



Factors Affecting Nebulization Therapy for Patients with Mechanical Ventilation in Emergency Care Unit

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Article History: Received: 26.06.2023

Revised: 28.07.2023

Accepted: 13.08.2023

Abstract:

Background: In critically ill patients undergoing mechanical ventilation, aerosol inhalation is a common intervention. An international survey demonstrated that 99% of 611 ICUs from 70 countries reported using aerosol therapy during mechanical ventilation. Many factors may affect the efficacious delivery of aerosols to the lungs. These factors are associated with patients, drugs, devices, artificial airways, ventilator settings, ventilator circuits and nurse's practice. **The study was aimed to** assess factors affecting nebulization therapy for patients with mechanical ventilation in emergency care units. **Setting:** The present study was conducted in two surgical intensive care units at surgical hospital at Zagazig university hospitals, Egypt. **Study subjects** a convenient sample of available emergency care nurses (30) working in the mentioned setting and a purposive sample of (30) patients who fulfilling the inclusion criteria. **Tool of data collection:** Three tools were used for collecting data. **Tool I:** An interview questionnaire to assess factors affecting nebulization therapy for patients with mechanical ventilation. **Tool II:** Self-administered questionnaire for nurses. **Tool III:** Observational checklist to assess nurse's practice regarding nebulization therapy administration. **Results:** There was statistically significant difference in pulse Immediately after session and 4 hrs after session; Also there was highly statistically significant difference in Systolic blood pressure, Diastolic blood pressure before, immediately after and 4 hrs after session at ($p \leq 0.01$)., Majority of studied nurses (80.0%) had unsatisfactory level of total knowledge, (86.7%) of the studied nurses had inadequate practice regarding nebulization therapy administration. **Conclusion:** Nebulized bronchodilators and corticosteroids can increase blood pressure, improve oxygen saturation, decrease (plateau pressure, peak inspiratory pressure) and increase static compliance, majority of studied nurses had unsatisfactory knowledge and inadequate practice. **Recommendation:** It is highly recommended to create training opportunities for nurses to increase their knowledge about nebulizer devices. In addition, we should establish a team of professionals to regularly measure nurses' knowledge of inhaler devices and Regular assessment and ongoing education on the correct inhaler technique for respiratory nurses are necessary to optimize device usage by nurses. Finally, related institutional improvements are important.

Keywords: Factors, Nebulization, Therapy, Mechanical ventilation, Emergency, Care unit.

DOI: 10.48047/ecb/2023.12.8.788

Introduction:

Nebulizer therapy has been broadly utilized in both inpatient and outpatient settings, due to its advantages, intensive care unit (ICU) patients often require respiratory support, including oxygen therapy and ventilatory support, such as noninvasive ventilation (NIV) or invasive mechanical ventilation (MV). aerosol delivery effectiveness is primarily assessed by the responses in the target organ. Nebulization of bronchodilators targeted at the tracheobronchial tree can be assessed by its immediate response, such as the changes in airway resistance, intrinsic positive end-expiratory pressure, or lung compliance (Li, et al, 2023).

Aerosol therapy delivers medications directly into the lung. Aerosol therapy has many advantages compared with systemic administration, including targeted delivery into the lung, faster response, and fewer systemic adverse effects. These differences have resulted in the broad use of aerosol therapy in intensive care units (ICUs) (Lyu, et al, 2020). A variety of factors that must be considered when delivering aerosols to mechanically ventilated patients. These factors include: Patient related factors, Ventilator related factors, Circuit related factors, nebulizer related factors, Medication related factors (Cairo, 2020).

Aerosol therapy is a routine, daily operation for ICU nurses, especially for patients with invasive MV. In China, ICU nurses receive instruction mainly through department training, hospitals and other methods. Although many recent studies have described principles or procedures to optimize the atomization effect, the current clinical practices of ICU nurses with aerosol therapy are unknown because few studies have focused on ICU nurses' knowledge or practices of nebulizer safety for patients with invasive MV. conducted a survey of 311 French nurses and found that their knowledge was lacking, and

inappropriate practices were used in aerosol therapy (Zhang, et al, 2021).

Aerosolized medications offer many advantages in the treatment of pulmonary diseases yet delivering them to patients is a challenge and it is difficult to achieve disease control in many patients. There is a large gap in the knowledge of clinicians who select and provide instructions for the correct use of aerosol devices. Since improper device selection and incorrect inhaler technique may result in inadequate disease control, individualized aerosol medicine is essential for effective disease management and control (Ari, et al, 2023).

Hazards associated with aerosol drug therapy may occur as a result of the type and dose of the inhaled medication, the aerosol generator being used, the aerosol administration technique, and the environment. Hazards of aerosol therapy can impact the patient receiving therapy, as well as care providers and bystanders. The lack of standardized technical information on inhalers for clinicians reduces effectiveness. heating, or the inability to nebulize suspensions efficiently. As a result of changes in drug concentration, the dose of the drug remaining in the nebulizer at the end of aerosol therapy is increased, and the patient is exposed to higher concentrations of inhaled medications (De Vries, et al, 2023).

Significance of the study:

In developed countries, 2 to 3 million intensive care unit patients receive invasive mechanical ventilation per year at estimated costs of 15–27 billion dollars (Hassen, et al, 2023). A web-based survey involving 447 hospitals in mainland China recorded a high proportion of aerosol therapy in both invasive (90.8%) and noninvasive (91.3%) mechanical ventilation; bronchodilators (64.8%) and topical corticosteroids (43.4%) were the most used drugs (Zhang, et al, 2022). Clinical practice of aerosol delivery in

conjunction with respiratory support devices for critically ill adult patients remains a topic of controversy due to the complexity of the clinical scenarios and limited clinical evidence (Li, et al, 2023). Ameen et al. (2022) in study conducted in Ain Shams University hospital reveal that 53.3% of studied nurses were unsatisfactory level of knowledge, 66.7% of studied nurses were incompetent level of practice.

Aim of the study: Was to assess factors affecting nebulization therapy for patients with mechanical ventilation in emergency care units.

Research Question:

-What are factors affecting nebulization therapy for patients with mechanical ventilation in emergency care units?

-What is the patient response on mechanical ventilation in emergency care units to nebulization therapy?

-What is the level of nurse's knowledge regarding nebulization therapy for patients with mechanical ventilation in emergency care units?

- What is the level of nurse's practice regarding nebulization therapy for patients with mechanical ventilation in emergency care units?

Research design: A descriptive research design was carried out in this study.

Setting: The study was conducted at two surgical intensive care units the first on the second floor which contain 13 bed and 12mechanical ventilations one of them portable and the second on third floor which contain 18 bed and 12 mechanical ventilations at surgical hospital at Zagazig university hospitals, Sharqia Governate, Egypt, within 6 months.

Subjects and methods

Subjects: A convenient sample of available emergency care nurses (30) working at the previous mentioned setting and a purposive sample of (30) adult patients who fulfilling inclusion criteria at Zagazig university hospitals, Sharqia Governate, Egypt.

Inclusion criteria:

Emergency patients on invasive mechanical ventilation and receiving nebulizer therapy through mechanical ventilator for at least 72hrs.

Tools of data collection:

Tool I: An interview questionnaire: It was designed by the researcher after reviewing related literature to assess factors affecting nebulization therapy for patients with mechanical ventilation which adopted from (Ari& Fink, 2010). divided into two parts:

Part I: used to assess factors affecting the nebulizer delivery for patients with mechanical ventilation and included (5) sections: **patient related factors** such as: demographic data (age , gender) , health related data(date of admission , days in ICU),current diagnosis, past medical history and level of consciousness; and **ventilator related factors** such as :mode of ventilation ,and tidal volume (VT) ;and **circuit related factors** such as :size of the airway and type of humidifier; and **nebulizer device related factors** such as: type of the device, and position of the device in the circuit and; **medication related factors** such as: dose, frequency, method of preparation, and fill volume of the nebulizer.

Part II: Mechanically ventilated patient's response to nebulization therapy: It included; hemodynamic status assessment such as: heart rate, blood pressure; and respiratory status assessment such as: use of accessory muscles, respiratory rate,SpO₂; and measured parameters from mechanical ventilation (MV) such as: tidal volume (VT), I:E ratio, peak inspiratory pressure, and plateau pressure.The observation will be done before and after the nebulization therapy session and will be repeated after 4 hours.

Tool II: Self-administered questionnaire for nurses' questionnaire It was designed by the investigator after reviewing related literature to assess nurses' knowledge regarding nebulization. This questionnaire divided into two parts:

Part I: Demographic characteristics for nurses: to assess demographic characteristics of studied nurses included five closed ended questions about (age, gender, level of education, years of experience and previous training programs regarding nebulizer administration for patients with invasive mechanical ventilation).

Part II: Nurses' knowledge assessment Questionnaire: To assess nurses' knowledge regarding nebulizer administration for patients with invasive mechanical ventilation). it was designed by the researcher based on the review of literature, which adopted from(**Zhang, et al, 2021**) in Arabic language to avoid misunderstanding, it was consisted of 16 multiple choice question.

Scoring system: was graded according to the items of interviewing questionnaire. The answers of nurses were evaluated using model key answer prepared by researcher. Each correct answer scored one grade, zero for incorrect answer, and don't know. For each area of knowledge, the scores of the items were summed- up and the total divided by the number of the items, giving a mean score for the part. These scores were converted into percentage scores. Knowledge was considered satisfactory if the percent score was equal to or above 80% and unsatisfactory if less than 80% based on statistical analysis.

Tool III: Observational checklist to assess nurse's practice regarding nebulization therapy administration: It was used to assess the level of nurses' practices regarding nebulizer administration for patients with invasive mechanical ventilation observational checklist was

adopted by the investigator as guided by (**Eltabakh, et al,2021**).it consisted of 5 items (Assessment patient status: Included 11 steps, Preparation: Included 17 steps, Implementation: Included 7 steps, Post Care: included 26 steps, Record &Report: included 4 steps).

Scoring system:

For observational checklist consisted of given score one for done step and score zero for the not done, the scores of the items were summed-up and the total divided by the number of the items, giving a mean score for the part. These scores were converted into percentage scores.

Administrative and ethical consideration:

An official permission for data collection in Zagazig University Hospitals was obtained from the hospital administrative personnel by the submission of a formal letter from the dean of the faculty of nursing Zagazig University explaining the aim of the study to obtain permission and help.

Ethical consideration:

Firstly, the study proposal was approved by the Research Ethics Committee (REC) and Postgraduate Committee of the Faculty of Nursing at Zagazig University (M.D ZU. R/183/13/6/2022). Then, the interview each subject (patient relatives, nurses) was informed about the purpose, benefits of the study, and they were informed that their participation is voluntary, and they have right to withdraw from the study at any time without given any reason. In addition, confidentiality, and anonymity of the subjects were assured through coding of all data. The investigator assured that the data collected will be confidential and would be used only to assess factors affecting nebulization therapy for patients with mechanical ventilation in emergency care unit and to improve nurses' knowledge and practice for the purpose of the study.

Pilot study:

A pilot study was conducted on three patients and three nurses (10%) of the

study sample. The goal was to check the clarity, applicability, relevance and feasibility of the tools. and to identify the difficulties that may be faced during the application. It also helped to estimate the time needed to fill in the sheets. Since no modifications were made.

Field work:

The data collection phase lasted for 6 months during the period from the beginning of September 2022 to the end of February 2023.

-The first phase of the work is the preparatory phase that was done by meeting with the head nurse at the two ICU after obtaining the official permission, to clarify the objective of the study and applied methodology.

- The second phase that done by obtaining the patient data from the patient file, the monitor and the ventilator after getting the verbal consent from the relatives as the study subjects comatose or semi-conscious.

- The third phase that done by meeting each nurse was met individually, got a full explanation about the aim of the study and was invited to participate. The nurse who gave his/her verbal informed consent to participate was handed the interviewing questionnaire and was instructed during the filling. The data were collected two days a week (Monday and Tuesday) from 10:00 am to 2:00 pm, the time used for finishing the patient questionnaire about 120 minutes for each patient along three days, the time used for finishing the self- administered nurse questionnaire ranged between 20-30 minutes for each nurse according to nurses' physical and mental readiness and for nurses practice, the investigator was observing nurses' practical skills about studied procedures. The time needed to complete the checklist is about 20 minutes for each nurse.

Content validity & Reliability:

Testing validity: Of the proposed tools by using face and content validity.

Face validity aimed at inspecting the items to determine whether the tools measure what supposed to measure. Content validity was conducted to determine whether the content of the tools cover the aim of the study. This stage was developed by a jury of five experts, two of them professors and three assistant professor who reviewed the tool's content for clarity, relevance, comprehensiveness, understanding, and ease for implementation. All recommended modifications were done.

Testing reliability: testing the reliability of the tools through Alpha Cronbach reliability analysis was 0.781 for assessment of the factors affecting the nebulizer delivery through the mechanical ventilation, 0.823 for mechanically ventilated patient's response to nebulization therapy, 0.841 for nurses' knowledge assessment Questionnaire, and 0.829 for nebulization therapy administration observational checklist for nurses.

Statistical analysis:

The statistical analysis of data was done by using the computer software of Microsoft Excel Program and Statistical Package for Social Science (SPSS) version 25. Data were presented using descriptive statistics in the form of frequencies and percentage for categorical data, the arithmetic mean (X) and standard deviation (SD) for quantitative data. Qualitative variables were compared using the chi square test (X²) between the group during the two visits and during the three visits were assessed by Friedman test. Differences between the group during the two visits were assessed by paired t test and different between the group during the three visits were assessed by repeated measures ANCOVA. Reliability of the study tools was done using Cronbach's Alpha.

Degrees of significance of results were considered as follows: P-value > 0.05 Not significant (NS), P-value ≤ 0.05 Significant

(S), P-value ≤ 0.01 Highly Significant (HS).

Results:

Table 1: Showed demographic characteristic and health related factors of the studied patients. Their age ranged from 18-85 with Mean \pm SD= 48.10 ± 20.21 years, more than two third (70.0%) were male, less than two third (63.3%) had an ICU stay of 3 to 10 days. Regarding current comorbid diagnosis, all the studied patients had respiratory diseases. Also, 53.3% had a history of respiratory diseases. As regard to level of consciousness, more than half (56.7%) were semi-conscious.

Table 2: Showed the ventilator related factors among the studied patients. Regarding type of ventilation, three quarters (76.7%) of the studied patients were on volume control, 100.0% were on synchronized intermittent mandatory ventilation (SIMV). While 23.3% of the studied patients were on pressure control, 85.7% were on continuous positive airway pressure+ pressure support ventilation (CPAP+PSV). Regarding trigger type, 100.0% had flow trigger. Also, the majority (90.0%) had 400-600 ml of tidal volume. As regards inspiratory flow, 86.7% were on 30-60 L/ min. Regarding duty cycle, majority (90.0%) had 0.2 s to 0.4 s. Also, 43.3% had rectangular inspiratory flow wave form.

Table 3: Showed the nebulizer device related factors among the studied patients. 86.7% of the studied patients were on Jet aerosol device during the session. Regarding the position of the device in the circuit, 100.0% were between the ETT and the circuit. Related time of the session, most of the studied patients (93.3%) were stay >15 Min. As regard residual (Dead) volume of the nebulized drug, 86.7% were 0.1 -2.5 ml, respectively. Also, 60.0% had three times of nebulization sessions/day.

Table 4: Showed there was statistically significant difference in pulse Immediately after session; Also there was highly statistically significant difference in pulse 4 hrs after session; Also there was highly statistically significant difference in Systolic blood pressure, Diastolic blood pressure before, immediately after and 4 hrs after session at ($p \leq 0.01$).

Table 5: Showed demographic characteristic of studied nurses. Their age ranged from 21 - 32 with Mean \pm SD= 24.73 ± 2.85 years, more than half (56.7%) were male, the majority (83.3%) had technical Institute. Regarding job title, 93.3% of them were nurses. Also, about three quarters (73.3%) had 1-< 5 years of experience with Mean \pm SD= 3.10 ± 2.89 years. Moreover, 70.0% don't attend training courses on nebulization therapy administration.

Figure I: Showed that 80.0% of the studied nurses had unsatisfactory level of total knowledge regarding nebulization therapy administration. While 20.0% of them had a satisfactory level of total knowledge.

Table 6: Showed that 90.0% and 80.0% of the studied nurses had inadequate practices regarding assessment and preparation, respectively. Also, 93.3% of them had inadequate practices regarding implementation and post care, respectively. Moreover, 86.7% of them had inadequate practices regarding record and report. Regarding the total practice score, 86.7% of them had inadequate practices regarding nebulization with mechanical ventilation.

Table 7: Indicate that, there was highly significant positive correlation between total nurses' knowledge and their total practice regarding nebulization with mechanical ventilation at ($P = < 0.01$).

Discussion:

Concerning age, results of the present study revealed that age ranged from 18-85 with Mean \pm SD= 48.10 ± 20.21 years. The finding of the present study is supported by

Zhang et al. (2021) in the study on "The Clinical Practice and Best Aerosol Delivery Location in Intubated and Mechanically Ventilated Patients: A Randomized Clinical Trial" revealed that most patients aged 22 to 89 years (57.3 ± 17.1 years).

Related to gender, results of the present study revealed that more than two thirds of studied patients were male. The present result is consistent with **Grasselli. (2020)** in the study on " Baseline Characteristics and Outcomes of 1591 Patients Infected With SARS-CoV-2 Admitted to ICUs " conducted in Italy were found 82% were male. Concerning ICU stay, results of the present study revealed that about two third (63.3%) had an ICU stay of 3 to 10 days. The present result is consistent with **COVID-ICU Group and the COVID-ICU Investigators. (2021)** in the study on " Clinical characteristics and day-90 outcomes of 4244 critically ill adults with COVID-19: a prospective cohort study" found that ICU stay was 6–12 days. Also, this result consistent with **Zhang et al. (2021)** in the study on "The Clinical Practice and Best Aerosol Delivery Location in Intubated and Mechanically Ventilated Patients: A Randomized Clinical Trial" revealed that length of ICU stay was 5 (3–9) days. It may be attributed to the increased mortality rate.

Regarding current comorbid diagnosis, results of the present study revealed that all the studied patients had respiratory diseases. The present result is consistent with **Eltabakh et al. (2021)** in the study on " Factors Hindering The Effect of The Nebulization Therapy among Critically Ill Mechanically Ventilated Patients" showed that all patients were admitted with respiratory diseases.

Regarding type of Ventilation, results of the present study revealed that 76.7% were on volume control. The present result is consistent with **Alqahtani et al. (2020)** in the study on " Global current practices of

ventilatory support management in COVID-19 patients: an international survey" found that the most frequently used modes of IMV and NIV were volume control (VC).

Regarding type of volume control mode, results of the present study revealed that 100.0% were on synchronized intermittent mandatory ventilation (SIMV) The present result is consistent with **Chittawatanarat M.D and Jaikriengkrai K, (2014)** who reported in study entitled " Survey of respiratory support for intensive care patients in 10 tertiary hospital of Thailand." that synchronized intermittent mandatory ventilation (SIMV) was more predominant in the surgical ICUs.

Regarding Preset tidal volume (VT), results of the present study revealed that the majority (90.0%) had 400-600 ml of tidal volume. This result was in the same line with **COVID-ICU Group and the COVID-ICU Investigators. (2021)** in the study on " Clinical characteristics and day-90 outcomes of 4244 critically ill adults with COVID-19: a prospective cohort study "reported that 80% were intubated during their ICU stay and tidal volume were (5.8–6.7) mL/kg. It attributed to a VT of > 8–10 mL/kg can result in volutrauma and should not be used to improve the delivery efficiency of aerosol devices during mechanical ventilation. Regarding Inspiratory Flow, results of the present study revealed that 86.7% were on 30-60 L/min. The present result is consistent with **Dugernier et al. (2016)** in the study on "Aerosol delivery with two ventilation modes during mechanical ventilation: a randomized study" reported that most patients were on inspiratory flow 30 L/min and peak inspiratory flow of 60 L/min. It is attributed to constant flow pattern 30 L/min delivers a higher amount of aerosolized drug through an endotracheal tube and using high inspiratory flow during mechanical ventilation creates transitional

and turbulent flows in the airways that make aerosols deposit in the ventilator circuit and in the artificial airway. As regard to type of aerosol device used during the session despite the existence of more efficient nebulizer types, the jet nebulizer was by far the most frequently used nebulizer in two ICU in surgery hospital in Zagazig university (86.7%). the present result is consistent with **Otto et al. (2022)** in the study on "Nebulization of emergency medications in the south German rescue service" reported that the jet nebulizer was the most frequently used nebulizer in the south German rescue services. Concerning the position of the device in the circuit 100.0% were between the ETT and the circuit. This finding was in harmony with **Zhang et al. (2021)** in study on "Knowledge and current practices of ICU nurses regarding aerosol therapy for patients treated with invasive mechanical ventilation: A nationwide cross-sectional study." reported that the most common nebulizer position was between the tracheal tube and the Y-piece. It may be attributed to means that the common nebulizer location is not the optimal position when ICU nurses implement aerosol therapy for intubated patients because the less efficient was received when nebulizer was placed between Y-piece and the tracheal tube. Related time of the session, the present study revealed that most of the studied patients were stay >15 Min on nebulizer session. This result is consistent with **Liu et al. (2019)** who found in the study about "Size distribution of colistin delivery by different type nebulizers and concentrations during mechanical ventilation" that VMN produces a greater total of emitted and inhaled drug doses but requires double the nebulization time of JN for both concentrations. Regarding hemodynamic status, the present result revealed that there was statistically significant decrease in heart rate immediately after session and 4

hrs. after session on the 1st and 2nd day of the study. This result is consistent with **Eltabakh et al. (2021)** in the study "Factors Hindering The Effect of The Nebulization Therapy among Critically Ill Mechanically Ventilated Patients" who reported decrease heart rate after session. It may be attributed to the effect of muscarinic receptor antagonists (ipratropium bromide) on heart rate which causes bradycardia. Concerning hemodynamic status, the present result revealed that there was statistically significant increase in systolic and diastolic blood pressure. This result is consistent with **Singla et al. (2018)** in the study" comparison of formoterol-budesonide formulation nebulized alone and in combination with ipratropium bromide formulation in patients with chronic obstructive pulmonary disease" who presented that there was statistically significant rise in SBP, DBP. The present study revealed that 80.0% of the studied nurses had unsatisfactory level of total knowledge regarding nebulization therapy administration. This result in harmony with **Xie et al (2023)** in the study about "Nurses in China lack knowledge of inhaler devices: A cross-sectional study" who reported that the nurses' knowledge of inhalers is not sufficient. Regarding total nurses Practice, the present study revealed that (86.7%) of nurses had inadequate performance about nebulizer therapy. The present result is consistent with **Fares et al (2013)** in study about" Knowledge and Performance of Critical Care Nurses Toward Nebulizer Therapy in the Intensive Care Unit" reported that (88.8%) of nurses had inadequate performance about nebulizer therapy. It attributed to no training courses about nebulizer therapy delivery. Concerning the correlation of total knowledge with total practice. there was a highly significant positive correlation between total nurses' knowledge and their

total practice regarding nebulization with mechanical ventilation. This result was in harmony with **Santambrogio et al (2021)** in study about "Hospital staff practical skills and theoretical knowledge in inhaled aerosol therapy: a single centre cross-sectional observational study" found that a lack of knowledge and practical abilities about aerosol therapy of health care professionals of a large Italian teaching hospital. The poor knowledge and skills in administering nebulizer session can limit patient response to nebulizer sessions.

Conclusion: On the light of results of the current study and answers to the research questions, it was concluded that nebulized bronchodilators and corticosteroids can decrease heart rate, increase blood pressure, improve oxygen saturation, decrease (plateau pressure, peak inspiratory pressure) and increase static compliance. According to studied nurses, the majority had unsatisfactory level of total knowledge and inadequate practice regarding nebulization therapy administration. there was a statistically significant relation between total nurses' knowledge and their

demographic characteristics as age, gender, education level, years of experiences and attendance of training course on nebulization therapy administration. There was statistically significant relation between total nurses' practice and their demographic characteristics as education level, years of experiences and attendance of training course on nebulization therapy administration. There was a highly significant positive correlation between total nurses' knowledge and their total practice regarding nebulization with mechanical ventilation.

Recommendations:

It is highly recommended to create training opportunities for nurses to increase their knowledge about nebulizer devices. In addition, we should establish a team of professionals to regularly measure nurses' knowledge of inhaler devices and Regular assessment and ongoing education on the correct inhaler technique for respiratory nurses are necessary to optimize device usage by nurses. Finally, related institutional improvements are important.

Table1: Frequency distribution of the studied patients according to their demographic characteristics and health related data (n=30).

variables	No.	%
Age (Years)		
18-20	2	6.7
20-< 30	4	13.3
30-<40	8	26.7
40-<50	2	6.7
50-<60	3	10.0
≥ 60	11	36.7
Mean ± SD= 48.10 ± 20.21 Max= 85 Min= 18 Range=67		
Gender		
Male	21	70.0
Female	9	30.0
Days in ICU		
3-<10	19	63.3
10-<20 days	2	6.7

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Section A -Research paper

20-<30 days	2	6.7
≥ 30 days	7	23.3
Mean ± SD= 16.80 ± 18.75 Max= 60 Min= 3 Range=57		
#Current Comorbid Diagnosis		
Respiratory	30	100.0
Cardiovascular	21	70.0
Renal	2	6.7
Neurological	23	76.7
GIT	8	26.7
Endocrine	5	16.7
Trauma /Burn	6	20.0
#Past Medical History		
Respiratory	16	53.3
Cardiovascular	13	43.3
Neurological	10	33.3
GIT	4	13.3
Endocrine	5	16.7
None	8	26.7
Level of consciousness		
Coma	6	20.0
Semi-conscious	17	56.7
Conscious	5	16.7
Sedated	2	6.6

Table 2: Frequency Distribution of The Studied Patients According to Ventilator Related Factors (n=30).

Ventilator Related Factors	No.	%
Type of Ventilation		
Volume Control	23	76.7
Pressure Control	7	23.3
Volume Control (n=23)		
SIMV	23	100.0
Pressure Control (n=7)		
CPAP	1	14.3
CPAP+PSV	6	85.7
Trigger: type		
Flow	30	100.0
Preset Tidal Volume (VT)		
400-600 ml	27	90.0
<400 ml	1	3.3
> 600 ml	2	6.7
Inspiratory Flow:		
30-60 L/ min	26	86.7
<30L/min	2	6.7
>90L/min	2	6.7

Duty Cycle		
0.2 s to 0.4 s	27	90.0
Reverse rate ventilation over 0.5 s	3	10.0
Inspiratory Flow Wave Form		
Rectangular	13	43.3
Sinusoidal	9	30.0
Ascending ramp	4	13.3
Descending ramp	4	13.3

Table 3: Frequency distribution of the studied patients according to nebulizer device related factor (n=30).

Nebulizer Device Related Factor	No.	%
Type of Aerosol Device Used During the Session		
Jet	26	86.7
Vibrating Mesh	4	13.3
Position of the Device in the circuit		
Between the ETT and the circuit	30	100.0
Time of the Session		
6-10 Min	2	6.7
>15 Min	28	93.3
Residual (Dead) Volume of The Nebulized Drug		
Zero	4	13.3
0.1 -2.5 ml	26	86.7
Frequency of nebulization sessions/day		
Three times	18	60.0
> Three times	12	40.0

Table 4: Distribution of Mean Score of Hemodynamic Status and Respiratory Status Among the Studied Patients at First and Second Day.

Variables	1st day			2nd day			(p1)	(p2)	(p3)
	Before Session	Immediately after Session	4 Hrs. After Session	Before Session	Immediately after Session	4 Hrs. After Session			
	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD			
Hemodynamic Status									
Pulse	96.3±21.5	99.40±19.2	97.2±15.8	90.5±16.1	90.4±18.7	89.8±14.8	t=1.293 P=0.206	t=2.22 P=0.034*	t=3.099 P=0.004**
Systolic blood pressure	124.6±24.3	118.8±21.8	120.9±15.3	131.0±23.5	127.2±21.6	127.1±25.5	t=14.25 P=0.000**	t=17.40 P=0.000**	t=24.95 P=0.000**
Diastolic blood pressure	78.2±11.9	75.8±11.9	76.8±8.98	81.0±11.9	76.6±14.6	77.1±12.1	t=11.45 P=0.000**	t=13.06 P=0.000**	t=16.05 P=0.000**

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Section A -Research paper

MAP	93.3±14.8	90.11±14.5	91.1±10.4	97.5±15.3	93.0±15.9	93.5±15.2	t=1.64 P=0.110	t=1.42 P=0.166	t=0.851 P=0.402
Respiratory Status									
Respiratory Rate	22.1±6.58	19.2±5.91	20.6±5.90	21.6±5.13	18.6±3.67	20.1±6.95	t=0.319 P=0.752	t=0.457 P=0.651	t=0.490 P=0.628
Use of Accessory Muscles	Yes	12 (40.0%)	2 (6.7%)	3 (10.0%)	12 (40.0%)	2 (6.7%)	X ² =0 P=0	X ² =0 P=0	X ² =0 P=0
	No	18 (60.0%)	28 (93.3%)	27 (90.0%)	18 (60.0%)	28 (93.3%)			
Spo2	94.7± 2.71	91.0±24.5	95.4±3.17	96.6±3.33	91.7±24.7	96.1±3.20	t=2.71 P=0.11	t=1.752 P=0.090	t=0.983 P=0.334

Table 5: Frequency Distribution of The Studied Nurses According to Their Demographic Characteristics (n=30).

Nurse's demographic Characteristics	No.	%
Age (Years)		
20-<25	15	50.0
25-<30	13	43.3
≥ 30	2	6.7
Mean ± SD= 24.73 ± 2.85 Max= 32 Min= 21 Range=11		
Gender		
Male	17	56.7
Female	13	43.3
Educational Qualification		
Diploma	2	6.7
Technical Institute	25	83.3
Bachelor of Nursing	3	10.0
Job title		
Nurse	28	93.3
Nursing supervisor	2	6.7
Years of experiences		
1-< 5	22	73.3
5-<10	6	20.0
≥ 10	2	6.7
Mean ± SD= 3.10± 2.89 Max= 1 Min= 10 Range=9		
Attending a training course on nebulization therapy administration		
Yes	9	30.0
No	21	70.0

Figure I: Percentage Distribution of The Studied Nurses According to their Total Knowledge Regarding Nebulization Therapy Administration (n=30).



Table 6: Frequency Distribution of The Studied Nurses According to Their Practice Regarding Nebulization with Mechanical Ventilation (n=30).

Nurse's practice regarding nebulization with M. V	Adequate		Inadequate		Mean ± SD
	No.	%	No.	%	
Assessment	3	10.0	27	90.0	3.43±2.4
Preparation	6	20.0	24	80.0	10.8±2.06
Implementation	2	6.7	28	93.3	0.53±1.7
Post Care	2	6.7	28	93.3	7.20±4.13
Record and report	4	13.3	26	86.7	1.96±0.99
Total practice score	4	13.3	26	86.7	23.92±10.3

Table 7: Correlation Between the Studied Nurses' Knowledge and Practice Regarding Nebulization with Mechanical Ventilation (n=30).

Variables	Total practice score	
	r	p-value
Total knowledge score	0.628	0.000**

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