https://menj.journals.ekb.eg
Print ISSN: 2735-3974
Online ISSN: 2735-3982
DOI: ----------

MNJ
Menoufia Nursing Journal
Faculty of Nuring
Menoufia University

Effect of Implementing Selected Nursing Interventions on Experiencing Post-Extubation Stridor in Ventilated Patients

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Abstract: Background: Post-extubation stridor occur in less than one quartile between extubated patients and it may be asymptomatic or mildly symptomatic for ICU staff. Extubated patients may need reintubation after extubation, which increases the mortality rate among those patients. **Purpose:** To study the effect of implementing selected nursing interventions on experiencing post-extubation stridor in ventilated patients. **Design:** A quasi-experimental research design. **Study participants**: A Purposive sample of 200 patients were included, divided into 50 patients in each of the control and intervention groups. Setting: General intensive care units at governmental hospitals of Albeheria government in Egypt. **Methods:** A Purposive sample from adult mechanically ventilated patients admitted to the selected study settings. Intubated patients with the end-stage disease were planned for tracheostomy, but those with a history of multiple extubation trial failures were excluded from the study. **Instruments:** Two instruments were used, instrument one assessed demographic and clinical data and risk factors associated with post-extubation stridor. Instrument two assessed post-extubation stridor manifestations, Clinical outcomes associated with the post-extubation stridor assessment instrument. **Results:** The selected nursing interventions decreased the clinical manifestations of post-extubation stridor, reintubation need, and ICU length of stay with percentage changes of -16%, -49.25, and -29.97. They improved the oxygenation indexes, such as PaO2 (% change12.62), SaO2 (% change 5.161), and ROX index (% change 44.37). Moreover, ventilation parameters improved in the minute ventilation (% change-17.4) and PaCO2 (% change -9.09) of the intervention group. **Conclusion:** The selected nursing interventions improved ventilation and oxygenation parameters associated with post-extubation stridor clinical manifestations. **Recommendations:** Further studies should be conducted to assess the long-term outcomes of selected nursing interventions

Keywords: *Extubation; Nursing; Post-extubation stridor; Mechanical ventilator; Weaning.*

Introduction

A mechanical ventilator (MV) is used to control, assist, and support breathing patients in intensive care units (ICU) according to the ventilator mode. The main indications for MV are reduced use of accessory muscles, oxygen consumption, respiratory distress, and improved gas exchange.

Patients on MV have increased lengths of hospitalization and may be at risk for MV and immobility complications. Therefore, nurses have an essential role in intubation, extubation, and delivering continuous nursing until discharge (Poeira et al., 2020).

The extubation from MV indicates that the patient has recovered from being dependent on MV and has become independent of ventilation. The weaning stage is critical for critically ill patients. The weaning process consists of three stages: pre-extubation, extubation, and post-extubation. Extubated patients may need reintubation after extubation, which increases their mortality rate. Maintaining oxygenation is the priority that should be considered during tracheal extubation (Poeira et al., 2020; Sturgess et al., 2017).

Upper airway edema, mainly laryngeal edema, occurs during tracheal intubation. Glottic damage may occur from prolonged intubation, which causes extubation failure and respiratory distress due to the narrowing of the tracheal lumen (Sturgess et al., 2017; Kumar & Cascella, 2020; Tanaka et al., 2021). Extubation failure may be an indicator of the deterioration of the patient's condition, increased dependency on MV, and need for reintubation (Kaur et al., 2022; Lange et al., 2017).

Post-extubation stridor is a clinical indicator for impaired vocal cords or laryngeal edema. It can be recognized by the auscultation of inspiratory noise or hoarseness after extubation due to the narrowing of the airway at a supraglottic, glottic, or infra-glottic level. Less than 30 % of the extubated patients experience post-extubation stridor, and not all patients with post-extubation stridor need reintubation. Nurses need to auscultate for abnormal breathing sounds. Expert physicians may use nasopharyngeal-laryngoscopy to assess laryngeal edema (Shinohara. et al., 2020; Sturgess et al., 2017). Shinohara. et al. (2020) report that patients intubated in the emergency units has a higher risk for post-extubation stridor than those intubated in ICU or operating room. The incidence rate is less than 30%. Nurse staff needs to assess and ensure airway patency and use the required nursing care to keep the airway patent to deliver oxygen and remove carbon monoxide (Elkarta & Eldegwy, 2021).

Moreover, ICU nurses need to assess early and categorize post-extubation stridor risk factors and use the nursing care protocol to decrease this risk. Those risk factors include young age, being female gender, prolonged MV length of stay, more frequent attempts for intubation, and trauma.in addition to, emergency intubation and unknown medical history before intubation, previously complicated intubation, tracheostomy, inaccurate estimation of weight and height, inappropriate selection of ETT size, hemodynamic instability, adverse effect of using sedition at that intubation time, aggressive fluid administration, gastro-oesophageal reflux, high cuff pressures, disturbed level of consciousness (LOC), and increased body mass index (C. Chu et al., 2017; Kumar & Cascella, 2020; Elkarta & Eldegwy, 2021; Shinohara et al., 2020, 2022). Lilienstein et al. (2016) report that all emergency admitted patients who need intubation might develop post-extubation stridor. The most risk factors are age <18 years, female gender, blunt injury, and more than five days stay on MV.

The post-extubation stridor pathophysiology may be due to edema, ulcer, and development of granulation tissue, which restricts the movement of the vocal cords. The limited mobility of the vocal cords causes a luminal airway narrowing. Besides the direct

pressure of the ETT on the contact, the area triggers the inflammatory reaction and accelerates edema (Shinohara et al., 2020). The associated complications of laryngeal edema are considered to be the main cause of extubation failure and prolonged ICU length of stay and hospitalization, more health care costs, the need for tracheostomy, risk of respiratory infection, and morbidity and mortality (Lange et al., 2017). Less than 25% of extubated patients after a successful MV weaning, may need reintubation within less than three days (Yasuda et al., 2021).

The nursing staff plans the patient's extubation from the initiation of intubation. Nurses should demonstrate these interventions in pre-extubation, during extubation, and post-extubation. Pre-extubation nursing interventions include establishing therapeutical relations with the patient, identifying criteria for weaning the patient from MV, considering risk factors that increase the risk for post-extubation stridor, notifying the ability of patients for spontaneous breathing trial, holding enteral feeding before extubation within four hours, assessing tracheal and oral secretion and suction as needed. The extubation should be performed in the morning. During extubation, nurses need to frequently assess LOC, elevate the head of the bed, apply ETT and oral suction as needed, reassure the patient to decrease anxiety, monitor vital signs and oxygen saturation, and administrate inhalation therapy following the orders of the doctor. After extubation, nurses need to assess vital signs and oxygen saturation, put a patient in a high fowler's position, and apply oral hygiene as needed (Chu et al., 2017; Higgs et al., 2018; Lange et al., 2018; Poeira et al., 2020; Algendy & Bahgat, 2021; C. Elkarta & Eldegwy, 2021; Konca et al., 2022).

Significance of the study:

Nurses directly utilize pre/during/ post-extubation nursing interventions to decrease the ICU stay of the patients and improve oxygenation and ventilation parameters. Less than 30 % of extubated patients experience post-extubation, and not all patients with post-extubation stridor need reintubation. Several risk factors are associated with post-extubation stridor such as gender, prolonged intubation time, use of sedition before intubation, and using steroids before extubation (Poeira et al., 2020). Thus, this study aims to study the effect of implementing selected nursing interventions on experienced post-extubation stridor in ventilated patients

Purpose:

This study seeks to assess the effect of implementing selected nursing interventions on experienced post-extubation stridor in ventilated patients.

Research hypothesis:

Ventilated patients who receive the selected nursing interventions are expected to have fewer primary and secondary outcomes than those who only experienced routine hospital care.

Materials and Methods

Study design:

A quasi-experimental research design was conducted (study and control groups).

Research settings:

General intensive care units at governmental hospitals of Albeheria government in Egypt were selected for data collection. The ICUs received patients with emergencies, such as road traffic accidents, poisoning, and respiratory, and neurological life-

threatening conditions who need MV and continuous monitoring.

Sampling:

A Purposive sample technique was used, and the sample size was calculated using an electronic calculator using the Sample Size Calculator by Rao soft, Inc. The total population size in the last three months was 130, with a 95.0% confidence level and 80.0% power. The minimal sample size was 98 participants. So, the sample size was 100 patients, equally divided into control and intervention groups. The inclusion criteria included all patients admitted to the previous setting and intubated on an MV. Exclusion patients: MV patients with end-stage disease and planned for tracheostomy and who had a history of multiple extubation trial failures were excluded from the study.

Instruments:

Instrument one, **the patient assessment post-extubation stridor instrument**, was developed after reviewing the relevant literature (C.Chu et al., 2017., Higgs et al., 2018; Lange et al., 2018; Poeira et al., 2020; Algendy & Bahgat, 2021; Elkarta & Eldegwy, 2021; Konca et al., 2022;). It included two parts. Part one was used to assess the patient's demographic and clinical data, such as age, gender, intubation type, body mass index, date of ICU admission, the reason for admission, sequential organ failure assessment score (SOFA), hypoxic index, vital signs, arterial blood gases (Paco2, Pao2, and Sao2), and cumulative fluid balance. Part two was used to assess risk factors associated with post-extubation stridor using an assessment checklist. It consisted of risk factors, including cuff leak test, previous intubation, prolonged intubation, previous two or more admission intubation attempts, use of sedative drugs at intubation, use of steroid before extubation, obesity, intubation days, unplanned reintubation within 48 hours, inter diameter of an endotracheal tube (mm), and measurement of cuff pressure using cuff manometer (cmH2o). Scoring system: Score 1 was used for the presence of risk factors and score 0 was used for the absence of risk factors.

Instrument two, Clinical outcomes associated with the post-extubation stridor assessment instrument, was developed after reviewing relevant literature (Lange et al., 2017; Prakash et al., 2021). This instrument consisted of two parts and was used after 48 hours of extubation. Post-extubation stridor manifestations assessment checklist was part one. It was used to assess the presence of post-extubation stridor manifestations that included stridor sound, difficulty breathing, excessive drooling or inability to swallow saliva, difficulty swallowing, and voice change. The manifestations were assessed after 48 hrs. of post-extubation time. Score 1 was used for the presence of manifestation and score 0 was used for the absence of manifestation. Part two included primary and secondary outcomes. The primary outcome included oxygenation indexes (FiO2/PaO2, SaO2, PaO2, PaCO2, and ROX index). ROX index means the ratio of SpO2/FiO2 ratio to respiratory rate. When the ROX index is more than or equal to 4.88, it means a lower risk for intubation, but less than 3.85 means a higher risk for intubation. If ROX Index is between 3.85 to less than 4.88, it should be repeated at least two hours later for further assessment (Prakash et al., 2021). The secondary outcomes included the reintubation needed within 48 hrs, ICU length of stay, frequency for endotracheal suctioning, and prolonged mechanical

ventilation > 4 days. Score 1 was used for the presence of outcomes and score 0 was used for the absence of outcomes. The clinical pulmonary infection score was used to diagnose ventilator-associated pneumonia. A score from 0 to 6 indicates a less likely VAP, and a score from 7 to 12 suggests a more likely VAP (EBM calc, 2020).

Reliability:

Cronbach's alpha was used to test instrument reliability and instrument one a =0.932. Instrument two a=0.827.

Validity:

The validity of the instruments was verified by presenting them to five experts in the field of the study who revised them (3 professors in critical care nursing and two professors in critical medicine). The recommended modifications were made

Pilot study:

A pilot study was carried out on 10 % (n =10) of the studied patients to assess the clarity, applicability and feasibility of the instruments. Pilot study sample were excluded from the total data collection sample and excluded from the study population; consequently, necessary modifications were made

Procedures:

A letter was submitted from the Dean of the Faculty of Nursing, Damanhour University to the director of Intensive Care Units in Damanhur Medical National institute; Kafar Eldawar; Itay El Barud in Albehera govemtnment hospitals in Egypt. The letter contained an explanation of the purpose and methods of data collection. The validity of the instruments was verified by presenting them to five experts in the field of the study who revised them (3 professors in critical care nursing and two professors in critical medicine). The recommended modifications were made. Data were collected by the researchers for approximately three months. All newly admitted mechanically ventilated patients were assessed by the researchers to detect the exclusion criteria on the first admission day. They were assigned equally into controlled and intervention groups. About five patients from the intervention group and five from the control group were excluded from the study due to self-extubation.

The demographic and clinical data of the patients were assessed and recorded using part one in instrument one, and risk factors associated with post-extubation stridor were assessed and recorded using part two in instrument one. A cuff leak test was used to detect possible laryngeal edema instead of direct laryngoscopy, which is considered the golden standard for laryngeal edema. A cuff leak test is a simple test used to measure a pre-set tidal volume when a patient is in assist-control mode. Before deflating the cuff, endotracheal tube suction should be used. After the ETT was thoroughly suctioned, the cuff was deflated. The expiratory volumes were measured for serial breath cycles for the patients before the deflation of the ETT cuff and after the deflation ETT cuff. The difference between the expired tidal volume with the cuff inflated and the cuff deflated: the higher leak was associated with a lower risk of post-extubation stridor. The cut-off point of the cuff leak volume test was 110 mL or 10% of tidal volume (Wang et al., 2015; Stieg, 2017; Tokunaga et al., 2022). The patients were assigned into two equal groups:

Control (A) and intervention (B) group. The A group received routine nursing care for extubation. The

control group patients were assessed for weaning preparedness depending on oxygen saturation and arterial blood gases (paO2). ETT was removed after the deflation cuff of ETT by the physician, using a nasal cannula with 60% FiO2, oral suction as needed, and using bronchodilator inhalation therapy as needed. Patient tolerance for weaning was assessed and needed for re-intubation.

The intervention group (B) received pre-planned nursing interventions before, during, and after extubation (Ward & Fulbrook, 2016; Glossop, 2017; Glover & Hetland et al., 2018; Poeira et al., 2020; Fadila et al., 2022).

Pre-extubation nursing interventions included establishing therapeutical nurse-patient relation, assessing the patient manifestations for weaning the patient from MV, assessing the patient level of sedation using the Richmond agitation sedation scale (RASS), patient with nothing per mouth (NPO) before the extubation within 4 hours at least, performing spontaneous breathing trial using T-pieces, assessing excessive ETT, oral secretion, and need for suction. Monitor signs of respiratory distress and vital signs were done every 15 minutes. The extubation should be performed in the morning, and the process should be explained to the patient before the extubation.

During extubation, nurses needed to assess LOC using the Glasgow coma scale frequently, assess the cough and swallowing reflex, put the patient in high fowlers' position, reassure the patient to decrease the level of anxiety, continuously monitor vital signs and oxygen saturation, and apply ETT and oral suction as needed with chest physiotherapy. Before removing ETT, oral suction was carried out, then the cuff of the ETT was deflated. The patient was asked to cough immediately after removing ETT, performing chest physiotherapy, and administrating an inhalation therapy as the doctor ordered. The humidified high-flow nasal oxygen therapy was used at flow rates ≤60 L/min.

After extubation, nurses assessment of vital signs and oxygen saturation were done every 15 minutes at least for the first 6 hours and then every hour, patients were kept in high Fowlers' position, and continuously connect the patient with a nasal cannula at high flow humidified oxygen. Oral care was performed every 12 hours after extubation.

Patients were NPO until oxygenation and ventilation parameters were stable after 48 hours of extubation to prevent aspiration in case of reintubation. The random blood glucose level was monitored at least every 6 hours to prevent hypoglycemia. Both groups were assessed for weaning intolerance, such as respiratory distress, desaturation, hemodynamic instability, and restlessness. Furthermore, the primary and secondary outcomes were assessed for both groups.

Ethical considerations:

Ethical approval was obtained from the Ethical Committee faculty of nursing, Damanhour university (code.59-a). After explaining the purpose of the study, informed consent was obtained from each patient, and the researchers assured participants that they had the right to refuse participation. The collected data anonymity, privacy, and confidentiality were maintained.

Statistical analysis

IBM SPSS software version 20.0 was used. Qualitative and quantitative data were described using the number and percent or mean with the standard deviation. Shapiro-Wilk test was used to test the normality of data. The level of significance was 5%. Chi-square/

Fisher's Exact test was used for categorical variables to compare different groups. Mann Whitney test and Student t test were used to comparing the two studied groups according to the normal distribution curve.

Results:

The results illustrated in **table 1** reveal that both groups had no significant difference concerning demographics. The mean age of group A was 41.12 ± 7.24, and that of group B was 40.14 ± 6.31. In group A, 64% were females, and in group B, 68% were males. Moreover, 64% of group A had planned intubation while 74 % of group B had planned intubation. The most common for admission was head trauma in group A (38%) and group B (50%). About 40% of group A and 42% of group B had a body mass index >24.6. The mean planned extubation days were 3.20±040 in group A and 3.20±040 in group B.

The mean hypoxic index on admission in group A was 66.68±0.77, and that of group B was 66.36±0.63. The mean of the Glassgow coma scale in group A was 10.02±0.32, and that of group B was 13.34±0.32 with a significant difference of (P<0.000). The majority of group B, (96%), used a nasal cannula, while 62% of group A used an oxygen mask as the method of oxygenation with a significant difference (p=0.000).

Table 2 illustrates a comparison between both groups regarding risk factors associated with post-extubation stridor. The mean value of the Cuff leak test for group A was 53.92±0.15 and for the group, B was 53.91±0.14. There was no obvious significant difference between them in the cuff leak test (p = o.731). Both groups had no history of tracheostomy. About 52% of group A and 26 % of group B experienced two or more admission intubation attempts, reintubation within 48 hours, and prolonged intubation. Furthermore, 92% of group A and 94 % of group B had physician orders to administer sedation. About 46% of group A and 52 % of group B had physician orders to administer steroids. The mean inner diameter of ETT (mm) was 7.60±12 in group A and 7.52±12 in group B. The mean cuff pressure measurement of the endotracheal tube was 26.6±13 in group A and 26.1±15 in group B. Group A had a significant difference from the group B about intubation attempts, reintubation within 48 hours, and measurement of cuff pressure (p<0.001, p <0.001, and p= 0.05, respectively).

Table 3 compares between vital signs and arterial blood gas parameters of both control and study groups at different intervals. There was a highly statistically significant difference between the control and intervention groups regarding arterial blood gases as follows: PaO2, PaCo2, and SaO2 at a significant level ≤ 0.05 (p= 0.003, p<0.001, p=0.000 correspondingly). Regarding the vital signs, there was no statisitical significant difference between both groups regarding the mean arterial pressure and temperature at pre-extubation and post-extubation (p =0.164, p=0.781). In contrast, group A had syatisitical significant differences from group B regarding the heart rate and respiratory rate (p=0.025, p=0.001). Both groups had a similar mean of cumulative fluid balance throughout the observation days (2160±10 in group A and 2163±14 in group B), and there was no significant difference between them (p =0.220).

Table 4 compares between groups regarding post-extubation clinical manifestations and clinical outcomes after 48 hours. Group B experienced fewer clinical manifestations than

group A following decreased stridor sound with percentage change (-16%), difficulty in breathing (-64.2%), and using accessory muscles (-16%). There was no statistically significant difference between both groups according to experiencing excessive drooling of secretion, dysphagia, voice change, productive cough, and cyanosis (p= 0.12, 0.164, 0.140, 0.12, and 0.14, respectively). The group B improved more than group A in the oxygenation parameters of the primary outcome following decreased percentage change fiO2/paO2; increased SaO2, PaO2, ROX indexes in the intervention group (-13.45, 5.161,12.623, and 44.37, respectively). The hypoxic index (FiO2/ PaO2) increased in group A to 76.68 ± 0.77 and in group B to 66.36 ± 0.63. They had a significant difference between them (p<0.000). Group B demonstrated an increase in the Mean ± SD of SaO2 (95.36 ± 0.51), PaO2 (86.36 ± 0.51), and ROX index (4.62±0.68) than group A with a significant difference between them (p< 0.001, p= 0.000, p =< 0.000, respectively). Concerning the ventilation parameters, the intervention group had a decrease in the mean ± SD of PaCo2 (40 ± 0.51), and minute ventilation was (8.72 ± 1.72) than the control group with a significant difference between them (p= 0.000 and p= 0.005, separately).

About the secondary outcome, group A needed reintubation after 48 hours from extubation than group B with significant differences (p=0.000). Additionally, group A had a longer stay in ICU with significant differences (p =0.003) than group B. The group B had fewer reintubation needs after 48 hrs., ICU length of stay, a frequency for endotracheal suctioning, and MV length of stay after extubation than group A with a percentage change of (-49.25, -28.97, -6.66, and -14.218, correspondingly).

TABLE 1 Comparison between both groups regarding demographic data and clinical data of ventilated patients

Characteristic	Group A (n=50)		Group B (n=50)		*t or* χ^2	p
Age (years) Mean ± SD	41.12 ± 7.24		40.14 ± 6.31		0.721	0.472
Sex n (%)						
Male	18	36.0	34	68.0	1.178	0.073
Female	32	64.0	16	32.0		
Intubation n (%)						
Planned intubation	32	64.0	37	74.0	1.169	0.280
Unplanned intubation	18	36.0	13	26.0		
Oxygen delivers system n (%)						
Oxygen mask at 100%	31	62	2	4	36.875	0.000*
Nasal cannula at 60 l/min	19	38	48	96		
Smoking history n (%)						
Nonsmoker	31	62.0	35	70.0	1.169	0.280
Former smoker	5	10.0	9	18.0		
Active smoker	19	38.0	6	12.0		
BMI (kg/m2) n (%)						
Normal (18.5- 24.5)	30	60	29	58.0	0.709	0.678
BMI >24.6	20	40	21	42.0		
Reason for admission* n (%)						
Respiratory failure	7	14.0	8	16.0	0.078	0.779
COPD	19	38.0	25	50.0	1.461	0.227
Coma due to poisoning	13	26.0	10	20.0	0.508	0.476
Congestive heart failure	3	6.0	1	2.0	1.042	0.617
Trauma	5	10.0	4	8.0	0.122	1.000
Shock	5	10	6	12	0.211	1.000
SOFA score (Mean ± SD)	2.44 ± 0.50		2.28 ± 0.45		1.673	0.097
Hypoxic index on admission (Mean ± SD)	66.68 ± 0.77		66.36 ± 0.63		3.277	0.025
Extubation day (Mean ± SD)	3.20 ± 0.40		3.16 ± 0.37		1.673	0.097
Fio2 on admission (Mean ± SD)	87.20 ± 0.40		8٧.20 ± 0.50		0.277	0.890
Random blood sugar (Mean ± SD)	130.34±0.32		129.34±0.32		1.461	0.227
Glasgow coma score (Mean ± SD)	10.02±0.32		13.34±0.32		51.875	0.000*

p: p-value for comparing between the two groups *: level of significance p ≤ 0.05 * multiple response * BMI: body mass index

TABLE 2: Comparison between both groups in relation to risk factors associated with post-extubation stridor

Risk factors	Group A (n=50)		Group B (n=50)		*t or* □□	p
Cuff leak test (Mean ± SD)	53.92±0.15		53.91±0.14		0.345	0.731
History of tracheostomy n (%)	0	0.0	0	0.0	–	–
Two or more admission intubation attempts n (%)	26	52	13	26	52.414*	<0.001*
Prolonged intubation	26	52	13	26	52.414*	<0.001*
Use of sedative drug at intubation n (%)	46	92	47	94	2.041	0.495
Use of steroid before extubation n (%)	23	46	26	52	1.071	0.195
Obesity n (%)	20	40	21	42.0	0.912	0.119
Reintubation within 48 hours n (%)	26	52	13	26	52.414*	<0.001*
Inner diameter of the endotracheal tube, mm (Mean ± SD)	7.60±12		7.52±12		2.041	0.495
Measurement cuff pressure (Mean ± SD)	26.6±13		26.1±15		2.912	0.05*

χ2: Chi-square test p: p-value for comparing between the two groups

TABLE 3: Comparison between control and intervention groups' relation to vital signs and arterial blood gas parameters of ventilated patients at different time intervals

Parameters	Group A (n=50)	Group B (n=50)	% Change *	*t or* □□	p
Arterial blood gases					
Pao2(mmHg)					
Pre extubation	٨٩.68 ± 0.٠7	٨٩.36 ± 0.٣3	12.6	3.829	0.003*
Immediately post-extubation	76.68 ± 0.02	86.36 ± 0.13			
24 hrs. post extubation	72.68 ± 0.04	86.36 ± 0.23			
48 hrs. post extubation	76.68 ± 0.02	86.36 ± 0.51			
PaCo2 (mmHg)					
Pre extubation	39 ± 0.11	39 ± 0.23	-9.09	58.730*	<0.001*
Immediate post-extubation	39 ± 11	38.7 ± 12			
24 hrs. post extubation	42 ± 0.02	40 ± 0.23			
48 hrs. post extubation	44 ± 0.02	40 ± 0.51			
Sao2					
Pre extubation	95.67 ± 0.05	95.37± 0.٠3	5.16	68.730*	0.00٠*
Immediately post-extubation	96.68 ± 0.02	96.36 ± 0.13			
24 hrs. post extubation	94.68 ± 0.04	96.36 ± 0.23			
48 hrs. post extubation	90.68 ± 0.02	95.36 ± 0.51			
Vital signs					
Heart rate (b/m)					
Pre extubation	87.68 ± 0.22	87.36 ± 0.02	-9.36	2.277*	0.025*
Immediately post-extubation	76.68 ± 03	76.36 ± 0.05			
24 hrs. post extubation	95.68 ± 0.20	٨6.36 ± 0.03			
48 hrs. post extubation	95.28 ± 0.20	٨6.36 ± 0.23			
Respiratory rate(c/min)					
Pre extubation	31.29±11	31.18±12	-12.0457	19.64	0.001*
Immediately post-extubation	30.29±11	25.31±30			
24 hrs. post extubation	33.29±12	29.28±25			
48 hrs. post extubation	33.29±11	29.28±25			
MAP (mmHg)					
Pre extubation	110.43±11	110.43±11	0.00	0.211	0.164
Immediately post-extubation	120.18±16	120.18±16			
24 hrs. post extubation	119.49±26	119.49±26			
48 hrs. post extubation	118.42±١١	118.42±١١			
Temperature (0c)					
Pre extubation	37.1±10	37.1±10	0.00	0.130	0.781
Immediately post-extubation	37.12±26	37.14±26			
24 hrs. post extubation	37.33±11	37.13±11			
48 hrs. post extubation	37.3±33	37.13±33			
Cumulative fluid balance (liter)	2160±10	2163±14	0.1388	1.233	0.220

*: Statistically significant at $p \leq 0.05$

p: p-value for comparing the studied groups at different points pre- and post-extubation

% Change between the control and intervention group in the 48-hour point time*

TABLE 4: Comparison between both group's post-extubation clinical manifestations and clinical outcomes after 48 hours:

Outcome Parameter	Group A (n=50)	Group B (n=50)	% Change *	*t or* χ^2	p
Post-extubation clinical manifestations					
Stridor n (%)	29 (58)	25 (50)	-16	18.64	0.001*
Difficulty breathing n (%)	42 (84)	15 (30)	-64.2	72.414	<0.001*
Using accessory muscle	30(60)	25 (50)	-16.66	16.64	0.001*
Excessive drooling secretion n (%)	43 (86)	42 (84)	–2.32	0.301	0.12
Dysphagia n (%)	19 (38)	20 (40)	5.26	0.211	0.164
Voice change n (%)	19 (38)	20 (40)	5.26	0.211	0.140
Productive Cough n (%)	43 (86)	42 (84)	–2.32	0.311	0.1200
Cyanosis n (%)	3 (6)	2 (4)	5	0.312	0.1400
Primary clinical outcome					
Oxygenation parameters					
Fio2/Pao2, (Mean ± SD)	76.68 ± 0.77	66.36 ± 0.63	-13.458	73.348*	< 0.000*
Sao2, (%) (Mean ± SD)	90.68 ± 0.23	95.36 ± 0.51	5.161	59.15	<0.001*
PaO2, (mmHg) (Mean ± SD)	76.68 ± 0.22	86.36 ± 0.51	12.623	72.64	0.000*
ROX index (Mean ± SD)	3.20±0.56	4.62±0.68	44.375	11.64	0.000*
Ventilation parameters					
PaCo2, (mmHg) (Mean ± SD)	44 ± 0.02	40 ± 0.51	-9.09	55.41	0.000*
Minute ventilation (l/min) (Mean ± SD)	10.56 ± 1.20	8.72 ± 1.72	-17.4	2.83	0.005*
Secondary clinical outcome					
Reintubation needs after 48 hrs., (Mean ± SD)	2.68 ± 0.77	1.36 ± 0.63	-49.25	9.382*	0.000*
ICU length of stay (Mean ± SD)	14.7±0.56	10.44±0.23	–28.97	3.037	0.003*
Frequency for endotracheal suctioning (Mean ± SD)	4.5± 2.30	4.2± 3.20	-6.66	0.538	0.59
MV length of stay after extubation (Mean ± SD)	6.33±0.56	5.43±0.56	–14.218	1.25	0.213
Clinical pulmonary infection score (Mean ± SD)	6.9± 1.36	6.8± 8.36	-1.44	0.918	0.360

p: p-value for comparing between the studied groups
*: level of significance $p \leq 0.05$
Hypoxic index= Fio2 /pao2 ratio
% Change between the control and intervention group in the 48-hour point of time

Discussion

Post-intubation upper airway edema more frequently occurs among intubated patients and clinically manifests as mild symptomatic or asymptomatic after extubation. About 50% of patients who developed post-extubation stridor required reintubation, increasing morbidity and mortality risk among reintubated patients(Kumar & Cascella, 2020). Using standardized weaning protocols is recommended as standardized care in ICUs with limited staff. Weaning protocols usually contain weaning readiness, ventilation support guidelines to reduce the need for reintubation, and extubation criteria (Hirzallah et al., 2019). Maintaining airway patency, fixation and placement, routine oral care, and turning patients to improve the patient condition to transfer from ICU is the main focus of nursing staff and are generally associated with unplanned extubation (Kiekkas et al., 2013).

To our knowledge, limited nursing studies discuss post-extubation stridor; this may be the less frequent incident rate of post-extubation stridor and may be asymptomatic for staff. The current study used selected nursing interventions in a planned manner in three phases: pre-extubation, during extubation, and post-extubation. It presented a significant relationship between selected nursing interventions, experienced post-extubation stridor, and clinical outcomes

in comparing the study groups.The current finding is supported by a scoping review performed by Poeira et al.(2020), who reported that using differentiated selected nursing interventions to deal with MV patients in a holistic manner empowers nursing knowledge and helps nurses to overcome associated risk factors followed by intubation attempts in the various stages of the extubation process.

The outcomes of the current study included post-extubation stridor clinical manifestations with primary and secondary outcomes. Regarding the outcomes of the selected nursing intervention on post-extubation stridor clinical manifestations, the intervention group significantly decreased in developing stridor, difficulty breathing, and using accessory muscle than the control group. No noticeable changes between both groups concerning the excessive drooling of the oral section, dysphagia, voice change, productive cough, and cyanosis were noticed, which can be interpreted due to airway flow in the inspiration and expiration that may be limited due to narrowing airway and edema of laryngeal tissue, which increase breath and require energy to overcome increased airway resistance (Elkarta & Eldegwy, 2021).

The primary outcome in this study included that the oxygenation and ventilation parameters significantly improved in the intervention group than the control group. The hypoxic index after 48 hours of extubation in the intervention group was significantly lower than in the control group. Moreover, SaO2, PaO2, and ROX index significantly improved in the intervention group than the control group. According to the ventilation parameters, the intervention group had significantly lower PaCo2 and minute ventilation than the control group.

Concerning the outcome of selected nursing intervention on the secondary outcome, the results of the study suggested that the intervention group experienced less ICU length of stay, and reintubation was needed after 48 hours than the control group. No significant difference was detected in the frequency of endotracheal suction, MV length of stay, and risk for developing VAP using the clinical pulmonary infection score.

Regarding the outcome of selected nursing interventions on arterial blood gases and vital signs, our findings demonstrated significant improvement in the PaO2, PaCo2, and SaO2 readings at different points in the intervention group than in the control group. Moreover, heart rate and respiratory rate showed significant improvement in the intervention group than the control group. No significant difference was detected concerning mean arterial pressure and temperature in both groups. Furthermore, the findings of this study revealed no significant difference in the mean value of cumulative fluid balance among the group understudies.

The current study is in line with Andreu et al. (2020), who studied and categorized post-extubation complications as minor and major. One of the major complications was upper airway obstruction and desaturation, which can cause an increased risk of extubation failure and reintubation. Increased heart rate, respiratory rate, blood pressure, thirst, bronchospasm, cough, and poor respiratory mechanics were minor complications. Most of the intervention group used a nasal cannula. In contrast, the face mask was used as the method of oxygenation for the control group and in patients who were diagnosed with COPD, the nasal cannula was used for them. More than half of the intervention group used a nasal cannula, as supported by Glover & Glossop (2017) and Nishimura (2016), who reported that using high-flow nasal oxygen therapy was preferred for adult patients to provide them with more

accurate oxygen concentrations, improved gas exchange, and lower risk for extubation failure. In contrast, Juang et al. (2020) used protocol to provide respiratory support post-extubation and prevent reintubation. The main intervention used in this protocol was a high-flow nasal cannula. Still, they concluded that compared with routine care, they used post-extubation protocolized for respiratory support mainly by a high-flow nasal cannula; it did not prevent reintubation. So, using the selected nursing interventions not only depending on the oxygenation method may prevent post-extubation complications and desaturation.

The present study showed that the intervention group experienced less need for post-extubation reintubation after 48 hours of extubation and stridor than the control group. One of the reasons for this outcome was that more than half of the control group were female, and those of the intervention group were male. The control group had a significant difference from the intervention group concerning experiencing more admission intubation attempts and prolonged intubation. The size of the airway may be affected by gender; females have anatomically smaller airways than males (Karmali & Rose, 2020). The current finding is supported by Kumar and Cascella (2020) and Lilienstein et al. (2016), who reported that female gender, decreased LOC, prolonged intubation, and more intubation attempts increased body mass index than 26.5 that was risk factors for post-intubation laryngeal edema. In contrast, Shinohara et al. (2022) reported that gender and airway size were not associated with developing post-extubation stridor in both male and female patients.

Another reason for this outcome was that the control groups experienced two or more admission intubation attempts than the intervention group. The endotracheal tube after intubation created extra pressure on the area of contact in the trachea, which accelerated the inflammatory reaction and increased the risk for laryngeal edema. Prolonged intubation and inflated cuff caused inflammation, swelling, and ulceration in the laryngeal contact area(Kumar & Cascella, 2020). Both groups administrated sedative drugs at intubation time and steroids before extubation with no significant difference. Kuriyama et al. (2017) reported that patients who had used prophylactic corticosteroids before extubation had significantly lower post-extubation airway stridor and reintubation. There was no significant difference between both groups concerning the cuff leak test. The cut-off point estimated the risk for post-extubation stridor was 100, and a lower value indicated a high risk for post-extubation stridor (Wang et al., 2015). Both groups were more at risk for post-extubation stridor because the airway mucus hypersecretion around the ETT tube and inflammatory response of the area of contact may cause narrowing of the area around the ETT after deflation and decrease the amount of air leak (Shen et al., 2018). In contrast, Moran et al. (2020) used the cuff leak test on most studied patients and did not successfully predict extubation. But the female gender, being older, and prolonged mechanical ventilation length of stay might be more predictors for post-extubation stridor.

The extubation phase should be followed by successful mechanical ventilation weaning. An extubation failure occurs when reintubation within 48 hours from ETT removal and if the patient is still without a need for mechanical ventilator support after 48 hours from extubation (Quintard et al., 2019). Nurses are advocators for patients admitted to ICU. Finally, nurses have a vital role in the extubation process through systematic nursing interventions based on the evidence of practice in a schematic

extubation plan, and further studies should be conducted. The selected nursing interventions in this study were simple and easy to apply for nurses, effectively improved clinical primary and secondary outcomes, especially oxygenation and ventilation parameters, and decreased post-extubation stridor manifestations extubation phase should be followed by successful mechanical ventilation weaning. An extubation failure occurs when reintubation within 48 hours from ETT removal and if the patient is still without a need for mechanical ventilator support after 48 hours from extubation (Quintard et al., 2019). Nurses are advocators for patients admitted to ICU. Finally, nurses have a vital role in the extubation process through systematic nursing interventions based on the evidence of practice in a schematic extubation plan, and further studies should be conducted. The selected nursing interventions in this study were simple and easy to apply for nurses, effectively improved clinical primary and secondary outcomes, especially oxygenation and ventilation parameters, and decreased post-extubation stridor manifestations

Limitations:

The single location of the current study was the primary limitation and limited its generalization. The lack of randomization might increase the risk of bias. Self-extubated patients limited application for nursing interventions step by step and increased the risk for reintubation.

Conclusion and recommendation:

The current findings demonstrated that exposing extubated MV patients to selected nursing interventions resulted in a considerable improvement in oxygenation and ventilation parameters and reduced experienced post-extubation stridor manifestations. Furthermore, selected nursing interventions in this study were applied to nurses and tolerated by patients without experiencing serious adverse effects.

The current study gained evidence for the knowledge and practice of critical care nurses in using the selected nursing interventions to extubate MV patients. In this study, these interventions safely improved oxygenation and ventilation parameters and decreased the post-extubation stridor. It is easy to apply, does not create an extra load on the nurses, and reduces the MV length of stay and associated mechanical ventilator complications**.**

Recommendations:

Using selective nursing intervention found to improve primary and secondary clinical outcomes. Measuring the long-term outcome of selected extubation nursing interventions is recommended for further studies. Performing a cuff leak test is valuable and makes it easy to predict risk for post-extubation stridor.

Acknowledgments:

The researcher appreciates and thanks the included patients in the present study and the administrative hospital authority.

References

Algendy, A., & Bahgat, Z. (2021). Effect of Oral Care Intervention and Safe-Swallowing Education on Dysphagia among ICU Patients Post Endotracheal Extubation. Tanta Scientific Nursing Journal, 23(4), 11–35. https://doi.org/10.21608/tsnj.2021.210227

Andreu, M. F., Bezzi, M. G., & Dotta, M. E. (2020). Incidence of immediate post-extubation complications in critically Ill adult patients. Heart & Lung, 49(6), 774–778. https://doi.org/10.1016/j.hrtlng.2020.09.016

Chu, C.-C., Liu, C.-J., Yen, S.-M., Chou, W.-Y., Kung, P.-T., Tsai, Y.-S., & Tsai, W.-C. (2017). Factors Associated With Re-Intubation Within 14 Days After Ventilator Liberation. Respiratory Care, 62(12), 1557–1564. https://doi.org/10.4187/respcare.05649

Chu, C. C., Liu, C. J., Yen, S. M., Chou, W. Y., Kung, P. T., Tsai, Y. S., & Tsai, W. C. (2017). Factors associated with re-intubation within 14 days after ventilator liberation. Respiratory Care, 62(12), 1557–1564. https://doi.org/10.4187/respcare.05649

EBMcalc. (2020). Clinical Pulmonary Infection Score (CPIS). https://www.msdmanuals.com/medical-calculators/CPIS.htm

Elkarta, Els., & Eldegwy, M. (2021). Airway Management in Critical Settings. In Special Considerations in Human Airway Management. https://doi.org/10.5772/intechopen.93923

Fadila, M., Rajasurya, V., & Regunath, H. (2022). Ventilator Weaning. In StatPearls. http://www.ncbi.nlm.nih.gov/pubmed/28613464

Glover, S., & Glossop, A. (2017). Managing extubation and the post-extubation period in the intensive care unit. EMJ European Medical Journal, 5(1), 85–91.

Hetland, B., Heusinkvelt, J., Krabbenhoft, L., & Grotts, E. (2018). Mechanical ventilation weaning. Nursing Critical Care, 13(6), 5–16. https://doi.org/10.1097/01.CCN.0000544397.74806.9a

Higgs, A., McGrath, B. A., Goddard, C., Rangasami, J., Suntharalingam, G., Gale, R., & Cook, T. M. (2018). Guidelines for the management of tracheal intubation in critically ill adults. British Journal of Anaesthesia, 120(2), 323–352. https://doi.org/10.1016/j.bja.2017.10.021

Hirzallah, F. M., Alkaissi, A., & do Céu Barbieri-Figueiredo, M. (2019). A systematic review of nurse-led weaning protocol for mechanically ventilated adult patients. Nursing in Critical Care, 24(2), 89–96. https://doi.org/10.1111/nicc.12404

Juang, J., Cordoba, M., Ciaramella, A., Xiao, M., Goldfarb, J., Bayter, J. E., & Macias, A. A. (2020). Incidence of airway complications associated with deep extubation in adults. BMC Anesthesiology, 20(1), 1–8. https://doi.org/10.1186/s12871-020-01191-8

Karmali, S., & Rose, P. (2020). Tracheal tube size in adults undergoing elective surgery – a narrative review. Anaesthesia, 75(11), 1529–1539. https://doi.org/10.1111/anae.15041

Kaur, R., Vines, D. L., Harnois, L. J., Elshafei, A., Johnson, T., & Balk, R. A. (2022). Identification and Prevention of Extubation Failure by Using an Automated Continuous Monitoring Alert Versus Standard Care. Respiratory Care, 67(10), 1282–1290. https://doi.org/10.4187/respcare.09860

Kiekkas, P., Aretha, D., Panteli, E., Baltopoulos, G. I., & Filos, K. S. (2013). Unplanned extubation in critically ill adults: Clinical review. Nursing in Critical Care, 18(3), 123–134. https://doi.org/10.1111/j.1478-5153.2012.00542.x

Konca, C., Tekin, M., & Kucuk, A. (2022). Incidence of Mechanical Ventilation Adverse Events in Critically Ill Children in a Tertiary Pediatric Intensive Care Unit. Turkish Thoracic Journal, 23(4), 277–283. https://doi.org/10.5152/TurkThoracJ.2022.21253

Kumar, A., & Cascella, M. (2020). Post Intubation Laryngeal Edema. In StatPearls. http://www.ncbi.nlm.nih.gov/pubmed/32809644

Kuriyama, A., Umakoshi, N., & Sun, R. (2017). Prophylactic Corticosteroids for Prevention of Postextubation Stridor and Reintubation in Adults. Chest, 151(5), 1002–1010. https://doi.org/10.1016/j.chest.2017.02.017

Lange, M., Badjatia, N., & Chang, W.-T. (2018). Implementation of a Clinical Pathway to Reduce Rates of Postextubation Stridor. Critical Care Nurse, 38(5), 34–41. https://doi.org/10.4037/ccn2018455

Lange, M., Badjatia, N., & Chang, W. (2017). Implementation of a clinical pathway aimed at reducing rates of post-extubation stridor. Neurocritical Care, 27(2), S215. http://ovidsp.ovid.com/ovidweb.cgi?T=JS&PAGE=reference&D=emed18&NEWS=N&AN=619001616

Lilienstein et al. (2016). Risk factors associated with post-extubation stridor in the trauma intensive care unit. The American Journal of Surgery, 212(3), 379–383. https://doi.org/10.1016/j.amjsurg.2016.02.010

Lilienstein, J. T., Davis, J. W., Bilello, J. F., & Dirks, R. C. (2016). Risk factors associated with post-extubation stridor in the trauma intensive care unit. The American Journal of Surgery, 212(3), 379–383. https://doi.org/10.1016/j.amjsurg.2016.02.010

Moran, J. V, Godil, S. A., Goldner, B., Godil, K., & Aslam, J. (2020). Post-Extubation Stridor Complicating COVID-19-Associated Acute Respiratory Distress Syndrome: A Case Series. Cureus, 12(9). https://doi.org/10.7759/cureus.10492

Nishimura, M. (2016). High-Flow Nasal Cannula Oxygen Therapy in Adults: Physiological Benefits, Indication, Clinical Benefits, and Adverse Effects. Respiratory Care, 61(4), 529–541. https://doi.org/10.4187/respcare.04577

Poeira, A. F., Flamino, R., Santos, N., & Rocha, M. B. (2020). Nursing interventions in the extubation process: a scoping review. In International Physical Medicine & Rehabilitation Journal (Vol. 5, Issue 6, pp. 258–263). https://doi.org/10.15406/ipmrj.2020.05.00268

Prakash, J., Bhattacharya, P. K., Yadav, A. K., Kumar, A., Tudu, L. C., & Prasad, K. (2021). ROX index as a good predictor of high flow nasal cannula failure in COVID-19 patients with acute hypoxemic respiratory failure: A systematic review and meta-analysis. Journal of Critical Care, 66, 102–108. https://doi.org/10.1016/j.jcrc.2021.08.012

Quintard, H., l'Her, E., Pottecher, J., Adnet, F., Constantin, J. M., De Jong, A., Diemunsch, P., Fesseau, R., Freynet, A., Girault, C., Guitton, C., Hamonic, Y., Maury, E., Mekontso-Dessap, A., Michel, F., Nolent, P., Perbet, S., Prat, G., Roquilly, A., … Donetti, L. (2019). Experts' guidelines of intubation and extubation of the ICU patient of French Society of Anaesthesia and Intensive Care Medicine (SFAR) and French-speaking Intensive Care Society (SRLF): In collaboration with the pediatric Association of French-speaking Anaesthetists and Intensivists (ADARPEF), French-speaking Group of Intensive Care and Paediatric emergencies (GFRUP) and Intensive Care physiotherapy society (SKR). Annals of Intensive Care, 9(1), 1–7.

https://doi.org/10.1186/s13613-019-0483-1

Shen, Y., Huang, S., Kang, J., Lin, J., Lai, K., Sun, Y., Xiao, W., Yang, L., Yao, W., Cai, S., Huang, K., & Wen, F. (2018). Management of airway mucus hypersecretion in chronic airway inflammatory disease: Chinese expert consensus (english edition). International Journal of COPD, 13, 399–407. https://doi.org/10.2147/COPD.S144312

Shinohara, M., Iwashita, M., Abe, T., & Takeuchi, I. (2020). Risk factors associated with symptoms of post-extubation upper airway obstruction in the emergency setting. Journal of International Medical Research, 48(5). https://doi.org/10.1177/0300060520926367

Shinohara, M., Iwashita, M., Abe, T., & Takeuchi, I. (2022). Association between post-extubation upper airway obstruction symptoms and airway size measured by computed tomography: a single-center observational study. BMC Emergency Medicine, 22(1), 1–8. https://doi.org/10.1186/s12873-022-00615-7

Stieg, G. (2017). Postextubation Stridor in Adult Icu Patients. Surgical Critical Care Evidence-Based Medicine Guidelines Committee Primary, 1–5.

Sturgess, D. J., Greenland, K. B., Senthuran, S., Ajvadi, F. A., van Zundert, A., & Irwin, M. G. (2017). Tracheal extubation of the adult intensive care patient with a predicted difficult airway – a narrative review. In Anaesthesia (Vol. 72, Issue 2, pp. 248–261). https://doi.org/10.1111/anae.13668

Tanaka, A., Uchiyama, A., Horiguchi, Y., Higeno, R., Sakaguchi, R., Koyama, Y., Ebishima, H., Yoshida, T., Matsumoto, A., Sakai, K., Hiramatsu, D., Iguchi, N., Ohta, N., & Fujino, Y. (2021). Predictors of post-extubation stridor in patients on mechanical ventilation: a prospective observational study. Scientific Reports, 11(1). https://doi.org/10.1038/s41598-021-99501-8

Tokunaga, K., Ejima, T., Nakashima, T., Kuwahara, M., Narimatsu, N., Sagishima, K., Mizumoto, T., Sakagami, T., & Yamamoto, T. (2022). A novel technique for assessment of post-extubation airway obstruction can successfully replace the conventional cuff leak test: a pilot study. BMC Anesthesiology, 22(1), 1–9. https://doi.org/10.1186/s12871-022-01576-x

Wang, W., Zhou, Y., Tong, H. sheng, Su, L., & Zhao, L. (2015). Value of the cuff leak test is limited. In Critical Care (Vol. 19, Issue 1). BioMed Central Ltd. https://doi.org/10.1186/s13054-015-1152-x

Ward, D., & Fulbrook, P. (2016). Nursing Strategies for Effective Weaning of the Critically Ill Mechanically Ventilated Patient. Critical Care Nursing Clinics of North America, 28(4), 499–512. https://doi.org/10.1016/j.cnc.2016.07.008

Yasuda, H., Okano, H., Mayumi, T., Narita, C., Onodera, Y., Nakane, M., & Shime, N. (2021). Post-extubation oxygenation strategies in acute respiratory failure: a systematic review and network meta-analysis. Critical Care, 25(1), 1–16. https://doi.org/10.1186/s13054-021-03550-4