Frequency of Resistant Microorganism Colonization and Risk Factors in Patients with Tracheostomy in Palliative Care

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Abstract

Aim: Patients who had a tracheostomy for various reasons have an increased risk of infection due to the artificial opening. In this study, we aimed to determine the frequency of resistant microorganism colonization isolated from endotracheal aspirate and the risk factors for colonization in the adult population with tracheostomy in the palliative care inpatient service.

Methods: Patients with tracheostomy who were hospitalized and followed up in the palliative care service between April 2022 and August 2023 were retrospectively examined and the microorganisms in aspirate cultures and antibiotic resistance status were determined.

Results: There were 74 tracheal aspirate cultures obtained from a total of 46 patients. There were 36 (78.3%) patients who had extensive drug resistance (XDR) or pan drug resistance (PDR) microorganisms in the culture. While the frequency of resistant colonization was found to be significantly higher in patients hospitalized in intensive care in the last three months (p = 0.04), no significant relationship was found between other clinical conditions and comorbidities.

Conclusions: We believe that adherence to isolation practices and appropriate antibiotic use can lower mortality rates and healthcare expenses in patients being monitored with tracheostomy, where colonization of resistant microorganisms is common.

Keywords: *Palliative care; tracheostomy; resistant microorganism; tracheal aspirate culture; antibiotic resistance*

1. Introduction

Tracheostomy is an invasive procedure performed to facilitate airway access in patients who are unable to maintain their airway due to various conditions such as trauma or severe neurological damage. This procedure is typically indicated for individuals requiring prolonged ventilatory support, exhibiting excessive secretions, necessitating secretion control, and presenting cognitive impairment or long-term consciousness disturbances.[1,2] It enhances patient comfort by ensuring respiratory tract safety and aspiration prevention.[3,4] However, patients undergoing tracheostomy are at an increased risk of pulmonary infections due to compromised local defense mechanisms, swallowing dysfunction, and the potential colonization of microorganisms through the artificial opening.[5-7] Overcoming the nasopharyngeal defense barrier, impairment of mucociliary activity, and increased susceptibility to pulmonary colonization by microorganisms via microaspirations are particularly prevalent in bedridden patients with tracheostomies.

In contemporary healthcare, the incidence of infections caused by resistant microorganisms is steadily rising. The escalating rates of methicillin resistance in gram-positive staphylococci and the diminished susceptibility of gram-negative bacilli to broad-spectrum beta-lactam antibiotics and carbapenems are well-documented.[8-10] Gram-negative microorganisms, especially in lower respiratory tract infections, exhibit a higher frequency compared to gram-positives.[11,12] Gram-negative microorganisms are important because they worsen prognosis and carry a high risk of morbidity and mortality, especially in patients hospitalized in intensive care units.[13-15] These microorganisms pose serious problems due to the increasing incidence of multidrug resistance and cause serious infections.[16,17] The risk of multidrug-resistant infection also increases in patients with accompanying comorbidities, in intensive care units, in patients who have used antibiotics before, and in the presence of long-term central venous catheters.[18]

The isolation of resistant microorganisms in aspiration cultures holds significance due to its correlation with a high likelihood of hospitalization, prolonged lengths of stay, and increased healthcare costs. Previous studies have identified factors such as age, comorbidities, recent hospitalizations within the past three months, intravenous antibiotic therapy within the last 30 days, and extended hospital stays as contributors to the colonization of resistant

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microorganisms.[19-21] In this study, our objective is to determine the frequency of resistant microorganism colonization isolated from endotracheal aspirate cultures in adult patients with tracheostomies under palliative care and identify the associated risk factors.

2. Materials and Methods

Patients aged 18 and above, who underwent tracheostomy for various reasons and were admitted to the palliative care service between April 2022 and August 2023, were retrospectively included in this study. Patients under the age of 18, those with incomplete medical records, and those without tracheostomies were excluded from the study. Deep tracheal aspirate cultures were routinely obtained from all tracheostomized patients during their initial admission to the palliative care service. Additionally, control aspirate cultures were taken in cases of clinical deterioration or increased secretions during the patient's follow-up. Deep tracheal aspirate culture samples were aseptically collected using aspiration catheters and transferred to appropriate culture containers for laboratory analysis.

Microorganisms cultured from patients' aspirates and their antibiotic resistance profiles were identified. The terms multi-drug resistant (MDR), extensively drug-resistant (XDR), and pan-drug resistant (PDR) were used for antibiotic resistance classification. The MDR term was used for microorganisms resistant to ≥ 3 classes of antibiotics, XDR for microorganisms sensitive to only 1 or 2 classes of antibiotics (such as colistin and tigecycline), and PDR for microorganisms resistant to all antibiotic groups, including colistin and tigecycline.[22]

The relationship between tracheostomized patients with resistant growth in aspirate cultures and their current conditions, including chronic diseases such as diabetes mellitus (DM), hypertension (HT), atherosclerotic cardiovascular disease (ASCVD), atrial fibrillation (AF), cerebrovascular disease (CVD), acute/chronic kidney injury, malignancy, traumatic cerebral disease, hypoxic encephalopathy, spinal cord injury, the presence of malnutrition according to the Nutritional Risk Screening (NRS-2002) score, the presence of pressure ulcers, the history of intensive care admission within the last 3 months, the history of intravenous antibiotic use within the last 1 month, and prolonged hospital stays exceeding 30 days, was also assessed. Patients with NRS-2002 score ≥ 3 were considered malnourished according to nutritional guidelines.[23] Ethical approval was obtained from the local ethics committee prior to the initiation of the study. Retrospective data retrieval was conducted through the hospital database. Due to the retrospective design of the study, it was not possible to obtain informed consent from the patients prior to data collection; however, all data were anonymized and patient confidentiality was strictly maintained.

2.1. Statistical Analysis

Data analysis was conducted using the SPSS for Windows 24 software package. Descriptive statistics, including mean ± standard deviation for normally distributed variables, median (min–max) for non-normally distributed variables, and counts (percentages) for nominal variables, were employed. Patients with XDR and PDR growths were compared to other patients in terms of comorbidities, antibiotic usage, history of intensive care admission, and other risk factors using Pearson's Chi-Square or Fisher's exact test. Results were considered statistically significant for $p<0.05$.

Table 1

Characteristics of Patients Followed with Tracheostomy in the Palliative Care Service

	Total N=46 n, (%)		Total N=46 n, (%)
Age, median (min-max)	51.5 (21-92)	Subdural Bleeding	7 (15.2)
Sex (female)	14 (30.4)	Intracerebral hemorrhage	5 (10.9)
DM	9 (19.6)	Neurodegenerative Disease	4 (8.7)
HT	13 (28.3)	Hypoxic Encephalopathy	15 (32.6)
ASCVD	11 (23.9)	Spinal Cord Injury	2 (4.3)
AF	3 (6.5)	Malnutrition	45 (97.8)
Chronic Kidney Injury	2 (4.3)	PEG	42 (91.3)
Acute Kidney Injury	10 (21.7)	Decubitus Ulcers	35 (76.1)
Ischemic CVD	4 (8.7)	ICU Admission History last 3 months	43 (93.5)
Hemorrhagic CVD	3 (6.5)	IV Antibiotic History last 1 month	44 (95.7)
Solid Malignancy	1 (2.2)	Prolonged Hospital Stay (>1 month)	42 (91.3)
Subarachnoid Hemorrhage	6 (13.0)	Home Type Mechanical Ventilator	20 (43.5)

DM: Diabetes Mellitus, HT: Hypertension, ASCVD: Atherosclerotic Cardiovascular Disease, AF: Atrial Fibrillation, CVD: Cerebrovascular Disease, PEG: Percutaneous Endoscopic Gastrostomy, ICU: Intensive Care Unit

3. Results

A total of 46 tracheostomized patients were followed in the palliative care service between the specified dates. The median age was 51.5 (21-92), and 14 patients (30.4%) were female. The most common comorbidities were HT (28.3%) and ASCVD (23.9%). Malnutrition was present in 97.8% of patients, and 76.1% had pressure ulcers. Among the patients, 91.3% were managed with Percutaneous Endoscopic Gastrostomy (PEG), and 43.5% with home mechanical ventilators. Hypoxic encephalopathy was present in 32.6% of patients. A history of intensive care admission within the last 3 months was observed in 93.5% of patients, intravenous antibiotic use within the last one month in 95.7%, and a hospital stay exceeding 30 days in 91.3%. The characteristics of patients under tracheostomy follow-up are summarized in Table 1. A total of 74 tracheal aspirate cultures were collected. The most frequently isolated microorganisms were *Acinetobacter spp.* (37.8%), *Pseudomonas spp*. (31.1%), and *Klebsiella spp.* (28.4%) (Table 2).

Table 2

Microorganisms Isolated from Aspirate Cultures and Their Resistance Characteristics

	n: 74	%		n: 74	%
Acinetobacter spp.	28	37.8	Escherichia coli	2	2.7
MDR	2	2.7	MDR	2	2.7
XDR	20	27.0	XDR	-	-
PDR	5	6.8	PDR	-	-
Klebsiella spp.	21	28.4	Staphylococcus spp.	6	8.1
MDR	8	10.8	MDR	2	2.7
XDR	8	10.8	XDR	-	-
PDR	2	2.7	PDR	-	-
Pseudomonas spp.	23	31.1	Others*	6	8.1
MDR	9	12.2	MDR	2	2.7
XDR	2	2.7	XDR	1	1.4
PDR	1	2.7	PDR	1	1.4

MDR - XDR - PDR Colonization Numbers and Percentages

	n (%)
MDR	25 (33.7)
XDR	31 (41.8)
PDR	9 (12.2)

** Proteus mirabilis, Enterobacter, Corynebacterium, Haemophilus influenzae.*

Less commonly, *E. coli, Staphylococcus*, and other microorganisms were isolated. XDR and PDR growths were separately considered due to the significant limitation of treatment options because of antibiotic resistance. XDR growth was present in 41.8% (31 aspirate cultures), and PDR growth in 12.2% (9 aspirate cultures). While XDR or PDR growths were significantly higher in patients with a history of intensive care admission within the last 3 months (p = 0.04), no significant relationship was found among other clinical conditions and accompanying comorbidities (Table 3).

4. Discussion

In this study, the most frequently isolated microorganisms from aspirate cultures of patients followed with tracheostomy in the palliative care service were identified as *Acinetobacter*, *Pseudomonas*, and *Klebsiella* species. Furthermore, it was determined that patients with a history of intensive care admission within the last 3 months had significantly higher rates of XDR and PDR growth.

Various publications in the literature have indicated the presence of resistant aspirate cultures in tracheostomized patients. In a study by Acharya et al. in 2015, comparing tracheal aspirate cultures taken on the day of tracheostomy with those taken on the 7th day, an increase in colonization frequency of *Acinetobacter* and *Pseudomonas* was observed, although antibiotic resistance was not evaluated.[24] Similarly, in a 2020 retrospective assessment by Segana et al., conducted on 108 tracheostomized patients admitted to intensive care units over 10 years, resistant *Pseudomonas*, *Acinetobacter*, and *Klebsiella* growths were identified, although, unlike our study, risk factors were not evaluated.[25] Lepainteur et al. 2019 observed an increase in the colonization frequency of *Staphylococcus* and *Pseudomonas* in the aspirate cultures of 77 tracheostomized patients, with mechanical ventilation being prominently identified as a colonization risk factor.[20]

Table 3

Risk Factors for Extensively Drug Resistant (XDR) and Pan Drug Resistant (PDR) Colonization

	XDR or PDR (-) n (%)	XDR or PDR (+) n (%)	p*
Number of Patients n (%)	17 (%37.0)	29 (%63.0)	
Age, median (min-max)	49 (23-78)	52 (21-92)	0.82**
Sex (female)	6 (35.3)	8 (27.6)	0.74
DM	4 (23.5)	5 (17.2)	0.70
HT	4 (23.5)	9 (31.0)	0.73
ASCVD	5 (29.4)	6 (20.7)	0.72
AF	0	3 (10.3)	0.28
Chronic Kidney Injury	1 (5.9)	1 (3.4)	1.00
Malnutrition	16 (94.1)	29 (100.0)	0.37
PEG	14 (82.4)	28 (96.6)	0.13
Decubitus Ulcer	11 (64.7)	24 (82.8)	0.28
Intensive Care Admission History	14 (82.4)	29 (100.0)	0.04
IV antibiotic history	15 (88.2)	29 (100.0)	0.13
Prolonged Hospitalization	14 (82.4)	28 (96.6)	0.13
Home Type Mechanical Ventilator	7 (41.2)	13 (44.8)	1.00

DM: Diabetes Mellitus, HT: Hypertension, ASCVD: Atherosclerotic Cardiovascular Disease, AF: Atrial Fibrillation, PEG: Percutaneous Endoscopic Gastrostomy

** Fischer's Exact Test ** Mann-Whitney U*

In a study by Scibik et al. in 2022, similar to our study, an increase in colonization frequency of *Pseudomonas*, *Acinetobacter*, and *Klebsiella* was found in aspirate cultures of 45 tracheostomized patients, and prolonged hospital stay was identified as the most significant risk factor.[21] Considering that the healthcare center where our study was conducted is a reference tertiary hospital, patient admissions to our palliative care service are generally from intensive care units, and broad-spectrum antibiotic treatments are used in intensive care, it is believed that this contributes to the high rate of resistant microorganism growth in tracheal aspirate cultures. The presence of accompanying comorbidities, a high rate of malnutrition, and prolonged hospital stays are thought to increase the risk of infection and colonization with resistant microorganisms in these patients. In a study between 2006 and 2008 involving 119 patients with community-acquired pneumonia and 238 controls, it was shown that the frequency of hospital-acquired pneumonia significantly increased in patients with malnutrition and the Charlson Comorbidity Index >3.[26] Another study involving 322 tracheostomized patients indicated an increased frequency of lower respiratory tract infections in those with accompanying comorbidities and longer hospital stays, with *Pseudomonas* being the most commonly isolated pathogen after tracheostomy. Additionally, in these patients, hospital stays due to infection were prolonged, and there was a significant increase in healthcare expenditures.[27]

Limitations of our study can be identified as single-center inclusion, the lack of a follow-up, and the absence of information on whether the growths in aspirate cultures constituted pneumonia. Its strengths include specifying the accompanying comorbidities, clinical conditions such as malnutrition, pressure sores, and the presence of PEG, indicating prolonged hospital and intensive care unit stays, examining antibiotic susceptibility, and determining resistance statuses. In addition, most of the similar studies previously conducted on patients with tracheostomy were conducted in intensive care units, whereas our study consists of patients hospitalized in the palliative care service and preparing for chronic care at home.

5. Conclusion

In conclusion, the frequent colonization of resistant microorganisms in aspirate cultures of tracheostomized patients highlights the importance of adhering to isolation rules, particularly in intensive care units, and the rational and appropriate use of antibiotics to reduce the development of antibiotic resistance. Knowledge of risk factors for colonization will aid in taking measures to reduce morbidity and mortality and make more efficient use of healthcare expenditures.

Statement of ethics

The study protocol was approved by the Ethics Committee of Adana City Training and Research Hospital Clinical Research Ethics Committee on August 3, 2023 (Decision No: 2742). All participants were informed in detail about the study's purpose and procedures, and written informed consent was obtained from each participant in accordance with the Declaration of Helsinki.

genAI

No artificial intelligence-based tools or generative AI technologies were used in this study. The entire content of the manuscript was originally prepared, reviewed, and approved by both authors.

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Conflict of interest statement

The authors declare that they have no conflict of interest.

Availability of data and materials

Due to institutional privacy policies, the datasets generated and/or analyzed during the current study are not publicly available, but they are available from the corresponding author upon reasonable request.

Author contributions

All authors read and approved the final version of the article. DDG conducted data curation and drafted the manuscript. EAB designed the study, performed statistical analysis, and conducted the conceptual review.

References

1.Mallick A, Bodenham AR. Tracheostomy in critically ill patients. European Journal of Anaesthesiology| EJA 2010; 27 (8): 676-82. [Crossref]
2.De Leyn P, Bedert L, Delcroix M, Depuydt P, Lauwers G et al. Tracheotomy: clinical review and guidelines. European journal of cardio-thoracic surgery 2007; 32 (3): 412-21. [Crossref]
3.Heffner JE. The role of tracheotomy in weaning. Chest 2001; 120 (6): 477S-81S. [Crossref]
4.Schönenberger S, Niesen W-D, Fuhrer H, Bauza C, Klose C et al. Early tracheostomy in ventilated stroke patients: Study protocol of the international multicentre randomized trial SETPOINT2 (Stroke-related Early Tracheostomy vs. Prolonged Orotracheal Intubation in Neurocritical care Trial 2). International Journal of Stroke 2016; 11 (3): 368-79. [Crossref]
5.Lusuardi M, Capelli A, Cerutti C, Gnemmi I, Zaccaria S et al. Influence of clinical history on airways bacterial colonization in subjects with chronic tracheostomy. Respiratory Medicine 2000; 94 (5): 436-40. [Crossref]
6.Ferro A, Kotecha S, Auzinger G, Yeung E, Fan K. Systematic review and meta-analysis of tracheostomy outcomes in COVID-19 patients. British Journal of Oral and Maxillofacial Surgery 2021; 59 (9): 1013-23. [Crossref]
7.DeVita MA, Spierer-Rundback L. Swallowing disorders in patients with prolonged orotracheal intubation or tracheostomy tubes. Critical Care Medicine 1990; 18 (12): 1328-30. [Crossref]
8.Ozden M, Demirdag K, Kalkan A, Kılıc SS. Frequency and resistance to antibiotics of bacteria isolated from patients who were followed up in intensive care units and developed nosocomial infections. Infection Journal 2003; 17 (2): 179-83.
9.Inan D, Saba R, Keskin S, Ogunç D, Ciftci C et al. Nosocomial infections in Akdeniz University Hospital intensive care units. Intensive Care Journal 2002; 2 (2): 129-35.
10.Koseoglu-Eser O, Kocagoz S, Ergin A, Altun B, Hascelik G. Evaluation of gram-negative bacilli as infectious agents in intensive care units. Journal of Infection 2005; 19 (1): 75-80.
11.Gales AC, Jones RN. Respiratory tract pathogens isolated from patients hospitalized with suspected pneumonia in Latin America: frequency of occurrence and antimicrobial susceptibility profile: results from the SENTRY Antimicrobial Surveillance Program (1997-2000). Diagnostic microbiology and infectious disease 2002; 44 (3): 301-11. [Crossref]
12.Weber DJ, Rutala WA, Sickbert-Bennett EE, Samsa GP, Brown V et al. Microbiology of ventilator-associated pneumonia compared with that of hospital-acquired pneumonia. Infection Control & Hospital Epidemiology 2007; 28 (7): 825-31. [Crossref]
13.Oliveira J, Reygaert WC. Gram negative bacteria. 2019.
14.Ak O, Batirel A, Ozer S, Čolakoğlu S. Nosocomial infections and risk factors in the intensive care unit of a teaching and research hospital: A prospecive cohort study. Medical science monitor: international medical journal of experimental and clinical research 2011; 17 (5): PH29. [Crossref]
15.Hormozi SF, Vasei N, Aminianfar M, Darvishi M, Saeedi AA. Antibiotic resistance in patients suffering from nosocomial infections in Besat Hospital. European journal of translational myology 2018; 28 (3). [Crossref]
16.Suárez CJ, Lolans K, Villegas MV, Quinn JP. Mechanisms of resistance to β-lactams in some common Gram-negative bacteria causing nosocomial

infections. Expert Review of Anti-infective Therapy 2005; 3 (6): 915-22. [Crossref]
17.Gales AC, Jones R, Forward K, Linares J, Sader HS et al. Emerging importance of multidrug-resistant Acinetobacter species and Stenotrophomonas maltophilia as pathogens in seriously ill patients: geographic patterns, epidemiological features, and trends in the SENTRY Antimicrobial Surveillance Program (1997-1999). Clinical Infectious Diseases 2001; 32 (Supplement_2): S104-S13. [Crossref]
18.Porreca AM, Sullivan KV, Gallagher JC. The epidemiology, evolution, and treatment of KPC-producing organisms. Current infectious disease reports 2018; 20: 1-12. [Crossref]
19.Soedarsono S, Widyaningsih PD, Mertaniasih NM. The Risk Factors of Multidrug-Resistant Organisms in Hospitalized Patients with Community-Acquired Pneumonia in Dr. Soetomo Hospital Surabaya, Indonesia. Acta Medica Indonesiana 2021; 53 (2): 169-76.
20.Lepainteur M, Ogna A, Clair B, Dinh A, Tarragon C et al. Risk factors for respiratory tract bacterial colonization in adults with neuromuscular or neurological disorders and chronic tracheostomy. Respiratory Medicine 2019; 152: 32-6. [Crossref]
21.Ścibik Ł, Ochońska D, Gołda-Cępa M, Kotarba A, Brzychczy-Włoch M. Microbiological analysis of tracheostomy tube biofilms and antibiotic resistance profiles of potentially pathogenic microorganisms. Otolaryngologia Polska 2022; 76 (5). [Crossref]
22.Falagas ME, Karageorgopoulos DE. Pandrug resistance (PDR), extensive drug resistance (XDR), and multidrug resistance (MDR) among Gram-negative bacilli: need for international harmonization in terminology. Clinical infectious diseases 2008; 46 (7): 1121-2. [Crossref]
23.Kondrup J, Allison SP, Elia M, Vellas B, Plauth M. ESPEN guidelines for nutrition screening 2002. Clinical nutrition 2003; 22 (4): 415-21. [Crossref]
24.Acharya R, Wakode P, Bhandary S, Khanal B, Khatiwada S. Colonization and infection in tracheostomized patients at tertiary care hospital in Eastern Nepal. Health Renaissance 2014; 12 (2): 68-73. [Crossref]
25.Cader SHA, Shah FA, Nair SR. Tracheostomy colonisation and microbiological isolates of patients in intensive care units-a retrospective study. World Journal of Otorhinolaryngology-Head and Neck Surgery 2020; 6 (01): 49-52. [Crossref]
26.Sopena N, Heras E, Casas I, Bechini J, Guasch I et al. Risk factors for hospital-acquired pneumonia outside the intensive care unit: a case-control study. American journal of infection control 2014; 42 (1): 38-42. [Crossref]
27.Sole ML, Talbert S, Penoyer DA, Bennett M, Sokol S et al. Comparison of respiratory infections before and after percutaneous tracheostomy. American Journal of Critical Care 2014; 23 (6): e80-e7. [Crossref]