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Spontaneous Breathing Trial: A Reliable Method for Weaning in Children

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Abstract

Introduction

Mechanical ventilation may be lifesaving intervention. It can be associated with complications, thus, successful weaning is constitutive. One of the factors which are important in successful weaning is method of weaning. It is shown that weaning is conducted successfully by using Spontaneous breathing trial (SBT) through T-piece and Pressure support (PS) ventilation. But few studies have not accepted it. In this study, we evaluated the role of SBT in extubation of patients in Pediatric Intensive Care.

Materials and Methods

In a cross sectional and analytical study, three hundred sixty patients with adequate gas exchange [Indicated by PaO_2 higher than 60 mm/Hg while FIO_2 of 0.40 or less (or PaO_2/FIO_2ratio> 300)] were enrolled. Patients underwent a 2-hour trial of spontaneous breathing with pressure support ventilation. They were monitored during the test for 2 hours and were classified as failing the test if at any time in the 2-hour period, there was tachypnea, excessive work of breathing, tachycardia and SPO_2<90%. Extubation failure was defined as needing reintubation within 72 hours of extubation.

Results

240 patients (66%) of 360 patients successfully underwent SBT and were immediately extubated. In 120 patients (33%), the trial of spontaneous breathing was stopped (trial failure; 33% vs. 66% P=0.04). Of the 240 patients with successful SBT, 29 patients were re-intubated (extubation failure) and 211 patients had successful extubation (12% vs. 88% P=0.002). For patients experienced successful extubation, the mortality rate was 5% While the rate of mortality was 27% in patients with needing re-intubation(5% vs. 27% P= 0.003).

Conclusion

The spontaneous breathing trial with pressure support prior to elective extubation may predict successful extubation in ventilated children.

Key Words: Children, Extubation failure, Spontaneous breathing trial, Weaning.

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Introduction

Acute respiratory insufficiency is common in the pediatric population. It is estimated that two to three million children die around the world of respiratory causes (1). Although Mechanical ventilation (MV) may be lifesaving intervention, it can be associated with complications such as nosocomial pneumonia, ventilator-induced lung injury, sedative dependency, and upper airway injury (2). It has been shown that prolonged weaning increases the incidence of MV-related complications and mortality in patients requiring MV in an Intensive Care Unit (ICU). Although difficult weaning increases the incidence of complications, it does not significantly influence hospital mortality (3, 4). Several factors contribute to weaning failure. Weaning outcomes affect by respiratory, circulatory, and nervous system activities as well as the psychological and nutritional status of patients (5).

The major factor in successful weaning is resolution of the precipitating illness. Other factors include comorbid illnesses, cause of acute respiratory failure, protocol, and the method of weaning (6).

However, successful early extubation is difficult, because extubation criterias may vary. Thus, the continued search for criteria to indicate the correct time to end mechanical ventilation is a priority. Several previous studies conducted in the pediatric population have tried to define predictors of successful extubation. However, it has not been possible to determine which set of parameters accurately predicts successful extubation (7-10).

The ability to breathe spontaneously can be assessed with a spontaneous breathing trial (SBT) using a T-tube (T-piece) or by reducing the applied airway pressure to provide low levels of pressure support (PS) (5 to 10 cmH2O) (11). Also, major weaning studies were conducted by using SBTs through T-piece and pressure support (PS) ventilation (12, 13). Common practice currently recommends an SBT for 30 min to 120 min before extubation (14). The test aims monitoring signs of respiratory muscle fatigue while the patient is still intubated. A previous study showed that SBT performed with a T-piece was able to predict successful extubation in 70% of intubated children (10).

The effects of complete elimination of the SBT procedure during extubation should be investigated. Some studies recommend SBTs, whereas others suggest that SBTs are inaccurate and that approximately 15% of extubation failures are unidentified in SBTs (15). The present study, to evaluat the role of SBT in extubation of children.

Materials and Methods

A cross sectional and analytical study was conducted in Pediatric Intensive Care Unit (PICU) from April 2010 to April 2014. The proposal of this study was approved by Ethic Committee of Tabriz University of Medical Sciences.

Inclusion criteria

In this study, all patients who received mechanical ventilation for >24 hours and were judged by the attending physician to be ready to undergo extubation were eligible for study. Patients were enrolled if they met the following inclusion criteria:

A. age between 1 month and 14 years;
B. improvement or resolution of the underlying cause of respiratory failure;
C. adequate gas exchange as indicated by a partial pressure of arterial oxygen (PaO_2) higher than 60 mmHg while breathing with a fractional inspired oxygen (FIO_2) of 0.40 or less (or PaO_2 / FIO_2 ratio> 300) and a Positive end-expiratory pressure (PEEP) of 5cmH_20 or less;
D. alert mental status after removal of sedative agents;
E. hemoglobin level above 10 g⁄dl.

Patients with tracheostomy, unrepaired cyanotic congenital heart disease, neuromuscular disease were excluded.

Protocol and data collection

Demographic information included age, gender, weight, and admission diagnosis. Recorded clinical information included duration of mechanical ventilation, endotracheal tube size and reason for mechanical ventilation. The physicians determined extubation readiness using standard clinical practice including assessment of physical exam, blood gases, chest radiographs, ventilator settings, and fluid status. There was no criterion for a specific ventilator rate to be considered for SBT but Children were considered ready for extubation on ventilator rates that ranged from 5 to 20 breaths/min.

Ventilator mode was changed to pressure support ventilation. Pressure support was set according to Endotracheal tube (ETT) size (3.0 –3.5 mm _ pressure support of 10 cmH2O, 4.0–4.5 mm_ pressure support of 8cm H2O, and 5.0mm pressure support of 6cmH2O). Patients were monitored during the test for 2 hours and were classified as failing the test if at any time in the 2-hr period their respiratory rate was outside of acceptable range for their age (for age2-12 months: ≥50⁄min; 1 to 5 yrs:≥40/min; >5 yrs:≥30/min), there was excessive work of breathing based on physician assessment (marked retractions, diaphoresis, or nasal flaring), tachycardia (for age 2 _12months>160/min; 1–2 years>120; 2–8years>110;>8 years>100) and oxygen saturations<90%. Patients who had not above signs and had normal blood gas analysis at the end of trial were extubated and received supplemental oxygen by an oxygen hood or face mask (trial successful). Therefore, trial failure was defined as the requirement for mechanical ventilation at any time during the trial of spontaneous breathing. Extubation failure was defined as the needing re intubation within 72 hours of extubation (16, 17).

Data analysis

Statistical analyses were performed using the Statistical Package for Social Science, version 17.0 (SPSS, Chicago, Illinois). Quantitive data were presented as mean± standard deviation (SD), while qualitative data were demonstrated as frequency and percent (%). The parameters were compared by Binomial test. P-value <0.05 was considered statistically significant.

Results

Three hundred sixty patients were enrolled in the study and satisfied the inclusion criteria for extubation (Figure. 1). Patients underwent a 2 hours trial of spontaneous breathing with pressure support ventilation. Table.1, shows the baseline characteristics of patients. Of these 360 patients, 240 patients(66%) successfully underwent SBT and were immediately extubated. In 120 patients(33%), the trial of spontaneous breathing was stopped and mechanical ventilation was reinstituted(trial failure; 33% vs. 66% P=0.04).

Of the 240 patients successful the pressure support trial, 29 patients were re-intubated (extubation failure) and 211 patients had successful extubation(12% vs. 88% P=0.002). Among of 120 patients with trial failure, 40 could be extubated after a further pressure support trial. For patients experienced successful extubation, the mortality rate was 5% (12 patients of 211). When the rate of mortality was 27% (8 patients of 29) in patients with needing re-intubation (5% vs. 27% P= 0.003).

Results showed 10% of patients who were failed SBT (12 patients of 120), required tracheostomy.

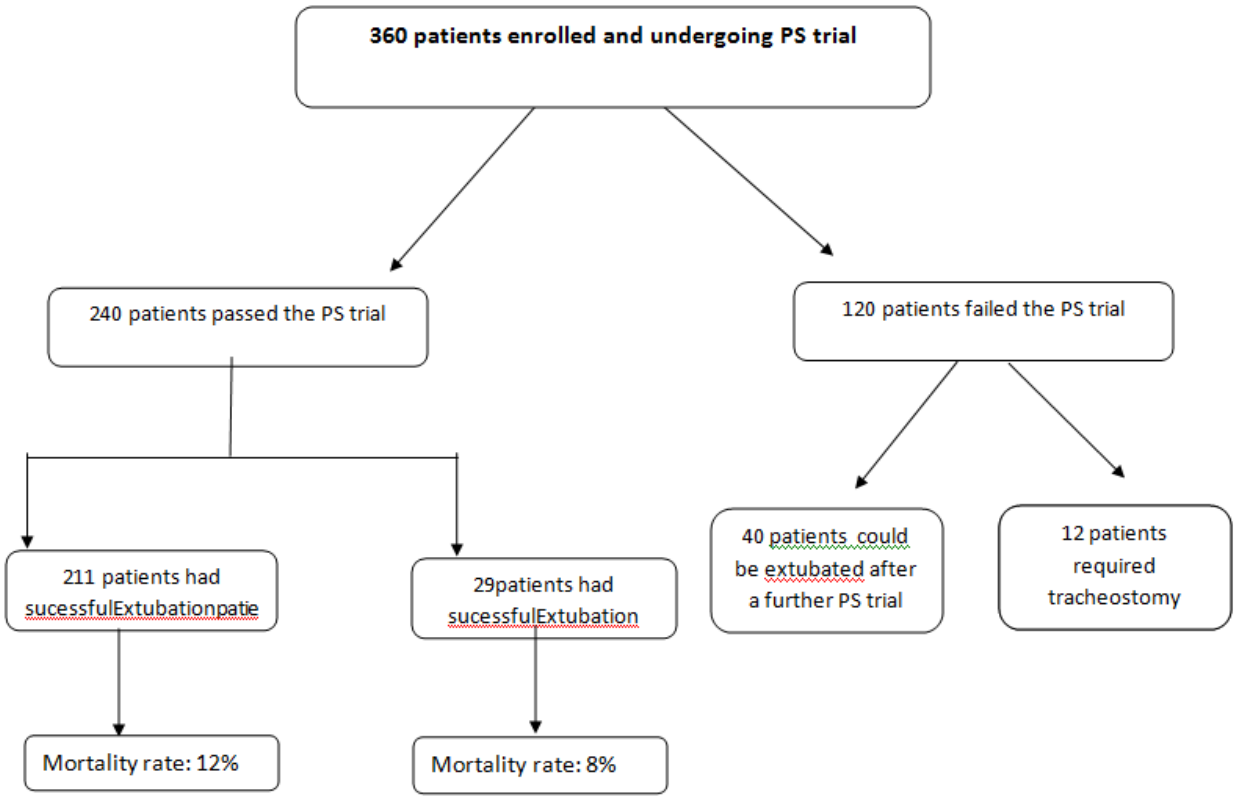

Fig.1 : Principle results of the study

Table 1: Characteristics of the study population

Characteristic	All patients
Gender	
Male	200(55.56%)
Female	160(44.44%)
Median age (month)	36.01± 12.338
Median (weight)	12.01±7.921
Median duration of intubation (hours)	143.98±95.559

Discussion

The goal extubation failure rate in a pediatric ICU is not known. Unnecessary delays in extubation increase cost and the complication rate associated with mechanical ventilation; however, aggressive discontinuation of ventilator support must be balanced against the possibility of extubation failure which carries intrinsic patient risks and complications (18). In this study, we evaluated the role of spontaneous breathing trial in extubation in pediatric intensive care unit. We observed that in 66% patients who were eligible for our study, trial of spontaneous breathing was successful. In our study, 29 patients (12%) were re-intubated. Similar to our findings, Sanjay et al. observed 41 babies of 49 infants(83%) passed SBT and extubation failure rate was 12% (5 of 41 infants) (19). Furthermore, a study of SBT with pressure support in pediatric patients by Lee P et al. revealed success rates of trial 83% and an extubation failure rate 11.2%(20). It

is shown that Successful completion of the SBT has a 95% sensitivity for predicting successful extubation with a positive predictive value of 92% and an odds ratio of 12 (95% confidence interval, 1.3, 53.7). Logistic regression analysis revealed a significant association between passing the SBT and extubation success (P =0 .017) (18).

Farias et al. reported 79.2% patients in the pressure support group ,completed the breathing trial, but 15.1% of them required reintubation within 48 hours. They showed, in infants and children mechanically ventilated, successful extubation was achieved equally effectively after a first breathing trial performed with pressure support or a T-piece(21). However, their study in pediatric patients and studies by Esteban et al. in adult patients demonstrated that the percentage of patients who remained extubated after an SBT with pressure support vs. T-piece ventilation did not differ (22). But Eric's study could suggest that Pressure supports underestimate the work of breathing following extubation (23).

This study has a number of limitations. Although the SBT is standardized, but decisions to extubate, re-incubate, as a planned measure or as a rescue therapy were not controlled and were at the discretion of attending physician. This study was not designed to identify risk factor for extubation failure. While Pediatric studies have shown that patients with a longer duration of intubation, younger age, and chronic respiratory and neurologic disorders have higher extubation failure rates (21, 24).

Conclusion

In this study, 240 patients passed the trial in the first attempt and 40 patients extubated in further trial. Thus, 280 patients (77.77%) passed the trial, successfully. So it could be said that the SBT with pressure support prior to elective extubation may predict successful extubation in ventilated children.

Conflict of interest: None.

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