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ORIGINAL ARTICLE

The Reasons for High Reintubation Frequency in Intensive Care: A Retrospective Study

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Abstract

Introduction: Mechanical ventilation is frequently applied in 3rd level intensive care units. Some patients may require reintubation due to positive fluid balance, electrolyte imbalances, prolonged mechanical ventilation, protein-energy imbalances, or age. Reintubation causes increase in morbidity and mortality in intensive care. Hence, we investigated the rates and causes of reintubation in our clinic.

Methods: We retrospectively analyzed the files of patients hospitalized in intensive care during the 18-month period from June 1, 2018, to January 1, 2019. We recorded patients with successful intubation and patients who were reintubated.

Results: Eighty-four patients who met the criteria were included in the study. The patients were studied under two groups, namely, 43 reintubated patients (51.2%) and 41 successfully extubated patients (48.8%). Mean age, Acute Physiology and Chronic Health Assessment II values, and comorbidity rates of the reintubation group were statistically significantly higher than of the successful extubation group. The rate of inotrope treatment (48.8%) in the reintubation group was statistically significantly higher than in the successful extubation group (14.6%). No statistically significant difference was found between reintubation and successful extubation groups in terms of energy and protein intake.

Discussion and Conclusion: Mechanical ventilation treatment in intensive care can usually be finished without any problems. However, some patients may need mechanical ventilation treatment again. Reintubation can occur as an unexpected result of mechanical ventilation and increase mortality in intensive care. Reintubation-mortality relationship has been shown in many studies. Our study reports that mortality rate is approximately 2-fold in reintubated patients. Therefore, before planning the extubation of patients, correcting the main problem causing respiratory support and reviewing other risk factors that may cause reintubation, will reduce the risk of reintubation.

Keywords: Mechanical ventilation; reintubation; successful extubation.

Majority of the patients in intensive care require invasive mechanical ventilation support when they are admitted to intensive care or during their follow-up period. Prolonged ventilation can lead to complications such as ventilator-associated pneumonia and ventilator-associated lung damage. These complications greatly affect the duration of intensive care and mortality. In addition, days in ventilator are an independent factor in terms of mortality in the intensive care unit[1,2]. Therefore, patients should be separated from the mechanical ventilator as soon as possible. Separation from ventilator envelopes the whole process of physically separating the patient from mechanical support and endotracheal tube, including problems related to the cause of hospitalization[3]. The weaning stage can take up 40-50%

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of the total mechanical ventilation time[4,5]. Use of ventilator separation protocols for spontaneous breathing trials is widely recommended for extubation[6]. Although this strategy is generally successful, reintubation may still be required in more than 15% of patients[7-9]. Mortality of patients who fail in extubation varies between 25% and 50%[7,10].

There are many reasons which make it difficult to separate a patient from a mechanical ventilator, and these are important factors that play a role in patients being reintubated after extubation. Conditions such as positive fluid balance, electrolyte imbalances, prolonged mechanical ventilation, protein-energy imbalances, age, and Acute Physiology and Chronic Health Assessment II (APACHE II) scores[10] can be listed among these risk factors. In addition, the causes of reintubation include respiratory failure, upper airway factors such as laryngeal complications, low level of consciousness, and hemodynamic instability[11].

Accurate timing is important for extubation because early separation of the patient from mechanical ventilator increases the possibility of reintubation, and delayed extubation increases the mortality by increasing the complications related to the mechanical ventilator. In their study, Coplin et al.[12] found that mortality rate was 12% when there was no delay in extubation and 27% when there was a delay in extubation in patients undergoing mechanical ventilation.

Materials and Methods

After obtaining Institutional and Ethics Committee permissions (KAEK 2019/20) required for our study, we retrospectively studied patients in intensive care for a period of 18 months, until January 1, 2019. Among the patients who were successfully extubated after mechanical ventilation during this period, patients with failed extubation and patients who were reintubated were recorded. Besides demographic data of these patients, Gamma Knife radiosurgery (GKS), mechanical ventilation (MV) days, sedation times, APACHE II scores, inotrope treatment times, electrolytes (K, Mg, Ca, and P), amount of energy intake, amount of protein intake, and total fluid balance were recorded during extubation.

In our intensive care units, spontaneous breathing trials on patients are performed using a T tube or using the pressure support mode in which 5 cm H_2O PEEP is applied in addition to the 6-8 cm H_2O pressure support.

Conditions such as hemodynamic instability, tachypnea, use of auxiliary respiratory muscles, reduced partial oxygen pressure in blood gas, and elevated carbon dioxide pressure were considered as indicators for reintubation need.

Statistical Analysis

When evaluating the findings obtained in the study, IBM SPSS Statistics 22 (SPSS IBM, Turkey) programs were used for statistical analyses. While evaluating the study data, the appropriateness of the parameters to normal distribution was evaluated using the Shapiro-Wilk test. Descriptive statistical methods (mean, standard deviation, and frequency) were used while evaluating the study data. In addition to these, Student's t-test was used for comparing quantitative data between the two groups with normally distributed parameters. Mann-Whitney U test was used for comparisons between two groups that did not exhibit normal distribution. Fisher-Freeman-Halton test and continuity (Yates) correction were used to compare qualitative data. Significance was evaluated at the level of $p<0.05$.

Results

The study was conducted with a total of 84 cases, 41 (48.8%) males and 43 (51.2%) females, whose ages ranged between 23 and 99. The cases were selected after examining the files of patients who were hospitalized in intensive care for a period of 18 months since January 1, 2019. The average age of the cases is 71.37±17.63. The study was conducted with two groups, namely, 43 patients with reintubation (51.2%) and 41 patients with successful extubation (48.8%).

Reasons of hospitalization seen in intubation groups and in total show distribution, as shown in Table 1.

Mean age, comorbidity rates, and APACHE II values of the reintubation group were found to be statistically significantly higher than those of the successful extubation group ($p<0.05$) (Table 2).

The values of MV days at the time when the reintubation group was extubated were found to be statistically significantly lower than those of the successful extubation group ($p=0.039$ and $p<0.05$) (Table 2).

There was no statistically significant difference between reintubation and successful extubation groups in terms of gender, diet, GKS during seizure, sedation time, and inotrope treatment time parameters ($p>0.05$) (Table 2).

The rate of sedation application in the reintubation group (18.6%) was found statistically significantly lower than the successful extubation group (46.3%) ($p=0.013$ and $p<0.05$).

While 72.1% of the cases passed in the reintubation group, 27.9% of them were discharged. The rate of inotrope treatment (48.8%) in the reintubation group was statistically significantly higher than in the successful extubation group (14.6%) ($p=0.002$ and $p<0.05$) (Table 2).

Table 1. Distribution of hospitalization reasons in groups and in total

Reason for hospitalization	Reintubation		Successful extubation		Total	
	n	%	n	%	n	%
Ary, gastrointestinal hemorrhage	0	0	1	2.4	1	1.2
Aks, ary	1	2.3	0	0	1	1.2
Acute resp. failure	16	37.2	7	17	23	27.1
Ary	1	2.3	0	0	1	1.2
Intox	0	0	2	4.9	2	2.4
Kah	1	2.3	0	0	1	1.2
Kky, p. effusion	1	2.3	0	0	1	1.2
Kky, renal ca	1	2.3	0	0	1	1.2
Koah attack	0	0	1	2.4	1	1.2
Pancreatitis	0	0	1	2.4	1	1.2
Pneumonia	7	16.3	9	21.9	16	19.1
Post-cpr	0	0	5	12.2	5	6
Post-cpr, sepsis	0	0	1	2.4	1	1.2
Post-operative	5	11.6	1	2.4	6	7.1
Post-operative (m.isk)	1	2.3	0	0	1	1.2
Post-operative (abscess)	1	2.3	0	0	1	1.2
Post-operative (kc tm)	0	0	1	2.4	1	1.2
Post-operative (stomach ca)	0	0	1	2.4	1	1.2
Sepsis	2	4.7	3	7.3	5	6
Svh	6	14	3	7.3	9	10.7
Trauma	0	0	5	12.1	5	6

Table 2. Evaluation of general characteristics between groups

	Reintubation Mean±SD	Successful extubation Mean±SD	Total Mean±SD	p
Age	76.14±13.27	66.37±20.25	71.37±17.63	[1]0.011*
GKS during extubation$_{(median)}$	12±3.08[13]	12.73±2.23[13]	12.36±2.7[13]	[2]0.339
MV days$_{(median)}$	8.6±5.53[7]	10.39±5.71[9]	9.48±5.66[8]	[2]0.039*
Sedation time$_{(median)}$	4.88±2.85[4]	5.53±3.44[5]	5.33±3.23[5]	[2]0.453
APACHE II	25.6±5.74	21.1±6.77	23.4±6.63	[1]0.001*
Inotrope treatment duration	6.52±5.84	6.33±3.78	6.48±5.39	[1]0.941
Number of reintubation occurrences$_{(median)}$	1.32±0.64 (1)	–	1.32±0.64[1]	–
Gender, n (%)				
Male	23 (53.5)	18 (43.9)	41 (48.8)	[3]0.509
Female	20 (46.5)	23 (56.1)	43 (51.2)	
Comorbidity, n (%)				
Yes	41 (95.3)	31 (75.6)	72 (85.7)	[3]0.023*
No	2 (4.7)	10 (24.4)	12 (14.3)	
Sedation, n (%)				
Yes	8 (18.6)	19 (46.3)	27 (32.1)	[3]0.013*
No	35 (81.4)	22 (53.7)	57 (67.9)	
Diet, n (%)				
P	2 (4.7)	3 (7.3)	5 (6)	[4]0.628
E	40 (93)	36 (87.8)	76 (90.5)	
P/E	1 (2.3)	2 (4.9)	3 (3.6)	
Mortality, n (%)				
EX	31 (72.1)	–	31 (72.1)	–
TB	12 (27.9)	–	12 (27.9)	
Inotrope treatment?				
Yes	21 (48.8)	6 (14.6)	27 (32.1)	[3]0.002*
No	22 (51.2)	35 (85.4)	57 (67.9)	

SD: Standard deviation; GKS: Gamma Knife radiosurgery; MV: Mechanical ventilation; APACHE: Acute Physiology and Chronic Health Evaluation; 1: Student's t-test; 2: Mann–Whitney U-test; 3: Continuity (Yates) correction; 4: Fisher-Freeman-Halton Test; *: P<0.05.

Table 3. Evaluation of study parameters between groups

	Reintubation Mean±SD	Successful extubation Mean±SD	Total Mean±SD	p
K	3.86±0.48	3.6±0.58	3.73±0.55	0.033*
Mg	1.84±0.4	1.84±0.31	1.84±0.36	0.980
Ca	7.66±1.23	7.9±0.64	7.78±0.99	0.275
P	3.58±1.46	2.96±0.67	3.28±1.18	0.014*
Energy obtained (%)	41.44±18.86	42.67±14.28	42.04±16.7	0.738
Protein intake (%)	39.42±19.52	43.45±16.09	41.39±17.94	0.306
Total fluid balance	4046.14±6346.96	2416.39±5571.5	3250.67±6001.34	0.215

SD: Standard deviation; Student's t-test; *: P<0.05.

K and p-values of the reintubation group were found statistically significantly higher than the successful extubation group (p<0.05). There was no statistically significant difference between the reintubation and successful extubation groups in terms of magnesium, calcium, energy obtained, amount of protein taken, and total fluid balance parameters (p>0.05) (Table 3).

Discussion

Intubation and mechanical ventilation are the primary treatments applied in intensive care. Although this treatment method is lifesaving, it is necessary to separate a patient from the ventilator as soon as the clinical conditions are appropriate. The day of extubation is a critical moment in intensive care period[13]. Mechanical ventilator treatment must be terminated at the most appropriate time; neither too early nor too late. In both cases, mechanical ventilator support may be needed again in patients after extubation. Early termination of mechanical ventilator treatment may cause separation of patients without understanding the exact reason which required mechanical ventilator support. Late termination may lead to reintubation due to complications stemming from prolonged effects of mechanical ventilation. In addition, reasons such as positive fluid balance, electrolyte imbalances, protein-energy imbalances, comorbidity, age, and cardiac pathology facilitate the transition to reintubation.

In their study, Upadya et al.[14] found that the positive fluid balance (input>output) was significantly higher than those of weaning failures at 24, 48, and 72 h before weaning and cumulatively (as from hospitalization). The number of patients with negative cumulative fluid balance was found to be twice as high as those with probability to successfully leave the ventilator at net positive balance (RR = 2.2; 95% CI = 1.3-3.8). In the study conducted by Rosenberg et al.[15] on 844 patients, they found on the 1st day of the recording that 683 patients were in positive on average by more than 3.5 L in fluid balance compared to 161 patients with negative fluid balance (p<0.001). They found that the cumulative negative fluid balance on the 4th day of the study was independently associated with lower hospital mortality (OR =0.50; 95% CI =0.28-0.89; p<0.001), fewer ventilators, and days of intensive care[15]. In addition, in a randomized controlled study, it was demonstrated that the use of a protective fluid strategy shortens the duration of mechanical ventilation in patients with acute pulmonary damage[16]. In our study, there was a positive fluid balance in both groups. Although there was no statistically significant difference, there was more positive (1.6 L) fluid balance in unsuccessful extubation (4046.14±6346.96) than in successful extubation (2416.39±5571.5). We can say that positive fluid balance is one of the important factors playing a role in extubation failure. In their study, Fujii et al.[6] did not find a significant difference in successful extubation and reintubation groups when compared with age, gender, APACHE II scores, and SOFA scores. In our study, the mean age and APACHE II values of the reintubation group were found to be statistically significantly higher than those of the successful extubation group. Many studies have shown that reintubation increases mortality. While intensive care mortality was 38.5% in the time period of our study, this rate was found to be 72.1% in reintubated patients. The data in our study also support the previous studies.

Cardiovascular system-related pathologies are one of the most important factors in patients not being able to leave the mechanical ventilator or the need for reintubation in a short time after extubation.

In Hurford and Favorito study,[17] 6 (35%) of 17 patients who could not leave mechanical ventilation were found to have myocardial ischemia at the time of participation into the study, and the presence of ischemia was found to be associated with non-separation from mechanical ventilation. In intensive care, insidious and unknown myocardial dysfunction may occur in some patients in the mechanical ventilator when they are exposed to the workload that occurs during the weaning stage[3]. Many studies have shown that even in patients with normal systolic function, diastolic dysfunction can cause a high rate of weaning failure[18,19]. For this reason, cardiac pathologies must be diagnosed, because they can be effectively treated with diuretics and/or vasodilators, or even with coronary angioplasty in case of cardiac ischemia[20]. In our study, the rate of inotropic treatment (48.8%) in the reintubation group was found to be statistically significantly higher than the successful extubation group (14.6%) (p=0.002 and p<0.05). In addition, among our patients in the study group, all patients with cardiac pathology among primary hospitalization reasons are in the reintubation group. For this reason, demonstrating that patients with prior cardiac pathologies are stable in cardiological level before extubation and terminating mechanical ventilation support for patients who use inotrope and vasopressor after at least reducing the doses of these supporting agents will undoubtedly reduce the possibility of reintubation.

Although malnutrition has been reported for about 40% of critically ill patients, data on malnutrition cause weaning difficulties are limited[3]. In our study, the protein and energy levels of both groups remained around 40% of what they needed to intake and there was no statistically significant difference between the reintubation and successful extubation groups in terms of the energy they obtained and the amount of protein they received (p>0.05). Our conclusion supports the data of the previous studies.

Some studies have shown higher rates of extubation failure in older and comorbid patients[8,21,22]. In our study, the mean age of the reintubation group was likewise found to be statistically significantly higher than that of the successful extubation group (p=0.011 and p<0.05). Again, the rate of comorbidity in the reintubation group (95.3%) was found to be statistically significantly higher than the successful extubation group (75.6%) (p=0.023 and p<0.05).

Would low GKS values cause reintubation? In our study, there was no statistically significant difference between the reintubation and successful extubation groups in terms of GKS values during extubation (p>0.05). Although GKS values in both groups were approximately 12 in average in our study, Coplin et al.[12] in their study, found a relatively low rate of reintubation (9%) in patients with stable brain damage with Glasgow Coma Score ≤4. Koh et al.[23] found that Glasgow Coma Score did not predict extubation failure in their study. However, there are studies reporting that low GKS poses a risk for reintubation; Namen et al.[24] in their study in neurosurgical patients, performed a successful extubation in 75% (60 of 80) of patients with GKS score ≥8 during extubation and in 36% (14 of 38) of patients with GKS score ≤7 during extubation. In Mokhlesi et al.[25] study on extubation failure reasons, 16 of 122 patients (13%) who left mechanical ventilation support required reintubation within 48 h. researchers predicted three clinical variables for reintubation: Moderate to profound endotracheal secretions during spontaneous breathing study, a Glasgow Coma Scale score of ≤10, and hypercapnia ($PaCO_2$ ≥44 mmHg). One of the important points in this study is the presence of secretion in patients, which is a critical reason for high level of carbon dioxide and extubation failure. Therefore, if the GKS score is low in patients who are scheduled for extubation, performing the extubation after ensuring that the airway reflexes are preserved and that there is no secretion will reduce the risk of reintubation.

In our study, although K and p-values were higher in the reintubation group in terms of electrolytes, both electrolyte values were within normal limits.

Conclusion

Mechanical ventilation treatment in intensive care can usually be finished without any problems. However, some of the patients may need reintubation after being separated from a ventilator. The relationship between reintubation and mortality has been demonstrated in many studies. In our study, we found that the mortality rate is approximately 2 times higher in reintubated patients. For this reason and as a precaution against the risk of reintubation, age and APACHE II values should be evaluated against risk factors such as cardiac pathology, inotrope treatment, and comorbidity as mentioned above, after remediation of the primary reason leading to mechanical ventilation and before separating the patient from their ventilator. Performing extubation after normalizing the improvable factors as much as possible will reduce the possibility of reintubation.

Ethics Committee Approval: The Haydarpasa Numune Training and Research Hospital Clinical Research Ethics Committee granted approval for this study (date: 19.02.2019, number: 1).

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