Main Article

Microbial Profile of Tracheal Aspirates in Pediatric Tracheostomised Patients at a Tertiary Centre

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Afshan Fathima,[1] Prem Kumar P,[1] Mahantesh Sangappa,[2] Chaitra Kini,[1] S.K Ranjani,[1] Sahiti Nori[1]

ABSTRACT

Introduction

Tracheostomy is a surgical procedure in which an opening is created between the external environment and trachea bypassing the upper airway. The presence of microorganisms colonizing the tracheobronchial airway of tracheostomised patients can potentially increase the risk of lower respiratory infections, failure of decannulation and poor surgical outcomes. The aim of the present research work was to study the microbiological profile of the tracheal aspirates and its antibiotic sensitivity in paediatric patients who had undergone tracheostomy.

Materials and Methods

The present study was conducted at the department of Otorhinolaryngology at a paediatric tertiary care hospital between August 2023-2024. 59 paediatric tracheostomised patients aged 1 day-18 years were included in the study. Tracheal aspirate obtained during regular tube changes was tested for the presence of microorganisms and their antibiotic sensitivity.

Results

Of the 68 patients who underwent tracheostomy tube changes, 59 were included in the present study. 91.53% of the study population tested positive for microbial growth in the tracheal aspirate. Pseudomonas aeruginosa (69.49%) was the most common organism isolated. 10.17% showed methicillin resistant Staphylococcus aureus (MRSA) and were positive for airway granulations.

Conclusion

Despite the numerous benefits of tracheostomy, the presence of tracheostomy tube in the airway acts as a contributing factor for the colonization of pathogenic bacteria. Presence of biofilm forming microorganisms in the airway can increase the risk of lower respiratory infections, decreased potential for decannulation and increased risk of airway surgical failure.

Keywords

Tracheostomy; Tracheal Aspirate; Culture & Sensitivity; P. Aeruginosa; MRSA

Tracheostomy is one of the oldest surgical procedure on record dating back to 3000 BC in Egypt.[1] It is a life-saving procedure in which the trachea is exteriorized creating a surgical opening between the external environment and trachea bypassing the upper airway.[2] It is done to relieve the airway obstruction and to assist in long-term ventilation support.[3] The tracheostomy acts as an alternative means of maintaining airway in patients with prolonged endotracheal intubation.

Bacterial colonization can occur following tracheostomy. The microorganisms can colonize the tracheobronchial airway of patients with tracheostomy tubes, which increases the risk of adverse respiratory events.[4-6] Long term and persistent airway colonization

1 - Department of Paediatric ENT, Indira Gandhi Institute Of Child Health, Bengaluru.
2 - Department of Microbiology, Indira Gandhi Institute Of Child Health, Bengaluru.
Corresponding author:
Dr. Afshan Fathima
email: afshan26@gmail.com

may increase the susceptibility to symptomatic infections. Additionally, patients with persistent colonization undergo antibiotic treatment and develop purulent tracheobronchitis.[7] Paediatric patients undergoing airway reconstruction surgeries have shown a high prevalence of airway bacterial colonization (MRSA; up to 32.5%). Some authors have also reported that preoperative treatment of MRSA colonization results in decreased postoperative infections and overall increased surgical success.[8]

One of the main mechanisms of tracheostomy tube colonization by pathogenic microorganisms is biofilm formation. Biofilms are present on more than 90% of tracheostomy tubes within 7 days of insertion.[9] They are associated with an increased risk of persistent airway and wound infections. It becomes imperative to identify and initiate appropriate treatment against the isolated organisms in order to prevent tracheostomy tube related complications.

The aim of the present research work was to study the microbiological profile of the tracheal aspirates in paediatric patients who had undergone tracheostomy. In addition to this we also studied the antibiotic sensitivity of the isolated microorganisms from the tracheal aspirate of these patients.

Materials and Methods

The present study is a prospective observational cross-sectional study which was conducted at the department of Otorhinolaryngology at a paediatric tertiary care hospital between August 2023- 2024. Study was conducted with ethical approval from institutional review board.

59 paediatric tracheostomised patients aged 1 day-18 years during the study period were included in the present study. Tracheal aspirate was obtained during regular tube changes.

Tube changes done in an emergency setting or patients not consenting for the study were excluded from the study population.

Samples were collected in sterile containers and mixed with sterile saline solution and sent to the microbiology department. The obtained samples were evaluated with 10% KOH, Gram staining and bacterial culture.

All the data was collected and tabulated into the SPSS version 20.0 computer software for result analysis. All means were presented with standard deviation (SD) values. Descriptive statistics, such as percentages were used to describe the cultured microorganisms in the study subjects. Fisher's exact test was used to determine if there was a non-random association between the categorical variables. A value of $p < 0.05$ was considered statistically significant for all analyses.

Results

A total of 68 tracheostomy tube changes were done during the study period, of which 59 were considered as per the inclusion criteria. Of these 59 patients, 36 (61.02%) were males and 23 (38.98%) females (Table I). 7.02 +/- 3.4 years was the mean age in our study population. The most common indication for tracheostomy in our study population was neurological causes (52.54%) followed by airway obstruction (28.81%) (Table II).

Table I: Gender Distribution

GENDER	NUMBER	PERCENTAGE
Males	**36**	**61.02**
Females	**23**	**38.98**
Total	**59**	**100.00**

Table II: Indications for Tracheostomy

SL. NO	INDICATION	NUMBER	PERCENTAGE
I	AIRWAY DISORDERS	17	28.81
	Laryngomalacia	3	5.08
	Subglottic stenosis	3	5.08
	Tracheomalacia	4	6.78
	Vocal cord palsy	5	8.47
	Tracheal stenosis	1	1.69
	Laryngeal cleft	1	1.69
II	NEUROLOGICAL CAUSES	31	52.54
	Guillain Barre Syndrome	9	15.25
	Encephalitis	5	8.47
	Meningitis	1	1.69
	Diffuse Axonal Injury	4	6.78
	Ataxia Telangiectasia	2	3.38
	Neurogenic Stridor	2	3.38
	FIRES Syndrome	2	3.38
	Lupus Encephalitis	1	1.69
	Brain Tumour	2	3.38
	Seizure Disorder	3	5.08
III	PULMONARY CAUSES	6	10.16
	Severe Pneumonia	6	10.16
IV	CARDIAC CAUSES	1	1.69
	Post VSD Repair	1	1.69
V	SYNDROMIC CAUSES	4	6.77
	Pierre Robin Sequence	3	5.08
	Edward Syndrome	1	1.69

Patients who underwent tracheostomy tube change during the study period underwent culture and sensitivity of the tracheal aspirate. 54 (91.53%) patients in our study population showed a positive culture of the tracheal aspirate. Of these positive cultures, 25 (46.29%) showed a single organism and 29 (53.71%) patients showed multiple organisms in the tracheal aspirate.

Most of the tracheal aspirates in our study population showed gram negative organisms (93.22%). The most common organism noted was *P. aeruginosa* which was seen in 41 (69.49%) patients, followed by *Klebsiella pneumoniae* in 17 (28.81%) patients. Methicillin resistant *S. aureus* (MRSA) was seen in 6 (10.17%) patients. 5 (8.47%) patients showed no growth and had a sterile culture (Table III).

Table III: Microbiological Profile of Tracheal Aspirates

SL. NO	MICRORGANISM	NUMBER	PERCENTAGE
1.	*Pseudomonas aeruginosa*	41	(69.49)
2.	*Klebsiella pneumoniae*	17	28.81
3.	Methicillin resistant *Staphylococcus aureus*	6	10.17
4.	*Acinetobacter baumannii*	8	13.55
5.	*Proteus mirabilis*	7	11.86
6.	*Morganella morganii*	3	5.08
7.	*Escherichia coli*	4	6.78
8.	No Growth	5	8.47

P. aeruginosa showed variable resistance to gentamycin, amikacin, ceftazidime and piperacillin/tazobactam. It showed 100% sensitivity to antibiotics such as ciprofloxacin, meropenem and imipenem. *K. pneumoniae* was found to be mostly sensitive to piperacillin, meropenem and imipenem antibiotics. Patients showing MRSA as the predominant culture organism was found to be sensitive to only linezolid antibiotic (Table IV).

Table IV: Antibiotic sensitivity of isolated microorganisms

SL. NO	MICROORGANISM & ANTIBIOTIC TESTED	NUMBER OF SAMPLES	ANTIBIOTIC SENSITIVITY
1.	*P. aeruginosa*	*41 (69.49%)*	
	Gentamycin		0 %
	Amikacin		0 %
	Ceftazidime		36.58%
	Ciprofloxacin		100%
	Piperacillin/ Tazobactam		65.85%
	Meropenem		100%
	Imipenem		100%
2.	*K. pneumoniae*	*17 (28.81%)*	
	Gentamycin		0 %
	Amikacin		29.41%
	Ceftazidime		64.70%
	Ciprofloxacin		88.23%
	Piperacillin/ Tazobactam		100%
	Meropenem		100%
	Imipenem		100%

Table IV (Contd.)

Table IV (Contd.) : Antibiotic sensitivity of isolated microorganisms

SL. NO	MICROORGANISM & ANTIBIOTIC TESTED	NUMBER OF SAMPLES	ANTIBIOTIC SENSITIVITY
3.	*Methicillin Resistant S. aureus*	*6 (10.17%)*	
	Benzylpenicillin		0 %
	Erythromycin		0 %
	Sulfamethoxazole /Trimethoprim		0 %
	Vancomycin		0 %
	Clindamycin		0 %
	Linezolid		100%
4.	*A. baumannii*	*8 (13.55%)*	
	Gentamycin		0 %
	Amikacin		33.33%
	Ceftazidime		66.66%
	Ciprofloxacin		83.33%
	Piperacillin/ Tazobactam		100%
	Meropenem		100%
	Imipenem		100%
5.	*P. mirabilis*	*7 (11.86%)*	
	Gentamycin		71.42%
	Co-trimoxazole		100%
	Amikacin		85.71%
	Ceftazidime		100%
	Ciprofloxacin		100%
	Piperacillin/ Tazobactam		100%
	Meropenem		100%
	Imipenem		100%
6.		*M. morganii*	*3 (5.08%)*
	Gentamycin		100%
	Co-trimoxazole		100%
	Amikacin		100%
	Ceftazidime		50%
	Ciprofloxacin		100%
	Piperacillin/Tazobactam		100%
	Meropenem		100%
	Imipenem		100%

Table IV (Contd.)

Table IV (Contd.) : Antibiotic sensitivity of isolated microorganisms

SL. NO	MICROORGANISM & ANTIBIOTIC TESTED	NUMBER OF SAMPLES	ANTIBIOTIC SENSITIVITY
7.	*E. coli*	*4 (6.78%)*	
	Gentamycin		60%
	Co-trimoxazole		100%
	Amikacin		80%
	Ciprofloxacin		100%
	Piperacillin/Tazobactam		100%
	Meropenem		100%
	Imipenem		100%

Discussion

The present study was conducted in a paediatric tertiary care hospital to evaluate the microbiological profile of tracheal aspirates in paediatric tracheostomised patients.

Of the 68 patients who underwent tracheostomy tube change during the study period, 59 patients were considered in our study. 36 (61.02%) were males and 23 (38.98%) females and 7.02 +/- 3.4 years was the mean age noted in our study. This was in accordance to a literature review of 19 similar studies done by Barros et. al.[10] in which 84% of their study population was males and 7.5 years was the mean age recorded.

91.53% of our study population showed positive pathogenic colonization of the tracheal aspirates. This was in accordance to other studies noted in literature which showed positive bacterial colonization in tracheostomised patients [11-12]. The most common organisms noted in our study were gram negative organisms such as *P. aeruginosa* (69.49%) followed by *K. pneumoniae* (28.81%). In a study done by Saravanam et. al[13] *P. aeruginosa* was the most common organism isolated from tracheal aspirates of 100 tracheostomised patients. Similarly in another study done by Vedhapoodi et al[14], *P. aeruginosa* was the most common organism noted in tracheal aspirates on day 1 (40%) and day 8 (45%) of tracheostomy. These studies were in accordance to our present study where *P. aeruginosa* was the most common bacterial colonization in the tracheal aspirates noted.

Methicillin resistant *S. aureus* (MRSA) is a major nosocomial pathogen and its incidence has been increasing in the community and in hospitals. The presence of MRSA in tracheal aspirates have an increased tendency to cause complicated lower respiratory infections. In a study done by Ahmed et al[15] on 37 children with tracheostomy tubes, children with MRSA had increased hospitalizations and intensive care admissions compared to children with methicillin sensitive *S. aureus* (MSSA). In our study MRSA was noted in 6(10.17%) patients. All these patients had increased suprastomal and infra-tip granulations on rigid laryngotracheobronchoscopy which was statistically significant (p value <0.05). These patients were sensitive to linezolid and showed resistance to most other antibiotics. Use of routine antibiotics in these patients will not be effective in controlling infections and granulations. This was in accordance to the study by Vedhapoodi et. al[14] where the tracheal aspirate with MRSA showed resistance to all antibiotics except linezolid.

Gram negative organisms such as *Pseudomonas*, *Klebsiella*, *Proteus* species etc are common colonization in tracheostomy patients.[7] These microorganisms produce an extracellular polysaccharide matrix which binds to implants or external surfaces resulting in biofilm formation.[16] It results in increased resistance to antimicrobials causing more infections in tracheostomised children. In our study, pseudomonas was found to show variable resistance to antibiotics such as gentamycin, amikacin and ceftazidime and showed 100% sensitivity

to higher antibiotics such as meropenem, imipenem and ciprofloxacin (table IV). Their ability to form biofilms helps them evade the antimicrobial action and hence can persist in the tissue environment for much longer periods. This can predispose the tracheostomised patient to more respiratory infections with complications.

In recent years, there have been significant improvements in airway reconstruction surgeries endoscopically and through the external access. This has allowed an increasing number of children to be decannulated. Presence of postoperative infections can decrease the overall surgical success rate due to loss of graft and wound sepsis.[17] The presence of bacterial colonization and biofilm formation in tracheostomised patients may result in failure of the airway reconstruction surgeries.[18,19] The knowledge of the nature of pathogens colonizing the airways can direct in appropriate management, prevent postoperative infections, reduce surgical failures and avoid the use of antibiotics of an inadequate spectrum.

Conclusion

Despite the numerous benefits of tracheostomy, multiple studies show the potential complications associated with it. The presence of the tracheostomy tube in the airway acts as a medium for colonization of pathogenic bacteria. The presence of MRSA in the tracheal aspirates was associated with increased persistence of suprastomal and infra-tip granulations. The most predominant bacteria found in our study was gram negative bacteria such as *P. aeruginosa*, *K. pneumoniae* etc. which have a potential to form biofilms. This can lead to increased risk of lower respiratory infections, decreased potential for decannulation and increased risk of airway surgical reconstruction failure in the paediatric population.

Hence it is imperative for the treating doctors to identify the pathogenic organisms colonizing the airway and their antibiotic sensitivity in paediatric tracheostomised patients for better overall management and surgical success of these patients.

References

1. Blomstedt P. Tracheostomy in ancient Egypt. J Laryngol Otol. 2014; 128(8): 665–8
2. Engels PT, Bagshaw SM, Meier M, Brindley PG. Tracheostomy: from insertion to decannulation. Can J Surg. 2009; 52(5): 427–33
3. Andriolo BN, Andriolo RB, Saconato H, Atallah ÁN, Valente O. Early versus late tracheostomy for critically ill patients. Cochrane Database Syst Rev. 2015;1(1):CD007271
4. Ewig S, Torres A, El-Ebiary M, Fábregas N, Hernández C, González J, et al. Bacterial colonization patterns in mechanically ventilated patients with traumatic and medical head injury: incidence, risk factors, and association with ventilator-associated pneumonia. Am J Respir Crit Care Med 1999; 159: 188-98
5. Leone M, Delliaux S, Bourgoin A, Albanèse J, Garnier F, Boyadjiev I, et al. Risk factors for late-onset ventilator associated pneumonia in trauma patients receiving selective digestive decontamination. Intensive Care Med 2005; 31: 64-70
6. George DL, Falk PS, Wunderink RG, Leeper KV Jr, Meduri GU, Steere EL, et al. Epidemiology of ventilator-acquired pneumonia based on protected bronchoscopic sampling. Am J Respir Crit Care Med 1998; 158: 1839- 47
7. Niederman M, Ferranti RD, Zeigler A, Merrill WW, Reynolds HY. Respiratory infection complicating long-term tracheostomy. The implication of persistent gram-negative tracheobronchial colonization. Chest 1984; 85: 39-44
8. Statham MM, de Alarcon A, Germann JN, Tabangin ME, Cohe AP, Rutter MJ. Screening and treatment of methicillin-resistant *Staphylococcus aureus* in children undergoing open airway surgery. Arch Otolaryngol Head Neck Surg 2012; 138: 153-7
9. Singhai M., Malik A., Shahid M., et al.: A study on device-related infections with special reference to biofilm production and antibiotic resistance. J Global Infect Dis, 2012; 4(4): 193–8
10. Barros CE, Almeida JA, Ayres GH, Oliveira CG, Braga CA, Avelino MA. Pediatric tracheostomy: epidemiology and characterization of tracheal secretion-a literature review. Revista da Associação Médica Brasileira. 2020 Jan 24; 65: 1502-7
11. Solomon DH, Wobb J, Buttaro BA, Truant A, Soliman AM. Characterization of bacterial biofilms on tracheostomy tubes. Laryngoscope 2009; 119(08): 1633–8
12. Nobre S, Roda J, Félix M, Estêvão MH. Traqueostomia em idade pediátrica - experiência de um quarto de século. Acta Pediatr Port 2011; 42(06): 269–73
13. Saravanam, Prasanna & Jayagandhi, Sathishkumar & Shajahan, Sumaya. (2019). Microbial Profile in Tracheostomy Tube and Tracheostoma: A Prospective Study. Indian Journal of Otolaryngology and Head & Neck Surgery. 74. 10.1007/s12070-019-01743-6

14. Vedhapoodi AG, Ankle NR, Nagmoti J. Microbial Pattern of Tracheal Aspirate in Tracheostomized Patients in a Tertiary Care Center and Its Clinical Implications. Int J Otorhinolaryngol Clin 2021; 13(3): 87–94
15. Molla Imaduddin Ahmed, Sarita Makam, Kamini Jain. Staphylococcus aureus in children with tracheostomy: Correlation with clinical outcomes. European Respiratory Journal Sep 2019, 54 (supl 63). PA988
16. Limoli DH, Jones CJ, Wozniak DJ (2015) Bacterial extracellular polysaccharides in Biofilm formation and function. Microbiol Spectr. 3(3):1–19
17. Monnier P. Pediatric Airway Surgery: Management of Laryngotracheal Stenosis in Infants and Children. NewYork, NY: Springer; 2011
18. Nouraei SA, PetrouMA, Randhawa PS, Singh A, Howard DJ, Sandhu GS. Bacterial colonization of airway stents: a promoter of granulation tissue formation following laryngotracheal reconstruction. Arch Otolaryngol Head Neck Surg 2006;132(10):1086–90
19. Reechaipichitkul W, Wongratanacheewin S, Ratanaanekchai T, Suetrong S, Nonthapa S. Bacteriology of granulation tissue in laryngotracheal stenosis patients. J Med Assoc Thai 2006; 89(09): 1487–90.