Level of success index of extubation of a pediatric intensive care unit

Nível do índice de sucesso de extubação de uma unidade de terapia intensiva pediátrica

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ABSTRACT | INTRODUCTION: The success of weaning from invasive mechanical ventilation (IMV) is defined by the maintenance of spontaneous ventilation for a period of at least 48 hours after the interruption of artificial ventilation. Weaning is considered a failure or failure if a return to artificial ventilation is necessary during this period. **OBJECTIVE:** To describe the extubation success rate of a Pediatric Intensive Care Unit (PICU). **METHODS:** Descriptive, cross-sectional and retrospective study. The study population consisted of patients older than 28 days of age and younger than 14 years of age, of both sexes, in the Hospital Estadual da Criança (HEC), Bahia, Brazil, who underwent IMV through the orotracheal tube (TOT) for more than 24 hours and who went through the process of weaning, based on the extubation protocol, of the hospital unit, carried out from January to August 2017 and April to July 2018. Data analysis was done through descriptive statistics, calculating the mean and values relative. **RESULTS:** The sample consisted of 74 records, the mean time of using IMV was 8.67 days. When the spontaneous breathing test was applied to perform extubation, 82.3% children had a high success rate and 17.56% a medium rate. Of these, 72.97% were successful in extubation. **CONCLUSION:** The records that comprised this sample showed a lower rate of extubation failure, corresponding to that observed in other reference services.

KEYWORDS: Airway extubation. Pediatrics. Intensive Care Units. Weaning.

RESUMO | INTRODUÇÃO: O sucesso do desmame da ventilação mecânica invasiva (VMI) é definido pela manutenção da ventilação espontânea durante um período de pelo menos 48h após a interrupção da ventilação artificial. Considera-se insucesso ou falência do desmame, se o retorno à ventilação artificial for necessário neste período. **OBJETIVO:** Descrever o índice de sucesso de extubação de uma Unidade de Terapia Intensiva Pediátrica (UTIP). **MÉTODOS:** Estudo descritivo, transversal e retrospectivo. A população do estudo foi composta por pacientes com idade superior à 28 dias de vida e inferior à 14 anos de idade de ambos os sexos, no Hospital Estadual da Criança (HEC), submetidos à VMI através do tubo orotraqueal (TOT) por mais de 24h e que passaram pelo processo de desmame, tendo como base, o protocolo de extubação, da unidade hospitalar, realizado no período de janeiro à agosto de 2017 e abril à julho de 2018. A análise de dados se deu por meio da estatística descritiva, calculando a média e os valores relativos. **RESULTADOS:** A amostra foi composta por 74 registros, o tempo médio do uso da VMI foi de 8,67 dias. Ao ser aplicado o teste de respiração espontânea para a realização da extubação, 82,3% crianças apresentaram alto índice de sucesso e 17,56% médio índice. Destas, 72,97%tiveram sucesso na extubação. **CONCLUSÃO:** Os registros que compuseram esta amostra demonstraram uma menor taxa de falha de extubação, correspondendo ao observado em outros serviços de referência.

PALAVRAS-CHAVE: Extubação. Pediatria. Unidade de Terapia Intensiva. Desmame.

Introduction

According to the III Brazilian Consensus on Mechanical Ventilation[1], it is estimated that approximately one in three pediatric patients admitted to Intensive Care Units (ICUs) will require respiratory support for an average of 4 days, and is currently considered a highly prevalent therapeutic resource.

The removal of the ventilatory support should be done as soon as the patient's condition in Invasive Mechanical Ventilation (IMV) stabilizes and evolves. Depending on the diagnosis, time in IMV and the ventilatory mode and technique used, complications due to delay in extubation may increase, which can be avoided if weaning is performed at the appropriate time[2].

According to Schettino et al. (2007)[3], Goldwasser et al. (2007)[1], Schettino(2007)[4], the III Brazilian Consensus on Mechanical Ventilation still establishes weaning as the transition process from mechanical ventilation to spontaneous ventilation. Extubation, in turn, is restricted to endotracheal tube removal[5].

Successful weaning from mechanical ventilation is defined by maintaining spontaneous ventilation for a period of at least 48 hours after the interruption of artificial ventilation. Failure or failure of weaning is considered if a return to artificial ventilation is necessary in this period[1]. For Gomes (2008)[6] patients who have been under mechanical ventilation for a long time have their respiratory muscles inactivated and need a progressive work to readapt them efficiently.

The professionals responsible should be attentive to signs indicating whether the patient is ready to start weaning or not. This should be done consciously in view of all the complications that may arise in the event of any failure. Therefore, it is possible to achieve success with this procedure, when the ideal moment to start is identified and when there is an adequate conduction of it[8].

The protocols were created to avoid complications arising from a failure in weaning, because before this procedure was done empirically, professionals performed it according to what they thought was feasible or not, thus generating high rates of failure. Faced with such reality, it became necessary to standardize this method[7].

However, it is necessary to say that there is not only one protocol where all ICUs follow it, but several strategies that provide professionals with a careful evaluation that allows them to establish if the patient is eligible for this procedure. The conduct to be adopted will depend on what the team deems necessary for the patients admitted to its unit[8].

As there is a variation between one protocol and another, the evaluation of the protocol is made through the failure rates, the acceptable rate being around 20% of cases[8].

This article aims to describe the success rate of extubation of a Pediatric Intensive Care Unit.

Methodology

It is a quantitative, descriptive, cross-sectional and retrospective study. The data were collected through the analysis of the admission records spreadsheet, the extubation protocol of pediatric patients who met the inclusion criteria determining the sample design. The protocols were separated by pathology to check the success and failure rate after extubation.

The study population consisted of patients over 28 days of age and under 14 years of age, of both sexes, who underwent invasive mechanical ventilation through the orotracheal tube (TOT) for more than 24 hours and who had undergone the weaning process, based on the extubation protocol, carried out from January to August 2017 and April to July 2018 at the Pediatric Intensive Care Unit (PICU) of the Children's State Hospital (HEC) in Feira de Santana, Bahia.

Patients previously submitted to tracheostomy, with less than 24 hours of intubation, accidentally extubated, protocols performed several times in the same patient and with incomplete filling were excluded from the study.

Patients followed ventilatory weaning according to the current protocol at HEC PICU. This protocol is composed of 2 steps: The first is performed by filling in the checklist (Figure 1), having as analysis factors: the underlying disease, the level of consciousness or sedation level, positive end expiratory pressure (PEEP), the Pediatric Tobin index, the arterial blood partial pressure (PaO2), carbon dioxide partial pressure (PCO2), the fraction of inspired oxygen (FiO2), the PaO2/FiO2 ratio and the cough. The score of these factors ranges from 0 (minimum value) to 2 (maximum value). If the child or adolescent reaches the medium or high rate of success, the second stage is performed for 30 minutes (Figure 2), by means of the ventilatory mode Ventilatory Support Pressure (PSV), observing the Heart Rate (HR), Saturation (SpO2), Tidal Volume (VC), Spontaneous Respiratory Rate (FR) and the level of consciousness. These items are scored from 0 (minimum value) to 2 (maximum value).

Figure 1. Checklist for assessment of children before ERR

	Doença de base	Nível de Consciência (Glasgow)	Nível de Sedação (Ramsey)	PEEP	Tobin Pediátrico (CPM/ml/kg)	PaO_2	$PaCO_2$	FiO_2	PaO_2/FiO_2	Tosse
0	Sem resolução	<8	≤2	>8	> 7	<60	>55	>50%	<200	Ausente
1	Controlado	≥8 <13	4 e 5	>5 ≤ 8	6,5 a 7	>60 ≤80	>45 ≤ 55	≥ 40 ≤ 50	> 200 < 300	Débil
2	Resolvido	>13	3	=5	< 6,5	>80	≥35 ≤ 45	<40	>300	Eficaz

	Estabilidade Hemodinâmica FC	DVA	Hemo-globina	Sepse	Teste do Cuff	Escala força (MRC)	Manovacuometria (PiMax)	BSA (PMV)
0	FC≥ 20 bpm acima do limite superior	Dose elevada	≥8	Controlada	VCe =VCi	<2	≤30	> 5
1	Acima do limite superior para a idade	Dose mínima	≥5 <8	Resolvida	VCe <5%VCi	>2≤4	> 30 ≤50	1 a 5
2	Normal para a idade	Sem DVA	<5	Ausente	VCe <VCi em mais 10%	>4	>50	0

Resultado do Pré-teste:
Alto índice de sucesso: 80 - 100% (27 a 34 pontos)
Médio índice de sucesso: 60 a 80 % (20 a 26 pontos)
Baixo índice de sucesso: < 60 (< 19 pontos)

Fonte: Hospital Estadual da Criança, 2019.

	PSV FC	SpO2	VC	BSA (PMV)	FR Espontânea (ipm)	Nível de Consciência(Glasgow)
0	Aumento acima de 20% da basal	<93%	<5	>5	Aumento acima de 50% da basal	<8
1	Aumento de 20% da basal	≥93 <95%	≥5 <6	>1≤5	Aumento de 50% da basal	≥8 <13
2	Aumento < 20 % da basal	≥95%	≥6	0	Aumento < 50 % da basal	>13

CHECK LIST APÓS 30 MINUTOS DE TRE
Resultado do teste:
Alto índice de sucesso: 80 - 100% (10 a 12 pontos)
Médio índice de sucesso: 60 a 80 % (7 a 9 pontos)
Baixo índice de sucesso: < 60 (≤ 6 pontos)
Data Extot: _____/_____/_____

VNI ( ) Não ( ) Sim Tipo: _____
Oxigenoterapia: ( ) Não ( ) Sim Tipo: _____

Source: Hospital Estadual da Criança, 2019.

Weaning was considered successful when the patient was extubated, remained without mechanical ventilatory assistance and without signs of acute respiratory failure for a period longer than 48 hours.

The data was organised, processed and analysed in Microsoft Excel® 2013 software. The data analysis was carried out using descriptive statistics, calculating the average and relative values. They were then systematized in tables.

The project was submitted to the Ethics and Research Committee of the Faculdade Adventista da Bahia, and was approved through Opinion No. 3,509,585, registered in CAAE 18537719.6.0000.0042.

Results

During the study period, 97 extubation protocols were collected. Of these, 23 were excluded because they did not fit the inclusion criteria, and 74 records were selected in which children used IMV for an average time of 8.67 days.

Table 1 shows the profile of children by sex, as well as the rate of success in ERR and the rate of success and failure after 48 hours of extubation.

Table 1. Characterization of children by sex, ERR success rate and success rate after extubation of children in the HEC PICU

Features	N	%
Sex		
Female	36	48.65%
Male	38	51,35%
Index of Success in the ERR		
High rate	61	82,44%
Medium index	13	17,56%
Success and failure rate after 48 h of extubation		
Success	54	72,97%
Failure	20	27,3%

Source: Developed by the authors, 2020. Field Research, 2019.

The records were separated according to clinical diagnosis and classified into neuropathy, heart disease, respiratory disease, metabolic disease, neuropathy and respiratory disease and other pathologies. After this classification, the index of success and failure according to the pathological chart was verified (Table 2).

Table 2. Pathological classification and index of success and failure after extubation of children admitted to HEC PICU

Pathology	N	%	Index of Success	Failure Rate
Neurological	18	24,32%	66,6%	33,33%
Cardiological	06	8,10%	83,3%	16,66%
Metabolic	01	1.35%	0%	100%
Respiratory	19	25.67%	78,94%	21,05%
Neurological and respiratory	09	12,16%	66,66%	33,33%
Cardiological and respiratory	06	8,10%	66,66%	33,33%
Other pathologies	15	20,27%	80%	20%

Source: Developed by the authors, 2020. Field Research, 2019.

Table 3 shows the use or not of support after removal of the VMI related to the success rate in the pre-extubation protocol (between high, medium and low) and the success/failed after removal of the TOT. A total of 09 records were excluded that did not contain such information.

Table 3. Use of post-extubation support, success rate in the extubation protocol and success/failed extubation in children admitted to HEC PICU

Post-Extubation		Performance in the ERR		Performance after 48 hours of extubation	
	n (%)	High rate n (%)	Medium index n (%)	Success n (%)	Failure n (%)
With support	48 (73,84)	41 (63,07)	7 (10,76)	35 (53,84)	13 (20)
Unsupported	17 (26,15)	15 (23,07)	2 (3,70)	16 (24,61)	1 (1,53)
Total (%)	65 (100)	56 (86,15)	9 (13,84)	51 (78,46)	14 (21,53)

Source: Developed by the authors, 2020. Field Research, 2019.

Discussion

The protocols are useful for performing safe and efficient weaning from mechanical ventilation, reducing unnecessary or harmful variations in the process, although these protocols should be used as a complement to clinical judgment[8]. There is no consensus on the best method for weaning from mechanical ventilation[9,10], and it is possible that not all patients need it[8]. In the hospital unit in question, there is an evaluation of several analysis factors and they are subsequently submitted to PSV for 30 minutes.

In a survey-type study, conducted by Bacci (2020)[11], nationwide, involving neonatal ICUs and 323 exclusively pediatric units, it was shown that weaning and extubation practices in Brazil vary widely according to the age group served. The same holds true for the most common weaning strategy in Brazil, which is the gradual reduction of ventilatory support, and the weaning protocol is more common in PICU.

In this study, most patients (72.97%) who underwent weaning and extubation protocols were successful, which corresponds to the findings in other studies[9,12-15]. In a systematic review conducted by Blackwood (2013)[16], it was suggested that weaning protocols decrease mechanical ventilation time in children. As pointed out in this study, where the mean time for patients who succeeded in extubation was 6.18 days and more than twice as long for those who failed with a mean stay of 15.4 days in IMV.

Weaning from VMI is equivalent to 40% of total ventilation time[1]. Complications related to IMV imply increased hospital stay, morbidity and mortality, generating the probability of airway trauma associated with reintubation and the risk of nosocomial infection[17].

Extubation failure stems from a number of interacting factors[9,12-14,18], leading to the belief that only one variable or index cannot accurately predict the success of extubation in a heterogeneous group of children undergoing mechanical ventilation[13].

Few studies relate clinical diagnosis to success/failure of extubation, most of them related to diagnoses of respiratory or cardiac pathologies. In this study, it was found that the greatest occurrence of failures occurred in individuals diagnosed with neurological pathology and those with respiratory and neurological disease in an associated manner

Some studies bring the importance of non-invasive ventilation as a prevention of respiratory discomfort after extubation[18-22]. In a randomized clinical trial[19] that included 108 patients, comparing non-invasive ventilation and standard oxygen therapy in severely ill children with respiratory failure, no differences were observed between groups regarding the indication of reintubation. It was verified in the records of the PICU of HEC, in the period in question, that 73.84% of the children used NIV or low flow oxygen therapy and that of these, 53.84% were successful after 48 hours of TOT withdrawal.

Bacci (2020)11 concluded in a survey that the age group served by the ICU influences the variability of weaning and extubation practices in Brazil, that the most common weaning strategy is the gradual reduction of ventilatory support, and weaning protocol is more common in PICU. The same author also concludes that, in general, despite the variability of the test duration, ERT is more frequently performed in PSV+PEEP ventilatory mode.

This research has some limitations. Among them, the number of the study population, incomplete completion of the extubation protocol, because they were not on mechanical ventilation, were extubated in less than 24 hours, or accidentally extubated, protocols performed several times in the same patient due to readmissions and also due to the decrease in patient turnover in the period, due to prolonged hospitalization.

It is suggested that further studies be carried out, assessing the impact of this protocol and validating the weaning predictors used in it. A comparison between the success and failure rate of extubation with age, clinical diagnosis, nutritional condition, sedation time and other variables is also necessary.

Conclusion

The present study, through the verification of the completed extubation protocols, realizes the need for uniformity in order to have a safe and effective extubation. The records that composed this sample showed a lower extubation failure rate, corresponding to that observed in other reference services.

Author contributions

Viana HPS participated in the conception, design, collection of research data, search and statistical analysis of research data, interpretation of data and results and writing of the scientific paper. Rodrigues RP participated in the design, statistical analysis and interpretation of research data, interpretation of results, and writing of the scientific article. Da Silva TB participated in the design, design, interpretation of research data, interpretation of results and writing of the scientific paper.

Competing interests

No financial, legal or political conflict involving third parties (government, business and private foundations, etc.) has been declared for any aspect of the work submitted (including, but not limited to grants and funding, participation in advisory board, study design, preparation of manuscript, statistical analysis, etc.).

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