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Ventilatory support in pediatric UTI: Observational study

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ABSTRACT

OBJECTIVE

To characterize the management of mechanical ventilation, ventilatory weaning and tracheal extubation in the Pediatric Intensive Care Centers (PICC) of the Hospital Geral do Grajaú.

METHODS

Prospective observational study conducted at the Pediatric Intensive Care Center (PICC) of the Hospital Geral do Grajaú (HGG) for 9 months.

RESULTS

Ninety patients who were under mechanical ventilation were included in the study. Of these, 40 were girls and 50 were boys. With a mean age of 5.52 months. Respiratory diseases were diagnosed with hospitalization in 84 patients (93.3%). In 100% of the cases, the Ventilatory Mode Controlled Pressure after tracheal intubation was used. Patients were submitted to MV on average for 6.6 days. In 89 patients (98.8%), the ERT with PSV was performed. Seventy-three patients (81.1%) used NIV after extubation with an average of 2 days of use. In 81 patients (90%) extubation was successful.

CONCLUSIONS

The pediatric population hospitalized in pediatric intensive care units requiring the use of invasive mechanical ventilation is mostly male, less than 6 months old, with indication for hospitalization for respiratory disorders. The use of invasive ventilatory support was on average 6.6 days. Success of tracheal extubation in 90% of patients. We suggest greater accuracy regarding the descriptions of health professionals in electronic medical records.

DESCRIPTORS

Mechanical ventilation, Weaning, Extubation, Pediatrics.

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INTRODUCTION

The pediatric population is particularly susceptible to develop more severe respiratory disorders due to particularities and anatomical, physiological, and immunological characteristics of the developing respiratory system[1].

Mechanical ventilation (MV) is a widely used resource in pediatric intensive care units. Management of mechanical ventilation in pediatric patients is a complex challenge for the multidisciplinary team. Indication of this resource must always consider the risks and benefits of its use and possible systemic and hemodynamic complications to the patient's body[2].

The main complications related to prolonged MV use are lung injury, barotrauma, hemodynamic repercussions, thromboembolism, pneumonia, airway trauma by the artificial airway institution and by inadequate cuff inflation, respiratory muscle atrophy and toxicity by inappropriate use of oxygen, predisposing to prolonged MV use and length of stay in the intensive care unit. Thus, early ventilatory weaning (MV) should be prioritized respecting the clinical characteristics of each child[3].

The Brazilian Consensus on Mechanical Ventilation in Pediatrics described that ventilatory weaning comprises 40% of the total time of mechanical ventilation. Some authors have studied protective ventilatory strategies and predictive tests for extubation success, and extubation failure rates are observed in up to 24% of the cases[4].

Some criteria must be well established to indicate tracheal extubation by the multiprofessional team, such as the resolution of the respiratory failure etiology, stable respiratory function, fraction of inspired oxygen (FiO2) lower than 50%, positive end expiratory pressure (PEEP) lower than 5 cmH2O; adequate respiratory rate according to the age range, absence of acidosis (pH=7.35 to 7.45) and absence of hypercapnia (pCO2 between 35 and 45 cmH2O)[4].

Intensive monitoring of the ventilatory parameters enables early ventilatory weaning if the clinical, laboratory and physiological criteria are followed. Thus, the indication of tracheal extubation performed at the ideal time avoids complications resulting from prolonged MV use, need for reintubation, increased hospital and intensive care unit length of stay[4,5].

The Spontaneous Breath Test (SBT) is the most common test, both for its efficacy to predict extubation success and for its practical application. It consists in allowing the patient to breathe spontaneously in a determined time interval while information is collected to tell if he tolerates or not the withdrawal of mechanical ventilation[5].

Extubation success is considered the maintenance of spontaneous breathing for 48 hours without the need of invasive ventilatory support. After the procedure the patient performs a series of physiological adaptations to maintain gas exchange, with increased diaphragmatic load, recruitment of accessory muscles and increased respiratory rate[4].

Thus, the objective of this study is to characterize mechanical ventilation, ventilatory weaning and tracheal extubation in pediatric patients, aiming to analyze factors determining extubation success.

METHODS

This is a prospective observational study, carried out at the Pediatric Intensive Care Center (PICC) of Hospital Geral do Grajaú (HGG) for 9 months.

All patients admitted to the Pediatric Intensive Care Center (PICC) under use of invasive mechanical ventilation were included in the study with the following criteria: both genders; invasive mechanical ventilation for more than 24 hours; presence of respiratory drive and level of consciousness adequate for extubation.

Exclusion criteria were patients admitted to the Pediatric Intensive Care Unit (PICU) who did not use invasive mechanical ventilation, on prolonged mechanical ventilation, absence of respiratory drive and patients with neuromuscular diseases.

This work was approved by the Research Ethics Committee of the Santo Amaro University (CEP-UNISA), under CAAE number 04345218.2.0000.0081, opinion number: 3.239.573 in April 2019.

Data collection was performed through a form with the following items: patient data, clinical diagnosis, data regarding tracheal intubation, mechanical ventilation and tracheal extubation. Collection was performed exclusively by the author of the study starting on 01/05/2019 and ending on 28/02/2020. Data were tabulated in spreadsheets and analyzed using descriptive statistics.

RESULTS

221 electronic medical records were selected and 97 were analyzed according to the inclusion and exclusion criteria. From the 97 patients included, 7 were excluded - 6 because of death and 1 because a tracheostomy was performed during the study, totaling 90 patients.

Of the 90 patients included, 50 (56%) were male, with a mean age of 5.52 months, and 5 patients were less than 30 days old.

Regarding the diagnosis of hospital admission, respiratory pathologies were observed in 84 patients (93.4%). The neurological diagnosis was observed in only 1 patient (1.1%). One patient was observed with a trauma diagnosis (1.1%). Cardiovascular pathologies were not observed in the diagnoses of admission to the PICC. In the description of the item others, 4 patients (4.4%) were observed, being 2 patients with diagnosis of dehydration, 1 patient with malnutrition and 1 with hemolytic anemia.

Table 1 describes the patients diagnosed with acute viral bronchiolitis at the PICC admission. We observed 59 patients (65.55%) with this diagnosis, being 33 (56%) with positive etiology for respiratory syncytial virus (RSV). These patients had a mean of 7.09 days of invasive mechanical ventilation and a mean age of 3.09 months. Twenty-six patients (44%) were RSV negative, with a mean of 6.9 days of invasive mechanical ventilation and 3.20 months of mean age.

Table 1. Hospitalizations for Acute Viral Bronchiolitis.

Acute viral bronchiolitis hospitalisations (n=59) 65.55%.	
Positive Respiratory Syncytial Virus (n=33), 56%.	7.09 days of invasive mechanical ventilation. 3.09 months of age.
Respiratory Syncytial Virus Negative (n= 26), 44%.	6.9 days of invasive mechanical ventilation. 3.20 months of age.

Data related to tracheal intubation are outlined in Table 2. Regarding the diameter of the tracheal tube used, 1 patient (1.1%) used a 2.5 mm tracheal tube; 4 patients (4.4%) with a 3.0 mm tube; 41 patients (45.6%) with a 3.5 mm tracheal tube; 31 patients (34.5%) with 4.0 mm tracheal cannula; 7 patients (7.8%) with 4.5 mm tracheal cannula; 5 patients (5.5%) with 5.0 mm tracheal cannula and 1 patient (1.1%) with 6.0 mm tracheal cannula. Regarding the presence of a balloon, 42 patients (46.6%) used cannulae without balloon and 48 patients (53.4%) with balloon. There was no description about cuff insufflation in the medical charts. Tracheal intubation was classified as difficult to perform in 21 patients (23%).

Table 2. Data related to tracheal intubation.

Data related to tracheal intubation (n= 90), 100%	
Tracheal cannula size (n=90), 100%.	Number 2.5 mm: (n= 1), 1,1% Number 3.0 mm: (n= 4), 4,4% Number 3.5 mm: (n= 41), 45,6% Number 4.0 mm: (n= 31), 34,5% Number 4.5 mm: (n= 7), 7,8% Number 5.0 mm: (n= 5), 5,5% Number 6.0 mm: (n= 1), 1,1%
Presence of Tracheal Cannula Balloon (n=90), 100%.	Yes: (n= 48), 53.4% No: (n= 42), 46.6%
Difficult intubation (n=90), 100%.	Yes: (n=21), 23.4% No: (n=69), 76.6%

The ventilatory variables used after tracheal intubation are described in Table 3. The 90 patients (100%) were ventilated in pressure controlled assisted mode. It was not possible to collect the ventilatory parameters used immediately after tracheal intubation, as they were not described in the clinical evolutions of the healthcare professionals. The mean number of days on invasive mechanical ventilation was 6.6 days.

Table 3. Characteristics of the use of invasive mechanical ventilation after tracheal intubation.

Characteristics of the use of invasive mechanical ventilation after tracheal intubation (n= 90.100%)	
Ventilatory Mode (n=90), 100%	Volume Controlled Watching: (n=), 0% SIMV + PS: (n=), 0% SIMV at Volume: (n=), 0% PSV: (n=), 0% CPAP:(n=), 0% CPAP
Average days on invasive mechanical ventilation (days).	6,6 days

Legend: SIMV +PS (SIMV - Synchronized Intermittent Mandatory Ventilation / PS - Pressure Support), SIMV - Synchronized Intermittent Mandatory Ventilation, PSV - Pressure Support Ventilation, CPAP - Continuous Positive Airway Pressure.

Data related to ventilatory weaning, tracheal extubation and post extubation respiratory support are detailed in Table 4. Management of ventilatory weaning was not described in the electronic medical records. Eighty-nine patients (98.9%) were submitted to Spontaneous Breathing Test (SBT) through Pressure Support (PSV). Only one patient (1.1%) was submitted to SBT with T-tube. One (1.1%) tracheal extubation was classified as accidental and 89 (98.9%) were programmed tracheal extubations.

After tracheal extubation, 71 patients (78.88%) underwent adrenaline inhalation, with no description in the medical charts about the indication of the medication use or if it was performed prophylactically. Regarding the respiratory support used after tracheal extubation, 2 patients (2.22%) were maintained in ambient air; 15 patients (16.66%) were submitted to oxygen therapy; 73 patients (81.11%) used non-invasive mechanical ventilation (NIV) with a mean of 2.37 days of use. Eighty-one patients (90%) had successful extubation.

Sixteen patients (17.77%) evolved with extubation failure as described in Table 5. The mean age of these patients was 4.7 months, with a mean of 7.7 days of invasive mechanical ventilation and use of NIV after extubation for an average of 2.2 days.

Table 4. Data related to ventilatory weaning, tracheal extubation and post extubation support.

Data related to ventilatory weaning, tracheal extubation and post-extubation respiratory support (n=90, 100%)	
Spontaneous Breath Test (n=90), 100%.	Supporting Pressure: (n=89), 98,9%
Tracheal Extubation (n=90), 100% Spontaneous Breath Test	T-tube: (n=1), 1.1%
Post Tracheal Extubation Inhalation (n=90), 100% Spontaneous Breathing Test	Scheduled: (n=89), 98,9%
Ventilatory Support Post Tracheal Extubation (n=90), 100% Spontaneous Extubation	Accidental: (n=1), 1,1%
Average of days of Non-Invasive Mechanical Ventilation (days)	Saline 0.9%: (n=0), 0%.
Spontaneous Breath Test (n=90), 100%.	Adrenaline: (n=71), 78,88%

Table 5. Characteristics of Patients with Extubation Failure.

Characteristics of Patients with Extubation Failure (n=16), 17.7%	
Average age (months)	4.7 months
Mean of days of Invasive Mechanical Ventilation	7.7 days
Average of days of Non-invasive Mechanical Ventilation	2.2 days

DISCUSSION

The objective of this study was to characterize mechanical ventilation, ventilatory weaning and tracheal extubation in pediatric patients with the purpose of analyzing factors that determine extubation success. Forty percent of the PICU admissions required the use of IMV. Corroborating the data of this work, a study carried out by Valenzuela and collaborators with the objective of analyzing information on weaning and extubation of pediatric patients, observed that the indication for use of invasive mechanical ventilation of patients admitted to Pediatric Intensive Care Units may vary from 30% to 64%[6].

Regarding the demographic characteristics of the population studied, the data observed in this survey agree with the work of Avendaño et al, with the objective of epidemiologically characterizing acute respiratory infections in pediatric hospitalizations. He concluded that 59% of his sample was comprised of male patients, most of them under 1 year of age[7].

Avendaño et al, in a study conducted in 2018, observed that the most frequent diagnoses of admission in intensive care units are acute respiratory disorders7. Escalante et al, in 2018 published work aimed at identifying the clinical characteristics, treatment and severity of AVB in children under 2 years. It concluded that the prevalence of children hospitalized for AVB was 22%, and 65.2% of the sample were male patients and under one year of age8. Guarcinuno et al concluded that this condition has a high incidence in children under 12 months, being clinically more severe in those under 6 months[9].

Kemper et al, in 2018, conducted a study aimed at comparing the types and sizes of orotracheal tubes used in pediatrics. The data corroborates with the present study and concludes that the indication of the size of the tracheal cannula should be made according to the patient's age. Tracheal cannulae of 3.5 mm are indicated for patients younger than 2 months and 4.0 mm for patients younger than 4 months[10].

A study conducted by de Ojeda et al, in 2017, aimed to determine whether the use of an inflated cuff on tracheal tubes increases the risk of post-extubation laryngeal stridor in children. They concluded that the use of an inflated cuff is not directly related to the occurrence of post-extubation laryngeal stridor, but rather with the child's age. That is, the younger the child is the more likely to present the sign after tracheal extubation[11].

Souza et al. conducted a study aiming to describe the frequency, types of complications of tracheal intubation and their main causes. Results show that 30% of the cases are intubated at the first attempt and in 14% of the sample five or more intubation attempts were necessary. The author concludes that

there is no correlation between difficulty of tracheal intubation and patient's age, but there was a higher difficulty of tracheal intubation by professionals in training. These findings agree with our study, carried out in a teaching hospital with medical professionals in training[13].

The pressure controlled assisted ventilation mode was used in 100% of the sample after tracheal intubation being justifiable by the need for administration of sedatives and neuromuscular blockers for tracheal intubation procedure. A study conducted in 2013 by Bonora and collaborators, aiming to assess the evolution and use of ventilatory modalities in a pediatric intensive care unit, observed that the most used ventilatory mode was controlled pressure. He concluded that the choice of ventilatory mode should be made with the objective of ensuring ventilatory comfort to the patient and allow reduction of daily sedation concomitantly[12].

In this survey we observed 1 patient (1.11%) with accidental extubation. The reason for the accidental tracheal extubation observed in the study was not described in the medical chart. Souza et al published a study aiming at analyzing the frequency, types of complications and main causes of tracheal intubation in the pediatric population. He concluded that most accidental extubations occur from 1% to 16% in pediatric intensive care units due to direct action of the patient himself with minimal sedation, inadequate fixation of the tracheal tube, inadequate handling during procedures and the weight of the mechanical ventilation apparatus circuit[13].

In a study by Motta et al, 2016 it was observed that administration of sedation with minimal doses promotes a decrease in ventilatory support time in almost 2.6 days, reduction of ICU stays in 3 days, with no increase in accidental tracheal extubation[20].

The Spontaneous Breath Test (SBT) was performed in 89 patients (98.88%) using pressure support. Only one patient (1.11%) underwent SBT with T-tube. The indication of choice of SBT for the study population was not described in medical records. Kneyber et al, in 2017, published an article aiming to establish a guideline on ventilatory weaning and predictive tests for extubation success in pediatrics. It concluded that there is not enough scientific evidence to recommend initiation and approach of ventilatory weaning and routine use of any test of readiness for extubation for the pediatric population[14].

In this study no data regarding indications and strategies for ventilatory weaning used for the studied population were found in medical records. Many researchers have studied appropriate ventilatory techniques in the management of IMV, but without scientific evidence regarding clinical outcomes[6,18].

Valenzuela et al, carried out a study with the objective of analyzing the available information about ventilatory weaning and tracheal extubation in pediatrics. It concluded that the institution and application of a ventilation, weaning and extubation protocol did not reduce significantly the ventilatory weaning time and extubation failure rate. The authors report about the relation between the indiscriminate use of sedative drugs and the increase of the ventilatory weaning time. They suggest that evaluation of clinical criteria and daily interruption of sedation may be effective measures in reducing days of IMV use in pediatric patients[6,18].

A study published in 2017 reports that there is no scientific evidence on the indication of NIV prophylactically for the pediatric population. It concludes that the use of NIV to prevent extubation failure should be indicated for patients at high risk of extubation failure, such as patients with severe scoliosis, neuromuscular disorders, or extubated patients with PEEP equal to or greater than 8 cmH2O[19].

The results of this study corroborate the data presented by Cuestas et al, who observed that extubation failures can range from 6 to 25% in the pediatric population[15]. Khemani et al, in 2017 reports in his work that weakness of the respiratory muscles is one of the main contributors to pediatric extubation failure[16].

The limitations of this research are related to the absence of detailed descriptions made by health professionals in electronic medical records. Ronchi et al, in 2012 cities in his research about the need for specific and detailed notes that meet the requirements of data standardization and essential communication. The computerization of the medical record is essential to meet the needs of access to information because the proper electronic medical record brings several benefits, such as: structured data; improvement in the quality of available information; agility of access to records; sharing of information about the patient and simultaneous access to them. In other words, all the patient's information is available in an organized manner and can be accessed quickly. This also facilitates integration and communication of the health team during care[20].

CONCLUSION

The pediatric population admitted to intensive care units with need of invasive mechanical ventilation is mostly male, less than 6 months old, with indication for admission due to respiratory conditions, with the highest percentage being acute viral bronchiolitis with positive etiology for respiratory syncytial virus (RSV).

The description of difficult airway during tracheal intubation may be related to the presence of medical professionals in training at the hospital where the study was carried out. The use of invasive ventilatory support was on average 6.6 days, spontaneous breathing test with pressure support and use of post-extubation non-invasive ventilation in most of the sample and successful tracheal extubation in 90% of the patients.

We suggest greater rigor regarding the descriptions of health professionals in electronic medical records.

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