SESSION II · SEVERE PNEUMONIA

16:20 – 16:50

Bronchoscopy for Severe Pneumonia

Why, When, and How

2026 Joint Symposium Respiratory Infections & Critical Care Research Groups · June 27, 2026

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Three questions structure the talk

Why

01

The evidence — diagnostic yield, mortality benefit, and stewardship.

When

02

Patient selection and the timing of the procedure.

How

03

Technique, specimen handling, molecular tests, and safety.

Part 00

Introduction & Background

Severe pneumonia is a leading cause of ICU admission and mortality — yet the causative pathogen often goes unidentified.

Conventional diagnostics miss the pathogen

10–20%

Blood cultures positive in severe pneumonia

30–50%

Sputum culture sensitivity, heavily contaminated by oral flora

Mixed

Endotracheal aspirates over-grow species — risking broad-spectrum overuse

50–70% of severe pneumonia cases go **without an identified etiology** using conventional methods alone.

1. Diagnosis and Treatment of Adults With Community-Acquired Pneumonia: An Official Clinical Practice Guideline of the ATS and IDSA. American Journal of Respiratory and Critical Care Medicine. 2019.

Part 01

Why Bronchoscopy?

Diagnostic superiority, mortality reduction, secretion clearance, and antibiotic stewardship — at an acceptable safety cost.

Diagnostic superiority

- **Protected sampling** (BAL, PSB) minimizes upper-airway contamination.
- **Quantitative cultures** distinguish infection from colonization.
- **Direct visualization** of endobronchial pathology, fungal disease, and alternative diagnoses.
- **Comprehensive detection** — bacteria, fungi, viruses, mycobacteria, etc.

76–90%

Sensitivity for bacterial pneumonia

84–100%

Specificity for bacterial pneumonia

2. Bronchoscopic Diagnosis of Severe Respiratory Infections. Journal of Clinical Medicine. 2024.

Mortality reduction

0.53

Relative risk of death

Therapeutic bronchoscopy · meta-analysis 2024, 11 studies, N=3,907 VAP (95% CI 0.35–0.81)

↓67%

Lower ICU mortality

HR 0.33 · MIMIC-IV database, N=1,560 VAP patients

↓60%

Lower in-hospital mortality

HR 0.40 · MIMIC-IV database, N=1,560 VAP patients

3. Role of Bronchoscopy in the Management of Patients With Suspected or Suffering From Ventilator-Associated Pneumonia: A Meta-Analysis. Heliyon. 2024.

4. The Association Between Bronchoscopy and the Prognoses of Patients With Ventilator-Associated Pneumonia in Intensive Care Units: A Retrospective Study Based on the MIMIC-IV Database. Frontiers in Pharmacology. 2022.

Infection control & respiratory recovery

87.9% vs 70.3%

Bacterial clearance with FOB + BAL versus conventional therapy.

N=86 severe VAP · 2025 · p<0.05

- Improved dynamic compliance and reduced airway resistance.
- Better PaO_2 / FiO_2 after secretion removal.
- Electrical impedance tomography confirms improved **regional lung ventilation** after BAL.

5. Impact of Fiberoptic Bronchoscopy With Bronchoalveolar Lavage on Infection Control in Patients With Severe Ventilator-Associated Pneumonia. Clinics. 2025.

Antibiotic stewardship

44%

of viral pneumonia episodes had **complete antibiotic cessation** by post-BAL day 5.

N=686 patients, 927 episodes · 2025

66%

treatment modification with comprehensive BAL analysis.

up to two-thirds of cases

› **FLAGSHIP II RCT** — multiplex bacterial PCR of BAL reduced time on inappropriate antibiotics.

› **mNGS of BAL** — lower antibiotic escalation rate (adjusted OR 0.466, p=0.02).

6. Fast Multiplex Bacterial PCR of Bronchoalveolar Lavage for Antibiotic Stewardship in Hospitalised Patients With Pneumonia at Risk of Gram-Negative Bacterial Infection (FLAGSHIP II): A Multicentre, Randomised Controlled Trial. The Lancet Respiratory Medicine. 2022.

7. Clinical Utility of Metagenomic Next-Generation Sequencing in Pathogen Detection for Lower Respiratory Tract Infections. Scientific Reports. 2025.

Shorter ventilation & ICU stay

60% vs 33.3%

Weaning success with FOB + BAL in very elderly patients.

p=0.038

14.9 vs 16.7 days

ICU length of stay — shorter with bronchoscopy.

14.93 ± 3.04 vs 16.67 ± 3.38 · p=0.041

5. Impact of Fiberoptic Bronchoscopy With Bronchoalveolar Lavage on Infection Control in Patients With Severe Ventilator-Associated Pneumonia. Clinics. 2025.

8. Clinical Efficacy and Safety of Mechanical Ventilation Combined With Fiberoptic Bronchoalveolar Lavage in Patients With Severe Pulmonary Infection. Medical Science Monitor. 2019.

9. Bronchoalveolar Lavage Combined With Electrical Impedance Tomography in the Treatment of Very Elderly Patients With Severe Pneumonia: A Prospective Study. Respiratory Medicine. 2025.

3. Role of Bronchoscopy in the Management of Patients With Suspected or Suffering From Ventilator-Associated Pneumonia: A Meta-Analysis. Heliyon. 2024.

Safety profile

Complication	Incidence	Management
Transient hypoxemia	~15%	Increase FiO_2, limit scope time
Post-procedure fever	5–10%	Usually self-limited
Significant bleeding	<1%	Suction, tamponade
Pneumothorax	<1% (0.16%)	Chest tube if significant
Procedure-attributable death	**0%**	—

10. Research Bronchoscopies in Critically Ill Research Participants: An Official American Thoracic Society Workshop Report. Annals of the American Thoracic Society. 2023.

11. Fiberoptic Bronchoscopy in Ventilated Patients: Evaluation of Cardiopulmonary Risk Under Midazolam Sedation. Chest. 1990.

WHY — IN SUMMARY

→ Diagnostic superiority + mortality reduction + secretion clearance + antibiotic stewardship.

→ An acceptable safety profile — even in the critically ill.

Part 02

When to Perform?

Patient population and timing — early diagnosis, delayed escalation, or therapeutic intervention as needed.

Patient populations & scenarios

A · Early 24–48 h

Immunocompromised

HIV, transplant, hematologic malignancy. Broad differential — bacteria, fungi (PCP, Aspergillus), viruses, mycobacteria. Rapid deterioration; early diagnosis is critical.

B · Escalate at 48 h

Ventilator-associated (VAP)

Non-invasive sampling before new antibiotics; start empiric therapy. Proceed to bronchoscopy if inadequate response at 48 h, persistent signs, or suspected MDR.

C · 48–72 h if non-response

Non-ventilated CAP / HAP

Empiric antibiotics per guidelines. Bronchoscopy if non-response at 48–72 h, inability to obtain sputum, or severe hypoxemic failure of unclear etiology.

12. Timing of Bronchoscopy and Plasma Microbial Cell-Free DNA Sequencing in Immunocompromised Host Pneumonia. Open Forum Infectious Diseases. 2026.

13. A Guide to Utilization of the Microbiology Laboratory for Diagnosis of Infectious Diseases: 2024 Update by the IDSA and ASM. Clinical Infectious Diseases. 2024.

Relative contraindications

Severe hypoxemia

PaO_2/FiO_2 <100 — use caution; consider NIV-assisted bronchoscopy.

Significant coagulopathy

Correct if possible — platelets >20,000/μL for BAL.

Hemodynamic instability

Stabilize vasopressors before proceeding.

Very high PEEP / air trapping

PEEP >15 cmH_2O — increased barotrauma risk.

10. Research Bronchoscopies in Critically Ill Research Participants: An Official American Thoracic Society Workshop Report. Annals of the American Thoracic Society. 2023.

WHEN — IN SUMMARY

EARLY 24–48 h — immunocompromised, unclear severe hypoxemic failure, suspected MDR.

DELAYED 48–72 h — non-response to empiric antibiotics, progressive infiltrates.

THERAPEUTIC As needed — thick secretions, mucus plugging, weaning difficulty.

Part 03

How to Perform?

Preparation, bronchoscope sizing, BAL technique, specimen handling, molecular diagnostics, and procedural safety.

Pre-procedure preparation

A · Patient assessment

- Assess relative contraindications — hypoxemia, coagulopathy, instability.
- Ensure adequate sedation in mechanically ventilated patients.

B · Ventilator adjustments

- VentSetFib trial; inspiratory flow < 25L/min, tidal volume 5mL/kg, and PEEP 5cmH20, reduce serous AE
- Switch to volume control if on pressure support.
- Sedate (propofol, remimazolam, + fentanyl); monitor SpO_2, $EtCO_2$, pressures, hemodynamics.

14. Preoxygenation Strategies for Intubation of Patients Who Are Critically Ill: A Systematic Review and Network Meta-Analysis of Randomised Trials. The Lancet Respiratory Medicine. 2025.

Bronchoscope sizing

THE RULE

Keep a ≥2 mm gap

between bronchoscope OD and ETT inner diameter — to prevent expiratory flow limitation and auto-PEEP.

ETT size	Max scope OD	Note
8.0 mm	6.0 mm	Most scopes fit
7.5 mm	5.0 mm	Use thin bronchoscope
6.5 mm	4.0 mm	Thin scope required

15. The Effects of Endotracheal Tube Size During Bronchoscopy in Simulated Models of Intubated Patients. The Laryngoscope. 2023.

Site selection strategy

General principle — the BAL site is guided by radiological findings and the clinical scenario.

Clinical scenario	Preferred BAL site	Rationale
VAP with focal infiltrate	Radiographically affected segment	Target the infected region for the highest pathogen yield.
Diffuse pneumonia / ARDS	Right middle lobe (RML) or lingula	Spatially heterogeneous disease; RML or lingula is standard unless frank purulence is present.
Immunocompromised, diffuse infiltrates	RML or lingula	Broad differential — a standardized sampling site.
Lobar consolidation	Most affected lobe / segment	Direct sampling of the consolidated area.
Frank purulence visible	Purulent segment	Highest bacterial load at the source.

Adapted from FLAGSHIP II (Lancet Respir Med 2022) and the ATS research-bronchoscopy workshop (Ann Am Thorac Soc 2023).

Why anatomical mapping matters

› **Target the pathogen source** — maximize diagnostic yield by sampling the most affected area.

› **Avoid contamination** — proper wedging technique prevents upper-airway flora diluting the sample.

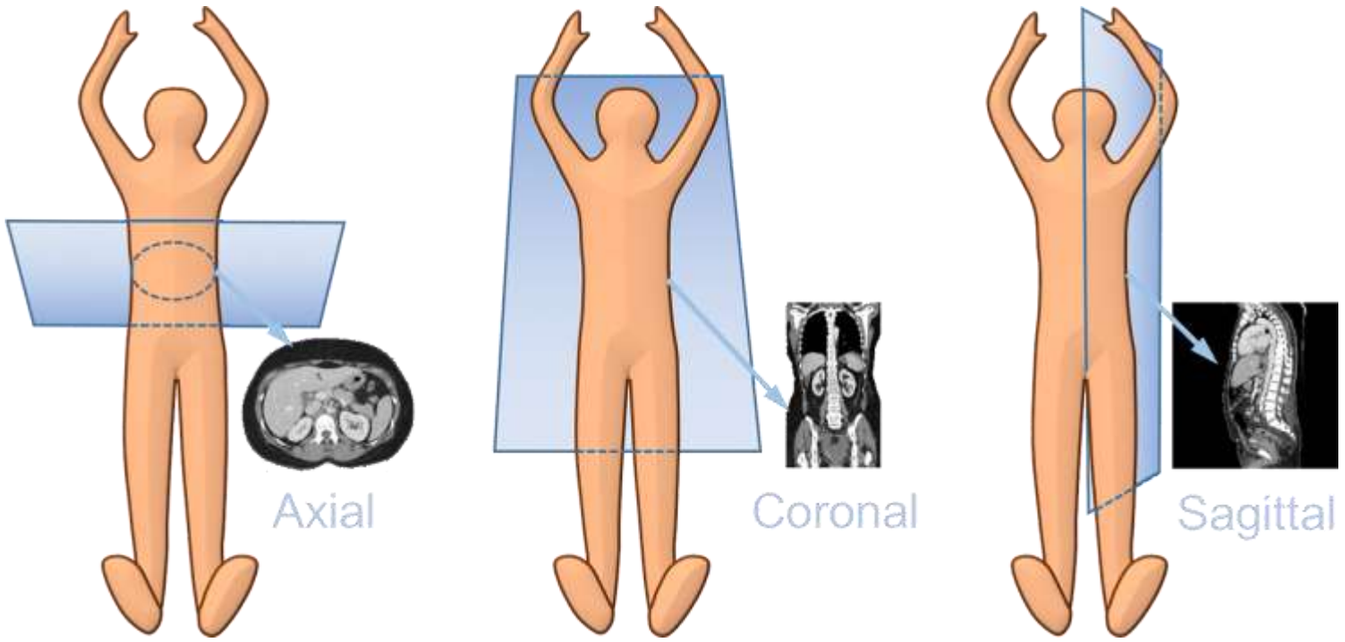
› **Optimize safety** — plan the approach to minimize scope time and hypoxemia risk.

› **Standardize sampling** — reproducible technique enables comparison across time and patients.

Anatomical targeting underlies diagnostic yield, contamination control, procedural safety, and sampling reproducibility.

Imaging planes & airway anatomy

Know the orientation before reading the scan — and before steering the scope.



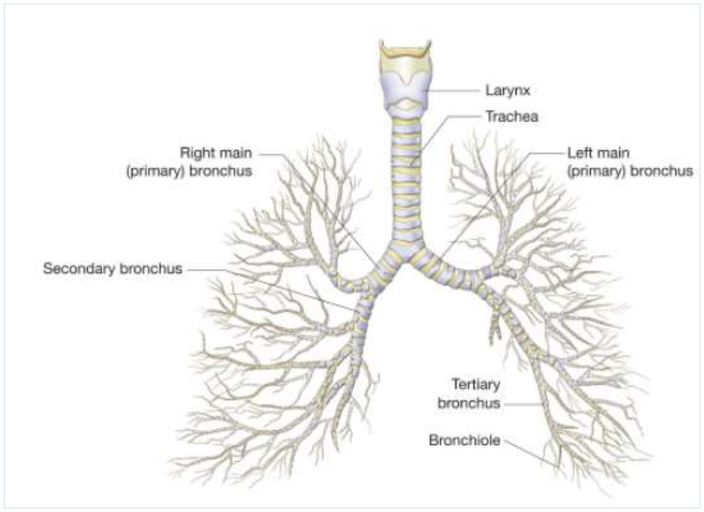
The three reference planes — axial, coronal, and sagittal.

Flexible bronchoscopy — the scope path from the airway to the segmental bronchi.

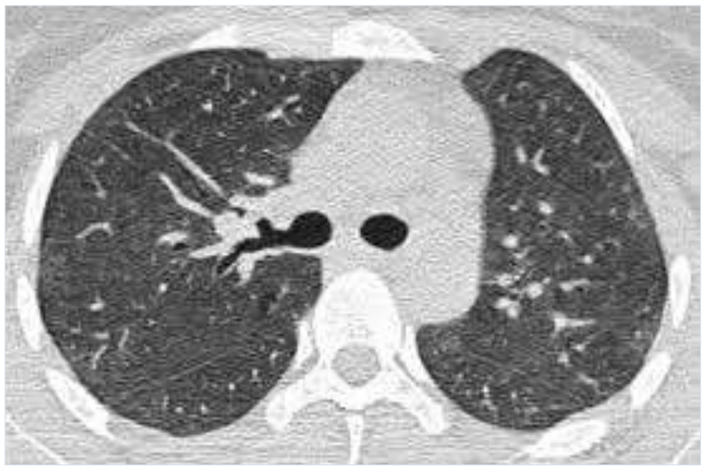
Plane orientation underlies the CT-rotation guide on the final slide of this section.

The bronchial tree & endobronchial roadmap

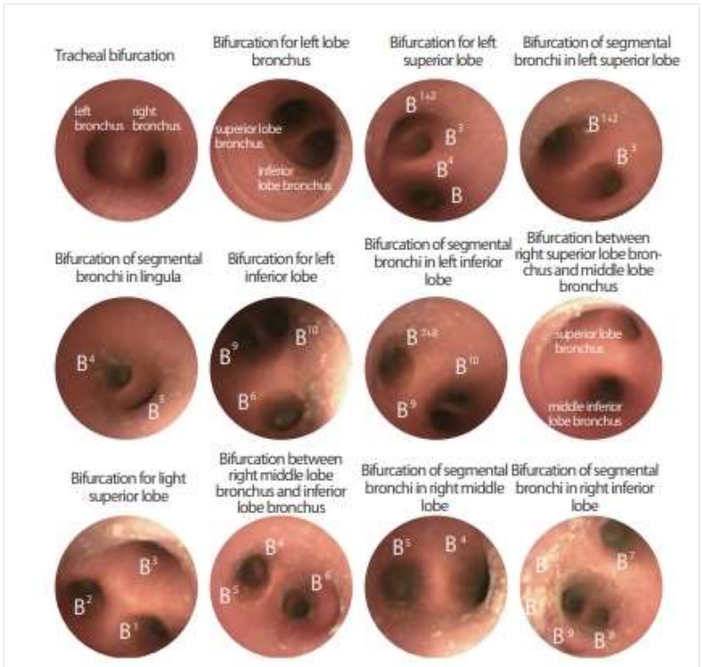
From cross-sectional anatomy to the live view through the scope.



Bronchial tree — trachea to segmental bronchi.



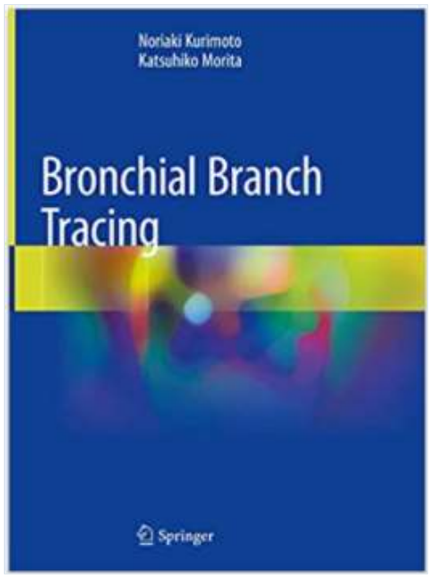
Axial CT correlate at the level of the carina.



Endobronchial views of each bifurcation (B1–B10).

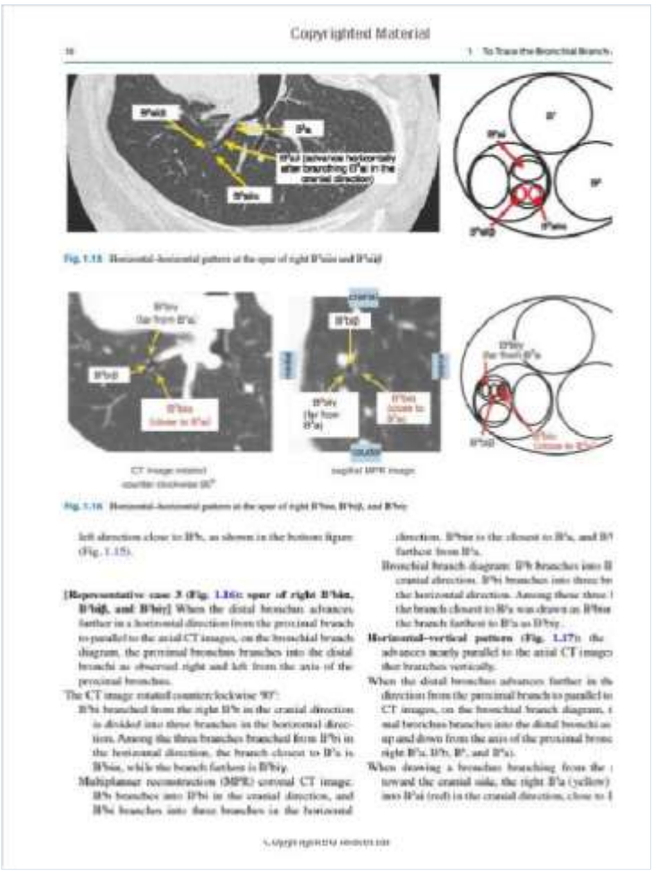
Anatomy diagrams and endobronchial photographs aligned to plan a systematic airway survey.

Bronchial branch tracing



Kurimoto & Morita — Bronchial Branch Tracing (Springer).

Prof. Noriaki Kurimoto



Sample page — CT-to-bronchoscopy branch correlation.

A systematic method for naming and tracing every bronchial branch on CT — aligning the bronchoscopic route with cross-sectional anatomy.

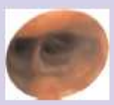
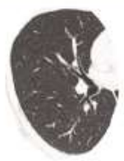
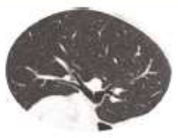
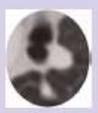
The target segment is reached reproducibly, and findings can be communicated in a shared language.

Kurimoto N, Morita K. Bronchial Branch Tracing. Springer.

Bronchial branch tracing

Stepwise navigation from the central airways to a peripheral target.

Table 3. How to orientate the appropriately selected computed tomography image to align with the bronchoscopic view

Lung segment where PPL is located	CT recon	Original CT view	Flipping sequence of CT	CT view after orientation	Bronchoscopic view	Direction of scrolling of CT scan
Right upper lobe	Sagittal		Nil			Medial to lateral
Right middle lobe	Coronal		Flip horizontally			Posterior to Anterior
Right lower lobe	Axial		Flip horizontally, then rotate 90 degrees counterclockwise			Cranial to caudal
Left upper division	Sagittal		Flip horizontally			Medial to lateral
Left lingula	Sagittal		Flip horizontally			Posterior to Anterior
Left lower lobe	Axial		Flip horizontally, then rotate clockwise 90 degrees			Cranial to caudal

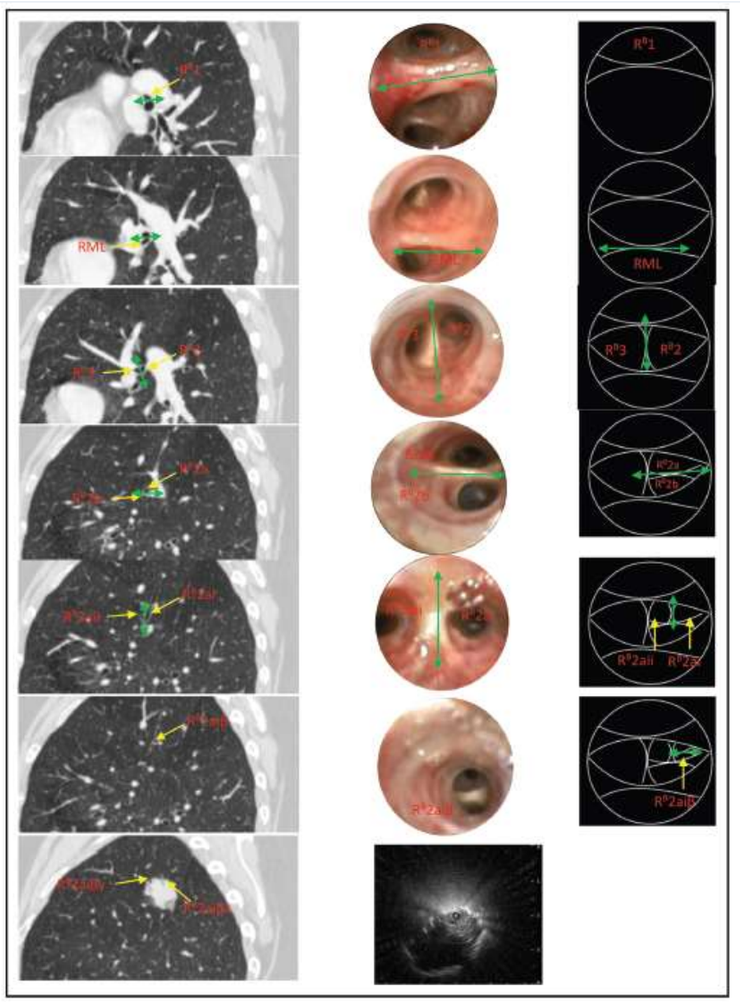


FIGURE 1. Case example of airway mapping. A PPL located in the posterior segment of the right upper lobe (R^B2a) is traced using the sagittal multiplanar reconstruction of the CT scan. The bronchial segments are mapped out based on the CT scan, and a r-EBUS probe inserted into R^B2ai/y (bronchoscopic image not available) confirms localization of the PPL. Fluoroscopy was utilized for biopsy and rapid on-site evaluation touch imprint demonstrated the presence of malignant cells.

Bronchial branch tracing

Representative figures of peripheral airway navigation and sampling.

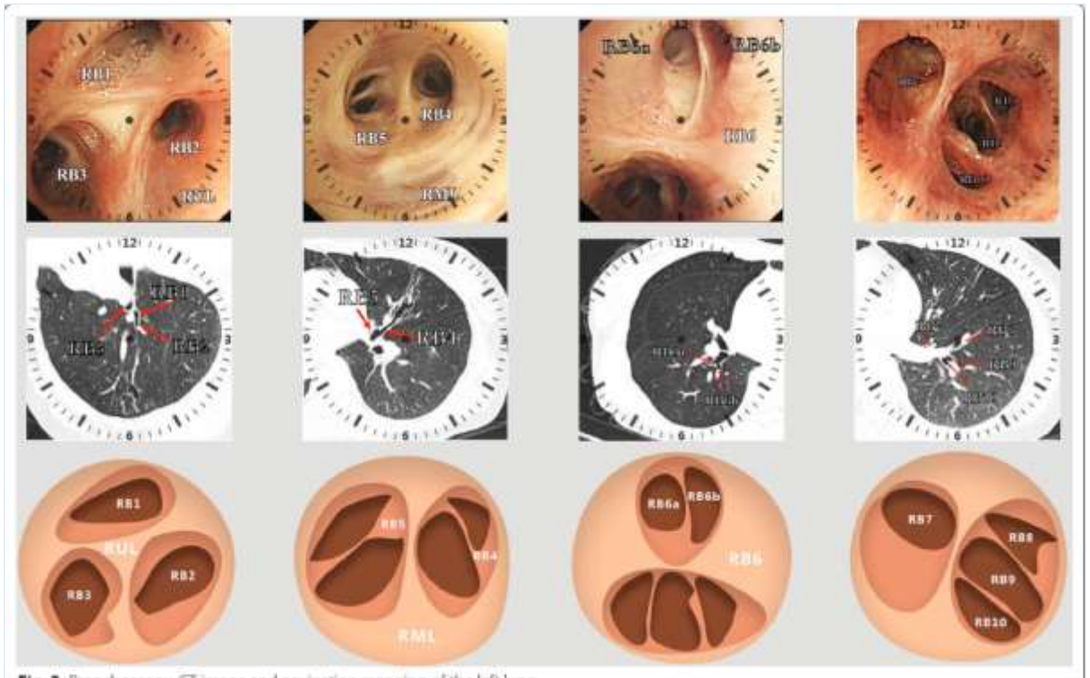


Fig. 2 Bronchoscopy, CT image and navigation mapping of the left lung

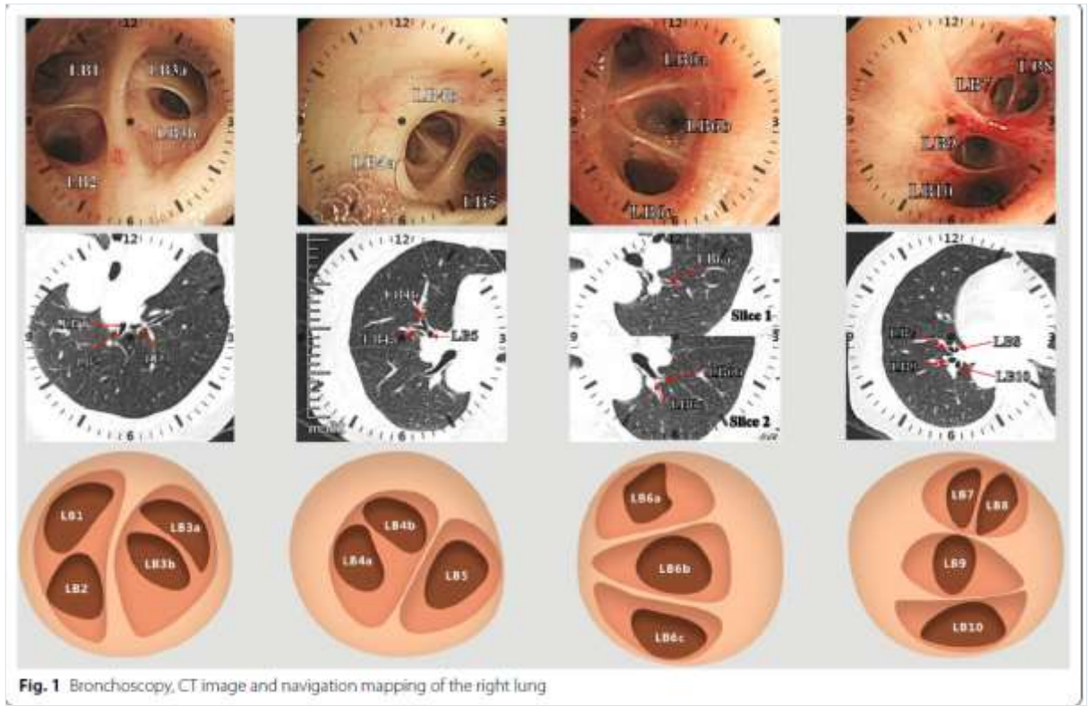


Fig. 1 Bronchoscopy, CT image and navigation mapping of the right lung

Reading the CT — Rotation, Zoom, 3D cursor

Rotation applied to each plane to match the bronchoscopic orientation, by segment.

Segment	Axial	Coronal	Sagittal
RUL	Counterclockwise 90°		그대로 (as is — start)
LUL upper division	Clockwise 90°		180° (start)
RML	180°	180°	
LUL lingular division	180°	180°	
RLL sup	180°	180° (머리가 아래로)	
LLL sup	180°	180° (머리가 아래로)	
RLL basal	180°		
LLL basal	180°		

Rotate each plane as indicated so the CT view matches what is seen through the bronchoscope.

Table 4. Proposed preferred computed tomography views depending on location of the peripheral pulmonary lesion

Lung segment	Proposed preferred views
Right upper lobe	Use sagittal view to draw branching of right upper lobe, then use the following views depending on the location of the PPL R^B1: Axial rotate counterclockwise 90 degrees R^B2a: Coronal R^B2b: Sagittal R^B3a: Sagittal R^B3b: Coronal, reversed horizontally
Middle lobe	Coronal view, reversed horizontally
Right Lower lobe	R^B6: Coronal R^B7–10: Axial view, reversed horizontally and rotate counterclockwise 90 degrees
Left Upper Lobe	Use sagittal view reversed horizontally to draw branching of left upper lobe, then use the following views to draw the subsequent branching depending on the location of the PPL L^B1+2: Axial, rotate clockwise 90 degrees L^B3a: Sagittal, reversed horizontally L^B3b: Coronal, reversed horizontally
Lingula	Coronal view reversed horizontally
Left lower lobe	L^B6: Coronal Axial view reversed horizontally and rotate counterclockwise 90 degrees

BAL technique: four steps

01

Wedge

Advance to a segmental bronchus until firmly wedged. Prefer RML or lingula; for VAP, target the affected area.

02

Instill

120–150 mL sterile 0.9% saline in 4–5 aliquots of 30 mL. Room temperature or warmed to 37°C.

03

Aspirate

Gentle suction 50–100 mmHg. Expect 40–60% return (50–90 mL). Discard the first aliquot; pool the rest.

04

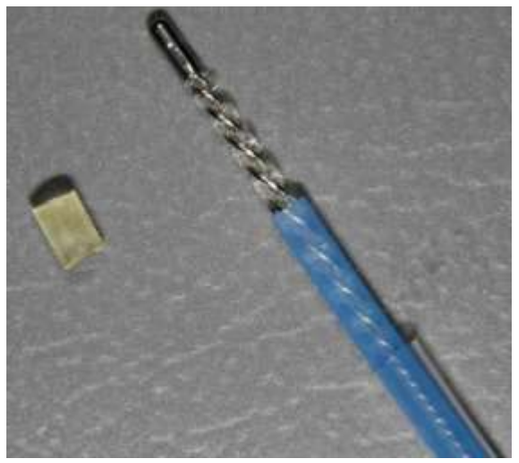
Handle

To the laboratory within 15 minutes. Keep at room temperature — do **not** refrigerate.

SITE Preferred: **Right Middle Lobe** or **Lingula** — unless frank purulence localizes elsewhere.

10. Research Bronchoscopies in Critically Ill Research Participants: An Official American Thoracic Society Workshop Report. Annals of the American Thoracic Society. 2023.

Protected specimen brush



- **Indication:** quantitative bacterial cultures with minimal upper-airway contamination.
- **Technique:** advance through working channel → extend brush into affected segment → gentle brushing.
- **Retrieve:** retract into sheath → cut brush into 1 mL sterile saline.

≥10³

CFU/mL

Diagnostic threshold — suggests VAP with high specificity.

13. A Guide to Utilization of the Microbiology Laboratory for Diagnosis of Infectious Diseases: 2024 Update by the IDSA and ASM. Clinical Infectious Diseases. 2024.

Diagnostic thresholds

Sample type	Threshold	Interpretation
BAL	≥10^4 CFU/mL	Suggests bacterial pneumonia
PSB	≥10^3 CFU/mL	Bacterial pneumonia — high specificity
Endotracheal aspirate	≥10^5–10^6 CFU/mL	Suggests pneumonia — lower specificity
Bronchial wash	No validated threshold	Qualitative interpretation only

13. A Guide to Utilization of the Microbiology Laboratory for Diagnosis of Infectious Diseases: 2024 Update by the IDSA and ASM. Clinical Infectious Diseases. 2024.

Rapid molecular diagnostics

Multiplex PCR

4–6 h

- Bacteria, resistance genes (mecA, carbapenemases), viruses, fungi — simultaneously.
- Less affected by prior antibiotic exposure than cultures.
- Enables faster stewardship decisions.

mNGS

unbiased

- No pre-specified targets needed.
- Higher positive rates in antibiotic-exposed patients.
- Identifies unexpected, rare, or co-infecting pathogens.

16. Multicentre Evaluation of Two Multiplex PCR Platforms for the Rapid Microbiological Investigation of Nosocomial Pneumonia in UK ICUs: The INHALE WP1 Study. Thorax. 2022.

13. A Guide to Utilization of the Microbiology Laboratory for Diagnosis of Infectious Diseases: 2024 Update by the IDSA and ASM. Clinical Infectious Diseases. 2024.

Therapeutic & NIV-assisted bronchoscopy

Therapeutic — secretion clearance

- For thick secretions, mucus plugging → lobar collapse, weaning difficulty.
- Saline lavage 10–20 mL aliquots → gentle suction; repeat per segment.
- Repeatable daily if benefit shown — RR 0.53 mortality reduction.

NIV-assisted — non-intubated

- Apply NIV (BiPAP: PEEP 8–10 cmH_2O + PS) throughout the procedure.
- Insert scope through the mask port; minimize air leak.
- Limit to <10–15 min; keep intubation equipment immediately available.

17. Bronchoscopy for Atelectasis in the ICU: A Case Report and Review of the Literature. Chest. 2003.

3. Role of Bronchoscopy in the Management of Patients With Suspected or Suffering From Ventilator-Associated Pneumonia: A Meta-Analysis. Heliyon. 2024.

Safety protocols & complications

Hypoxemia ~15%

Withdraw scope to ETT → FiO_2 1.0

Recruitment: 30–40 cmH_2O × 30 s

PEEP +2–5;

Limit scope time <15–20 min

Hemodynamic instability

Pause; adjust sedation

Fluid bolus if hypotensive

Abort if persistent instability

Auto-PEEP / high pressures

Remove scope;

Reduce respiratory rate

Ensure adequate expiratory time

Smaller scope; avoid prolonged wedging

KEY PRINCIPLE

Operator experience is the single most important predictor of BAL tolerance and procedural safety. Adequate training and supervision are essential.

18. Ventilator Settings for Fiberoptic Bronchoscopy During Mechanical Ventilation: A Randomized Adjudicator-Blinded Controlled Trial (VentSetFib). Critical Care. 2026.

19. Bronchoscopy in Intubated and Non-Intubated Intensive Care Unit Patients With Respiratory Failure. Journal of Thoracic Disease. 2021.

The procedural checklist

PRE-PROCEDURE

- ☐ Consent obtained (if possible)
- ☐ Contraindications addressed
- ☐ Scope size checked vs ETT
- ☐ Pre-oxygenated (FiO_2 1.0 × 5 min)
- ☐ Vent optimized
- ☐ Sedation adequate; monitoring on
- ☐ Team briefing completed

DURING

- ☐ ≥2 mm gap confirmed
- ☐ Systematic airway inspection
- ☐ Target segment per CXR/CT
- ☐ BAL: 120 mL in 4 × 30 mL
- ☐ Return adequate (>40–50 mL)
- ☐ Samples labeled & sent at once
- ☐ Total procedure time <20 min

POST-PROCEDURE

- ☐ Vent returned to baseline; FiO_2 weaned
- ☐ Vitals q15 min × 1 h, then hourly
- ☐ ABG at 1–2 h post-procedure
- ☐ CXR if deterioration / PTX concern
- ☐ Preliminary Gram stain reviewed
- ☐ Documentation completed
- ☐ Plan results follow-up & therapy

10. Research Bronchoscopies in Critically Ill Research Participants: An Official American Thoracic Society Workshop Report. Annals of the American Thoracic Society. 2023.

HOW — IN SUMMARY

- → Size the scope — keep a ≥2 mm gap vs the ETT.
- → Wedge in RML/lingula; 4 × 30 mL; return 50–90 mL.
- → Add multiplex PCR or mNGS for rapid stewardship.
- → FiO_2 1.0 + Optimize vent setting before inserting.
- → BAL ≥10^4; PSB ≥10^3
- → **Experience matters most** for safety.

KEY TAKEAWAYS

What to carry into the ICU

Why

Diagnostic superiority and a real mortality benefit, at an acceptable safety cost.

When

Early for immunocompromised and suspected MDR; delayed for non-response; therapeutic for secretions.

How

Size, prepare, wedge, quantify, and add molecular testing — experience is the safety backbone.

Thank you — questions welcome.

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1. Metlay JP, Waterer GW, et al. Diagnosis and Treatment of Adults With Community-Acquired Pneumonia: An Official ATS/IDSA Clinical Practice Guideline. *Am J Respir Crit Care Med.* 2019.

2. Röder M, et al. Bronchoscopic Diagnosis of Severe Respiratory Infections. *J Clin Med.* 2024.

3. Tang F, Zhu F, Wang Y, et al. Role of Bronchoscopy in the Management of Patients With Suspected or Suffering From Ventilator-Associated Pneumonia: A Meta-Analysis. *Heliyon.* 2024.

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9. Xiong J, Zhao C, Wu L, et al. Bronchoalveolar Lavage Combined With Electrical Impedance Tomography in the Treatment of Very Elderly Patients With Severe Pneumonia: A Prospective Study. *Respir Med.* 2025.

10. Mikacenic C, Fussner LA, Bell J, et al. Research Bronchoscopies in Critically Ill Research Participants: An Official American Thoracic Society Workshop Report. *Ann Am Thorac Soc.* 2023.

11. Trouillet JL, Guiguet M, Gibert C, et al. Fiberoptic Bronchoscopy in Ventilated Patients: Evaluation of Cardiopulmonary Risk Under Midazolam Sedation. *Chest.* 1990.

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