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Outcomes following neuromuscular blockade in patients receiving tracheostomies

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ABSTRACT

Objective: The purpose of this study is to determine whether the use of neuromuscular blockade agents (NMBAs) in pediatric patients following tracheostomy is associated with increased rates of complications or a prolonged length of stay.
Methods: This was a single-center retrospective chart review of pediatric patients undergoing tracheostomy placement between 2010 and 2013 who were admitted to the pediatric or neonatal intensive care units and did or did not receive NMBA within 7 days post-procedure.
Results: Out of 114 included patients, 26 (23%) received NMBAs during the postoperative period. Patients receiving NMBAs were more likely to have cardiac disease and preoperative respiratory failure but less likely to have neurologic disease. Patients receiving NMBAs had a longer median postoperative length of stay (33 vs. 23 days, $p = 0.043$) and were more likely to have postoperative ileus (12% vs. 3%, $p = 0.037$).
Conclusion: In patients undergoing tracheostomy placement, use of NMBAs is associated with prolonged postoperative hospital courses. NMBAs are not associated with a higher likelihood of postoperative complications.

1. Background

Tracheostomy is a relatively common pediatric procedure, with 5000 tracheostomy placements performed annually in children within the United States [1,2]. Tracheostomies are placed for prolonged mechanical ventilation in children with complex neurologic and cardiopulmonary diseases and to manage critical airways in premature infants and children [3–8]. Risks following pediatric tracheostomy are numerous and can be as high as 24% [3]. Risks include A National Surgical Quality Improvement Program review revealed up to 7.8% of patients suffer postoperative pneumonia, 5.8% suffer sepsis or death, and 3.9% have deep or organ surgical site infections [3]. One potential devastating complication following tracheostomy placement is accidental decannulation, occurring in 8–15% of patients and resulting in a 0–3.5% rate of mortality for these patients [4,9–13].

To limit the likelihoodof decannulation, patients have to be carefully controlled post-procedure, often with medical means, to prevent agitation or excessive movement. This is most often achieved with sedation by means of opioid analgesia, other sedative medications, or paralysis by means of neuromuscular blocking agents (NMBAs). Selecting between the two strategies can be difficult, as this group of children requires highly coordinated management of multiple medical problems [14,15].

Studies that focus onlimiting the use of muscle relaxants or the non-continuous use of muscle relaxants following single-stage laryngotracheoplasty show that this method can be safe and may decrease intensive care unit and hospital length of stay, decrease total days of mechanical ventilation, and reduce post-operative weakness [16–19]. However, there is currently no investigation on the use of neuromuscular blockade agents following tracheostomy and the effects of these medications on hospital length of stay and complications. The hypothesis of theinvestigation is use of

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neuromuscular blockade agents following tracheostomy will prolong length of stay and increase the rate of complications in the post-operative period.

2. Methods

This is a retrospective chart review of pediatric patients (0–18 years of age) who had a tracheostomy placed at Nationwide Children's Hospital in Columbus, Ohio between 2010 and 2013 who did or did not receive a neuromuscular blockade agent (NMBA) following surgery. Patients who were admitted to the cardiothoracic intensive care unit were excluded as the differences in practitioners in this unit and high rate of co-morbities precluded meaningful analysis. This study was approved by the Nationwide Children's Hospital Institutional Review Board.

Patient medical records during the admission for the procedure and thirty days following the procedure were reviewed. Patients were defined as having had an NMBA following surgery if they received at least one bolus injection or one period of continuous administration of one of the following agents within 7 days of surgery: pancuronium, pipercuronium, vecuronium, rocuronium, rapacuronium, d-turbocurarine, cisatracurium, atracurium, doxacurium, mivacurium, and succinylcholine. Recorded demographics included patient age at time of surgery, gender, race, and ethnicity. The location of medical care prior to tracheostomy placement was recorded as either neonatal intensive care unit (NICU) or pediatric intensive care unit (PICU). Clinical characteristics of the patients that were recorded include patient weight, height and mode of nutrition (oral, enteral, parenteral) as recorded within progress notes nearest the date of surgery. Chronic medical problems in the following categories were documented: congenital anomalies, cardiac, respiratory, neurologic, palatal anomaly, musculoskeletal anomalies, and genetic syndromes. The indication for tracheostomy was denoted as one of the following categories: neurological, cardiopulmonary, craniofacial, trauma, upper airway obstruction, or multiple indications [1]. The presence of respiratory failure within three days prior to surgery was noted and the duration of intubation prior to surgery was documented. Use of inotropes at or before surgery, cardiopulmonary resuscitation within seven days of surgery, corticosteroid or aminoglycoside (excluding inhaled tobramycin) use within thirty days prior to operation due to possible potentiation of neuromuscular blockade, and administration of blood products within 48 h prior to surgery were recorded. The following labs and vitals were recorded nearest the date of surgery: temperature, heart rate, systolic blood pressure, Glasgow Coma Scale, pupillary response, arterial blood gas, blood urea nitrogen, creatinine, potassium, glucose, white blood cell count, platelet count, and coagulation values. These variables were utilized to calculate the Pediatric Risk of Mortality (PRISM) score for patients in the PICU. The use of neuromuscular blockage agents was recorded including amounts and rates. The use of sedative medications was documented and converted to total parenteral morphine equivalents from postoperative day 0–7. If decannulation was performed, then the date of this procedure was noted. The use of blood products within the first 72 h postoperatively was recorded. Complications which occurred within 30 days postoperatively were recorded in the following categories: decubitus ulcer, pneumonia, urinary tract infection, ileus, deep vein thrombosis, tracheostomy-related pressure ulcer, and death.

Statistical analyses were performed to compare patients who received NMBA to those who did not. Chi-square and Fisher Exact tests for categorical variables and Wilcoxon rank sum tests for continuous variables were used to compare baseline patient characteristics. In all analyses, p-values <0.05 were considered statistically significant. All statistical analyses were performed using SAS version 9.3 (SAS Institute, Inc., Cary, NC).

Table 1
Characteristics of patients treated with and without neuromuscular blockade agents (NMBA) following tracheostomy placement.

	No NMBA ($N=88$)	NMBA ($N=26$)	p-Value
Age, years	0.9 (0.2–5.2)	0.5 (0.3–2.3)	0.340
Female	33 (38)	16 (46)	0.428
Race			
White	63 (72)	11 (42)	0.020*
Black	15 (17)	10 (38)	
Other or unknown	10 (11)	5 (19)	
Body mass index (BMI)	17.0 (15.0–19.5)	16.6 (14.9–20.0)	0.970
Prior medical conditions			
Congenital disease	60 (68)	21 (81)	0.214
Cardiac disease	19 (22)	13 (50)	0.005*
Neurologic disease	71 (81)	14 (54)	0.006*
Pulmonary disease	79 (90)	26 (100)	0.116
Palate anomalies	5 (6)	3 (12)	0.380
Musculoskeletal disease	38 (43)	10 (38)	0.668
Genetic syndrome	23 (26)	9 (35)	0.398
Reason for tracheostomy placement			
Cardiopulmonary	16 (18)	14 (54)	<0.001*
Craniofacial	1 (1)	1 (4)	0.406
Neurological	33 (38)	2 (8)	0.003*
Trauma	13 (15)	2 (8)	0.514
Upper airway obstruction	29 (33)	9 (35)	0.875

Results are expressed as frequencies (percent) for categorical variables and median (interquartile range) for continuous variables. Reasons for tracheostomy placement sum to greater than total because some patients had multiple reasons for tracheostomy placement.

* Significant at $p < 0.05$.

3. Results

Out of 114 patients who met inclusion criteria, 26 (23%) patients received paralytics in the postoperative period. Table 1 presents demographics and preoperative factors. Patients receiving NMBAs were more likely to have cardiac disease or cardiopulmonary indications for tracheostomy placement but were less likely to have neurologic disease or neurological indications for tracheostomy placement.

Table 2 compares the inpatient course of patients undergoing tracheostomy placement who did or did not receive postoperative NMBAs. There were no instances of decannulation in either cohort. There was no difference in the proportion of patients treated in the NICU or PICU. Patients receiving NMBAs did have longer preoperative lengths of stay and longer periods of intubation prior to tracheostomy placement. They were also more likely to have respiratory failure prior to tracheostomy placement. There were no differences in the preoperative treatments provided or in the mode of nutrition for patients in either group. They also did not differ with respect to PRISM score, an indicator of overall mortality for intensive care patients.

The postoperative outcomes of patients treated with and without NMBAs are presented in Table 3. Patients receiving NMBAs had a longer postoperative length of stay (insert data, p-value). Patients receiving NMBAs were not more likely to receive opioid analgesia and did not receive more opioid analgesic agents postoperatively (insert data). Benzodiazepine use was also similar between the two groups. Patients who received NMBAs were more likely to receive dexmedetomidine for sedation than patients who did not receive NMBAs (insert data). Patients receiving NMBAs were not more likely to have postoperative complications or death prior to discharge.