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Pediatric tracheostomy: Survival and long-term outcomes

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ABSTRACT

Objectives: The objective of this study was to investigate if there were any differences in survival and long-term outcomes between pediatric patients with and without neurological impairment who underwent tracheostomy.
Methods: A retrospective chart review of pediatric patients (age 0–15 years) who underwent tracheostomy between March 2002 and December 2013 was conducted. Patients were categorized into two groups: those who were neurologically impaired (NI) (pediatric cerebral performance category, 3–6) and those who were not neurologically impaired (NN) (pediatric cerebral performance category, 1–2). Survival rates and cumulative incidence of weaning from mechanical ventilation or decannulation were calculated using the Kaplan-Meier method.
Results: A total of 212 patients were included. Among them, 141 were categorized into NI group and 71 into NN group. Between the two groups, there were no significant differences in survival rates and cumulative incidence of weaning from mechanical ventilation. In total patients, one-year survival rate was 0.86 (95%CI 0.80–0.90) and five-year survival rate was 0.71 (0.62–0.78). One-year weaning rate was 0.58 (0.51–0.65) and five-year weaning rate was 0.66 (0.59–0.74). Decannulation rates were significantly lower in NI group than in NN group ($p < 0.001$). One-year and five-year decannulation rates were 0.04 (0.01–0.09) and 0.17 (0.10–0.29), respectively, in NI group, and 0.20 (0.12–0.33) and 0.54 (0.40–0.69), respectively, in NN group.
Conclusions: In children who underwent tracheostomy, the decannulation rate was lower in those with neurological impairment compared with that in those without neurological impairment. There were no significant differences in survival or ventilator weaning between the two groups.

1. Introduction

The frequency and indications of pediatric tracheostomy have undergone notable changes over the last 30 years, and pediatric tracheostomy has recently become a relatively common procedure with approximately 5000 procedures performed in the United States each year [1]. Pediatric patients who require tracheostomy tend to be younger and with chronic diseases [1–7]. The current literature on pediatric tracheostomy contains limited objective data, especially those that describe Kaplan-Meier estimates of survival and long-term outcomes after pediatric tracheostomy.

The aim of this study was to investigate if there are any differences in survival and long-term outcomes between pediatric patients with and without neurological impairment who underwent tracheostomy. We hypothesized that the long-term outcomes would be worse in patients with neurological impairment regardless of their comorbidities. Thus, we categorized our pediatric patients into two groups using the pediatric cerebral performance category (PCPC) as those who were neurologically impaired (NI) (PCPC, 3–6) and those who were not neurologically impaired (NN) (PCPC, 1–2) at discharge from the pediatric intensive care unit (PICU). We evaluated survival and long-term outcomes by using the Kaplan-Meier method.

2. Materials and methods

This is a retrospective observational study at the PICU of the National Center for Child Health and Development (NCCHD) in

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Tokyo, Japan. This study was approved by the ethics committee of our institution (receipt number 1003).

2.1. Patients

We enrolled all the patients aged under 16 years old who underwent tracheostomy between March 2002 and December 2013, and who were admitted to the PICU at the NCCHD. We extracted these patients from the operation register and the PICU register. Medical records were reviewed and the following data were recorded: intubation days before tracheostomy, disposition before tracheostomy, age at tracheostomy, primary diagnosis, follow-up duration after tracheostomy, PCPC at discharge from the PICU, occurrence of an event of weaning from mechanical ventilation, decannulation, death after tracheostomy, and the period from the tracheostomy until weaning from mechanical ventilation or decannulation. Outcomes were survival rates and cumulative incidence of weaning from mechanical ventilation or decannulation after tracheostomy. We estimated these outcomes at the end of June 2015. The unit is a multivalent PICU composed of 20 beds at a tertiary child hospital.

2.2. Tracheostomy procedure and postoperative management

All tracheostomies were performed by otorhinolaryngologists at our institution. In general, systemic management was applied in the PICU during the postoperative acute phase (10–14 days after tracheostomy). Weaning from ventilation was achieved when patients could breathe spontaneously without hypercapnia. Decannulation was considered when all of the following preconditions were satisfied: restoration of the voice, ability to swallow, and no demand for oxygen. Before decannulation, the cannula was exchanged for one that is of smaller size to ensure adequate air circulation, and velopharyngeal training was given when necessary.

2.3. PCPC scale

The PCPC scale was developed to describe the short-term outcome of pediatric intensive care by quantifying cognitive impairment[8]. It is a six-point graded scale of increasing disability from normal function (score = 1) to death (score = 6) (Table 1). A child with Down syndrome is usually classified as PCPC 3. Scale score has been found to be significantly associated with several measures of morbidity, including length of stay in the PICU, total hospital charges, discharge care needs, and the Pediatric Risk of Mortality Score [8].

2.4. Statistical analyses

Patients who underwent tracheostomy were categorized into two groups: NI (PCPC, 3–6) and NN (PCPC, 1–2). Patients' PCPC scores were evaluated at discharge from the PICU by clinicians of the unit.

Descriptive statistics were expressed as medians and interquartile ranges for continuous data, or absolute frequencies and percentage for categorical data. Bivariate comparisons between groups were performed using Mann–Whitney U for continuous data, and Fisher exact for categorical data. Ninety-five percent confidence intervals (95% CI) were also calculated for relevant outcomes. Survival rates were calculated using the Kaplan-Meier method and cumulative incidence of weaning from mechanical ventilation or decannulation were demonstrated as one minus the Kaplan-Meier survival method. Comparisons between groups were performed using the log-rank test. The potential confounding factors were adjusted by Cox proportional hazards model. Two-sided p values less than 0.05 were considered statistically significant. All analyses were performed using R version 3.2.0.

3. Results

A total of 212 patients out of 10,250 patients in the PICU during the study period were included. Among the included patients, 141 were categorized into NI group (PCPC, 3–6) and 71 into NN group (PCPC, 1–2). The characteristics of the two groups are shown in Table 2. The age at tracheostomy was significantly older in NI group than in NN group ($p < 0.001$). In total patients, 142 patients were followed-up for more than one year, and 55 patients for more than five years. Deaths were reported in 47 patients. Causes of death were progression of the underlying disease in 25 patients, sepsis in five, airway-related causes in four, pneumonia in four, and other causes in nine.

Kaplan-Meier estimates of survival rates and cumulative incidence of weaning from mechanical ventilation or decannulation are summarized in Figs. 1–3. Between the two groups, there were no significant differences in survival rates and cumulative incidence of weaning from mechanical ventilation. In total patients, one-year survival rate was 0.86 (95%CI 0.80–0.90) and five-year survival rate was 0.71 (0.62–0.78). One-year weaning rate was 0.58 (0.51–0.65) and five-year weaning rate was 0.66 (0.59–0.74). Decannulation rates were significantly lower in NI group than in NN group ($p < 0.001$). In NI group, one-year and five-year decannulation rates were 0.04 (0.01–0.09) and 0.17 (0.10–0.29), respectively, and in NN group, 0.20 (0.12–0.33) and 0.54 (0.40–0.69), respectively. When adjusting for age in the Cox proportional hazards model, decannulation rates remained significantly lower in NI group than in NN group ($p < 0.001$).

Thirty patients received additional airway surgical interventions under general anesthesia after tracheostomy to achieve or attempt decannulation. Among them, there were 21 cases of resection of tracheal granuloma, two cases of resection of upper airway tumor, and two cases of glossectomy. Bronchial foreign body removal, tracheoesophageal fistula repair, anterior tracheal wall suspension,

Table 1
Pediatric cerebral performance Category scale.

Score	Category	Description
1	Normal	Normal; at age-appropriate level; school-age child attending regular school classroom
2	Mild disability	Conscious, alert, and able to interact at age-appropriate level; school-age child attending regular school classroom, but grade perhaps not appropriate for age; possibility of mild neurologic deficit
3	Moderate disability	Conscious; sufficient cerebral function for age-appropriate independent activities of daily life; school-age child attending special education classroom and/or learning deficit present
4	Severe disability	Conscious; dependent on others for daily support because of impaired brain function
5	Coma or vegetative state	Any degree of coma without the presence of all brain death criteria; unaware, even if awake in appearance, without interaction with environment; cerebral unresponsiveness and no evidence of spontaneous eye-opening, and sleep-wake cycles
6	Brain death	Apnea, areflexia, and/or electroencephalographic silence