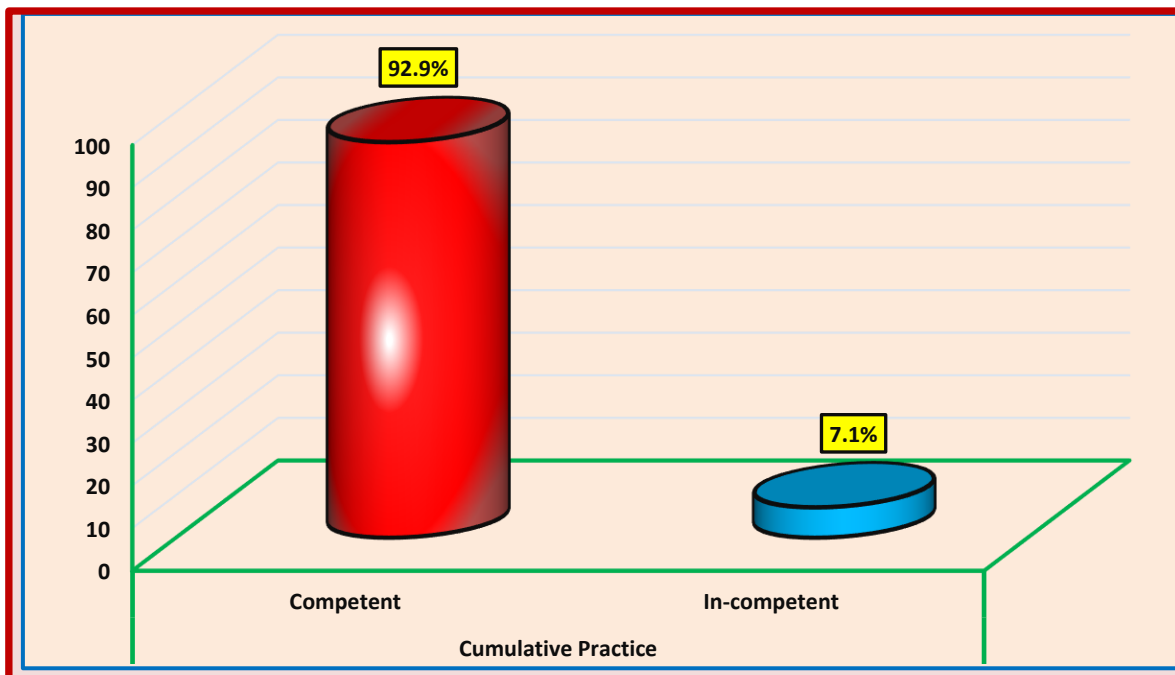NS: > 0.05   N.C.: NOT Computed as variable is constant

Figure 1: Percentage distribution of cumulative total practice regarding the care of mechanically ventilated patients during pre, post & three months follow up among the studied nursing staff (n=84).

5. Conclusions

Applying the acuity score during assigning nurses to patients has significant effect on the quality of care of mechanically ventilated patients and thus patients' outcomes. The researcher recommends that the acuity score should be applied in all hospitals to assign nurses to patients. Further researches need to be carried out to explore the effects of the administrative variables on the direct nursing care of different cases.

Conflict of interest

The author declares that no conflict of interest is in connection with the submitted article

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Authors Contribution

All authors contributed to the project and the study design. All authors contributed to subsequent revisions and editing. All authors read and approved the final manuscript.

Ethic Committee

The ethical considerations of the research included the following; The research approval was obtained from the ethical committee before starting the study. The researcher assured anonymity and confidentiality of the subjects' data. Nurses were informed that they are allowed to choose to participate or not in the study and that they had the right to withdraw from the study at any time. Ethics, values, culture and beliefs were respected. Study subjects were informed about research purposes.

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