Interventional pulmonology

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HARVARD MEDICAL SCHOOL

Relevant disclosures

- None

Outline

- Advanced diagnostic bronchoscopy
- Advanced therapeutic bronchoscopy
- Advanced pleural procedures

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Advanced diagnostic bronchoscopy:

1. The mediastinum & EBUS (endobronchial ultrasound)

- EBUS-TBNA = FNA of a lymph node or other structure under *real-time* US guidance
  - Approx. 90% sensitivity for malignancy
    - Comparable to mediastinoscopy
    - Provides enough tissue for molecular testing
  - Approx. 80-85% for sarcoidosis
    - Incremental benefit w/ EBBX/TBBX
  - Approx. 70% for lymphoma
    - Closer to 75% for recurrent, 65% for incident

- Complication rate: <1% (i.e., highly favorable)
  - Bleeding, pneumothorax, pneumomediastinum, infection

Advanced diagnostic bronchoscopy:

1. The mediastinum & EBUS (endobronchial ultrasound)

- **ACCP 2013 guidelines: In NSCLC patients with suspected* mediastinal LN involvement + no distant metastases, a needle technique (e.g., EBUS-TBNA or trans-esophageal FNA) is recommended as the best first test**
  - *Remark:* In cases where the clinical suspicion of mediastinal node involvement remains high after a negative result using a needle technique, surgical staging (e.g., mediastinoscopy, video-assisted thoracic surgery [VATS], etc.) should be performed.

*Grade 1B for high suspicion | Grade 2B for intermediate suspicion

EBUS-TBNA: To ROSE or not to ROSE

- ROSE = Rapid On-Site Evaluation – typically by a cytology tech using “Diff-Quik” staining
  - An optional accompaniment to EBUS-TBNA
    - Provides real-time assessment of specimen adequacy

Which of the following is true about the use of rapid on-site evaluation (ROSE) in EBUS?

A. Increases diagnostic sensitivity for malignant lymph node involvement in NSCLC
B. Decreases procedure time
C. Increases procedure time
D. Decreases number of sites sampled

Advanced diagnostic bronchoscopy:

2. The lung parenchyma & peripheral bronchoscopy

1. **Conventional bronchoscopy**
   - Flexible bronchoscopy (with TBBX, TBNA, brushing, and/or BAL)
2. **Guided (e.g., navigational) bronchoscopy (needs pre-op CT)**
   - CT-based rendering for tracking of scope/instrument location
3. **Robotic bronchoscopy (needs pre-op CT)**
   - CT-based tracking + thinner, more maneuverable scope

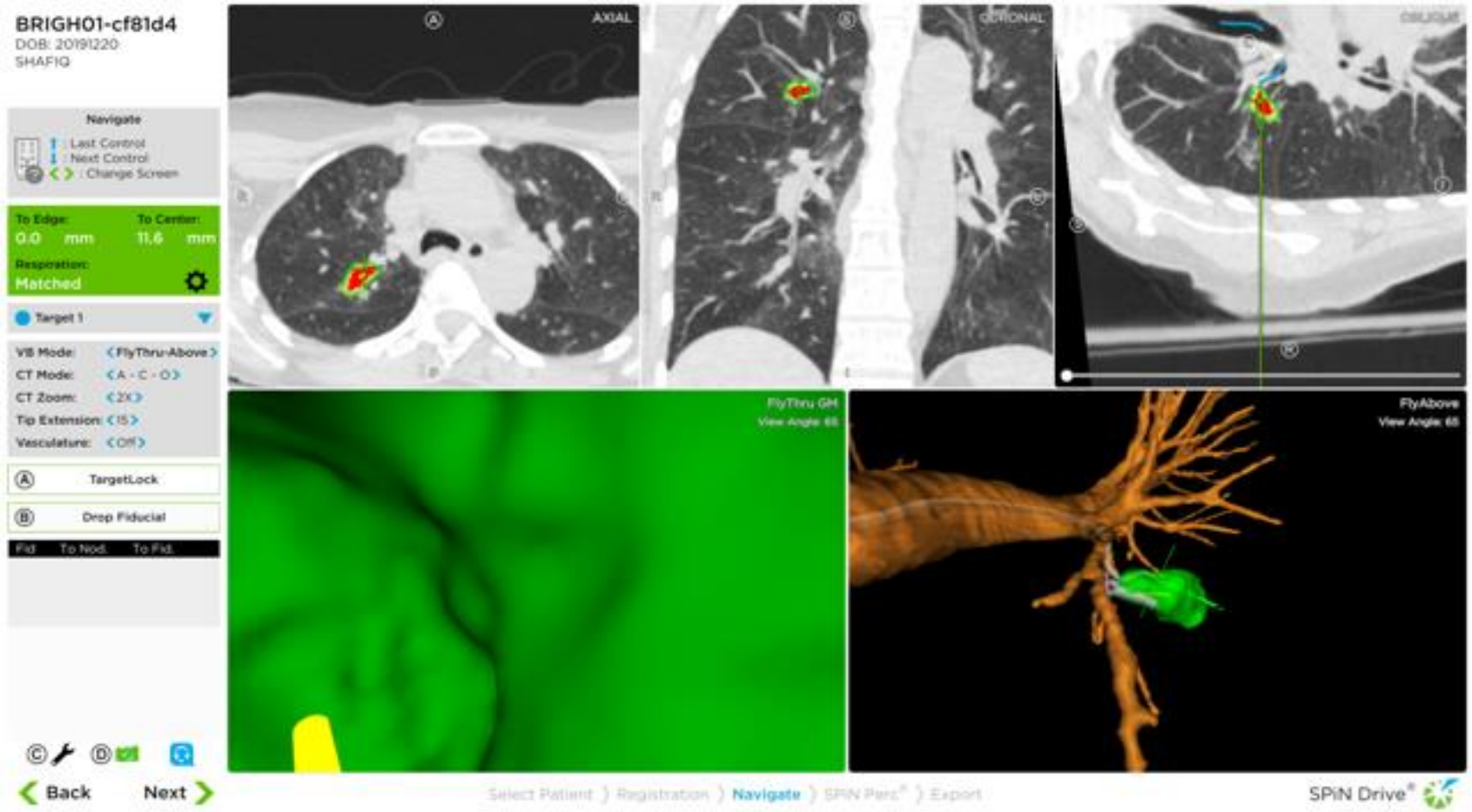
❑**Add-on: Radial EBUS (different from "linear" EBUS)**

- Real-time visualization of lesion (but not of "tool-in-lesion")

❑**Add-on: Cone-beam CT (and related variants)**

- Real-time visualization of tool-in-lesion (but not of live sampling)

Guided bronchoscopy (using EM navigation) to reach a lung nodule



Peripheral bronchoscopy:
Sensitivity for a malignant lung nodule

1. **Conventional bronchoscopy**
   - Around 35% (variable estimates)
2. **Guided bronchoscopy**
   - Around 70%
3. **Robotic bronchoscopy**
   - Early data: Around 80-90%

❑**Add-on: Radial EBUS**

- Up to around 70% (variable estimates) with either #1 or #2

❑**Add-on: Cone-beam CT**

- Early data: Up to 90% with either #2 or #3

Peripheral bronchoscopy:
What sampling tool to use?

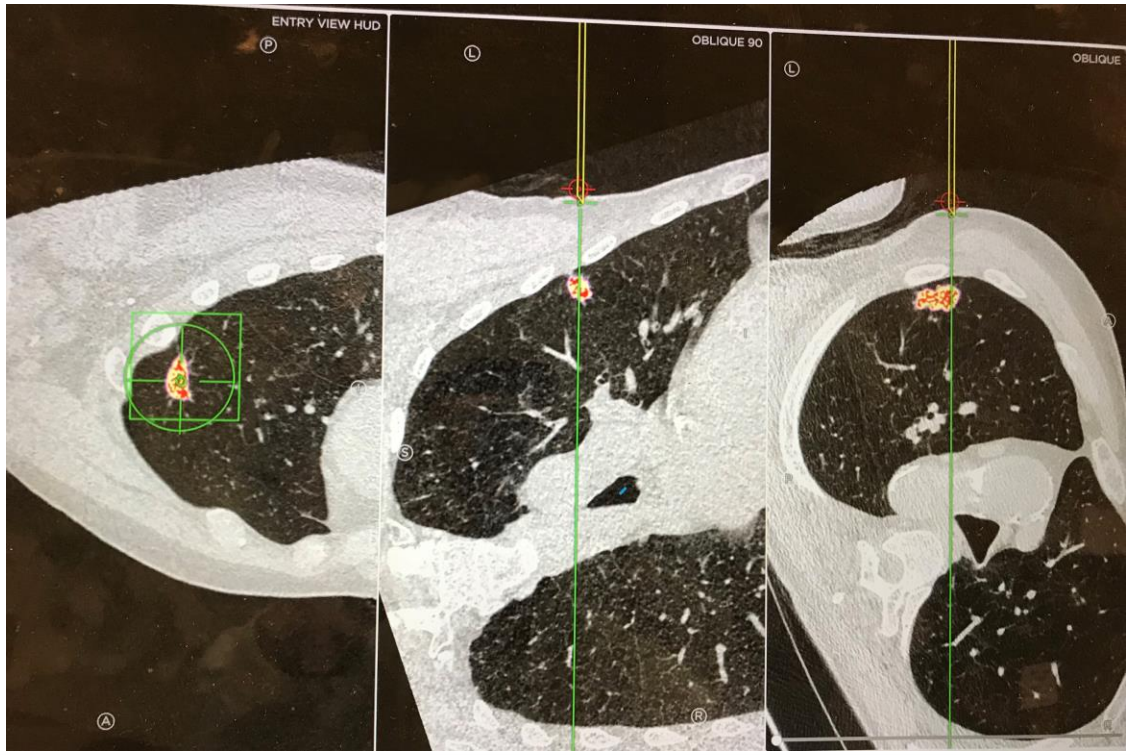
- Sensitivity for cancer: **TBNA > TBBX > brushing** or **BAL**
  - Pathology may be extraluminal, require traversing airway wall
  - Adding TBBX to TBNA may increase pooled sensitivity
  - **Cryobiopsy** for ILD: TBBX variant using cryoprobe instead of forceps; approx. 70% agreement w/ surgical biopsy for final IPF dx
    - Concern for significant bleeding (15%) & 30d mortality (up to 2%)
    - Need for more data, greater standardization

➢Unclear how many specimens to obtain for max. sensitivity

- Retrospective data: 3 TBBX samples enough for lung nodules
- In contrast: ≥5 pieces of alveolated tissue (by TBBX) needed for formal assessment of acute rejection post-lung transplant

Also in the IP toolkit: Trans-thoracic approach

- Can switch to navigational TTNA/TTBX if ROSE suggestive of inadequate bronchoscopic sampling



Outline

- Advanced diagnostic bronchoscopy
- Advanced therapeutic bronchoscopy
- Advanced pleural procedures

Advanced therapeutic bronchoscopy:
1. Symptomatic tracheobronchomalacia (TBM)

➢ **Controversies galore:**

1. Should we distinguish types of expiratory airway collapse?
   - "True" TBM (cartilage) vs. EDAC (posterior membrane)
2. How to diagnose and characterize severity etc.?
   - Dynamic CT, flex bronch, both? How best to protocolize them?
   - What cut-off to use for expiratory collapse?
3. Rx (wt. loss, CPAP, flutter valve, expectorant, pursed lips):
   - Does surgery (membranous tracheoplasty) have a role?
   - Should an airway stent trial precede selection for surgery?

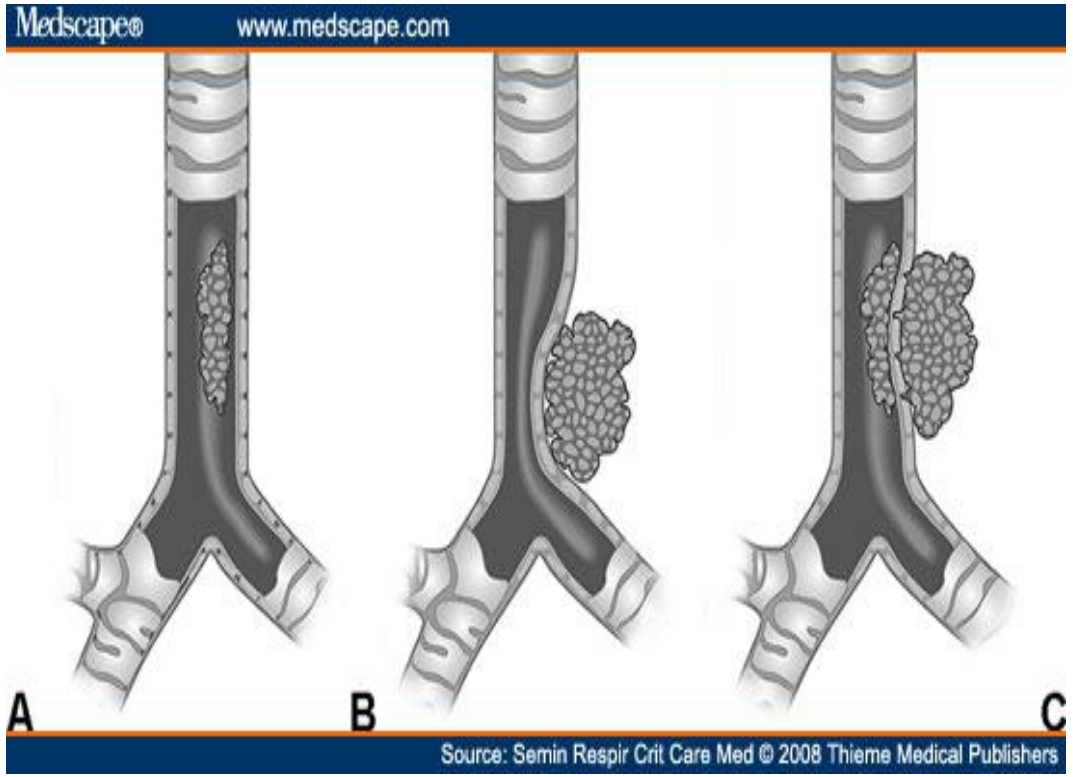
Advanced therapeutic bronchoscopy:

2. Central airway obstruction (i.e., proximal to lobar bronchi)

A. Intraluminal
   - Tumor debulking

B. Extrinsic (compression)
   - Airway stenting

C. Mixed
   - Possibly both

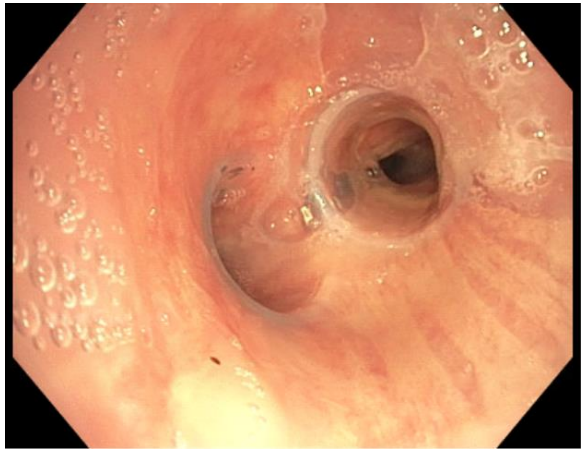


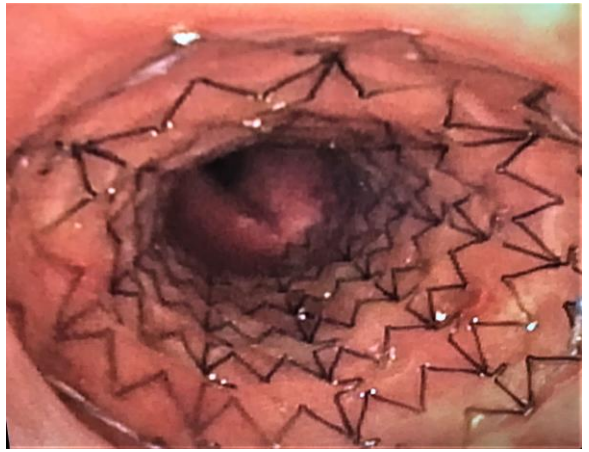
Options in hand:
Tumor debulking

	Mechanical (rigid barrel or forceps)	Electro-cautery	Argon plasma coagulation (APC)	Laser (Nd: YAG, KTP, etc.)	Cryo-therapy (spray vs. contact)	Brachy-therapy (high-dose local XRT)	Photo-dynamic therapy (PDT)
Requires contact	Y	Y	N	N	**Spray**: N **Contact**: Y	N	N
Immediate effect?	Y	Y	Y	Y	**Spray**: Y **Contact**: Y & N	N	N
Depth of effect (mm)	Varies	3-15	3	Varies	10	10-20	5-10
Fire risk (need FiO2 <40%)	N	Y	Y	Y	N	N	Y (during activation)

Options in hand:
Airway stenting

- 2 broad types: Silicone vs. metallic
  - Metallic stents are self-expanding (SEMS) and collapsible; hence can be deployed through a flexible bronchoscope too
  - Most SEMS: Metal frame “covered” w/ silicone/polyurethane





Management considerations post-stenting

- All stents represent a new disease. Complications include:
  - Mucostasis & infection 2/2 compromised airway wall clearance
  - Granulation tissue esp. around edges of stent
  - Migration, fracture, bleeding, epithelialization, perforation, etc.
  - **FDA Black Box (2005):** SEMS in non-malignant tracheal disease
    - Longer lifespan -> more complications, esp. with 1st gen, uncovered SEMS

➢Consider the following post-stenting:

- Expectorant (guaifenesin) and/or saline nebs
- Surveillance bronchoscopy (data favors q6weeks) to pro-actively deal with issues

JANUARY 8, 2020 / NEWS RELEASES

FDA Approves 3D-printed Airway Stents

- Stent material: Silicone
- Allowing customization to patient airway
  - Potentially longer stent life without requiring replacement for stent fracture, migration, or other stent-related issues

vs.

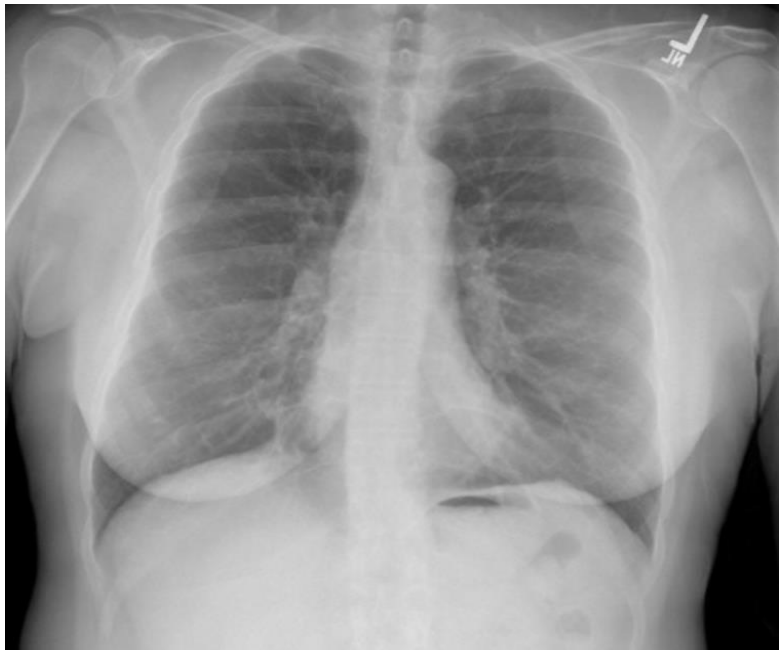
Which of the following is a pre-requisite for bronchoscopic lung volume reduction using one-way valves?

A. Collateral ventilation across lobes
B. Hyper-inflation
C. Active smoking
D. Frequent COPD exacerbations

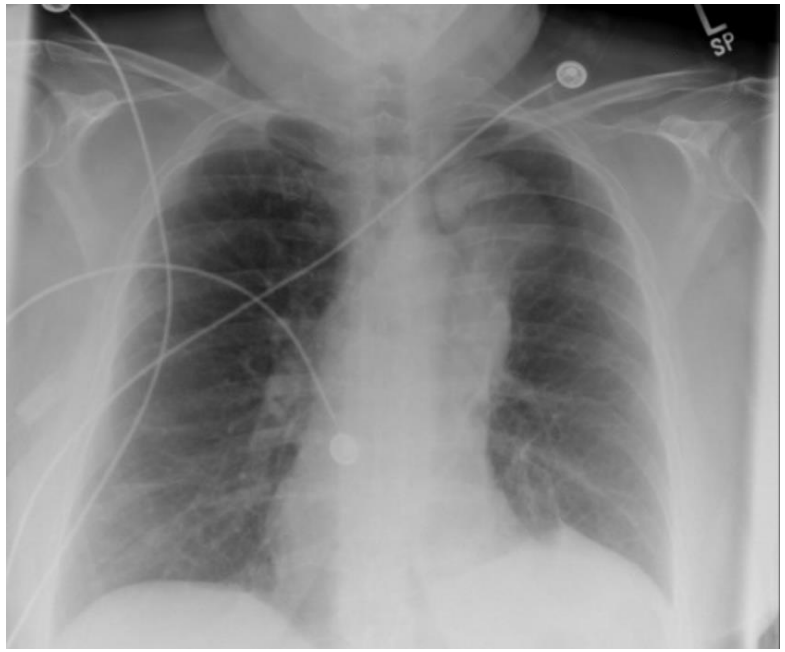
Advanced therapeutic bronchoscopy:
3. Emphysema with hyper-inflation

- Bronchoscopic lung volume reduction (BLVR) via one-way valves improves FEV1 (in 50%), 6MWD, symptom scores
  - To date, not shown to reduce mortality (unlike surgical LVR)
  - But more favorable peri-op M&M compared to surgery
- **Major challenge**: Not valve placement, but patient selection!
  - Need complete lobar fissure to avoid back-door air entry into the treated lobe through collateral ventilation
- **Major complication**: PTX in 1/3rd (on top of poor baseline)
  - Keep patient hospitalized for 3 days post-op; consider sending out with MedicAlert bracelet; ensure close follow up

Successful LUL volume reduction via endobronchial valve placement



BEFORE



AFTER

Advanced therapeutic bronchoscopy:
4. Severe asthma

- AIR-2 RCT (sham-controlled): Bronchial thermoplasty improves AQLQ symptom scores + decreases exacerbations, ED visits, hospitalizations, and days missed from work/school
  - Excluded patients with >10mg/d OCS, >3 hospitalizations/year
  - Newer data post-FDA approval: Sustained effects at 5 years
  - **BT10+ study (2021): Sustained effects (10+ yrs), excellent safety profile**
  - Unclear what asthma subtype(s) benefits most

- Major short-term complication: Asthma exacerbation
  - Pre-op spiro (consider postponing if post-BD FEV1 <85% of recent)
  - 5 days of steroid burst starting 3 days pre-treatment

Chaudhuri R, et al. Lancet Respir Med 2021. PMID: 33524320.

Advanced therapeutic bronchoscopy:
5. Miscellaneous modalities in early stages of development

- Ablation of lung nodules (e.g., via microwave or RFA)
  - Needs confirmation of tool-in-lesion
- Bronchoscopic coil placement for BLVR
  - Coils unfurl post-deployment -> not reversible (unlike valves)
- Bronchial rheoplasty for chronic bronchitis
  - Pulsed Electric Fields -> ablation of mucus-producing airway cells
- Targeted lung denervation for COPD (GOLD stage B or D)
  - Peri-bronchial parasympathetic n. ablation (RFA) -> bronchodilation
  - AIRFLOW-3 (international sham-controlled RCT) underway

Outline

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Advanced pleural procedures

1. Indwelling pleural catheter (IPC)

- Symptomatic management for recurrent effusion
  - Role established in both malignant or non-malignant effusions
  - Can lead to “auto-pleurodesis” in up to half of all cases
- IPC compared with chemical (e.g., talc) pleurodesis:
  - Done as outpatient; fewer hospital days overall
  - More cost-effective if shorter life expectancy (around <3mo)
  - IPC-Plus = Talc via IPC: Auto-pleurodesis faster, more likely
- IPC-related pleural infection rate approx. 5%
  - Usually treated pharmacologically without catheter removal

Advanced pleural procedures

2. Pleuroscopy for malignant pleural effusion

✓ Diagnostic role:

- High sensitivity for malignant effusion (around 95%)
  - Pleural fluid cytology, closed pleural biopsy: much lower sensitivity (esp. for mesothelioma)

x Therapeutic role:

- TAPPS RCT (JAMA 2019): No difference between talc slurry (chest tube) vs. talc poudrage (pleuroscopy) in terms of pleurodesis success for malignant effusion

Medical pleuroscopy	Video-assisted thoracoscopic surgery (VATS)
• Typically single entry port	• Typically 2-3 entry ports
• Patient typically awake, spontaneously breathing	• Patient under GA and single-lung ventilation
• Typically limited to parietal pleura (biopsy) and pleural space (talc, indwelling catheter)	• Encompasses lung biopsy or resection, diaphragm repair, sympathectomy, etc.

Why choose medical pleuroscopy* over VATS for pleural biopsy (e.g., for undiagnosed effusion)?

- Similar diagnostic performance
- Similar safety profile
- Shorter hospital LOS & fewer overall costs
  - *With “awake” pleuroscopy i.e., not involving GA

McDonald CM, et al. Ann Thorac Surg. 2018. PMID: 29577922.

Take-home points

- EBUS-TBNA is preferable to surgery (mediastinoscopy, VATS) as 1st line for NSCLC mediastinal staging
- ROSE does not increase diagnostic yield of EBUS-TBNA
  - But may decrease the number of sampled sites
- Guided bronchoscopy has lower sensitivity for malignant nodules than TTNA (but lower PTX rate)
  - Will newer modalities (robotic bronch, CBCT) change that?
- Airway stents require meticulous care and follow up
- A complete lobar fissure is essential for valve-based BLVR
- Bronchial thermoplasty is a highly safe long-acting (life-long?) therapeutic option for patients with uncontrolled asthma despite optimal medical management
- Awake pleuroscopy is cost-effective over VATS for pleural biopsy

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