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Original Article

Flexible bronchoscopic findings and the relationship to repeated extubation failure in critical children

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Abstract

Background: Extubation failure (EF) in acute pediatric cases causes high morbidity and prolonged hospitalization, some of which might encounter EF repeatedly. This study aims to investigate flexible bronchoscopic findings of airway problems associated with repeated EF (REF) in children.

Methods: We retrospectively reviewed the medical records of intubated children from 2005 to 2013 and enrolled those with EF (reintubated within 48 h after extubation) and receiving flexible bronchoscopy (FB) examinations. We divided all subjects into two groups, the REF group (reintubated within 48 h after FB examination) and control group (no need of reintubation), and compared the related clinical conditions and outcomes.

Results: We assessed 30 children (REF group, 17 cases; control group, 13 cases). Among them, no significant difference was observed in age, weight, and underlying diseases. In the REF group, the outpatient ratio, tracheostomy rate, intubation days, respiratory or oxygen supported days, and EF episodes were significantly higher than the control group ($p < 0.05$). Moreover, the FB findings in the REF group exhibited higher ratios of all airway problems and significantly in the presence of upper airway granulations (odds ratio [OR], 17.9, 95% confidence interval [CI]: 2.7−116.9) and subglottic stenosis (OR, 5.4; 95% CI: 1.1−26.0). After discharge, subjects of the REF group required higher medications than those in the control group (OR, 81.0; 95% CI: 3.9−1655.8).

Conclusion: Upper airway granulations or stenosis significantly augment the risk of REF in children; however, these could be diagnosed early by FB, guiding the therapeutic protocol in acute cases. Thus, anatomical problems of upper airways should be considered in intubated children with EF, and FB is a useful tool for the early diagnosis and management.

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Keywords: Children; Extubation failure; Flexible bronchoscopy; Granulation; Intensive care; Subglottic stenosis

1. Introduction

Mechanical ventilation (MV) is a life-saving tool commonly used in pediatric and neonatal intensive care units (ICUs). Pediatric patients with different forms of respiratory failure receive effective airway support from endotracheal tube (ETT) intubations. Patients are typically weaned from MV as they resume spontaneous breathing. MV has been associated

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with several adverse effects, including ventilation-induced lung injury and nosocomial infection, and the positive pressure ventilation (PPV) might cause interactions between the heart and lungs.[1] Thus, shortening the duration of invasive ventilation is imperative. However, patients often require reintubation for adequate respiratory supports within 24−48 h after extubation failure (EF).[2] Reportedly, children with EF have longer hospital and ICU stays, undergo more courses on a ventilator,[3−5] exhibit a longer post-extubation intubation time, a higher mortality rate, and higher hospitalization costs than those without extubation.[2−4,6,7] Moreover, noninvasive ventilation is reportedly used after extubation to reduce the occurrence rate of EF.[1,8]

Little children might encounter EF repeatedly[9]; these repeated EFs (REFs) increase the suffering of children and increases the risk of morbidity. Thus, determining and preventing factors associated with EF and REF are essential in treating acute pediatric cases.

EF is defined as the replacement of an ETT within <48 h after extubation.[2] Reportedly, the incidence of EF is estimated to be 22%−28% in infants and 16%−19% in children; overall, 30%−40% of extremely preterm infants require ETT replacement within 1 week of extubation.[10−13] Lately, several studies have investigated the risk factors and reasons for EF among critically ill children. Reportedly, the risk factors associated with pediatric EF are age younger than 24 months, dysgenetic conditions, syndromic conditions, chronic respiratory and neurological conditions, medical or surgical airway condition, prolonged intubation duration, the mean oxygen index >5, and an MV duration >15 days.[3] Research has established the upper airway obstruction as the leading cause of EF,[1,3,5] necessitating a prompt and precise diagnosis for the adequate management of children with EF to prevent further REF.

In the evaluation of airway disease in children, bronchoscopy facilitates both diagnostic and interventional procedures.[14] Flexible bronchoscopy (FB) is a safe and valuable diagnostic tool for the anatomical airway problems in pediatric ICUs.[15−17] Moreover, therapeutic interventions with FB efficiently relieve airway problems,[15−17] highlighting the potential benefits of applying FB to children with EF. Although the use of FB has been suggested in preterm infants with REF,[9] reports regarding bronchoscopic findings in children with EF are rare. Therefore, comprehensive investigation of airway problems and their relationship to REF in children is mandatory. We hypothesized that airway problems could be diagnosed by FB in REF children. This study aims to investigate FB findings and the related factors to REF in acute pediatric cases.

2. Methods

2.1. Study subjects

We retrospectively reviewed the medical records of all intubated children admitted between January 2005 and December 2013 in the pediatric ICU of a tertiary medical center. In our medical center, the care protocol for children with EF comprised performing FB to assess airway problems if an attending physician judged that a patient was not ready to be extubated 24−48 h after the last reintubation. This study was approved by the Institutional Review Board of Taipei Veterans General Hospital (approval number: VGHIRB2014-11-007A).

The inclusion criteria were as follows: younger than 18 years, experienced EF and requiring reintubation with MV for >24 h, and examined by FB after that episode. We defined EF as the ETT replacement within <48 h after extubation. Conversely, the exclusion criteria were that children had already undergone tracheostomy before the MV of that hospitalization. We divided all enrolled subjects into two groups as follows: (a) REF group, subjects required reintubation after the FB examination within <48 h and (b) control group, subjects required no further intubation after the FB examination.

Data of subjects comprised the following five aspects: (1) demographic variables: children's age, weight, gender, transfer from another hospital, EF episodes before the initial FB examination, total EF episodes, time to reintubation, and etiologies of EF before initial FB examination. (2) Variables associated with patients' diseases: major underlying diseases and respiratory complications. (3) Requirement for the clinical management during hospitalization: total intubation days, intubation days before the initial FB examination, duration of invasive MV (IMV) days, duration of noninvasive PPV (NIPPV) days, respiratory and oxygen requirement days, hospital stay, total ICU stay, ICU readmission rate, tracheostomy rate, requirement for inhaled nitric oxide (iNO), requirement for extracorporeal membrane oxygenation (ECMO), requirement for use of surfactant, and requirement for high-frequency oscillatory ventilation (HFOV). In this study, some children had been transferred from other hospitals and their medical records were collected from the referring hospital; these included intubation days, duration of IMV and NIPPV days, EF episodes, hospital stay, total ICU stay, and any requirement for special intervention (iNO, ECMO, surfactant, and HFOV). We defined respiratory and oxygen requirement days as the total IMV, NIPPV, and supplemental oxygen days required during the patients' complete hospitalization. (4) The outcome of the FB examination: we collected and analyzed all FB procedures and reports. (5) The outcome at discharge: hospital death or survival, requirement for transfer to a long-term facility or for respiratory or oxygen support at discharge.

2.2. Procedures of FB

FB was first performed using a 3.0-mm external diameter with a 30-cm working length without a working channel and was introduced through the ETT to assess the airway below the ETT tip. If the internal diameter of ETT were <3.0 mm, FB would be performed using a 2.2-mm external diameter with a 60-cm working channel. Following the initial FB examination, the trial of extubation was performed, and the FB

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