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Analysis of failure in extubation of patients admitted to the intensive care unit of a regional hospital in the southern region of Tocantins.

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Abstract**—***Introduction: Mechanical ventilation (MV) is one of the forms of treatment of serious patients in the intensive care unit (ICU). Since most patients who undergo removal from ventilatory support, i.e., extubation, are successful. However, a proportion of these have the inability to manage spontaneous breathing after removal of the artificial airway. Objective: To analyze the failure in the extubation of patients hospitalized in the intensive care unit of a Regional Hospital in the Southern Region of Tocantins. Methodology: The research was carried out through a quantitative, descriptive cross-sectional study with documentary survey conducted in the medical records and analysis of conducts/evaluations performed by on-call physiotherapists on the day of the extubation of patients in the ICU, from October 1, 2018, to March 6, 2019. Patients aged ≥ 14 years, with any pathology and extubated in the hospital ICU were included. Results: Of the nineteen patients followed by the study, fifteen (78.95%) achieved success in extubations and four (21.05%) failure in extubations. Of the 15 patients who succeeded in extubations, only 1 patient (6.67%) died, while the 04 patients who did not succeed in extubations, half (50%) died. Conclusion: This result of failure in extubation resulted in the hospital sector greater financial impact, as well as in health indicators, among them, the increase in the mortality rate and length of stay of hospitalization. Future studies with longer time and for greater reliability are recommended to use in all extubation processes a specific protocol with greater adherence of the health team to perform pre-extubal tests.*

Keywords**—Airway Extubation, Intensive Care Unit, Ventilator Weaning, Respiratory Insufficiency.**

I. INTRODUCTION

Mechanical ventilation (MV) is one of the forms of treatment of serious patients in the Intensive Care Unit (ICU). Being a life support resource, performed by means of a machine that can replace the patient's ventilatory activity in whole or in part. In other words, it aims to restore oxygen demand and thus decrease the respiratory workload of patients who currently present ineffective pulmonary ventilation [1].

Ventilatory support can be offered through invasive mechanical ventilation (IMV) and noninvasive ventilation (NIV), and currently, artificial ventilation is obtained with the application of positive pressure in the airways, and the difference between them is in the form release of pressure. In the IMV, a prosthesis is used that is introduced into the airway, that is an oro or nasotracheal tube or a tracheostomy cannula. In NIV, a mask connected between the patient and the artificial ventilator is used [2].

Among the reasons leading to prosthesis placement are acute respiratory failure (ARPA), coma patients, patients with decompensated chronic obstructive pulmonary disease (COPD) and cases of patients with neuromuscular disease [3] [4].

When the patient is connected to the ventilatory prosthesis, it should be monitored constantly in order to

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identify the appropriate time for weaning of IV, because early withdrawal increases the chances that the patient will not support spontaneous ventilation [1] [4] [5] [6].Another strategy adopted to reduce the prolongation of IVF is to prevent respiratory and peripheral muscle weakness, that is, preventing hypotrophy [7] [8]

The physiotherapist plays an important role in the multidisciplinary team in the critical patient within the ICU, acting both in patients without the need for ventilatory support, in order to avoid motor and respiratory complications, and in those who are under the aid of MV and in the follow-up of patients who are fit for extubation, assisting in the prevention of complications [9].

The first phase of removal of the ventilatory support is called discontinuation of the ventilatory support. After the time of withdrawal is defined, the decision to be performed is initiated6 [6] [10]. Extubation is defined as withdrawal of artificial airway, leading the patient to spontaneous ventilation [11] [12] [13].

A large part of the patients who are submitted to removal of ventilatory support, that is, extubation presents success [14] [15], however, a proportion of these are unsuccessful, that is, the patient is unable to manage spontaneous breathing after removal of the artificial airway, requiring return to MV within a period ranging from 24 to 72 hours after a planned extubation [16] [17].

Failure may be associated with several factors, including the imbalance between respiratory muscle capacity and ventilatory work, the inability to protect airway and management of respiratory secretions, airway obstruction changes in mental status, hypoxemia, muscle weakness and failure in spontaneous breathing test (SBT) [18] [19] [20] [16]. Furthermore, the failure of extubation may be related to the prolongation of ICU stay associated with increased risk of mortality and higher frequency of tracheostomy [21].

Therefore, this study aimed to analyze the failure in the extubation of patients admitted to the intensive care unit of a regional hospital in southern Tocantins.

II. MATERIALS AND METHODS

This is a quantitative, descriptive cross-sectional research with a documentary survey conducted in the medical records of extubated patients and in the analysis of conducts/evaluations performed by on-call physiotherapists on the day of extubation of patients in the ICU of a regional hospital in southern Tocantins between October 1, 2018, and March 6, 2019, after approval by the Research Ethics Committee of Gurupi-UnirG University, under protocol 2,915,971.

The inclusion criteria adopted were individuals of both sexes, aged ≥ 14 years, having any pathology and having been extubated in the ICU of the aforementioned hospital, between October 1, 2018, and March 6, 2019. Patients who were not admitted to the ICU, children, and neonates were excluded, having been extubated outside the mentioned period and extubated and readily reintubated patients because they had the need for orotracheal tube exchange.

Some data were extracted from the analysis of the medical records of patients hospitalized in the established period. The following information were considered: characterization of the patient, through the diagnosis, date and time of intubation, use of sedative, date and time of extubation, form of extubation, date and time of reintubation, date, and type of ICU output and causes of intubation.

The other data were extracted from the analysis of tests performed by the physiotherapist on duty for the evolution of the extubation process. From this, the following information was extracted: in the pre-extubation tests contained the SBT, cuff leak test, peak flow, Tobin index [9] [13] and evaluation of the leukogram. Already post-extubation, the criteria evaluated were accidental extubation, inability to protect the airway, management of respiratory secretions, laryngeal edema, laryngospasm, mental state changes, Glasgow coma scale, failure of breath test and use of NIV.

The researchers were informed of the probable daily extubations, through the coordinator of the physiotherapy sector of the ICU of the Regional Hospital of Gurupi-TO. As soon as they were aware, they attended the respective sector for data collection before, during and after the extubation were, and this were was performed by the on-duty physiotherapist. Data after extubation were collected at four different moments, the same being immediately after extubation, one hour later, two hours after and seventy-two hours after extubation.

The information obtained through the medical records of each patient and through the conduct of the on-call physiotherapist with regard to the pre- and post extubatory were individually typed into a database, organized from an electronic spreadsheet, this is used to analyze the failure in the extubation of patients in the ICU related.

Data tabulation, significance test, and tables were performed from the tab in Microsoft Excel® 2010 and use of the Statistical Package for the Social Sciences (SPSS®) program to perform the estimates. The Student t-test was performed to test the hypothesis of the work regarding the

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high incidence of failure, and the one established in all cases was 5% (P≤0.05).

III. RESULTS AND DISCUSSION

The database that comprises the sample of this research was collected in an ICU of a Regional Hospital in Tocantins, between the period from October 1, 2018, to March 30, 2019, with information from 19 patients, of these 12 men and 07 women, aged between 14 and 83 years of age.

The cost of treatment evidenced per day was between R$ 7.729,72 to R$ 189.378,14, and the length of hospitalization between 02 days and 49 days, as can be observed in Table 1 that presents descriptive analysis of the variables of patients successfully in extubations with minimum value, maximum, average and standard deviation.

Table 1. Descriptive analysis of the variables of patients successfully in extubations, aged (years), length of hospitalization (days) and total cost in days.

Variable	Minimum	Maximum	Average	Standard deviation
Age	14 years	78 years	41,40	23,442
Length of stay	02 days	49 days	18,07	12,826
Total Cost	R$ 7.729,72	R$ 189.378,14	R$ 69.825,13	R$ 49.569,03

The characteristics of patients with failure in extubations that were consequently reintubated are presented in Table 2. The age was between 19 and 83 years, with a mean of 47.25 and standard deviation of 26,862 for more and less. For length of hospitalization, the minimum of days hospitalized was 13 and the maximum of 31, mean of 22 and standard deviation of 7,348. Regarding the hours for reintubation, the minimum was 02 hours and a maximum of 72 hours, mean of 37.50 and standard deviation of 31,472.

Table 2. Characteristics of patients with failure in extubations and reintubated, aged (years), length of hospitalization (days), hours of reintubation and total cost in (days).

Variable	Minimum	Maximum	Average	Standard deviation
Age	19	83	47,25	26,862
Length of stay	13	31	22,00	7,348
Time for reintubation	02	72	37,50	31,427
Total Cost	R$50.243,18	R$118.810,66	R$85.026,92	R$ 28.400,80

When comparing the data in table 1 with 2, it is observed that a higher age group can contribute to failure in extubations. This result was also verified by Teixeira et al [5] in his study in which he may conclude that advanced age was considered a predictor of extubation failure since most intubated individuals were over 70 years of age. When we observed the length of stay among patients who were successful in extubations and those who did not obtain it, we can observe an increase in the mean and minimum length of hospitalization of patients with failure in extubations. This finding was also evidenced in the study by Epstein et al [22], where it was observed that reintubation was responsible for an average of twelve days longer of MV when compared to successfully extubated patients. The average calculation of the costs of each ICU patient, participants of this research, was based on the results of the research: Hospital ICU bed cost analysis that found all the average elements spent per ICU bed, with the daily cost per bed being quantified at R$ 3.864,86 [23].

When comparing the expenses of patients successfully in extubations and those with failure, a significant increase in values can be observed. This generates the provider system greater burden, thus causing a high financial impact on the system. The same was observed in Seymour study *et al* [24] in which it was found that the increase in the duration of care with the patient after extubation failure doubled the total hospital cost and the cost per day when compared to patients who did not require reintubation.

Table 3 presents the diagnosis and causes of OTI. According to the data, several patients presented more than one pathology both in the diagnosis and causes of OTI. Among the diagnoses, polytrauma was the one with the highest occurrence, with 05 patients, of these 04 successfully in extubations and 01 with failure in extubations. For causes of OTI, the lowering of the level of consciousness was the one that presented the highest incidence for both groups, with 12 patients, being verified in 09 patients successfully, and in 03 patients, with failure.

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Table 3. Causes of orotracheal intubation and result of extubations.

Variable	Total	Success	Failure
Diagnostics			
Polytrauma	05	04	01
Brain skull trauma	03	02	01
Pneumonia	02	01	01
Acute respiratory failure	02	01	01
Acute myocardial infarction	02	02	00
Alcoholic encephalitis	01	01	00
Heart ailure	01	01	00
Acute lung edema	01	01	00
Chronic alcoholism	01	01	00
Convulsive crisis	01	01	00
Syncope to clarify	01	00	01
Firearm injury	01	01	00
Cardiorespiratory arrest	01	01	00
Subdural hematoma	01	01	00
Hepatic abscess	01	01	00
Diabetes Mellitus	01	00	01
Eclampsia	01	01	00
Pleural effusion	01	01	00
Chest Trauma	01	00	01
Stroke sequels*	01	01	00
Appendectomy	01	01	00
OTI Cause **			
Lowering level of consciousness	12	09	03
Acute respiratory failure	09	07	02
Respiratory surgical intervention	01	01	00
Cardiorespiratory arrest	01	01	00
Hepatic abscess	01	01	00
Seizure	01	01	00

* Brain Stroke; ** Orotracheal intubation.

When analyzing the result of the present study, it was observed that the lowering of the level of consciousness was the one that presented the highest incidence of causes of orotracheal intubation. Freitas *et al* [25], corroborate the present data by showing that 51,1% of cases of orotracheal intubation were due to the lowering of the level of consciousness. The same study still infers that the initial diagnosis of admission most frequently were respiratory complications 61,9%.

Table 4 presents the result of the type of output of the patient hospitalized in the ICU. Of 19 patients analyzed sixteen (84,21%) were discharged, and of these two (10,53%) failed extubation. Three patients (15,79%) died, one (5,26%) successfully in extubations and two (10,53%) with failure in extubations. Thus, from the total sample, 03 patients died, one who succeeded in extubation and two who did not succeed in extubation.

Table 4. Result by output type

	Success	%	Failure	%	Total	%
High	14	73,68	02	10,53	16	84,21
Death	01	5,26	02	10,53	03	15,79
Total	15	78,94	04	21,06	19	100,00

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When analyzing these results, it can be observed that there was a higher incidence of deaths in patients who were unsuccess- ful in extubations when compared to those who succeeded. Epstein findings *et al* [22] corroborate this result, after concluding in their study that patients undergoing reintubation were more likely to progress to death in the hospital or spend more time in the ICU. Also, according to these authors, extubation failure is an independent predictor of death and need for transfer to a long-term care facility.

The pre-extubatory tests used in this study were: SBT, Cuffleak test, Expiratory Flow Peak and Tobin Index, as shown in Table 5. By tabulating analysis, it can be observed that there was a case of accidental extubation. The Peak Flow test can be highlighted with 13 cases evaluated, and all obtained aptitude results and in 06 cases the test was not performed. The Tobin Index test presented the lowest adherence rate by the health team, in 17 cases the aforementioned test was not performed, in only 02 cases performed, there was a result of fitness. The results of the other tests were favorable to the fitness of patients to be extubated.

The opportunity of extubation should be evaluated in view of the risks involved both in early withdrawal and in superfluous stay of the cannula. Therefore, the decision on the appropriate time to perform extubation has to be based on accurate, objective and reproducible criteria. Thus, when the health team does not, it assumes the risk of failure which can significantly impact the patient's life [26].

Table 5. Extubation tests.

Extubatory Tests	Performed	Unrealized	Able	Accidental extubation
Spontaneous Breathing	16	03	16	01
Test Cuffleak	17	02	17	01
Peak Flow	13	06	13	01
Tobin Index	02	17	02	01

Table 6 presents the causes of reintubation, use of NIV without success, fitness in SBT and leukogram levels. For the causes of reintubations, laryngeal edema was the most verified with 50% of the cases. For NIV, 75% of the patients used the therapy and were still submitted to reintubation. For spontaneous breathing testing, 75% of patients were considered fit. And for leukogram, half of patients (50%) presented ascendant results in the examination.

Table 6. Causes of reintubations, use of NIV, SBT and leucogram of patients with failure and submitted to reintubations.

Variable	Absolute value	%
Causes of reintubations		
Change in mental state	1	25%
Laryngeal edema	2	50%
Management of respiratory secretions	1	25%
NIV*		
Yes	3	75%
No	1	25%
Spontaneous Breathing Test		
Not fit	1	25%
Fit	3	75%
Leucogram		
Up	2	50%
Descendant	1	25%
Normal	1	25%

***** Noninvasive ventilation.

Among the causes of reintubation, already mentioned above, 50% of the cases were due to laryngeal edema. In line with this result, Freitas et *al* [3] affirm that laryngeal edema is an important cause of failure in extubation, that is, this condition increases the need for reintubation. De Backer [27], it also contributes to studies by stating that laryngeal edema is a factor that contributes to extubation failure, thus leading to reintubation in about 15 to 38% of

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cases. However, Souza *et al* [15], in the study comparing the pre-extubation cuff leak test with three SBT methods, they stated that the absence of escape does not necessarily mean that there will be extubation failure and that patients with negative leak test are safely extubated, suggesting that failure in the specificity of the test.

The alteration of mental status and secretion management in this study were also crucial factors that contributed to reintubations. Similar fact was found in the study by Salam et *al* [18], since they observed cumulative increase in the risk of extubation failure, reaching 100% among patients with low cough power, accumulation of secretions and low level of consciousness. In another study, Khamiees et *al* [28] showed that patients with moderate to large volume of secretions are 8 times more likely to fail extubation when compared to patients with little or no secretion.

Conti and Soroksky *et al* [29] [30] propose that ventilation with noninvasive positive pressure (NIV), in addition to improving gas exchange and clinical evolution in different types of acute respiratory failure, reduces the risk of nosocomial pneumonia, the need for intubation and mortality. This perception is present in Rahal study *et al* [31] because there was a reduction in the incidence of nosocomial pneumonia, reduced mechanical ventilation time and ICU admission, which contributes to a higher probability of survival. However, in this study, 75% of patients who used NIV therapy after extubation to reverse signs of respiratory distress and/or denaturation were unsuccessful and were unfortunately submitted to reintubation.

For the spontaneous breathing test, in this study, 75% of patients with failure in extubations were considered fit when submitted to the test. Andrade *et al* [32], in a study conducted with the ph yto to verify whether or not the SBT is a predictor of extubation success in preterm neonates, does not corroborate the findings of this research. Therefore, in the aforementioned study, it was possible to verify that the group that performed the SBT previously obtained a significant result associated with the success of extubation when compared to the control group. However, in Chavez study *et al* [33], of the patients who were able to successfully complete the SBT, the extubation failure index was 7,8%, while for those who failed, half needed to return to invasive ventilatory support.

In this study, half (50%) of patients with failures submitted to reintubations presented an ascending result in the leukogram,

that is, presence of leukocytosis. Lima [6], in his study entitled: Respiratory rate as a predictor of weaning failure of mechanical ventilation, states that, of the reintubated patients, 40% had important leukocytosis, that is, above 15.000, which could characterize a process underlying inflammatory, a new infection or persistence of the current disfavoring the weaning process of mechanical ventilation.

Table 7. Student's T-Test.

Variables	**t***	**sd****	**p-value**	**Average difference**	**95% confidence interval**	
					Bottom	**Top**
Age	7,897	18	0,000	42,632	31,29	53,97
Length of stay	6,969	18	0,000	18,895	13,20	24,59
Output type	9,798	18	0,000	0,842	0,66	1,02
Sex	3,240	18	0,000	0,368	0,13	0,61
Cost per day	6,969	18	0,000	73.025,512	51.011,70	95.039,31
Result	8,216	18	0,000	0,789	0,59	0,99

* Student T; *Difference, *P≤0.05.

After this descriptive exposure, it can be concluded that of the 19 patients followed by the study, 15 (78,95%) achieved success in extubations and 04 (21,05%) failure in extubations. Of the 15 patients who succeeded in extubations, only one patient (6,67%) died, while the 04 patients who did not succeed in extubations, half (50%) died.

The causes of OTI were: lowering of the level of consciousness and acute respiratory failure. For patients who presented need for reintubation, the most verified complication in these patients was laryngeal edema, occurring in half (50%) of the cases.

IV. CONCLUSION

In this study, it was possible to observe that extubation is inserted in the weaning process of MV, it is complex and likely to fail because it depends on several clinical and physiological factors that may indicate the possibility of failure or not extubation. The failure of the procedure generates high impacts on the health and

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financial indicators of the in-hospital sector, including the increase in the mortality rate, length of stay of hospitalization and higher frequency of tracheostomy.

Future studies with longer time and for greater reliability are recommended to use in all extubation processes a specific protocol for the performance of the procedure.

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