ORIGINAL ARTICLES
PHILIPPINE JOURNAL OF OTOLARYNGOLOGY-HEAD AND NECK SURGERY VOL. 34 NO. 2 JULY – DECEMBER 2019

Timing of Tracheostomy, Weaning from Mechanical Ventilation and Duration of Hospitalization among a Sample of Pediatric Patients

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ABSTRACT

Objective: To determine if there is a difference in the duration of mechanical ventilation and hospitalization between patients who underwent early compared to late tracheostomy.

Methods:

Design: Causal-Comparative (*ex post facto*) Chart Review

Setting: Tertiary National University Hospital

Participants: Records of 68 pediatric patients who underwent elective tracheostomy from January 1, 2013 to June 30, 2018 were considered for inclusion. Patients were excluded if invasive mechanical ventilation was not done for at least a day prior to tracheostomy, if they underwent emergency tracheostomy or had incomplete records. Selected patients were categorized in the early tracheostomy group if the procedure was performed within 14 days of mechanical ventilation and late tracheostomy group if performed beyond 14 days. Early post-tracheostomy weaning from mechanical ventilation was defined as less than 7 days from time of tracheostomy.

Results: A total of 21 patients were included, 6 in the early tracheostomy group and 15 in the late tracheostomy group. Although early tracheostomy did not show significant association with shortened post-tracheostomy duration of mechanical ventilation (O.R. 6; C.I. 0.276 to 130.322; p = .476), two-sample t-tests showed the early tracheostomy group had a significantly shorter mean duration of mechanical ventilation and hospitalization compared to the late tracheostomy group (13.17 vs. 54.13 days, p = .0012; 21.17 vs. 66.67 days, p = .0032).

Conclusion: Although early tracheostomy does not shorten post-tracheostomy mechanical ventilation support, there is a significant difference in the duration of mechanical ventilation and hospitalization between early and late tracheostomy groups and this may suggest potential benefits of performing tracheostomy earlier in children.

Keywords: *tracheotomy; pediatric; mechanical ventilation; hospitalization*

Historically, the common indication for tracheostomy in children was for relief of acute inflammatory airway obstruction, but this changed with the use of vaccines and development

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Philipp J Otolaryngol Head Neck Surg 2019; 34 (2): 16-19

of modern neonatal intensive care units. These changes allowed increased survival of neonates and preterm babies with complex cardiopulmonary disease, shifting the main indication of tracheostomy to cases of prolonged intubation.[1,2]

For adults, it is generally recommended that patients who are on mechanical ventilation or expected to be on mechanical ventilation for > 2 weeks undergo tracheostomy.[3] For pediatric patients, to the best of our knowledge, it seems there is currently no consensus as to when to perform tracheostomy[4,5] although it is claimed that children can tolerate intubation for longer period than adults.[6] A current institutional guideline[7] recommends a safe period of 30 to 60 days intubation before considering elective tracheostomy in pediatric patients more than 1 year old. However, this prolongs hospital stay of patients, extends use of hospital resources, and increases expenses.

This study aims to determine if there is a difference in the duration of mechanical ventilation and hospitalization between patients who underwent early compared to late tracheostomy.

METHODS

This causal-comparative chart review considered for inclusion records of all pediatric patients (age ≤ 18) admitted in the Philippine General Hospital who were referred for tracheostomy to the Department of Otorhinolaryngology and underwent the surgical procedure between January 1, 2013 and June 30, 2018. The study was approved by the University of the Philippines Manila Research Ethics Board (UPMREB 2018-310-01). Informed consent was waived by the board.

Data of tracheostomies performed on pediatric patients were reviewed from the departmental operating room (OR) census, then in-patient records were retrieved from the hospital records section and the following variables were obtained: age, sex, indication for tracheostomy, date of hospital admission, date of intubation, date of tracheostomy, date of weaning from mechanical ventilation and date of hospital discharge. Patients were excluded if they were not on mechanical ventilation for at least a day prior to tracheostomy, if they underwent emergency tracheostomy or had incomplete records.

Duration of mechanical ventilation was counted in days starting from the date of intubation up to the date of weaning. Duration of hospitalization was counted in days starting from the date of admission up to the date of hospital discharge. The patients were categorized in the early tracheostomy group if the tracheostomy was performed within 14 days of mechanical ventilation and late tracheostomy group if performed beyond 14 days. This definition was based on a previous study.[8] Post-tracheostomy duration of mechanical ventilation was determined, with weaning from mechanical ventilation considered early if within < 7 days from the time of tracheostomy, and late if ≥ 7 days from the time of tracheostomy. Tests for association between early tracheostomy and shortened post-tracheostomy duration of mechanical ventilation among patients 3 years old or younger, and those above 3 years old (based on pediatric airway development) was performed.

The deidentified data were recorded by the principal investigator in MS Excel for Mac v.16.20 (2018, Microsoft Corp., Redmond, WA) and analyzed by a statistician using STATA Release 14 (2015, StataCorp LP, College Station, TX) software. Descriptive summary measures (mean, standard deviation, range) were used and inferential statistics included a two-sample T-test for two means to compare the average difference of patients in the two treatment arms that were considered as independent samples. A p-value of less than .05 was considered statistically significant. Odds ratios were computed to test for association between early tracheostomy and post-tracheostomy duration of mechanical ventilation.

RESULTS

Records of a total of 68 pediatric patients who underwent tracheostomy between January 1, 2013 and June 30, 2018 were considered for inclusion. Excluded were 47 patients: 34 who underwent emergency tracheostomy and 13 who had incomplete records. The records of 21 patients (13 male, 8 female) were finally included in the study. Age range was 2 months to 12 years old with a mean age of 5 years. There were 6 in the early tracheostomy group and 15 in the late tracheostomy group, with a M/F ratio of 4:2 and 9:6 in the early and late tracheostomy group respectively.

The indication for tracheostomy in most (n=19) was prolonged intubation while a minority (n=2) were due to airway obstruction. The minimum time before tracheostomy was 2 days while the maximum time was 93 days. The average pre-tracheostomy MV duration was 10.33 days in the early tracheostomy group and 46.13 days in the late tracheostomy group.

Table 1 presents the total duration of mechanical ventilation in the two tracheostomy groups. In the early tracheostomy group the mean duration of mechanical ventilation was 13.17 days while in the late tracheostomy group it was 54.13 days. There was a significant difference between the duration of mechanical ventilation in the early tracheostomy group compared to the late tracheostomy group (p = .0012)

Table 2 presents the hospital duration in the two groups. The mean hospital duration in the early tracheostomy group was 21.17 days while in the late tracheostomy group it was 66.67 days. Comparing the two means showed a significant difference (p = .0032)

However, the associations between early tracheostomy and shortened post-tracheostomy duration of mechanical ventilation across the population [O.R. 6 (0.276 to 130.322); P = .476], for patients 3 years old and below [O.R. 2.4 (0.079 to 72.896); P = .798], and those above 3 years old [O.R. 3.6 (0.13 to 99.424); P = .928] were not statistically significant. *(Tables 3, 4, 5)*

Table 1. Comparison of Early and Late Tracheostomy with Duration of Mechanical Ventilation

	N	Mean (Day)	Std. Err.	Std. Dev.	95% Conf. Interval	p-value
Early	6	13.17	1.89	4.62	8.32 - 18.02	
Late	15	54.13	7.24	28.05	38.60 - 69.67	.0012
Diff		-40.97	11.69		-65.43 - -16.50	

t = -3.50
Degrees of freedom = 19

Table 2. Comparison of Early and Late Tracheostomy with Hospital Duration

	N	Mean (Day)	Std. Err.	Std. Dev.	95% Conf. Interval	p-value
Early	6	21.17	4.40	10.78	9.86 - 32.48	
Late	15	66.67	8.24	31.92	48.99 - 84.34	.0032
Diff		-45.5	13.50		-73.76 - -17.24	

t = -3.37
Degrees of freedom = 19

Table 3. Early tracheostomy vs Early weaning from post-tracheostomy mechanical ventilation

	Weaning from MV after tracheostomy for < or = 7 days	Weaning from MV after tracheostomy for > 7 days
Tracheostomy after intubation for <14 days	6	0 (0.5)
Tracheostomy after intubation for >= 14 days	10	5

Odds ratio: 6 (0.276 to 130.322)
P value .476

Table 4. Early tracheostomy vs Early weaning from post-tracheostomy mechanical ventilation for pediatric patients less than or equal to 3 years old

Age 3 years old or less	Weaning from MV after tracheostomy for <or = 7 days	Weaning from MV after tracheostomy for > 7 days
Tracheostomy after intubation for <14 days	3	0 (0.5)
Tracheostomy after intubation for >= 14 days	5	2

Odds ratio: 2.4 (0.079 to 72.896)
P value .798

Table 5. Early tracheostomy vs Early weaning from post-tracheostomy mechanical ventilation for pediatric patients greater than 3 years old

Age above 3 years old	Weaning from MV after tracheostomy for <or = 7 days	Weaning from MV after tracheostomy for > 7 days
Tracheostomy after intubation for <14 days	3	0 (0.5)
Tracheostomy after intubation for >= 14 days	5	3

Odds ratio: 3.6 (0.13 to 99.424)
P value: .928

DISCUSSION

Our study showed that there was a statistically significant difference in the total duration of mechanical ventilation and hospitalization among early versus late tracheostomy groups of tracheotomized pediatric patients in our institution.

In adult patients, tracheostomy is usually performed within two weeks of mechanical ventilation[3] with some recommending adult tracheostomy at < 10 days[4,9] or even as early as 72 hours on mechanical ventilation.[10] In contrast, there is still seems to be no definite criteria with regards the timing of tracheostomy in pediatric patients.[4,5] A survey of 28 pediatric intensive care units in the UK showed variation in answers with regards to the duration of invasive ventilation before considering tracheostomy: four units suggested less than 14 days of mechanical ventilation while other units suggested > 14 days or > 28 days with some respondents even considering more than 90 days.[11] Wakeham *et al.*[12] reported a variation of pre-tracheostomy ventilation ranging from 4.3 days to 30.4 days. Further analysis revealed that an infectious or cardiac diagnosis and 2 or more reintubations are associated with longer time to tracheostomy. Our current institutional guidelines suggest 30 to 60 days before considering tracheostomy in patients more than one year old.[7]

In our current study, the range of pre-tracheostomy ventilation was 2 to 93 days. The cut-off of 14 days to delineate between early and late tracheostomy was extrapolated from adult studies cited by Holloway *et al.*[8] In their study of 73 pediatric patients, they determined that the total hospital length of stay was 4 weeks shorter in the early tracheostomy group. A similar study of 111 pediatric patients by Lee *et al.*[5] showed a significantly shorter duration of MV, and length of ICU and hospital stay in the early tracheostomy group. In this study, a cut-off of 14 days was also used to classify patients into early and late tracheostomy groups.[4] Lin *et al.*[1] also concluded that earlier tracheostomy can shorten total MV

and hospital duration although the study set their cut-off at < 30 days for early tracheostomy.

There was no association between early tracheostomy and the post-tracheostomy duration of mechanical ventilation across the pediatric population in our study as shown in table 3-5. This suggests that overall duration of mechanical ventilation (pre-tracheostomy + post-tracheostomy) and hospital stay may be decreased by shortening the pre-tracheostomy period, i.e., performing an early tracheostomy.

The possible relationship of early tracheostomy to early weaning is easy to posit. Bypassing the upper airway with a tracheostomy decreases the work of breathing, which may in turn aid a patient with neurological or muscular disease or one experiencing difficulty in weaning.[6] Subsequently, earlier weaning can increase patient comfort, facilitate earlier ambulation and mobilization, improve tracheal toilette, oral feeding and rehabilitation and overall better quality of life for the patient[5,6,11] while earlier hospital discharge can possibly reduce nosocomial infection.[6]

Our study has several limitations. First, the small sample size prevented determination of correlations between variables. Other possibly confounding or intervening variables were not accounted for, from which possible biases could arise. These include differences in underlying diseases and morbidities (such as concomitant neurological disease or cardiovascular disease) that may have influenced the timing of tracheostomy. Another limitation is the bias from selection inclusion (inherent to our study design), where measurement of pre-tracheostomy time contributes to the outcome measurement of overall mechanical ventilation and hospital time.

A prospective multi-center study with a larger sample size is recommended to obtain better correlations. Such variables as early and long-term follow-up, early and late complications, concomitant diseases and decannulation rates that can better establish the optimum time for tracheostomy in individual pediatric patients, should be analyzed.

In conclusion, our study found significant differences in the duration of mechanical ventilation and hospitalization between early and late tracheostomy groups and may suggest these benefits of performing tracheostomy early in children, although early tracheostomy does not shorten post-tracheostomy mechanical ventilation support.

ACKNOWLEDGEMENTS

We thank Angelica Anne E. Latorre, MPH, MSPH(candidate) of the University of the Philippines Manila - College of Public Health for her assistance with statistical analysis.

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