Multidisciplinary Approaches to Cancer Symposium

# Complications of Stage II/III Lung Cancer (Surgical Perspective)


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# Disclosures

- I do not have any relevant financial relationships.

*This presentation and/or comments will provide a balanced, non-promotional, and evidence-based approach to all diagnostic, therapeutic and/or research related content.*

# Cultural Linguistic Competency (CLC) & Implicit Bias (IB)

**STATE LAW:**

The California legislature has passed Assembly Bill (AB) 1195, which states that as of July 1, 2006, all Category 1 CME activities that relate to patient care must include a cultural diversity/linguistics component. It has also passed AB 241, which states that as of January 1, 2022, all continuing education courses for a physician and surgeon **must** contain curriculum that includes specified instruction in the understanding of implicit bias in medical treatment.

*The cultural and linguistic competency (CLC) and implicit bias (IB) definitions reiterate how patients' diverse backgrounds may impact their access to care.*

***EXEMPTION:***

Business and Professions Code 2190.1 exempts activities which are dedicated solely to research or other issues that do not contain a direct patient care component.

***The following CLC & IB components will be addressed in this presentation:***

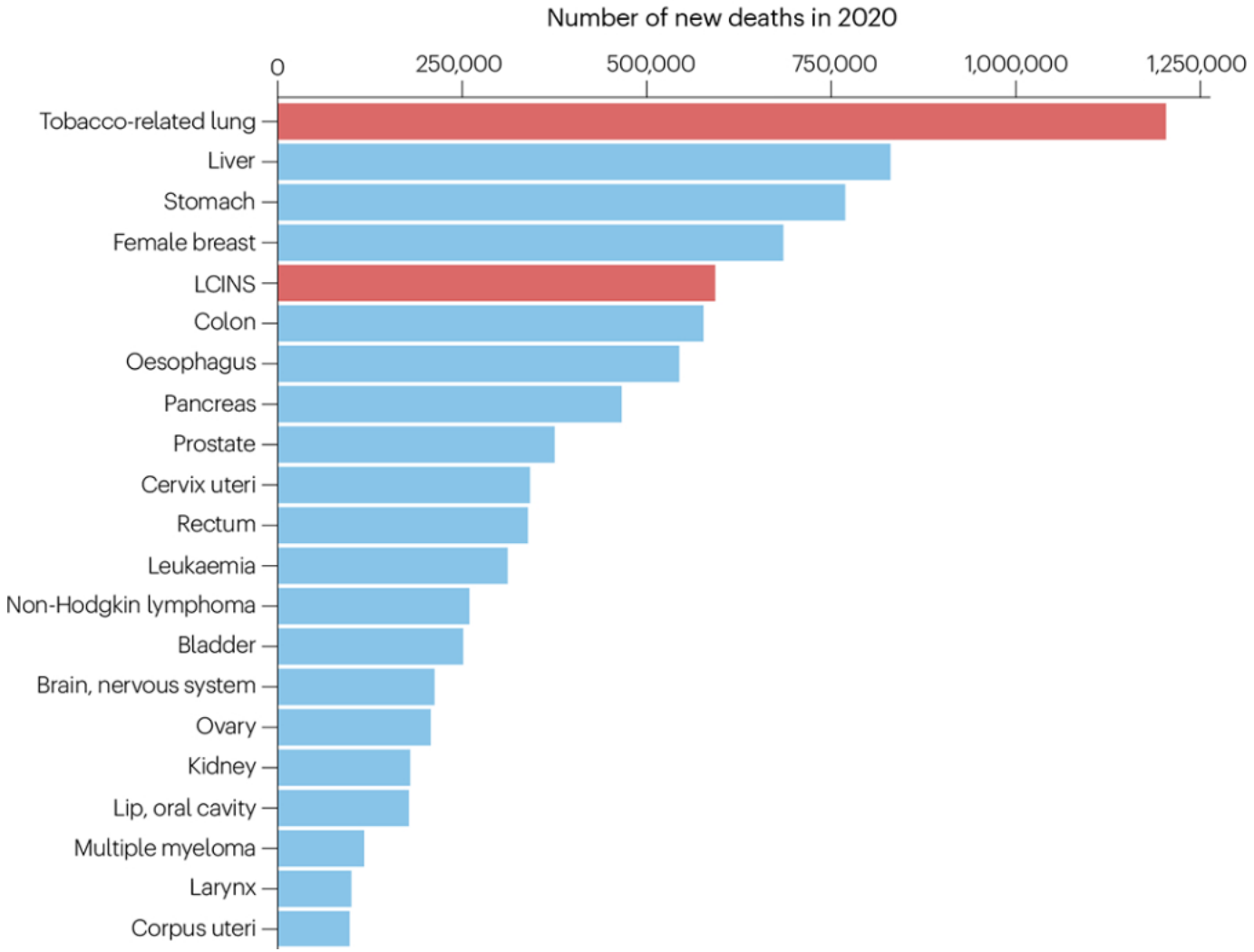
- *Addressing barriers to care*

# Lung Cancer

- Biggest cause of cancer deaths worldwide: nearly 2 million deaths yearly

- Lung cancer 2 main flavors
  - Small cell lung cancer (SCLC) (15%)
  - Non-small cell lung cancer (NSCLC) (85%)
    - Adenocarcinoma
    - Squamous cell carcinoma
    - Others (NET, etc.)
- In the United States
  - Second most common cancer in both men and women
  - Estimated >226,000 new cases of lung cancer in the US in 2025

- Can also be classified as:
  - Tobacco-related lung cancer
  - Lung Cancer in Non-smokers




LoPiccolo J et al., Nature Reviews Clinical Oncology, 21:121, 2024.

# Features of Lung Cancer in Non-Smokers Compared to Tobacco-related Lung Cancers

| Feature | LCINS | Tobacco-related lung cancer |
|---|---|---|
| Demographics | Two-thirds are women, younger | More likely to be male, older |
| Histology | Largely Adenocarcinomas | Adenocarcinoma, Squamous Cell, Small Cell |
| Targetable driver alterations | Present in 78–92% of Adenocarcinomas (most commonly EGFR mutations) | Present in 49.5% of Adenocarcinomas (most commonly *KRAS* mutations) |
| PD-L1 expression level | Low | Highest with current smoking<br>PD-L1 staining intensity correlated with pack-years of smoking |
| TMB | 0–3mut/Mb (median 1.1 mut/Mb) | Up to tenfold higher than in LCINS<br>TMB directly related to pack-years of smoking history |



Adapted from: LoPiccolo J et al., Nature Reviews Clinical Oncology, 21:121, 2024.

# Lung Cancer Staging

- T-size
- N-nodes
  - Unilateral vs mediastinal/subcarinal vs contralateral
- M-metastases

- What's resectable?
  - Stage I
  - Stage II
  - Some Stage IIIA
  - Rarely IIIB

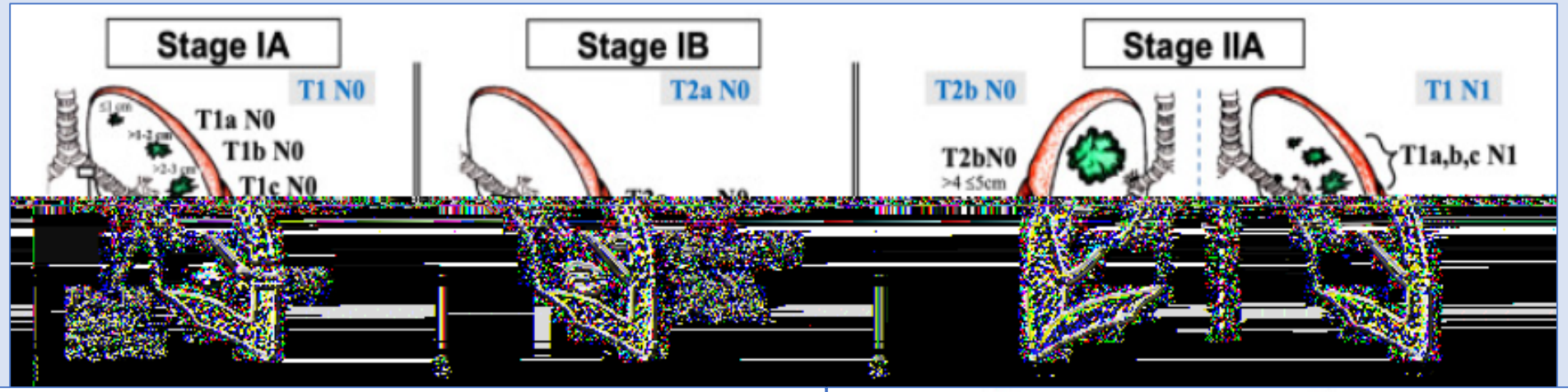
**9th Edition TNM Categories**

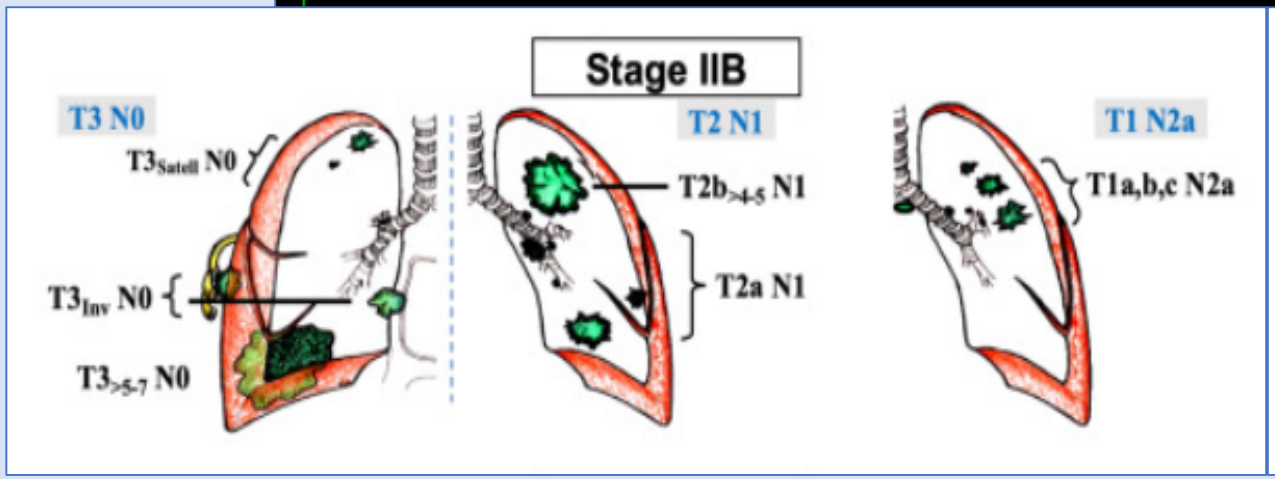
| T/M | Description | N0 | N1 | N2 | | N3 |
|---|---|---|---|---|---|---|
| | | | | **N2a** | **N2b** | |
| T1 | T1a ≤1 cm | IA1 | IIA | IIB | IIIA | IIIB |
| | T1b >1 to ≤2 cm | IA2 | IIA | IIB | IIIA | IIIB |
| | T1c >2 to ≤3 cm | IA3 | IIA | IIB | IIIA | IIIB |
| T2 | T2a Visceral pleura / central invasion | IB | IIB | IIIA | IIIB | IIIB |
| | T2a >3 to ≤4 cm | IB | IIB | IIIA | IIIB | IIIB |
| | T2b >4 to ≤5 cm | IIA | IIB | IIIA | IIIB | IIIB |
| T3 | T3 >5 to ≤7 cm | IIB | IIIA | IIIA | IIIB | IIIC |
| | T3 Invasion | IIB | IIIA | IIIA | IIIB | IIIC |
| | T3 Same lobe tumor nodule | IIB | IIIA | IIIA | IIIB | IIIC |
| T4 | T4 >7 cm | IIIA | IIIA | IIIB | IIIB | IIIC |
| | T4 Invasion | IIIA | IIIA | IIIB | IIIB | IIIC |
| | T4 Ipsilateral tumor nodule | IIIA | IIIA | IIIB | IIIB | IIIC |
| M1 | M1a Pleural/pericardial dissemination | IVA | IVA | IVA | IVA | IVA |
| | M1a Contralateral tumor nodule | IVA | IVA | IVA | IVA | IVA |
| | M1b Single extrathoracic lesion | IVA | IVA | IVA | IVA | IVA |
| | **M1c1** Multiple lesions, 1 organ system | IVB | IVB | IVB | IVB | IVB |
| | **M1c2** Multiple lesions, >1 organ system | IVB | IVB | IVB | IVB | IVB |

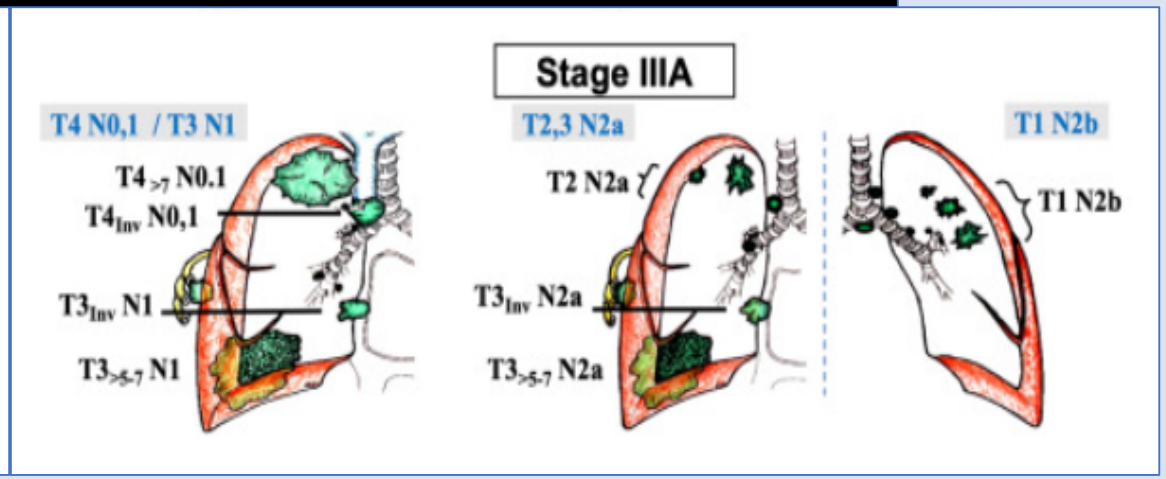


Detterbeck FC, et al. Chest 166: 882, 2024

# What does stage II/III look like?
# Resectable Disease



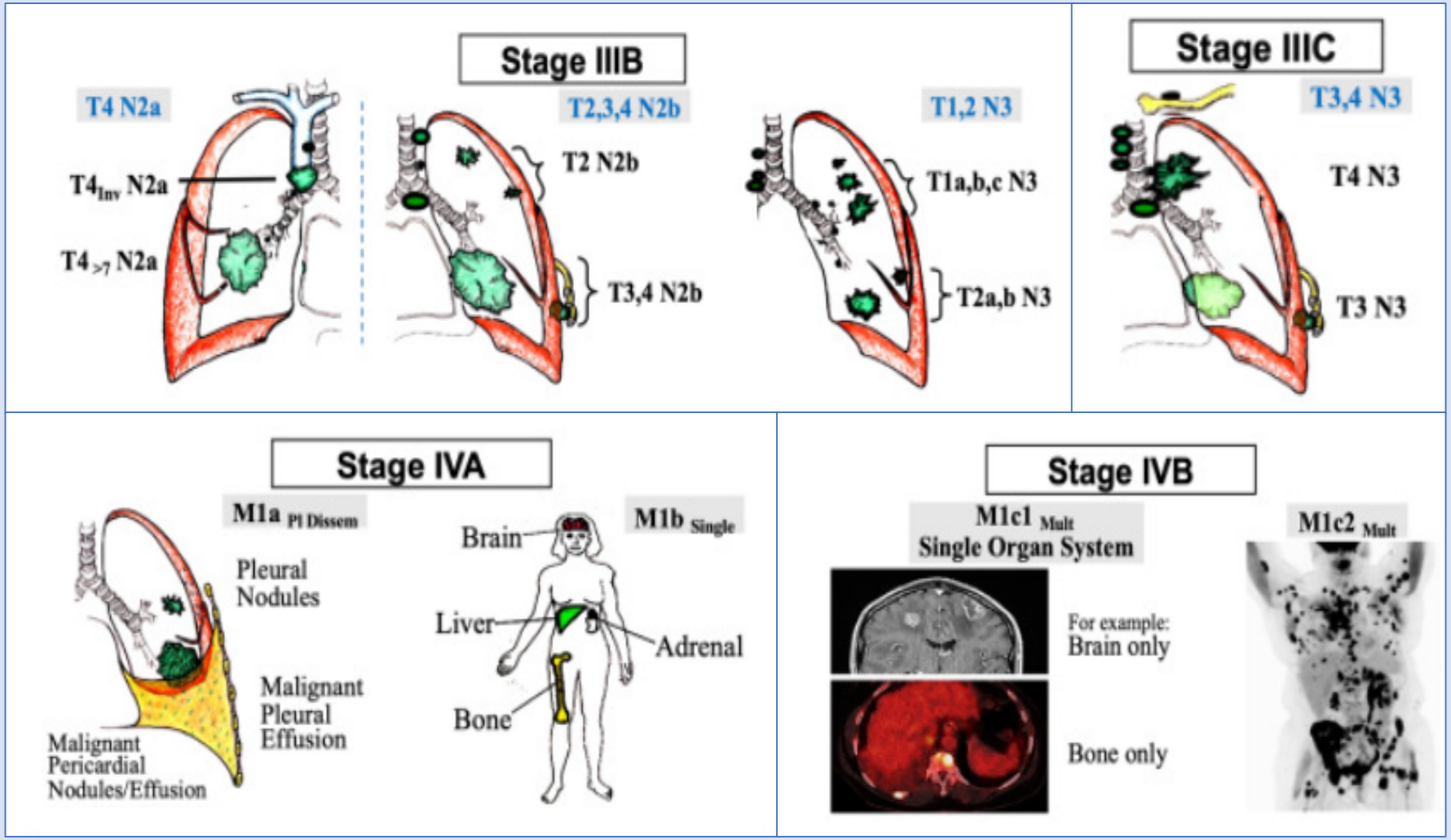






Detterbeck FC, et al. Chest 166: 882, 2024

# Stage III/IV
# Generally Un-resectable Disease

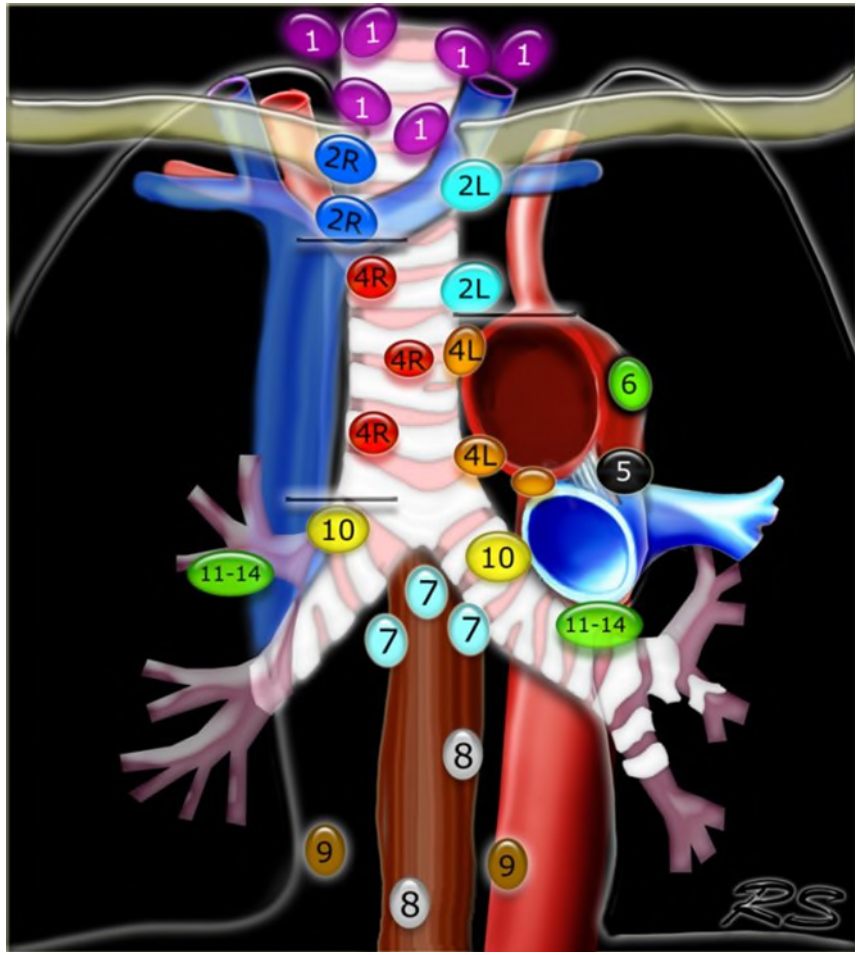





Detterbeck FC, et al. Chest 166: 882, 2024

# How do we treat it?

- Appropriate staging
  - PET-CT
  - MRI brain
  - EBUS/mediastinoscopy
- Systemic therapy
  - Neoadjuvant
  - Adjuvant
  - Perioperative
- Local therapy
  - Surgery
  - Radiation



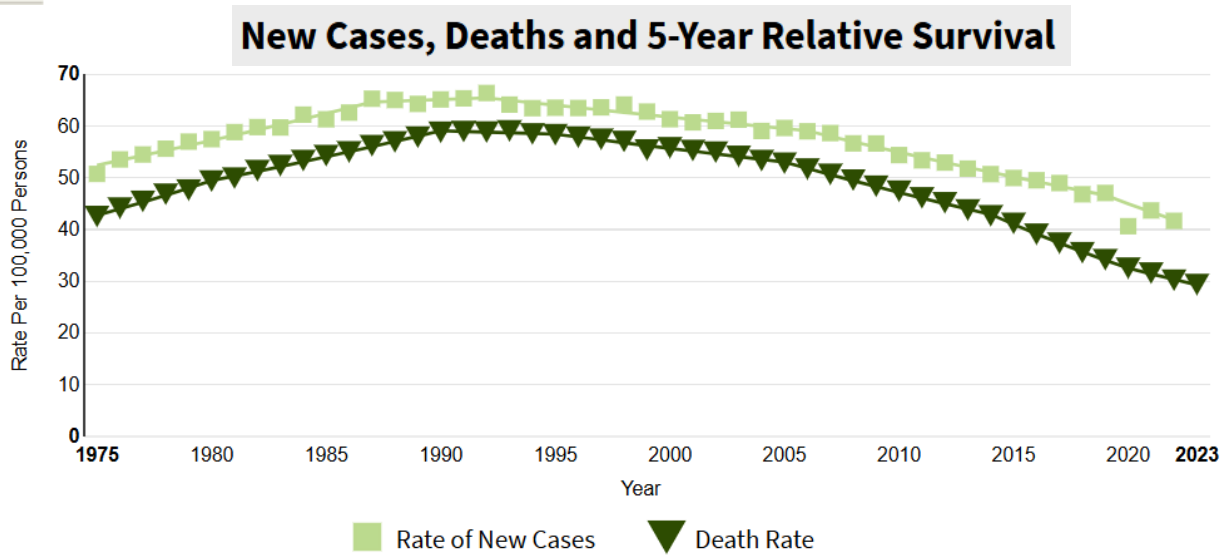

Mediastinal Lymph Node Stations

# Lung Cancer Outcomes

- Significant improvements in survival in recent years
- Better systemic therapy
- Earlier cancers are now found with screening
- Lung-sparing and MIS surgical approach increasingly adopted

**Table. Period Survival (SEER-18)**

| Characteristic | Period survival rate, % | | | | |
|---|---|---|---|---|---|
| | 1-year | 2-year | 3-year | 4-year | 5-year |
| Overall | 55.1 | 41.0 | 33.8 | 29.5 | 26.4 |
| Age, y | | | | | |
| <65 | 57.7 | 42.7 | 35.2 | 30.8 | 27.9 |
| ≥65 | 53.7 | 40.1 | 33.1 | 28.8 | 25.5 |
| Men | 50.4 | 35.6 | 28.6 | 24.6 | 21.9 |
| Women | 60.3 | 46.9 | 39.5 | 34.8 | 31.3 |
| Stage | | | | | |
| I | 92.8 | 85.2 | 78.2 | 73.1 | 68.4 |
| II | 78.7 | 64.3 | 55.3 | 49.2 | 45.1 |
| IIIA | 66.5 | 47.3 | 37.2 | 30.6 | 26.2 |
| IIIB | 54.3 | 34.3 | 25.4 | 20.5 | 17.3 |
| IV | 31.3 | 16.6 | 10.6 | 7.5 | 5.8 |

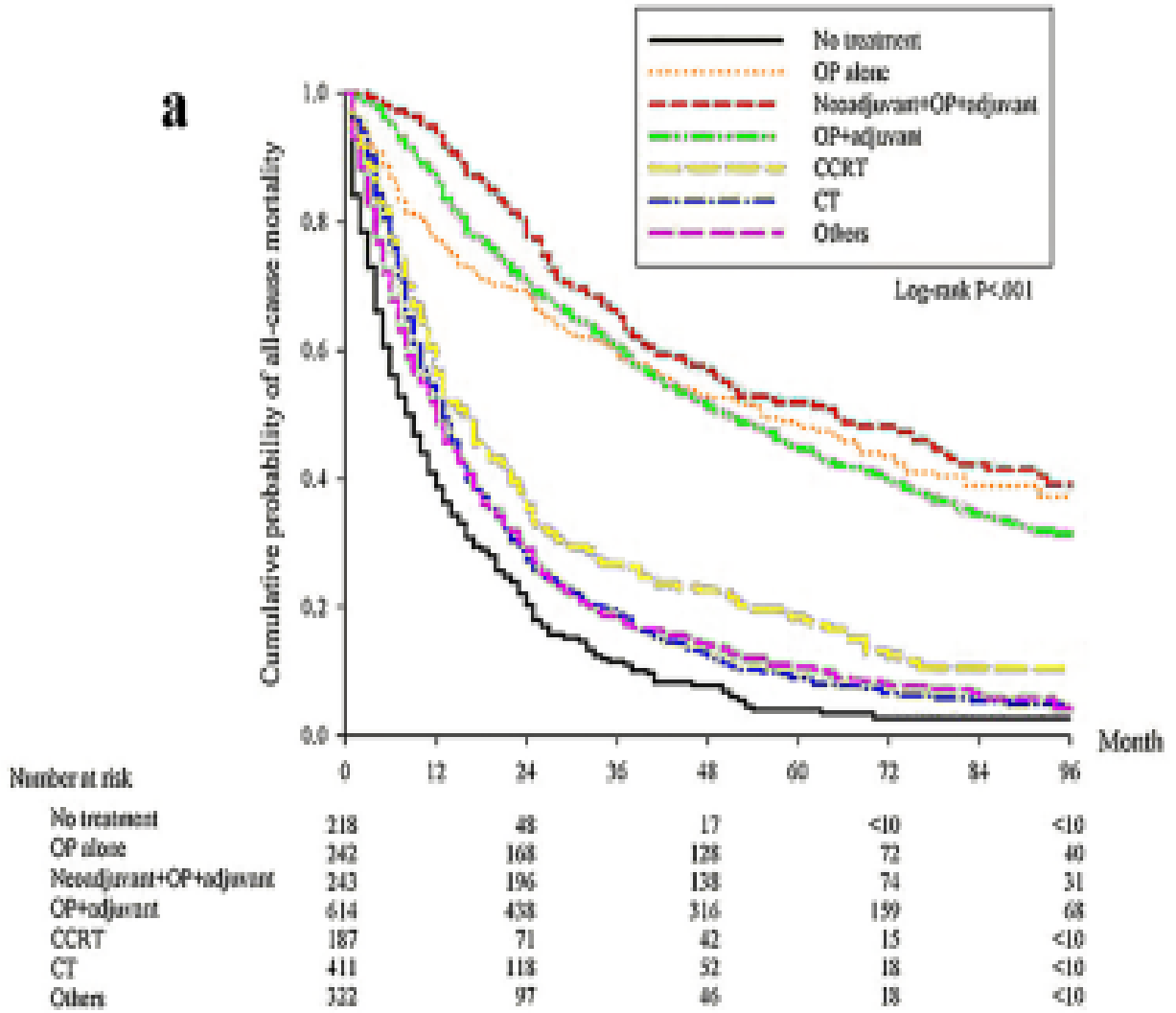



Ganti, et al. JAMA Oncology, 2021
https://seer.cancer.gov/statfacts/html/lungb.html

# Benefits of Surgery

- In stage II and III lung cancer, multimodal treatment with systemic therapy and surgery can result in cure
- For stage II lung cancer, surgical resection has survival benefit and disease-free progression benefit compared to chemotherapy or chemoradiotherapy alone
- For stage III lung cancer, surgical resection has shown benefit in progression free survival and in some studies survival, though mixed survival results especially for patients with single station N2 disease, R0 resection undergoing lobectomy
- Data on impact of immunotherapy is still maturing, but shows great effect in improved disease control

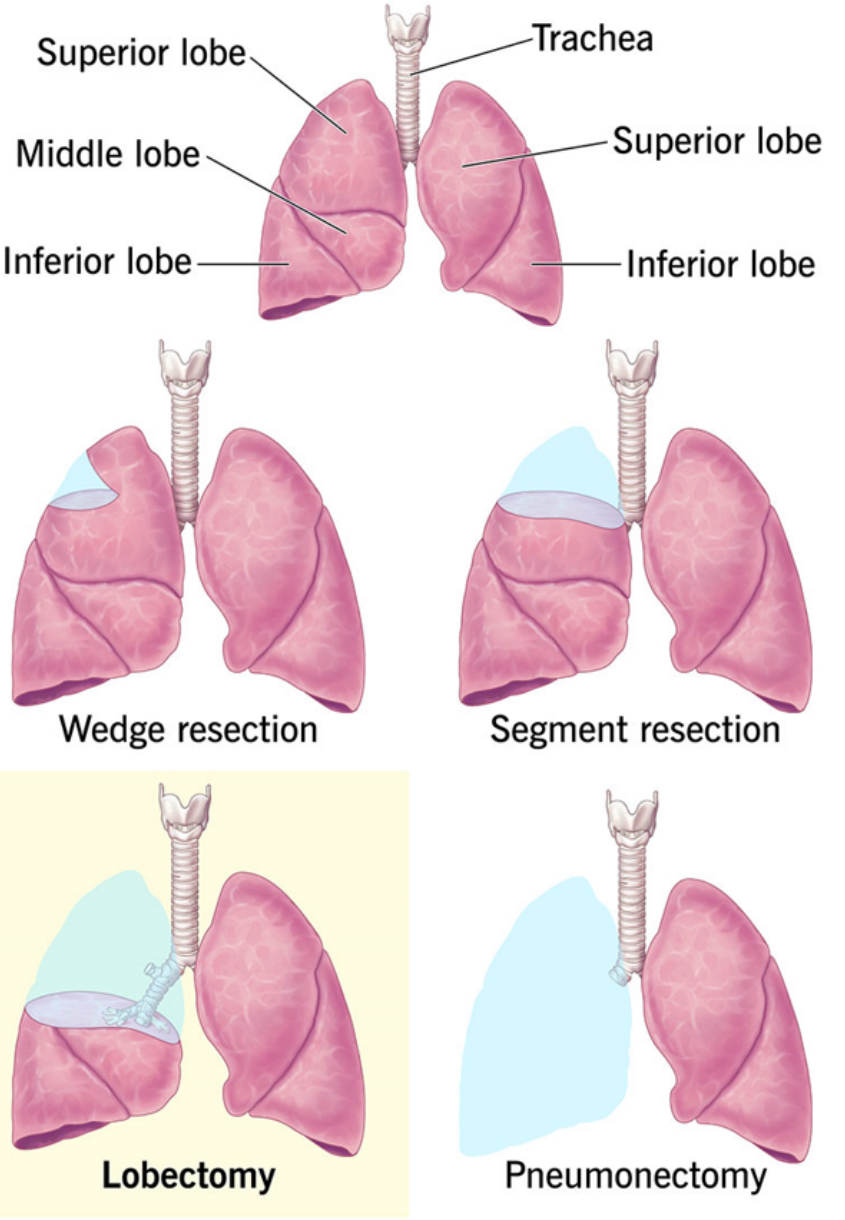
Survival Stage III Lung Cancer By Treatment




Hu PC et al., Scientific Reports 14:29441, 2024

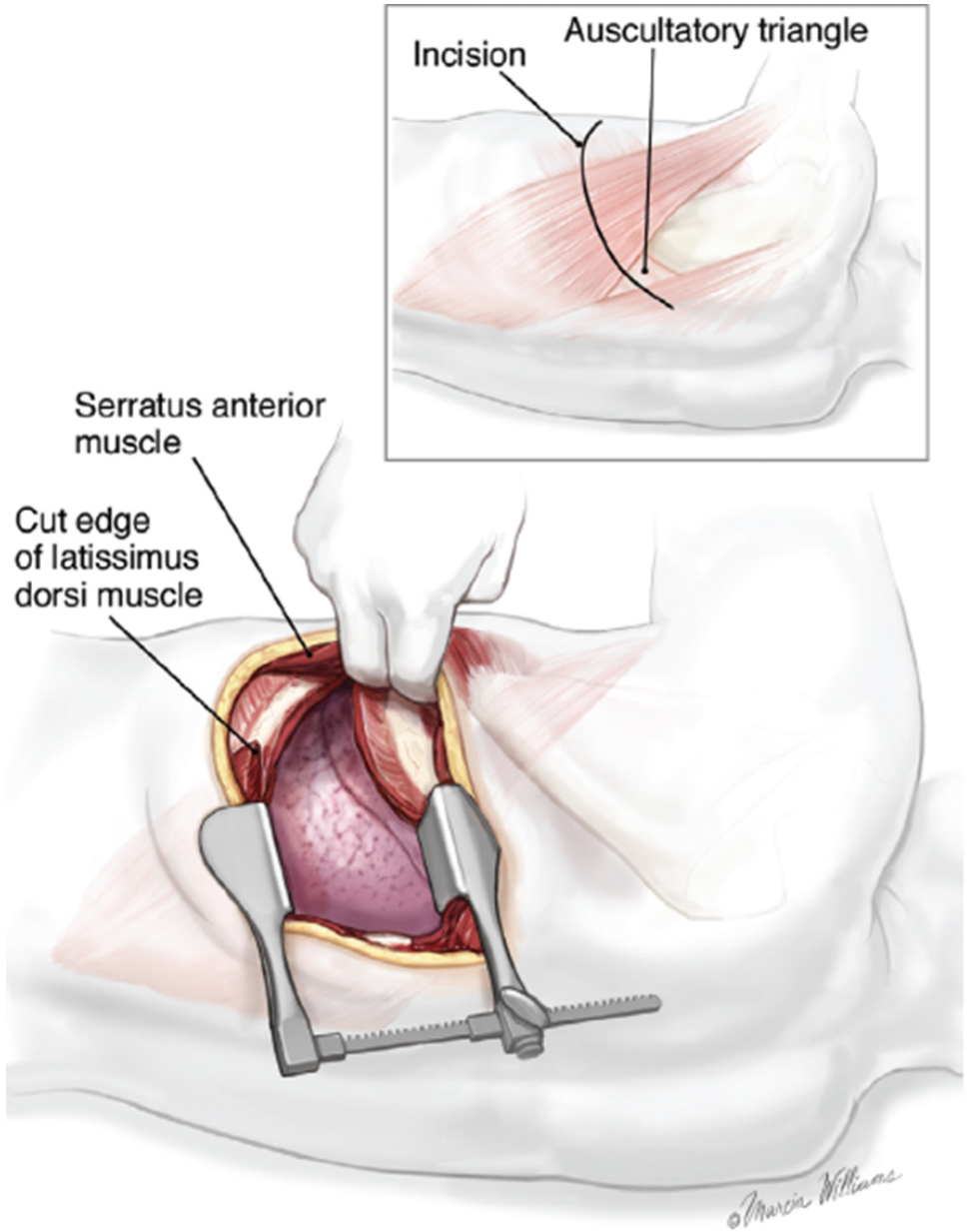
# Surgery

- Surgical resection extent
- Types of Surgery:
  - Open surgery
  - Video Assisted Thoracoscopic Surgery (VATS)
  - Robotic Assisted Thoracoscopic Surgery
- Preoperative work up includes
  - PFTs
  - Preoperative risk/cardiac risk assessment



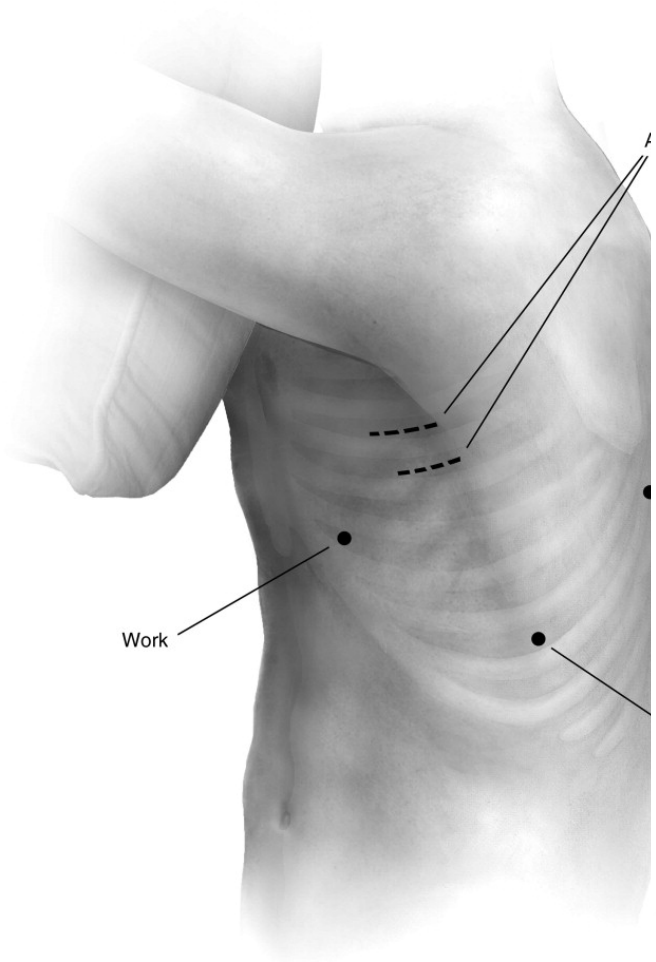
# Open Surgery

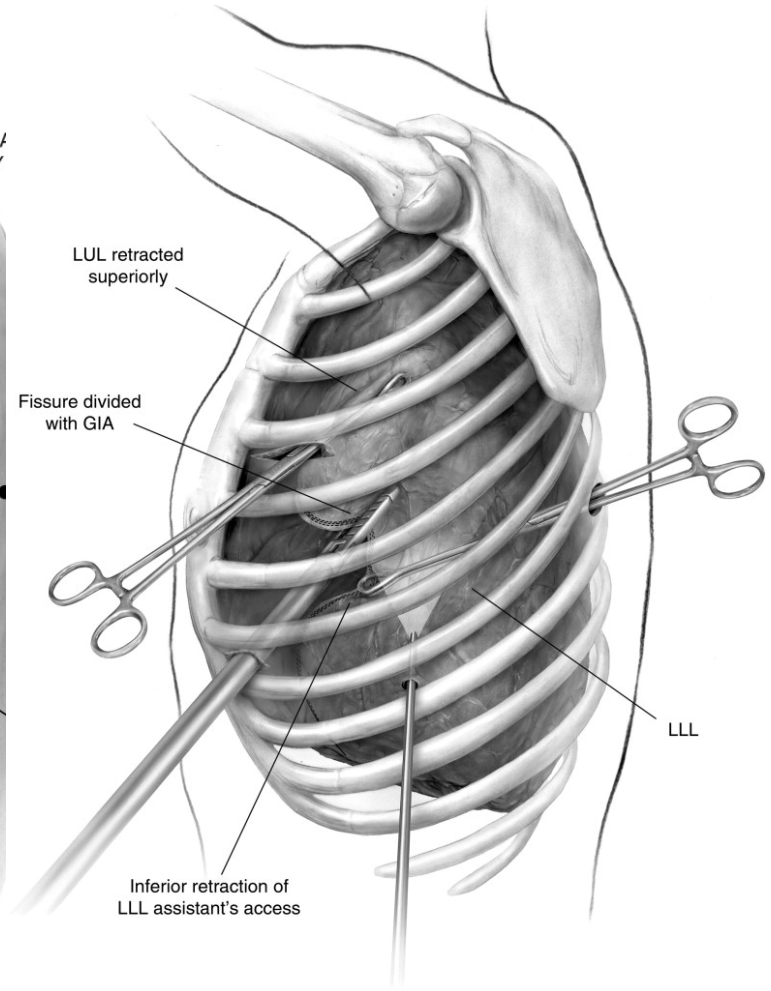
- Traditional Technique
- Still used in complex cases (scar tissue, complex anatomy) or to address complications (bleeding)
- More invasive
- Increased post-operative pain
- Allows direct visualization/palpation of structures
- Outcomes:
    - Longer LOS
    - Increased pain
    - More complications
    - Oncologic gold standard prior to the invention of MIS surgery



# Video-assisted Thoracoscopic Surgery (VATS)

- Similar to laparoscopic surgery but in the chest
- Long, straight instruments
- Smaller incisions
- More technically difficult
- Outcomes:
  - Shorter LOS
  - Less pain
  - Less complications
  - Oncologic equivalent to open surgery



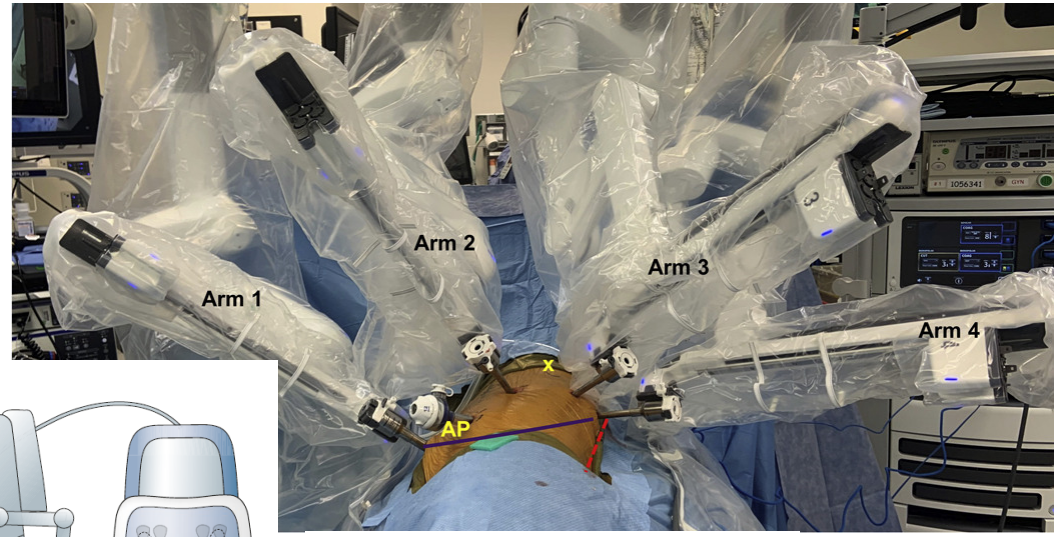



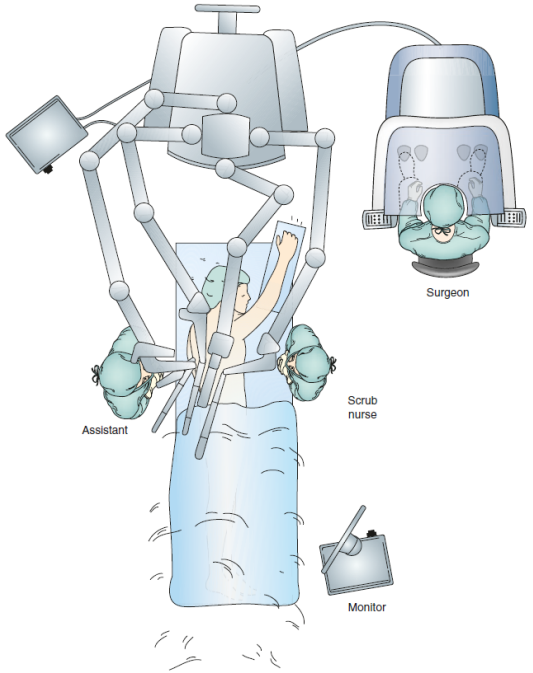


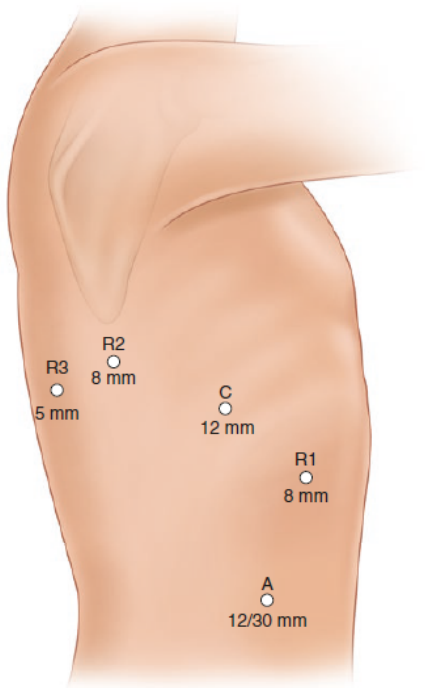

MS Mulligan, Video-Assisted Thoracic Surgery Lobectomy, in: Operative Techniques in Thoracic and Cardiovascular Surgery, 2012

# Robotic Assisted Surgery

- Similar to VATS surgery (ie MIS) but instruments driven via Robotic platform
- Generally 5 incisions
- Instruments with 7 degrees of freedom
- 3D visualization
- Easier technique to learn than VATs
- Allows more complex MIS dissection than VATs
- More costly
- Surgeon not at bedside
- Outcomes:
  - Shorter LOS than open surgery
  - Less pain than open surgery
  - Less complications than open surgery
  - Lower conversions to open surgery than VATS
  - Oncologic equivalent to open surgery





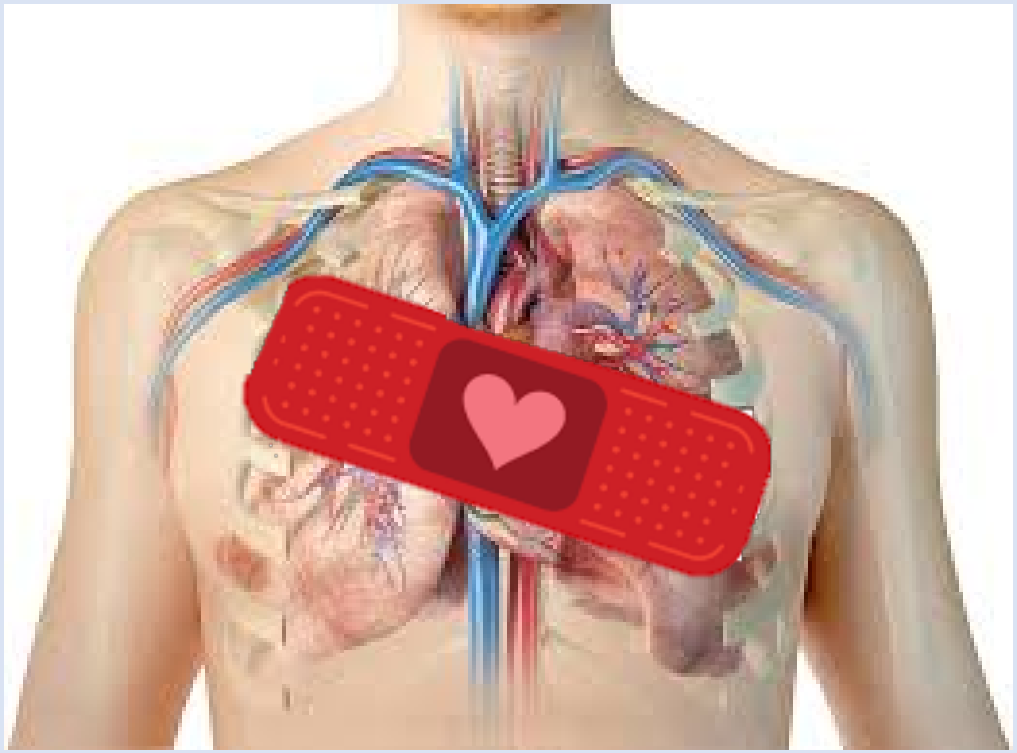

A. Fong, Minimally Invasive Lung Surgery, in Interventional Oncology, Springer 2025

# Comparison of Techniques

- Surgical approach is a tool
  - Anatomy, location of tumor, patient factors and surgeon expertise can influence approach
- Oncologically, all are good options with generally comparable OS and DFS in all three modalities
- MIS (VATS/Robotic) tend to have lower pain, shorter LOS, lower chest tube duration and lower complications than open surgery
- Robotic surgery allows for more complex MIS dissection
- The best approach is the safest one that gets the patient a good outcome

# Intra-operative Complications

- Intraoperative
  - Bleeding
  - Injury to other structures
    - Pulmonary artery/vein, lung, heart, phrenic nerve, aorta
    - Higher stage tumors, neoadjuvant therapy, difficult anatomy or previous surgery can all increase likelihood of complication
- Treatment:
  - Intraoperative repair of injury
  - Conversion to open surgery
  - Transfusion when needed



# Post-operative Complications

| | Lobectomy (n=2,277) | Segmentectomy (n=989) | Wedge (n=2912) |
|---|---|---|---|
| Mortality | 1.3% | 0.7% | 0.4% |
| Complications | 41% | 29% | 28% |
| Length of Stay | 11.2 days | 8.4 days | 6.0 days |

- German thorax registry
- N=7,923 thoracic procedures
- Complications in 27.7% of patients
- Bigger resections had bigger complications
- Most common complications
  - Air leak
  - afib

| | Lobectomy (n=40,026) | Segmentectomy (n=5202) | Wedge (n=20,072) |
|---|---|---|---|
| Atrial Arrythmia | 5.5% | 2.8% | 0.5% |
| ARDS | 0.2% | 0 | 0 |
| Pneumonia | 11.2% | 8.7% | 2.7% |
| Resp Failure | 9.7% | 6.3% | 2.9% |
| PE | 0.4% | 0.4% | 0.1% |
| Air Leak>7 days | 16% | 11% | 2.8% |
| MI | 0.7% | 0.1% | 0.1% |
| Recurrent Nerve Injury | 0.7% | 0.4% | 0.001% |


Schieren M et al., J Cadiothoracic and Vascular Anesthesia, 39:2377, 2025

# Post-operative Complications

| | Lobectomy (n=40,026) | Segmentectomy (n=5202) | Wedge (n=20,072) |
|---|---|---|---|
| Mortality | 0.7% | 0.6% | 0.3% |
| Major Morbidity | 7.9% | | |
| Return to OR | 3.4% | 2.0% | 1.5% |
| Length of Stay | 5.2 days | 3.7 days | 3.2 days |

- Treatments
  - Time
  - BB, antiarrhythmics
  - Antibiotics
  - Anticoagulants
  - ICU as needed

| | Lobectomy (n=40,026) | Segmentectomy (n=5202) | Wedge (n=20,072) |
|---|---|---|---|
| Atrial Arrythmia | 9.8% | 4.3% | 2.3% |
| ARDS | 0.5% | 0.2% | 0.2% |
| Pneumonia | 3.4% | 2.0% | 1.2% |
| Resp Failure | 2.3% | 1.5% | 1.0% |
| PE | 0.5% | 0.2% | 0.2% |
| Air Leak>5 days | 12% | 6.9% | 4.9% |
| MI | 0.3% | 0.2% | 0.3% |
| Recurrent Nerve Injury | 0.3% | 0.2% | 0.1% |



Servais EL et al., Ann Thoracic Surg 110: 768, 2020.

# Long-term Effects

- Chronic
  - Pain: Nerve pain, chest wall discomfort
  - SOB
- Frequency:
  - Chronic post surgical pain (>2 mo) seen in 35% of patients
  - 32% of those are neuropathic pain
  - Associated with open surgery, female sex, high post-operative pain
  - Generally improves/resolves over time
- Treatment:
  - Analgesia (Gabapentin, Lyrica)
  - Pain interventions (injections, PT)
  - Time
  - Support

# Conclusions

- Stage II/III lung cancer can represent a wide presentation of lung cancer with larger tumors and positive lymph nodes
- Multimodality treatment is indicated
- Surgery for appropriately selected patients can improve survival and disease-free progression
- MIS surgery reduces pain, complications and LOS
- Major complications happen in about 8% of patient, most common complications are air leaks and atrial fibrillation
    - Mortality is low 1-2%
- Dr. Malhotra will now discuss systemic therapies

# Thank you

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