LESS

Original Article

Laparosc Endosc Surg Sci 2025;32(1):32-39
DOI: 10.14744/less.2025.04568

Bronchoscopy applications and procedural safety in the intensive care unit: A single-center data

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ABSTRACT

Introduction: Bronchoscopy in the Intensive Care Unit (ICU) is essential for managing respiratory failure, secretions, airway obstructions, and pulmonary infections. This study aimed to evaluate the indications, frequency, and clinical outcomes of bronchoscopy in the ICU.

Materials and Methods: This retrospective study analyzed patients who underwent bronchoscopy in the ICU of Koşuyolu High Specialization Training and Research Hospital from January 1, 2022, to December 31, 2024. Data were obtained from the hospital's automation system. Patients from the cardiology, cardiovascular surgery, chest surgery, and gastroenterology departments who underwent bronchoscopy were included. Pediatric ICU patients, non-ICU ward patients, and lung transplant recipients were excluded. A total of 258 procedures were analyzed. Data were analyzed using IBM SPSS 26, with Chi-square and Kruskal-Wallis tests. A p-value of < 0.05 was considered significant.

Results: A total of 258 bronchoscopy procedures were performed on 162 patients (62.3% male, median age 60.4 years). The most common diagnoses were coronary artery bypass graft (CABG) (30.2%), non-surgical cardiovascular diseases (21.6%), and heart valve surgery (16.7%). The main indications for bronchoscopy were increased secretions (41.1%), atelectasis (25.9%), and hemoptysis (9.7%). Increased secretions (53.5%) were the most common finding, with 9.3% of procedures reported as normal. Of the patients, 62.8% required mechanical ventilation, and 7.4% received ECMO. Lavage for culture was performed in 63.4%, with microbial growth detected in 43%. *Klebsiella pneumoniae* was the most common microorganism.

Conclusion: Our study confirms the safe use of bronchoscopy in patients with major cardiac surgery or advanced heart failure. Bronchoscopy is frequently used in the ICU for managing secretion accumulation and atelectasis. Bronchoalveolar lavage is crucial for identifying infectious agents like *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* in specific patient groups.

Keywords: Bronchoscopy, intensive care, respiratory management, lavage culture

Received: 05.03.2025 **Revision:** 17.03.2025 **Accepted:** 18.03.2025

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Introduction

Bronchoscopy is a widely used procedure in intensive care unit (ICU) patients for both diagnostic and therapeutic purposes, with significant importance due to its efficacy and safety. It plays a crucial role in the evaluation of airway and parenchymal lung diseases.[1] In addition to assessing airway pathologies, bronchoscopy is frequently performed in the ICU for various clinical indications.[2,3] Diagnostic indications include direct visualization of airway obstructions, detection of respiratory infections through bronchoalveolar lavage (BAL) and tissue sampling, and identification of the source of hemoptysis. Therapeutic indications involve the aspiration of bronchial secretions, removal of mucus plugs, resolution of atelectasis, and clearance of blood during hemoptysis.[4,5]

Bronchoscopy plays a critical role, especially in patients under mechanical ventilation (MV), by clearing secretions and preventing complications. This technique offers the advantage of being performed at the bedside, allowing immediate intervention, which makes it a valuable tool in intensive care practice. However, the necessity and effective use of bronchoscopy can vary depending on patient characteristics and clinical conditions. Therefore, it is important to evaluate current data on bronchoscopy usage in the ICU and establish standardized practices.

This study retrospectively examines the frequency, indications, and clinical outcomes of bronchoscopy procedures performed in the ICU. The data obtained will be compared with the existing literature to provide clinical recommendations for bronchoscopy practices in ICU patients. The aim of this study is to contribute to the more effective and safe use of bronchoscopy in ICU settings.

Materials and Methods

This retrospective observational study includes patients who underwent bronchoscopy in the ICU at a tertiary training and research hospital between January 1, 2022, and December 31, 2024. Patient data, including demographic information, indications, and findings, were obtained from the hospital's electronic medical record system. Patients from the cardiology, cardiovascular surgery, chest surgery, and gastroenterology departments who underwent bronchoscopy in the ICU for diagnostic or therapeutic purposes were included in the study. Pediatric ICU patients, patients admitted to non-ICU wards, and lung transplant recipients were excluded.

A total of 258 bronchoscopy procedures were analyzed, with 55 performed in 2022, 82 in 2023, and 121 in 2024. The study recorded patient demographics, indications for bronchoscopy, findings, use of respiratory support, and culture results. The indications for bronchoscopy, clinical diagnoses, and microbiological culture results were analyzed, and statistical comparisons were made between patient groups where applicable.

Bronchoscopy was performed using a flexible bronchoscope under sterile conditions, following standard aseptic techniques. Patients were preoxygenated, and local anesthesia with lidocaine was applied to the upper airway when necessary. Sedation and analgesia were administered according to the patient's clinical condition. The procedure was conducted through the endotracheal or tracheostomy tube in mechanically ventilated patients and via the nasal or oral route in spontaneously breathing patients. BAL and bronchial washing were performed when indicated for microbiological and cytological analysis. Suctioning was used to facilitate secretion clearance and mucus plug removal as needed.

Throughout the procedure, vital signs, oxygen saturation, and hemodynamic parameters were continuously monitored to ensure patient safety.

Statistics

The data were analyzed using IBM SPSS 26. Descriptive statistics, including mean, median, minimum, and maximum values, were calculated for continuous variables, while frequency and percentage distributions were presented for categorical variables. The Chi-square (χ^2) test was used to compare categorical variables between groups. The distribution of gender, bronchoscopy indications, bronchoscopy findings, bronchoscopy methods, respiratory support, and microbiological culture results across groups was evaluated using the Chi-square test.

To analyze differences among continuous variables, the Shapiro-Wilk test was first applied to assess the normality assumption. For age, which did not follow a normal distribution, the Kruskal-Wallis test was used for comparison. A p-value of < 0.05 was considered statistically significant, and post-hoc analyses were conducted to further evaluate differences between groups for significant results. All statistical analyses were performed using appropriate statistical software.

The study was approved by the Local Ethics Committee of Koşuyolu High Specialization Training and Research Hospital (Date: March 04, 2025 / Approval No: 2025/03/1061). Written consent was obtained from the parents or guardians of participants under the age of 18.

Results

A total of 784 bronchoscopy procedures were performed during the study period across the hospital. Of these, 381 were conducted in the Chest Surgery and Lung Transplant Unit, 137 in other clinical departments, and 8 in the Pediatric ICU. These cases were excluded from the study. Excluding lung transplant patients, a total of 258 bronchoscopy procedures were performed on 162 patients from the Surgical and Cardiology ICUs. Among these patients, 62.3% (n=101) were male, with a median age of 60.4 years, ranging from 18 to 91 years. The most common diagnoses were coronary artery bypass graft (CABG) (30.2%), non-surgical cardiovascular diseases (21.6%), and heart valve surgery (16.7%). The most frequently used method for bronchoscopy was through an endotracheal tube (50%), followed by a tracheostomy tube (25.2%) and the nasal route (19.8%) (Table 1).

The most common indications for bronchoscopy were increased secretions and culture sampling (41.1%), atelectasis (25.9%), and hemoptysis (9.7%). The most frequent findings during bronchoscopy were increased secretions (53.5%), followed by mucus plugs (17%), tracheobronchial malacia and stenosis (7%), aspiration-related food residues and other materials (3.5%), and respiratory tract bleeding (3.1%). In 9.3% of procedures, findings were reported as normal. Among the patients, 62.8% required MV, and 7.4% received extracorporeal membrane oxygenation (ECMO). Lavage for culture was performed in 63.4% of procedures, with microbial growth observed in 43% of these cases. A lavage sample for culture was not obtained in 23.6% of cases (Table 1).

The most common microorganism identified was *Klebsiella pneumoniae* (16.1%), followed by *Pseudomonas aeruginosa* (12.1%), *Stenotrophomonas maltophilia* (12.1%), *Candida albicans* (10.4%), *Acinetobacter baumannii* (9.7%), *Serratia marcescens* (8.1%), and *Enterobacter* (8.1%). Additionally, *Escherichia coli*, *Proteus mirabilis*, and other rare pathogens were identified (Tables 1 and 2).

Bronchial polypoid lesions were observed in two cases, and biopsy results were reported as benign. Two procedures were terminated early due to hypoxemia.

The Chi-square test for gender distribution revealed a significant difference between groups (p=0.0035). Post-hoc analyses indicated that this difference was particularly prominent in the CABG and heart valve surgery groups. In the CABG group, the proportion of males (75.5%) was significantly higher than that of females (24.5%) (p<0.05), whereas in the heart valve surgery group, the proportion of females (70.4%) was significantly higher than that of males (29.6%) (p<0.05). The Kruskal-Wallis test for age differences revealed no significant difference across groups (p=0.423) (Table 3).

A significant difference was observed in the indications for bronchoscopy (p=0.00197), with the most common indications being increased secretions and microbiological culture sampling (ISMC). ISMC was most frequently performed in the CABG (13.2%) and lung surgery/disease (8.1%) groups. Atelectasis was most common in CABG patients (9.3%), while hemoptysis was observed most frequently in patients with non-surgical cardiovascular diseases (4.6%).

Significant differences were found in bronchoscopy findings (p<0.001), particularly for aspiration material (p<0.001), normal bronchoscopy findings (p<0.05), and mucus plugging (p<0.05). Increased secretions (p<0.05) were most frequently observed in the CABG (30.4%) and lung surgery/disease (23.2%) groups, while tracheobronchial mucus secretion (TBMS) was most commonly found in the non-surgical cardiovascular disease group. No significant difference was found for aspiration material or respiratory tract bleeding (p>0.05).

Regarding bronchoscopy methods, a significant difference was found (p=0.015). The endotracheal tube (ETT) was more commonly used in the CABG, non-surgical cardiovascular disease, and lung surgery/disease groups. The tracheal cannula (TC) was most frequently used in the CABG (30.8%), non-surgical cardiovascular disease (26.2%), and lung surgery/disease (15.4%) groups.

Significant differences were also observed in the respiratory support analysis (p=0.001). MV was most commonly applied in the CABG (34%), non-surgical cardiovascular disease (17.9%), and lung surgery/disease (13%) groups.

No significant difference was observed in culture lavage results (p=0.272). Positive cultures were most frequently detected in the CABG (32.4%), lung surgery/disease (19.8%),

Table 1. Demographic characteristics, bronchoscopy indications, findings, and culture results

	Diagnosis	CABG N=49 (30.2%)	Heart valve surgery N=27 (16,7%)	Non-surgical cardiovascular diseases N=35 (21.6%)	Lung Surgery and lung disease N=17 (10.5%)	Heart transplantation N=7 (4,3%)	Gastrointestinal surgery N=7 (4.3%)	Other N=20 (12.4%)	Total N=162 (%)
Gender	Female	12 (7.4)	19	14	7	1	1	7	61 (36.7)
	Male	37 (22.8)	8	21	10	6	6	13	101 (63.3)
Age	Mean (min-max)	63.7 (45-82)	65.5 (32-85)	57.9 (18-88)	53.9 (18-91)	51.1 (22-71)	69.1 (63-79)	59.9 (24-91)	60.4 (18-91)
Br	N:258 (%)	79 (30.6)	34 (13.1)	55 (21.3)	43 (16.7)	11 (4.3)	11 (4.3)	25 (9.7)	258 (100)
BI n=258(%)	Atelectasis	24 (9.3)	13 (5)	13 (5)	8 (3.1)	0 (0)	2 (0.8)	7 (2.7)	67 (25.9)
	ISMC	34 (13.2)	14 (5.4)	15 (5.8)	21 (8.1)	8 (3.2)	5 (1.9)	9 (3.5)	106 (41.1)
	UH	5 (1.9)	0 (0)	1 (0.4)	0 (0)	1 (0.4)	0 (0)	2 (0.8)	9 (3.5)
	Hemoptysis	4 (1.6)	4 (1.6)	12 (4.6)	3 (1.1)	1 (0.4)	0 (0)	1 (0.4)	25 (9.7)
	Aspiration	2 ((0.8)	0 (0)	1 (0.4)	3 (1.1)	0 (0)	3 (1.2)	1 (0.4)	10 (3.9)
	Other	10 (3.9)	3 (1.1)	13 (5)	8 (3.2)	1 (0.4)	1 (0,4)	5 (1.9)	41 (15.9)
BF n=258(%)	Increased secretion	42 (16.3)	14 (5.4)	24 (9.3)	32 (12.4)	11 (4.4)	2 (0.8)	13 (5)	138 (53.5)
	Mucous plugging	19 (7.3)	10 (3.9)	9 (3.5)	1 (0.4)	0 (0)	2 (0.8)	3 (1.1)	44 (17)
	TBMS	4 (1.55)	3 (1.1)	9 (3.55)	1 (0.4)	0 (0)	0 (0)	1 (0.4)	18 (7)
	Aspiration materials	2 (0.8)	0 (0)	0 (0)	3 (1.2)	0 (0)	3 (1.1)	1 (0.4)	9 (3.5)
	Respiratory tract bleeding	1 (0.4)	2 (0.8)	3 (1.1)	0 (0)	0 (0)	0 (0)	2 (0.8)	8 (3.1)
	Other	2 (0.8)	3 (1.1)	4 (1.5)	6 (2.4)	0 (0)	0 (0)	2 (0.8)	17 (6.6)
	Normal bronchoscopy	9 ((3.5)	2 (0.8)	6 (2.4)	0 (0)	0 (0)	4 (1.5)	3 (1.1)	24 (9.3)
RB n=258(%)	Nasal route	16 (6.2)	11 (4.4)	12 (4.6)	5 (1.9)	1 (0.4)	1 (0.4)	5 (1.9)	51 (19.8)
	Oral route	3 (1.1)	1 (0.4)	1 (0.4)	8 (3.1)	0 (0)	0 (0)	0 (0)	13 (5)
	Endotracheal tube	40 (15.5)	16 (6.2)	25 (9.7)	20 (7.7)	9 (3.5)	8 (3.1)	11 (4.3)	129 (50)
	Tracheostomy tube	20 (7.6)	6 (2.4)	17 (6.6)	10 (3.9)	1 (0.4)	2 (0.8)	9 (3.5)	65 (25.2)
RS n=258(%)	Mechanical ventilation	55 (21.3)	22 (8.6)	29 (11.2)	21 (8.1)	9 (3.5)	10 (3.9)	16 (6.2)	162 (62.8)
	ECMO	4 /1.5)	0 (0)	2 (0.8)	10 (3.9)	1 (0.4)	0 (0)	2 (0.8)	19 (7.4)
	No	20 (7.8)	12 (4.6)	24 (9.3)	12 (4.6)	1 (0.4)	1 (0.4)	7 (2.7)	77 (29.8)
CLR n=258(%)	Not collected	17 (6.6)	10 (3.9)	13 (5)	9 (3.5)	1 (0.4)	4 (1.5)	7 (2.7)	61 (23.6)
	Growth detected	36 (14)	12 (4.6)	18 (7)	22 (8.6)	7 (2.7)	3 (1.1)	13 (5)	111 (43)
	No growth detected	26 (10.1)	12 (4.6)	24 (9.5)	12 (4.6)	3 (1.1)	4 (1.6)	5 (1.9)	86 (33.4)
	Polymicrobial Growth	1	2	2	6	0	0	2	13

Table 1. Cont.

Diagnosis		CABG N=49 (30.2%)	Heart valve surgery N=27 (16,7%)	Non-surgical cardiovascular diseases N=35 (21.6%)	Lung Surgery and lung disease N=17 (10.5%)	Heart transplantation N=7 (4,3%)	Gastrointestinal surgery N=7 (4.3%)	Other N=20 (12.4%)	Total N=162 (%)
IMP n=124 (%)	*Klebsiella pneumoniae*	4 (3.2)	5 (4)	3 (2.4)	6 (4.9)	1 (0.8)	1 (0.8)	0 (0)	20 (16.1)
	Pseudomonas aeruginosa	3 (2.4)	2 (1.6)	4 (3.2)	6 (4.9)	0 (0)	0 (0)	0 (0)	15 (12.1)
	Candida albicans	7 (5.6)	0 (0)	0 (0)	5 (4)	0 (0)	0 (0)	1 (0.8)	13 (10.4)
	Stenotrophomonas maltophilia	3 (2.4)	0 (0)	3 (2.4)	3 (2.4)	5 (4.1)	1 (0.8)	0 (0)	15 (12.1)
	Acinetobacter baumannii	5 (4.1)	2 (1.6)	2 (1.6)	2 (1.6)	0 (0)	0 (0)	1 (0.8)	12 (9.7)
	Serratia marcescens	4 (3.3)	0 (0)	1 (0.8)	3 (2.4)	0 (0)	0 (0)	2 (1.6)	10 (8.1)
	Enterobacter	2 (1.6)	1 (0.8)	2 (1.6)	1 (0.8)	0 (0)	0 (0)	4 (3.3)	10 (8.1)
	Other	10 (8)	4 (3.2)	5 (4.1)	2 (1.6)	1 (0.8)	1 (0.8)	6 (4.9)	29 (23.4)

Br no, Number of bronchoscopies; BI: Bronchoscopy indication; ISMC, Increased secretion and microbiological culture; UH, Unexplained hypoxemia and hypercarbia; Other,Unexplained infiltrative lesions on chest X-ray and CT scan, suspected tracheal stenosis , suspected tracheoesophageal fistula, other; BF, Bronchoscopy findings; TMMS, Tracheobronchial malacia and stenosis; RB, Route of bronchoscopy; RS, Respiratory support; ECMO, Extracorporeal Membrane Oxygenation; CLR, Culture lavage results; IMP, Isolated microbial pathogens.

Table 2. Distribution of microorganisms isolated from bronchoalveolar lavage samples

Isolated Microbial Pathogens	Number (n=124)	%
Klebsiella pneumoniae	20	16.2
Pseudomonas aeruginosa	15	12.2
Candida albicans	13	10.5
Stenotrophomonas maltophilia	15	12.2
Acinetobacter baumannii	12	9.7
Serratia marcescens	10	8.1
Enterobacter aerogenes	6	4.9
Escherichia coli	5	4.1
Proteus mirabilis	4	3.3
Kocuria kristinae	4	3.3
Staphylococcus aureus	3	2.4
Enterobacter cloacae	2	1.7
Enterobacter gergoviae	2	1.7
Klebsiella oxytoca	2	1.7
Enterococcus faecium	2	0.8
Citrobacter braakii	1	0.8
Corynebacterium striatum	1	0.8
Pasteurella pneumotropica	1	0.8
Serratia fonticola	1	0.8
Staphylococcus haemolyticus	1	0.8
Haemophilus influenzae	1	0.8
Diphtheroid bacillus	1	0.8
Aspergillus species	1	0.8
Mycobacterium tuberculosis	1	0.8

and non-surgical cardiovascular disease (16.2%) groups. However, significant differences were found in the microbial growth analysis (p=0.006). *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* were most commonly detected in the lung surgery/disease (4.9%) and heart valve surgery (4.0%) groups. *Candida albicans* was more commonly found in the CABG (5.6%) and lung surgery/disease (4.0%) groups, while *Stenotrophomonas maltophilia* was most frequently isolated in the heart transplant (4.1%) group (Table 3).

Discussion

Bronchoscopy is a widely performed procedure in the ICU for both diagnostic and therapeutic purposes. In our study, it was safely conducted, primarily in middle-aged male patients who had undergone CABG and heart valve surgery. We found that bronchoscopy was most frequently performed for indications such as secretion accumula-

Table 3. Test results for diagnostic groups

Parameter	Chi-Square Value	p	Significance
Gender Distribution	19.42	*0.0035	Yes
Age	6.0	**0.423	No
Bronchoscopy Indications	91.3	*0.00197	Yes
Bronchoscopy Findings	91.3	<0.001	Yes
Route of Bronchoscopy	15.2	*0.015	Yes
Respiratory Support	20.4	*0.001	Yes
Culture Lavage	5.3	*0.272	No
Microbial Pathogens	18.7	*0.006	Yes

*chi-square, **Kruskal-Wallis. p<0.05.

tion, microbiological culture sampling, and atelectasis, with the most common finding being increased secretions (53.5%). These findings underscore the significance of bronchoscopy in respiratory management for ICU patients. Particularly in those receiving MV, bronchoscopy plays a crucial role in secretion clearance and the prevention of complications. In our study, 62.8% of patients received MV, and bronchoscopy was observed to contribute to improved respiratory function.

In the literature, bronchoscopy is commonly performed for secretion clearance and microbiological culture sampling. In a study by Olopade et al.[6], 45% of bronchoscopy procedures were performed for secretion clearance, 35% for culture sampling, 7% for airway assessment, 2% for hemoptysis, 0.5% for assisting intubation, and 0.5% for foreign body removal. Similarly, Demirer and Taş[7] reported that 27% of bronchoscopy procedures were performed for atelectasis and mucus plugs, 17% for ARDS and pulmonary edema, 13% for airway stenosis or tracheobronchomalacia, 13% for pneumonia or empyema, 8% for hemoptysis, and 8% for foreign body aspiration.

In our study, the most common indications for bronchoscopy included secretion accumulation (53.5%) and culture sampling (29.3%). The effectiveness of bronchoscopy in clearing mucus plugs and improving lung aeration varies between 41% and 81%.[8] These findings support the therapeutic efficacy of bronchoscopy and its importance in respiratory management for ICU patients.

Microbiological culture collection via bronchoscopy is an important tool for identifying infectious agents through BAL[9] In a study by Cracco et al.,[10] the diagnostic yield of BAL in non-intubated critically ill patients was reported to be 59%.

In accordance with the literature, the most commonly isolated microorganisms in our study were *Klebsiella pneumoniae* (16.1%), *Pseudomonas aeruginosa* (12.4%), and *Acinetobacter baumannii* (9.7%). In a study by Negi et al.,[11] the most commonly isolated microorganisms were *Pseudomonas aeruginosa* (41.02%), *Klebsiella pneumoniae* (17.94%), and Acinetobacter spp. (15.38%). These findings highlight the high prevalence of nosocomial infections in ICU patients and the role of bronchoscopy in managing these infections.

Microbiological cultures obtained through bronchoscopy play a crucial role in the diagnosis and treatment of respiratory tract infections. *Klebsiella pneumoniae* and *Pseudomonas aeruginosa* are pathogens commonly isolated in ICU patients, influencing treatment decisions. In our study, the frequent isolation of these microorganisms in lung surgery and heart valve surgery patients underscores the importance of bronchoscopy in infection management.

The most frequently used method in bronchoscopy procedures was the ETT (49.2%), providing direct airway access and making it a safer and more effective intervention, particularly in critically ill patients. In our study, the use of ETT was more commonly observed in the CABG (30.2%) and lung surgery/disease (15.3%) groups. This suggests that bronchoscopy via endotracheal tube is more frequently preferred in patients requiring respiratory support and airway intervention.[12]

In our study, the most common admission diagnosis for patients undergoing bronchoscopy was CABG (30.2%). Given the hospital's focus on cardiology and cardiovascular surgery, it is likely that cardiac diseases are more frequently observed in the ICU. Additionally, non-surgical

cardiovascular diseases (21.6%) and heart valve surgery (16.7%) were among the other common diagnoses. A significant proportion of ICU patients undergoing bronchoscopy (62.8%) required mechanical ventilation, indicating the more frequent use of bronchoscopy in these patients.

Analysis of bronchoscopy findings revealed significant differences between diagnostic groups, with variations in aspiration material, mucus plugging, and normal bronchoscopy findings. These findings demonstrate the impact of bronchoscopy in preventing airway obstruction and complications in ICU patients. Additionally, bronchoscopy was observed to improve respiratory function and contribute to reducing ventilation requirements.

Bronchoscopy is generally considered a safe procedure [13], with only two patients in our study experiencing hypoxemia that necessitated early termination of the procedure. The potential for significant hypoxemia during bronchoscopy is well-documented in the literature.[14]

Limitations

This study has a retrospective design, which limits the ability to establish causal relationships. Its single-center nature and the predominantly cardiovascular surgical patient population restrict the generalizability of the findings. Potential gaps in the registration system and data losses may also have affected the analysis process. The lack of direct comparison between bronchoscopy and alternative diagnostic and treatment methods complicates a broader assessment of its efficacy. Additionally, long-term clinical outcomes and the impact of bronchoscopy on mortality and morbidity were not evaluated. Future multi-center, prospective studies are needed to validate these findings.

Conclusion

Our findings emphasize the role of bronchoscopy in secretion clearance and respiratory management, particularly in mechanically ventilated ICU patients. When performed with appropriate indications, bronchoscopy supports treatment by preventing complications through therapeutic procedures such as secretion clearance and microbiological culture sampling. Additionally, the ability of bronchoscopy to isolate microorganisms provides a significant advantage in infection management for critically ill patients. However, the necessity and effective use of bronchoscopy may vary depending on patients' clinical characteristics and treatment processes. Therefore, the role of bronchoscopy should be better understood within clinical decision-making processes and more effectively integrated into treatment protocols.

Generalizability

This study was conducted in a single tertiary cardiac hospital ICU, where the majority of patients had cardiovascular and thoracic conditions. As a result, the findings may not be fully generalizable to ICUs with a more diverse patient population, such as general medical or trauma ICUs. Additionally, the retrospective design may introduce selection bias, and variations in bronchoscopy indications and outcomes could exist across different healthcare settings. However, this study provides valuable insights into bronchoscopy practices in a specialized ICU and can serve as a reference for future multicenter and prospective studies to validate its findings across broader patient populations.

Disclosures

Ethichs Committee Approval: The study was approved by the Local Ethics Committee of Koşuyolu High Specialization Training and Research Hospital (Date: March 04, 2025 / Approval No: 2025/03/1061). Written consent was obtained from the parents or guardians of participants under the age of 18.

Peer-review: Externally peer-reviewed.

Conflict of Interest: The authors declare that they have no conflicts of interest.

Funding: The author(s) received no financial support for the research, authorship, and/or publication of this article.

Authorship Contributions: Concept – E.S., M.V.; Design – E.S., A.N.H.; Supervision – E.S., P.A.G.; Resource – E.S., S.Ç.; Materials – E.S., A.P.; Data Collection and/or Processing – E.S., H.O.; Analysis and/or Interpretation – E.S., F.F.A., A.M.K.; Literature Review – E.S., M.E.Ç., Y.U.K.; Writing – E.S., M.V.; Critical Review – E.S., E.T.

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