Japan Journal of Otolaryngology

Available Online: https://jjo.edwiserinternational.com

Pediatric Tracheostomy Practice in the Developing World: A Thai Experience

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Article info

Received 02 July 2020
Revised 20 July 2020
Available Online 24 July 2020

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Abstract

Objective: *To review pediatric tracheostomy practices in a middle-income country at a resource limited hospital.*

Methods: *We conducted a two-part study reviewing pediatric tracheostomy practice at a Thai tertiary academic center. Patients aged under eighteen who underwent a tracheostomy at Thammasat University Hospital (TUH) between January 2010 to September of 2019 were reviewed. Secondly, a cost analysis was done to review the financial implication from transitioning tracheostomy tube changes in the operating room suite to the outpatient clinic. Additionally, we review our Department's process with transitioning to this modality.*

Results: *Twenty-four patients underwent tracheostomy at TUH during the study time frame. The mean total cost of tracheostomy tube changes for inpatient (n=19) and outpatient cases (n=4) were 47,603.59 THB (1586.79 USD) and 787.38 THB (26.25 USD) respectively. There was a near-19-fold reduction in tracheostomy tube change costs when performed in the outpatient clinic.*

Conclusion: *Pediatric tracheostomy changes in the outpatient clinic is a safe, cost-saving, modality in the developing world. The long-term financial benefit from transitioning from an inpatient to outpatient setting for pediatric tracheostomy change is promising.*

Keywords: *Global health; Cost analysis; Developing healthcare; Pediatric; Tracheostomy*

Introduction

Tracheostomy remains a common and safe procedure providing relief for children with upper airway obstruction or needs for long-term ventilation [1]. With the advancement of neonatal care and specifically the care of premature infants throughout the years, we know that most pediatric tracheostomy procedures occur within the first year of life. Most of these being for prolonged ventilatory needs [2]. The burden, however, put upon a patient's family when a tracheostomy is chosen is significant and even more so in the developing world. The most recent guidelines regarding pediatric tracheostomy care occurred in 2013 and included a review of both adult and pediatric tracheostomy literature [3]. Medical care during the postoperative period and proper education to caregivers is paramount to decrease complications requiring re-admission [4]. Many of these patients will have a tracheostomy tube for prolonged time frames, averaging at least two years [5]. Additionally, complications remain an unsettling problem for patient's families and surgeons during this time period. These complications can include further airway obstruction, air leakage, and tracheal injury [6]. Thailand, similar to more socio-economically advanced countries, perform pediatric tracheostomies on a regular basis. However, postoperative care remains widely varied, and this discrepancy may not always be easily clarified. This is even more so in the developing world.

Most pediatric patients with a tracheostomy tube in Thailand, regardless of severity of the patient's airway, undergo routine tracheostomy tube changes by their treating physician in the clinic and in some instances in the operating suite. We know that in the West and in more developed nations, many children are able to have their tubes changed at home by their primary caregivers or nursing personnel. However, home tracheostomy tube changes for pediatric patients in Thailand is met with considerable barriers. With roughly 77% of the general public finishing secondary education compared to around 90% in the United States, the educational gap is not insignificant [7]. It is understandable why many families may be uncomfortable performing with a higher level of tracheostomy care. Therefore, in resource-limited settings such as Thailand, an outpatient setting may alternatively serve as the most cost-effective and viable approach to performing tracheostomy tube changes.

In this study, the Senior author hopes to elucidate pediatric tracheostomy care in the developing world where resources are limited. Additionally, we clarify the transition of pediatric tracheostomy changes from an inpatient to outpatient procedure and the barriers associated with such a move at a tertiary academic healthcare center located in Pathum Thani Province, Thailand. In addition to a review of patient demographics, parental concerns and experience with tube care, current decannulation protocol, we also perform a cost-effective analysis on reforming the routine protocol in tracheostomy tube changes at our hospital. The transition to an outpatient protocol presents a challenge in resource-limited settings with limited prior experience in the matter.

Material and Methods

This study was divided into two independent parts:

(1) Retrospective analysis of pediatric tracheostomy patients-

This included a review of demographics, indication for tracheostomy, comorbidities, and current parent concerns from patients who underwent a tracheostomy from January 1st, 2010 to September 30th, 2019 at TUH.

(2) Tracheostomy tube change protocol transition-

Staff members were surveyed regarding the barriers to transitioning to an outpatient procedure. Once those concerns were addressed, we implemented training to prepare staff members and repeated the survey to assess whether their fears were allayed.

The new protocol has allowed tracheostomy tube changes to occur as an outpatient case, where patients undergo tube changes by the treating physician with help from Otolaryngology nursing staff, eliminating the need for overnight admission or general anesthesia. Of note, routinely pediatric patients with a tracheostomy who underwent general anesthesia necessitated an inpatient stay per hospital policy.

Analysis of the former strategy of inpatient (operating room) tracheostomy tube changes, including fixed costs for the patient, such as fees associated with nursing, anesthesia, and operating room use was completed. Next, a cost comparison was made to the newly implemented change of tracheostomy changes in the outpatient clinic. Data with regards to hospital, treatment, and administrative fees pre- and post-protocol change were acquired from the Accounting Department, patient's electronic database system, and the Information Technology Department when relevant.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

This study was approved by the Human Research Ethical Committee, Faculty of Medicine, Thammasat University.

Decannulation protocol

All tracheostomies at our hospital are performed by an otolaryngologist, and recently within the past three years, solely by a Pediatric Otolaryngologist. For patients under one year of age, the patient is typically evaluated for decannulation at a minimum of twelve months of age. Given that most of our infant pediatric cases are also followed by our Pulmonary colleagues, these patients undergo clearance from the Pediatrics faculty member prior to discussion for decannulation. The child then undergoes a flexible laryngoscopy in the clinic to rule out any supraglottic anomaly. If the child has been stable without any tracheostomy or airway concerns, and no known subglottic or tracheal anomaly exists, the family is instructed to practice finger occlusion with the child and monitor closely if the child has any symptoms at home. Once a trial of finger occlusion is passed, the family is then instructed to utilize medical tape to occlude the tracheostomy tube while the child is monitored and awake. Currently, our hospital does not stock manufactured caps for tracheostomies (both adult and pediatric) due to its low-cost benefit ratio. They are then instructed to report how long the child is able to tape-occlude without symptoms. Next, airway patency and tracheal lesions are assessed via direct laryngoscopy and rigid bronchoscopy. Granulomas are excised that potentially could cause obstruction. A repeat airway evaluation is then done two weeks post excision to assure no concerning regrowth occurs. Once a stable airway is confirmed on repeat

endoscopic exam, decannulation is planned during the same admission. The child is admitted to the PICU postoperatively and the tracheostomy tube is removed. The child then spends 48 hours in the PICU for observation and an additional 24 hours on the pediatric ward prior to discharge, monitoring vital signs and oxygen saturation. We acknowledge that some children may be symptomatic with a capped pediatric tracheostomy tube in the airway and in these cases consider decannulation if the endoscopic exam is normal and prior clinical evaluations did not reveal concerns.

Results

Patient's Demographic Data

A total of 24 tracheostomy cases between the 1st of January 2010 and 30th of September 2019 were analyzed. Among those, fifteen patients were male, and nine patients were female. The most common nationality was Thai, followed by those from Myanmar. The mean age at the time of tracheostomy was 2.54 years, ranging from zero days to fourteen years. The health coverage of these patients, along with other demographic data, are summarized in Table 1. Fifty-eight percent of tracheostomies were done within the 1st year of life. The chief indication was airway access due to prolonged ventilation (58.34%), followed by craniofacial abnormalities (20.83%), laryngomalacia (8.33%), unknown causes (8.33%), and subglottic stenosis (4.17%). Six patients (25.00%) were deceased at the time of data collection. Table 2 demonstrates the different primary diagnoses of patients who underwent tracheostomy due to prolonged ventilation (n=14), with the most common diagnosis being hypoxic-ischemic encephalopathy, at four out of 14 cases (28.57%). Pierre Robin Sequence and Treacher Collins Syndrome (two out of five, 40%) were the only conditions which required patients to undergo tracheostomy due to craniofacial abnormalities (n=5), as demonstrated in Table 3. Other indications for tracheostomy are listed in Table 4. Five different syndromes were seen in the population group, which included 5q deletion syndrome, inv9(p12,p13) syndrome, DiGeorge Syndrome, Pierre Robin Sequence, and Treacher Collins Syndrome, as illustrated in Table 5. One patient required return to the operating room for control of bleeding, and all patient deaths were from non-tracheostomy related complications. There were no other major complications including tracheoinnominate fistula or tube obstruction.

Protocol change

Twenty-four billing accounts from patients were reviewed pre- and post-protocol transition. Demographic data was reviewed and is listed in Table 1. A total of four Otolaryngology outpatient clinic nurses (all current staff) were surveyed regarding their opinions and concerns regarding tracheostomy tube changes before institution of protocol change. A pediatric basic life support class was organized with compulsory attendance of all Otolaryngology residents, the Senior author, and nursing personnel in the outpatient department. Next, all nursing personnel, accompanied by the Senior author made an organized visit to the only public Children's Hospital in Thailand to witness pediatric tracheostomy tube changes in the outpatient clinic setting.

Patient cost for pre- and post-protocol change

A total of 24 patients who had a tracheostomy at TUH during the study period were identified. Eleven patients who did not receive further tracheostomy tube changes at our institution were excluded. An additional seven billing accounts had insufficient billing data, and therefore were discarded. For the remaining six patients, 23 receipts were acquired from the patient's electronic database system. Nineteen receipts recorded the cost of the in-patient tracheostomy tube change, and four receipts documented the cost of a tracheostomy tube change after the new protocol implementation (outpatient tracheostomy tube change). Two in-patient tube change receipts had to be excluded from the study as the receipt also contained the cost of the tracheostomy procedure. The mean total cost of tracheostomy tube changes for inpatient (n=17) and outpatient cases (n=4) were 21,296.34 THB (709.88 USD) and 787.38 THB (26.25 USD) respectively. Table 6 lists the cost comparison for patients who had coverage via one of three government subsidized entities: Universal Healthcare Scheme (UC), Social Security Scheme (SSS), and Government or State Enterprise Officer Coverage (OFC), where the patient is only required to pay the non-refundable fee. An adjusted in-patient cost of a tracheostomy tube change was also calculated where a case which had an extensive length of stay at the hospital due to multiple complications after the tube change, was removed. The adjusted cost for an in-patient tracheostomy tube change was at 14,737.73 THB (491.26 USD). By comparison, the adjusted cost for the in-patient tracheostomy tube change and an out-patient tracheostomy tube change revealed near-19-fold reduction in cost. As illustrated in Table 6, the highest cost burden for a non-adjusted in-

patient tracheostomy tube change is room costs at a mean of 6,217.65 THB (207.26 USD), followed closely by the cost for anesthesia, and anesthesia-related procedures at 6,127.94 THB (204.26 USD). For the adjusted in-patient tracheostomy tube change cost, the highest cost burden is the procedural and anaesthesia costs at 4,373.44 THB (145.78 USD), followed by room costs at 3,006.25 THB (100.21 USD). In regard to an out-patient tracheostomy tube change, the cost for the tracheostomy tube, ensues the highest burden at 328.75 THB (10.96 USD), followed closely by the cost of local anaesthesia, at 305.00 THB (10.17 USD).

Nurses' opinions and concerns

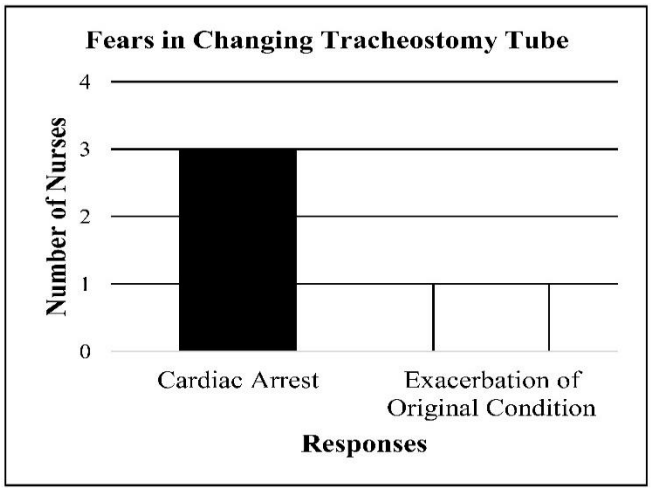

Figure 1: Chart illustrating Otolaryngologic nurses' response on fears in changing tracheostomy tube.

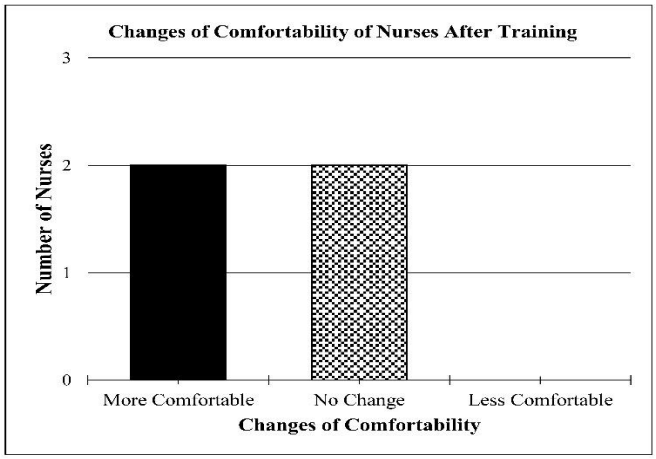

Figure 2: Chart demonstrating Otolaryngologic nurses' response on comfortability in changing tracheostomy tube after workshop training in pediatric cardiopulmonary resuscitation.

We surveyed our four Otolaryngologic nurses with regards to their opinions and potential concerns during the process of a tracheostomy change. The average number of years of experience our nursing personnel in the Otolaryngology clinic have is 10 years. The most feared potential complication of tracheostomy tube was cardiac arrest, as illustrated in Figure 1. The nurses viewed that both specialized physicians and nurses should be responsible for changing tracheostomy tubes (50%). One nurse (25%) believed that tracheostomy tubes should solely be changed by a specialized physician, and another nurse (25%) was unsure. Following completion of a basic life support training refresher, our nursing staff was queried again. Although wo nurses (50%), as shown in Figure 2, viewed that the workshop training in pediatric cardiopulmonary resuscitation made them more comfortable in changing tracheostomy tubes; however, all of the nurses (100%) stated that they are still uncomfortable changing the tubes by themselves. Of note, current hospital policy requires physicians to perform all tracheostomy tube changes in the hospital.

Discussion

Pediatric tracheostomy remains a procedure that although safe, remains one that is predominantly done in the most complex of patients [8]. Non-tracheostomy related mortality remains relatively high, especially in the neonate group [9-10]. Our data reflect similar results. Additionally, once patients are discharged, the burden of tracheostomy care for parents can be overwhelming. This is even more so in groups from lower socioeconomic and educational backgrounds. Institutions in the West and in more developed nations typically can entrust the primary caregiver to do most tracheostomy care after standardized teaching. In our population and center, most patients felt comfortable with cleaning the inner cannula and suctioning, but expressed concerns when tracheostomy changes were needed, even in emergency situations. Given that most of our nursing personnel felt uncomfortable changing a tracheostomy tube, we assume that that fear translated to our patient population as well. Although all caregivers are closely instructed, prior to discharge, the technique for caring for the tracheostomy tube and complications that can arise, all of our patients required routine tracheostomy tube changes done by a physician. We have developed a monthly clinic where all of our patients undergo changes by an Otolaryngology resident accompanied by the Pediatric Otolaryngologist every three months. Many times, fear can be a barrier to advancements in the management of patients, but our hope is that this study offers similar hospitals and those

smaller than ours an experience which can easily be duplicated. The financial savings made by the hospital are evident, while keeping patients safe. Additionally, these savings yet to incorporate the cost of transportation and accommodation of the patient's caretakers must be made during their family member's hospital stay. Since implementation of our outpatient tracheostomy tube changes, no complications have occurred. No patients required admission or further interventions after tube change. At publication of this study, all of our tracheostomy tube patients undergo outpatient changes, except one. This patient's care is complicated by severe developmental delay and morbid obesity.

Our general data for children undergoing a tracheostomy is in line with most other studies [11]. Most common complications encountered by our patients, outside the initial postoperative period, included accidental decannulation, bleeding, and one case of a fractured tracheostomy tube that fell into the distal airway. With regards to complications within 30 days from surgery, Mahida JB et. al. [12] found that neonates had an increased risk. Two of our most recent deaths included a neonate who succumbed to multi-organ failure and was diagnosed with congenital high airway obstruction, while the other patient was diagnosed with cerebro-costo-mandibular syndrome and palliative care was chosen. The other deaths included were also non-tracheostomy specific related deaths as most other publications have reported [13].

Further advancements in pediatric tracheostomy care at our center will require broader education efforts, but at a slow transition. Improving patient and staff education is key to this development. Following a year of outpatient tracheostomy changes, in an attempt to broaden public knowledge of pediatric tracheostomies, we have hosted a community event that allowed our patients and families to learn more about tracheostomies in general while enjoying camaraderie with fellow parents and patients. The stigma of a tracheostomy is many times fueled by un-education. Most toddlers in our care are prohibited from attending public school given fears of accidental decannulation. Slowly, we hope to continue to change the perception that a tracheostomy has in the public eye, which may potentially lead to the change of tracheostomy tubes by caregivers in the home similar to our counterparts in western nations.

Conclusion

Pediatric tracheostomies, although a safe procedure remains complex both due to the patients who undergo the procedure and the impact it has on families after the fact. Outpatient pediatric tracheotomy changes is a safe and cost-saving modality that can be done in resource-limited hospitals in the developing world. Our experience reflects that of a developing country in Southeast Asia which may assist in guiding similar practice in hospitals with similar barriers. Despite the slow move for change, education and community involvement may eventually change the fear and stigma associated with tracheostomy tubes. We hope to one day achieve a level where more patients would feel comfortable changing a tracheostomy tube in the home setting.

Funding

Nil.

Conflict of Interest

Non declared.

Table 1: Table showing the demographic data of pediatric patients who had a tracheostomy performed at TUH.

	Gender		Nationality		Age at Tracheostomy (Years)				Insurance				Indication for Tracheostomy				
	Male	**Female**	**Thai**	**Burmese**	**Mean**	**Median**	**Min**	**Max**	**UCS[a]**	**OFC[b]**	**None**	**Unknown**	**Prolonged Intubation**	**Craniofacial Abnormalities**	**Severe Laryngomalac**	**Subglottic Stenosis**	**Unknown**
Pediatric Patients at TUH (n = 24)	15 (62.50%)	9 (37.50%)	22 (91.67%)	2 (8.33%)	2.54	0.43	0	13.72	13 (54.16%)	1 (4.17%)	9 (37.50%)	1 (4.17%)	14 (58.34%)	5 (20.83%)	2 (8.33%)	1 (4.17%)	2 (8.33%)

[a]UCS – Universal Coverage Scheme; [b]OFC – Government or State Enterprise Officer Coverage

Table 2: Table summarizing the different diagnoses for patients with prolonged ventilation as an indication for tracheostomy.

Diagnoses for Patients with Prolonged Ventilation	
Primary Diagnoses	Number of Patients
Neurologic Disorders	
Acquired	
Diffuse Encephalopathy	1
Hypoxic-Ischemic Encephalopathy	4
Subdural Hematoma	2
Chromosomal Abnormalities	
5q deletion syndrome	1
Congenital	
Cerebral Palsy	2
Sepsis with Respiratory Distress	
Pneumonia	2
Pierre Robin Sequence	1
Tracheal Stenosis	1
Total	14

Table 3: Table summarizing the different diagnoses for patients with craniofacial abnormalities as an indication for tracheostomy.

Diagnoses for Patients with Craniofacial Abnormalities	
Primary Diagnoses	Number of Patients
Pierre Robin Sequence	3
Treacher Collins Syndrome	2
Total	5

Table 4: Table summarizing the different diagnoses for patients with other indications for tracheostomy.

Diagnoses for Patients with Other Indications for Tracheostomy	
Primary Diagnoses	Number of Patients
Laryngomalacia	1
Subglottic Stenosis	1
Unknown	2
Total	4

Table 5: Table illustrating the different syndromes seen in pediatric patients who underwent tracheostomy at TUH.

Syndromes encountered in Pediatric Tracheostomy Patients at TUH	
Syndromes	Number of Patients
5q deletion Syndrome	1
inv9(p12,p13) Syndrome	1
DiGeorge Syndrome	1
Pierre Robin Sequence	4
Treacher Collins Syndrome	2
Total	9

Table 6: Table comparing refundable, non-refundable, and total cost for patients receiving tracheostomy changes in different settings at TUH.

	Mean Length of Stay (days)	Room costs	Food costs	Artificial organs, or medical equipment not otherwise specified	In-patient Medication costs[a]	In-patient Medication costs[b]	Home Medication Costs	Medical supply cost	Medical supply cost (non-refundable)	Laboratory costs	Radiology costs	Procedural and Diagnostic tool costs	Procedural and Anesthesia costs	Nursing costs	Other costs	Total cost	Reimbursable cost	Non-reimbursable cost
IPD (n=17)	6.65	6217.65 (207.26)	894.12 (29.8)	438 (14.6)	975.03 (32.5)	47.29 (1.58)	95.53 (3.18)	1116.71 (37.22)	649.66 (21.66)	1023.24 (34.11)	343.53 (11.45)	1660 (55.33)	6127.94 (204.26)	1590 (53.00)	117.65 (3.92)	21296.34 (709.88)	14007.82 (466.93)	7288.51 (242.95)
Adjusted IPD* (n=16)	5.5	3006.25 (100.21)	518.75 (17.29)	382.81 (12.76)	845.59 (28.19)	9.69 (0.32)	100.56 (3.35)	1128.31 (37.61)	462.64 (15.42)	1040.31 (34.68)	288.75 (9.63)	1394.38 (46.48)	4373.44 (145.78)	1061.25 (35.38)	125 (4.17)	14737.73 (491.26)	10506.16 (350.21)	4231.58 (141.05)
OPD (n=4)	0.00	0.00 (0.00)	0.00 (0.00)	328.75 (10.96)	18.63 (0.62)	0	0	0	0	0	0	0	305 (10.17)	135 (4.5)	0	787.38 (26.25)	774.88 (25.83)	12.5 (0.42)

All costs are expressed as their mean values, and are expressed in THB (USD), where 30 THB = 1 USD; [a] Medications which are included in the national list of essential medicine; [b] Medications which are not included in the national list of medicine; *A patient's receipt was not included due to extensive duration of hospital stay with multiple complications

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