Lung Cancer Radiotherapy

Indications, Outcomes, and Impact on Survivorship Care

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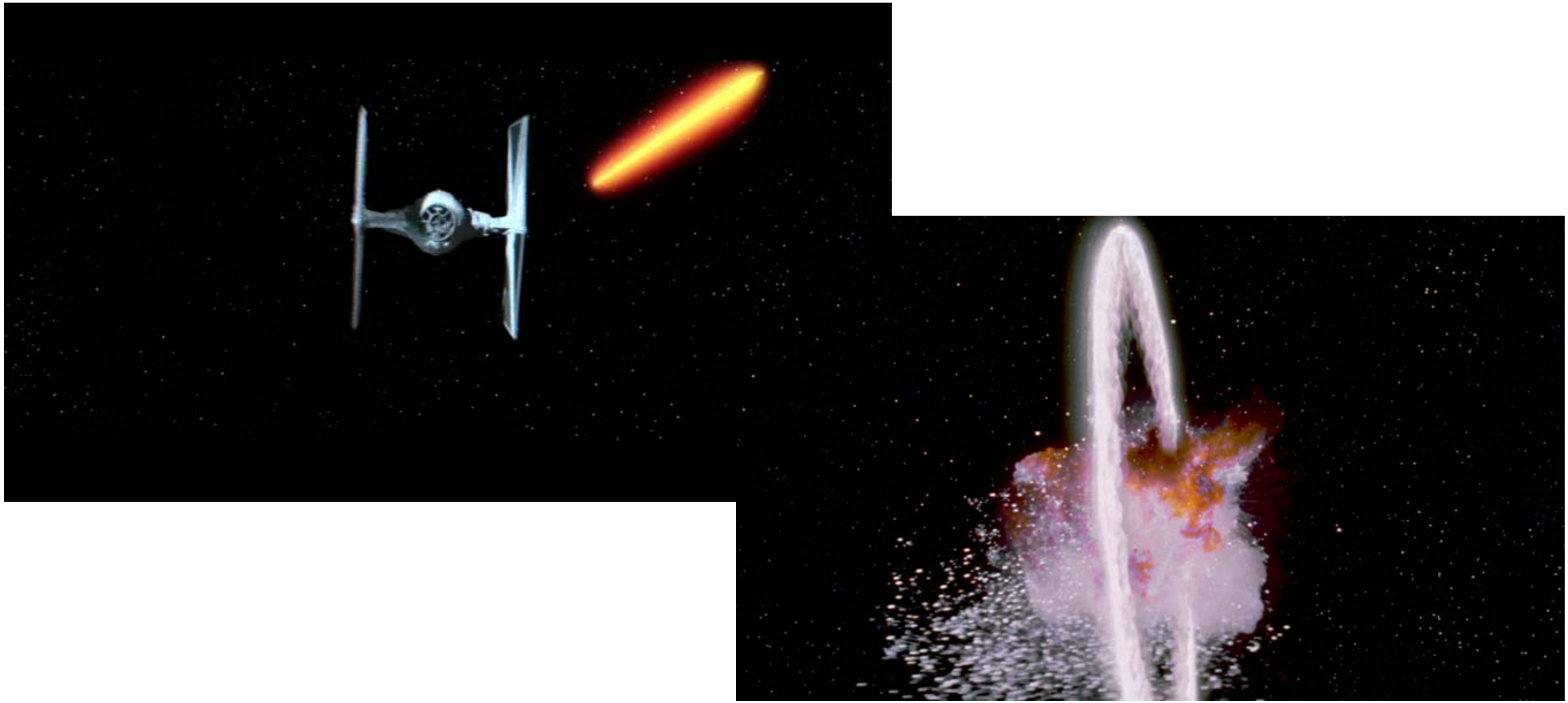
When people think about radiation, they think…

The reality of radiation therapy is quite different

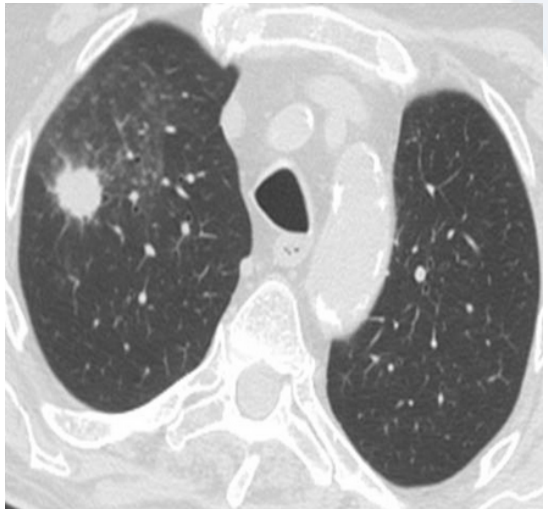
- ~ 2/3 of patients with cancer receive radiation at some point in their course
- When used appropriately, radiation is a highly effective way of both **curing** a cancer and preserving quality of life.
- When used appropriately, radiation is a highly effective way of **palliating** symptoms (e.g. pain, bleeding, neurologic) with minimal side effects.

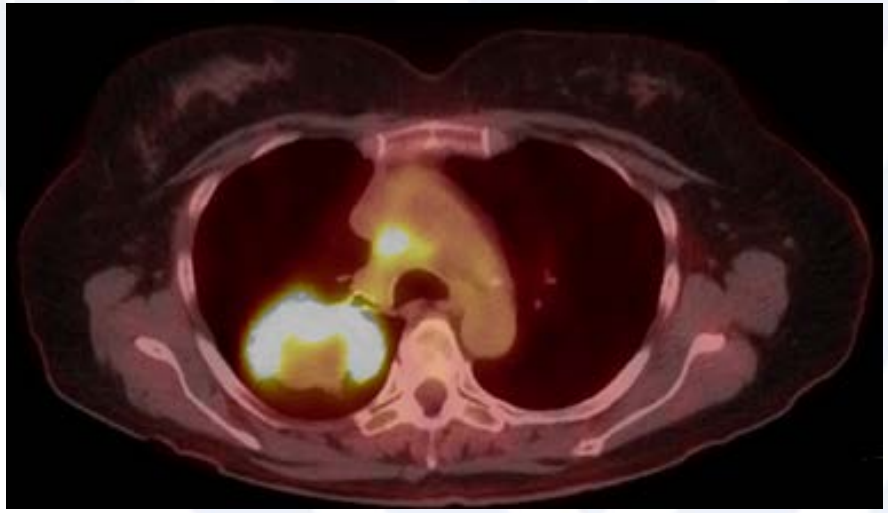
If you want to compare radiation oncology to anything…



Radiotherapy for Lung Cancer

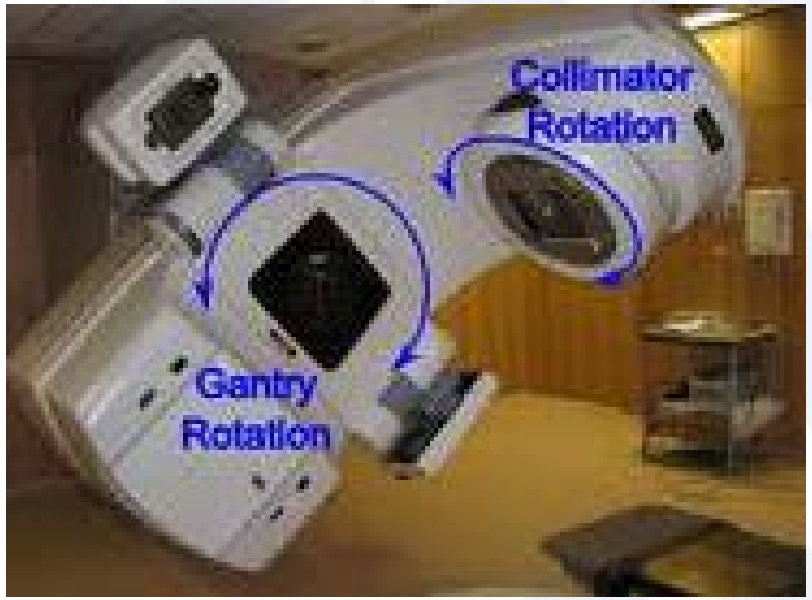
The context of the tumor (type, size, location, and stage) impacts the technique of RT delivery, which impacts survivorship concerns.





External Beam Radiation Therapy (EBRT)

- The main form of RT for lung cancer
- Delivered using a linear accelerator (Linac)

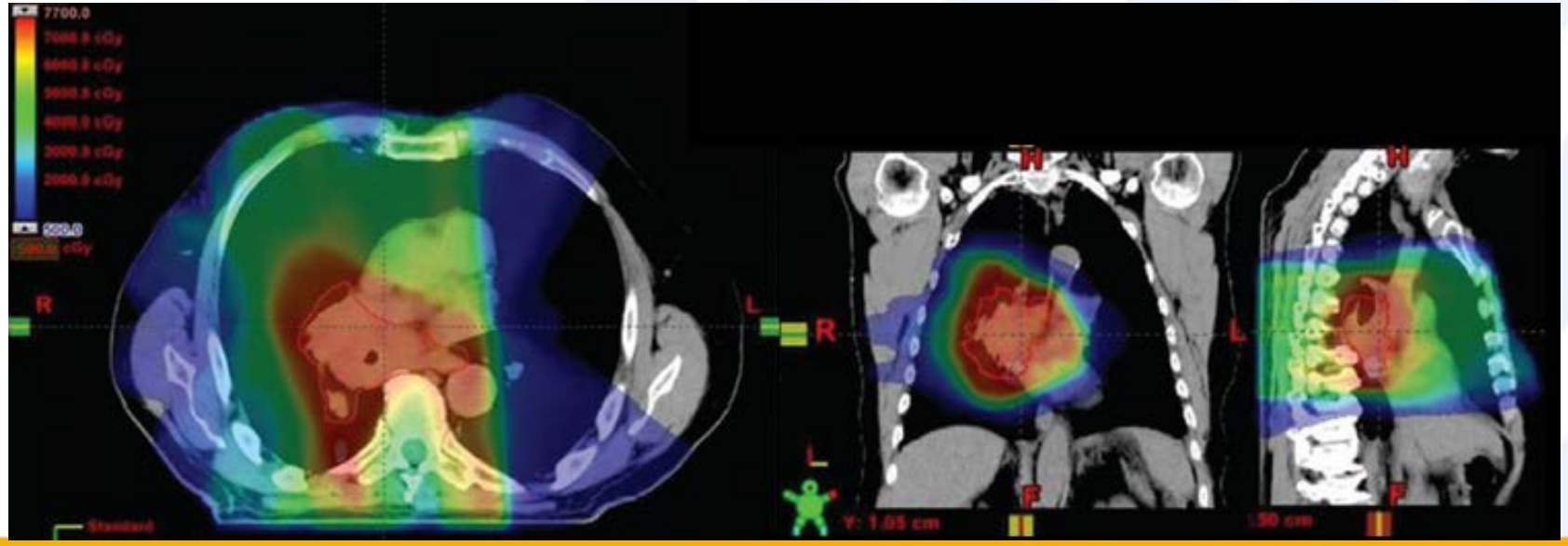


Conventional Fractionation

For locally advanced NSCLC or SCLC

A large target volume is treated with significant dose to normal tissue

- **Conventional fractionation 3DCRT or IMRT (typically 1.8-2.0 Gy/fraction in 30-35 fractions, to a total dose of 60-70Gy)**

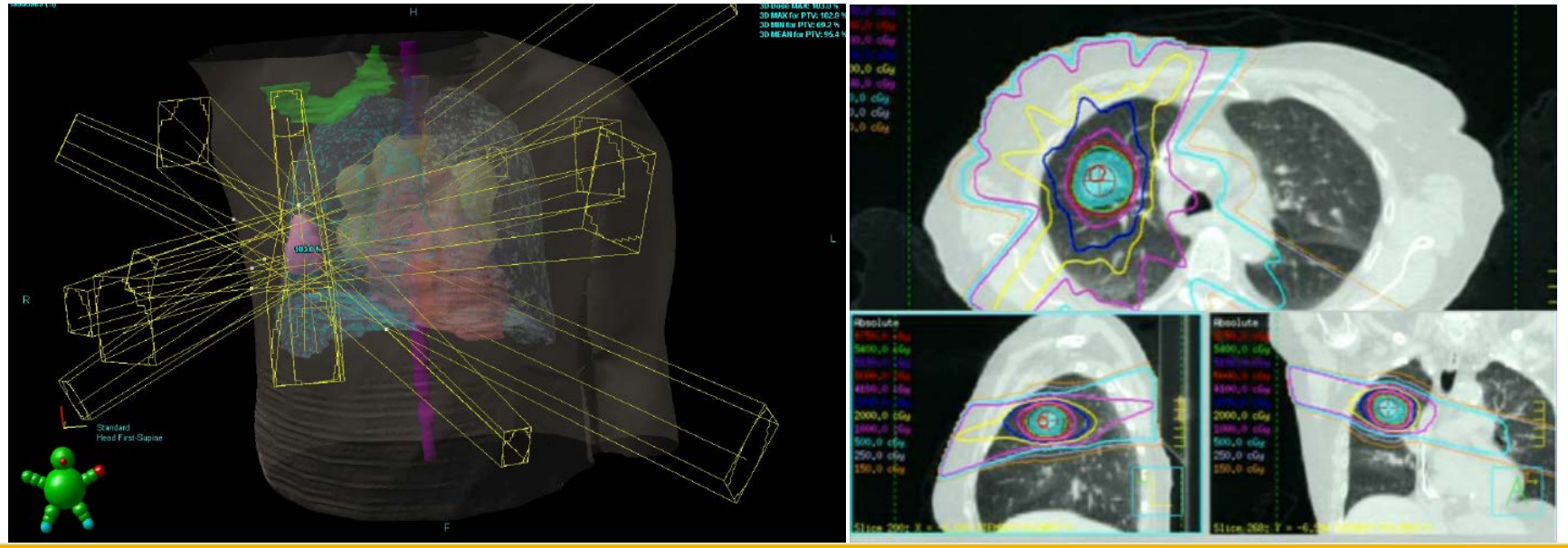


Hypofractionation/Radiosurgery

For early stage NSCLC

A smaller target volume is treated with less dose to normal tissue

- **SBRT/SABR (typically 10-18Gy/fraction in 3-5 fractions, to a total dose of 50-54 Gy)**



3DCRT/IMRT vs. SBRT/SABR

	3DCRT/IMRT	SBRT/SABR
Dose/Fraction	Low	High
# Fractions	30-35	1-5
Target Type	Gross and/or microscopic disease Any size	Well defined gross disease Small-medium size
Dose Conformity	Moderate - High	Very High
Immobolization	Secure	Very Secure
Image-Guidance	Good	Excellent
Local Control	50-75%	>90%

What SBRT Is Not

Not simple or low tech

Not a biologically elegant treatment (ablative!)

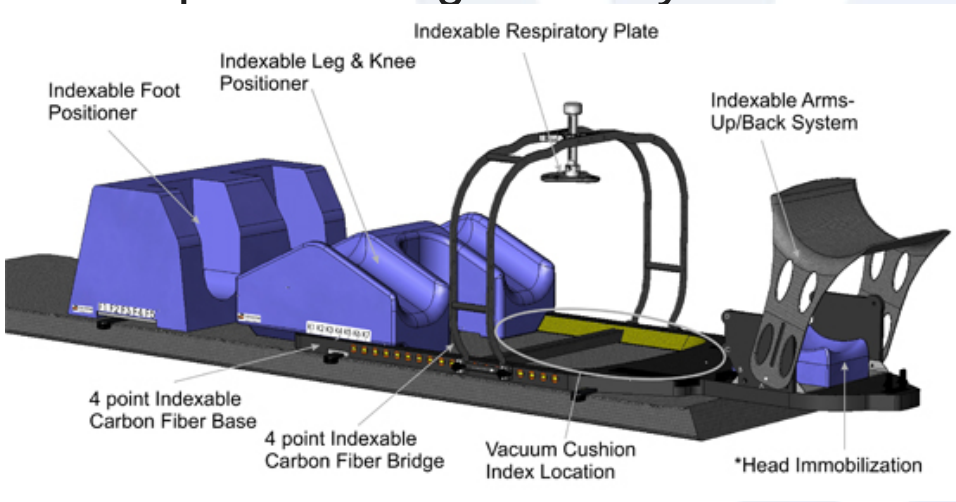
Not a “forgiving” treatment

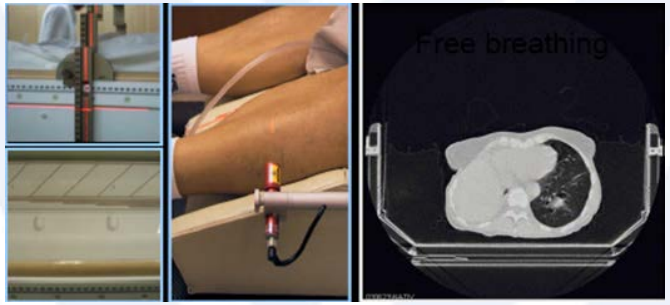
- An experienced team and systematic approach to QA, staff training, and credentialing is essential for safety.

SBRT

No rigid frame, no coordinate system

- Reproducible positioning of body frame on table



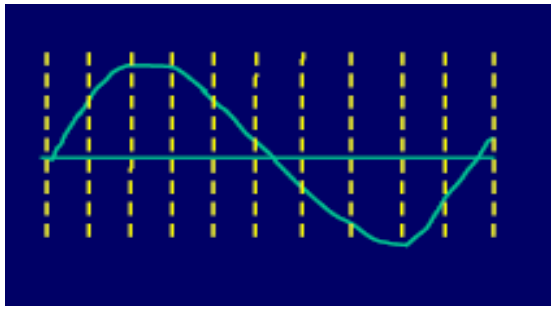


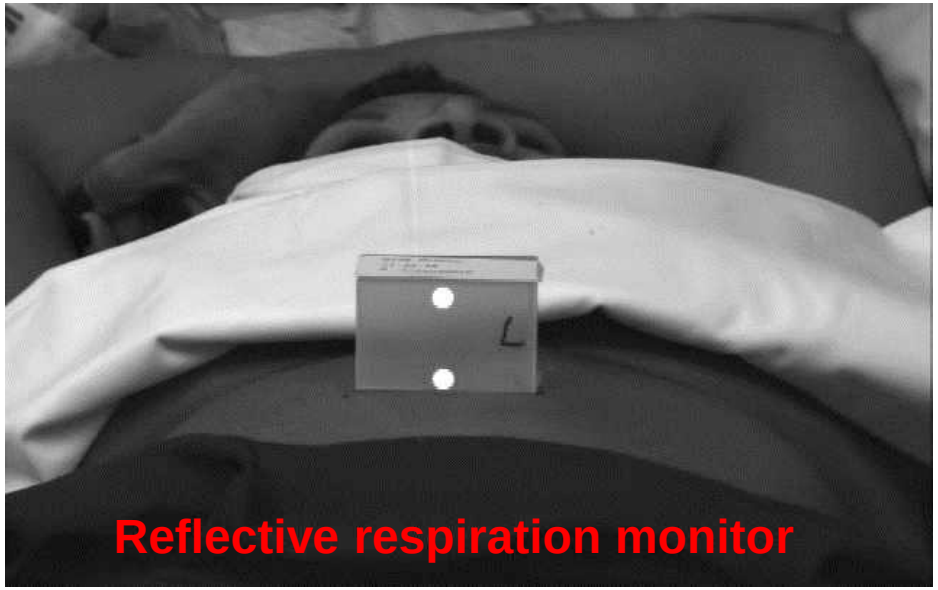
- Reprod rame
- Reproducible positioning of target within patient

“Stereotactic” = precise positioning

Characterizing Tumor Motion

- 4DCT: Infrared camera tracks the motion of a reflective marker, measuring respiratory patterns and excursion
  - CT scan is correlated with respiratory trace
  - Respiratory trace divided into 10% “phase” bins

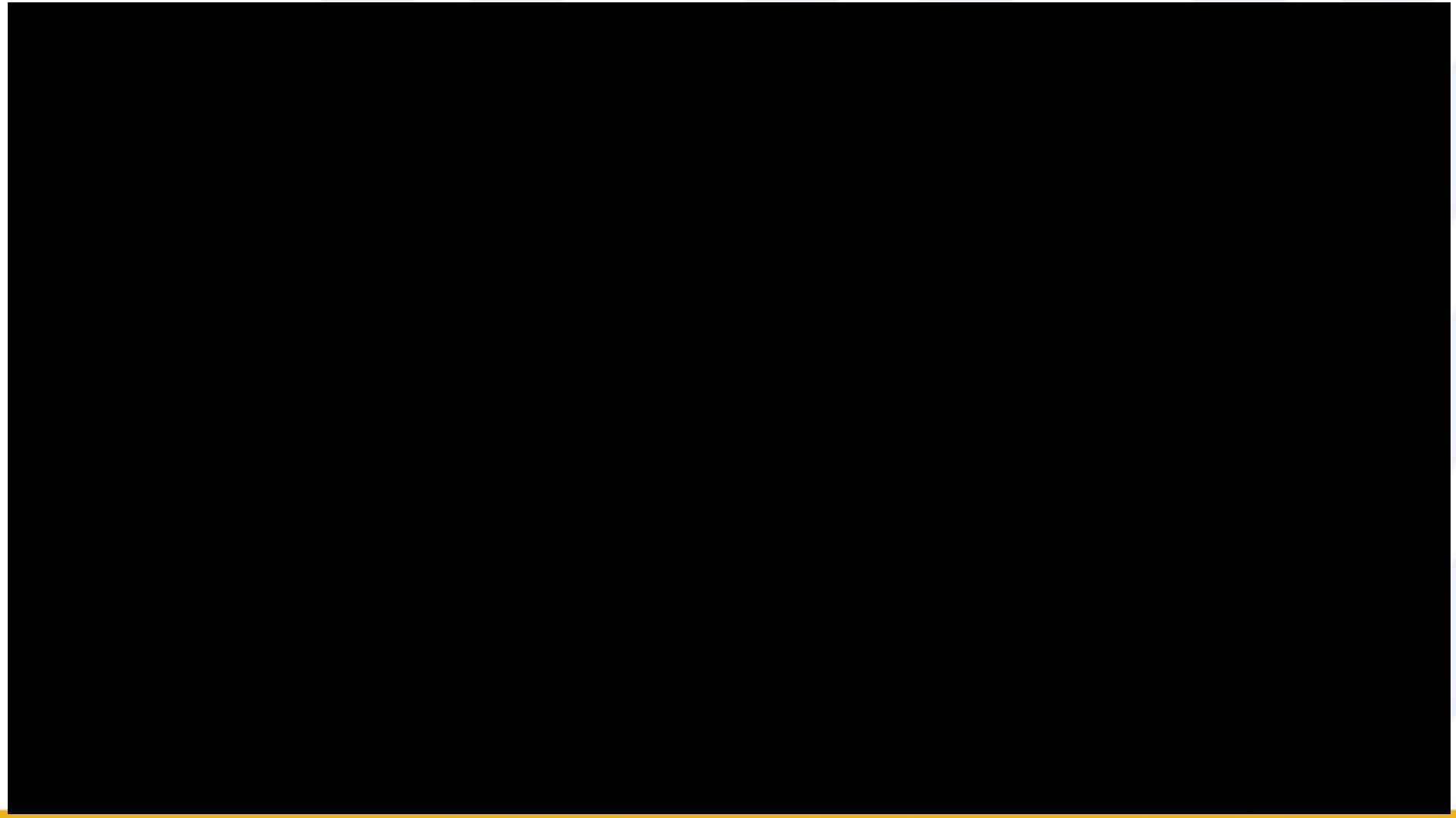




Like Sports Photography

- Oversampling: Capture the states or “phases” between inhale and exhale

4DCT



https://www.youtube.com/watch?v=DfijRBvaG7o

Strategies of RT Delivery to Account for Respiratory Motion

Conventional (ITV-based)

- Contour and treat full tumor ROM

Accelerator beam gating

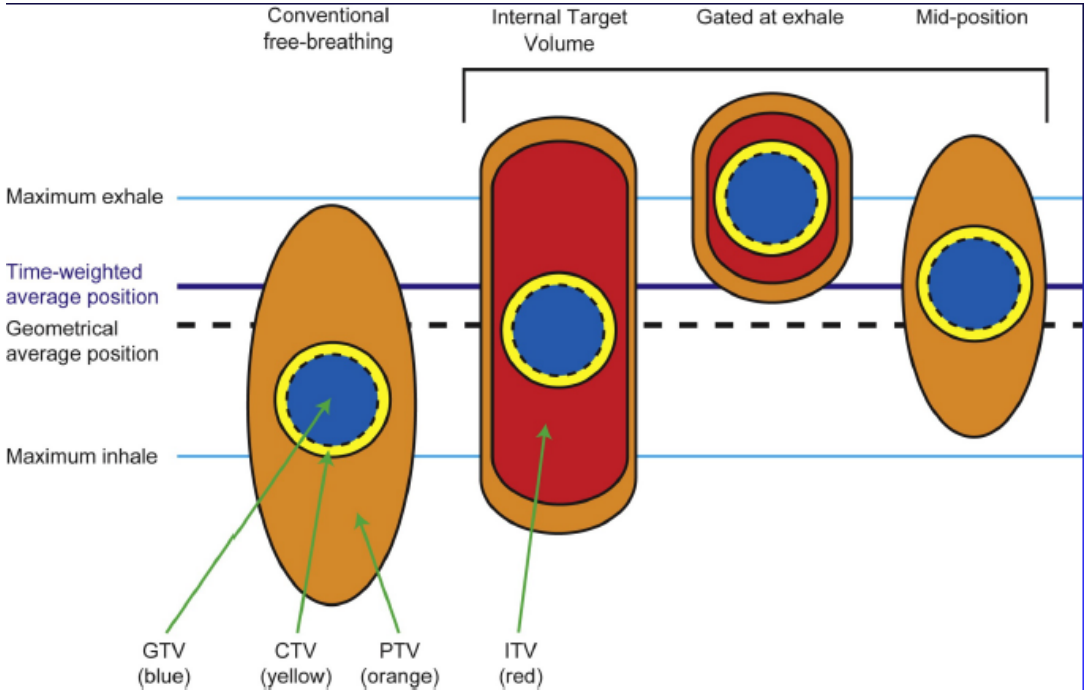
- Patient breathes normally; beam only on while patient is in a certain phase of the respiratory cycle

Active breathing control

- Patient holds breath in a certain position; beam only on in that phase of the respiratory cycle

Dynamic tumor tracking

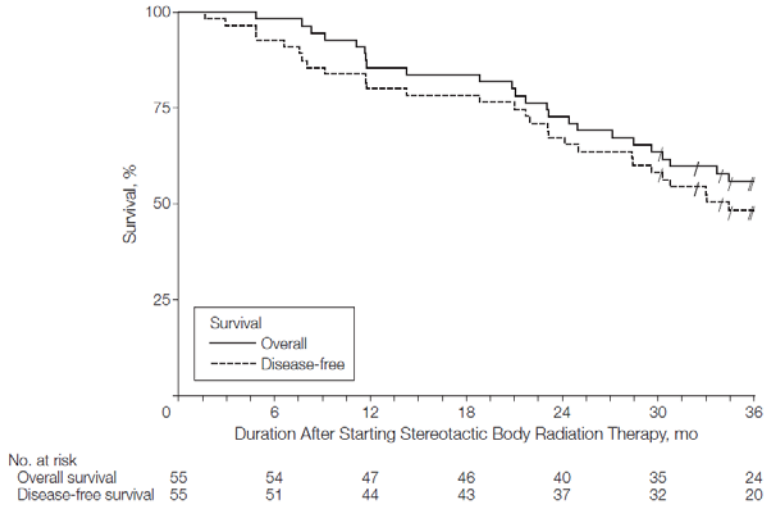
- Patient breathes normally; tumor is tracked; beam always on and moves with tumor



DATA FOR LUNG SBRT

RTOG 0236

- Multicenter phase II study (n=55)
- T1-2N0M0 NSCLC (<5 cm), medically inoperable, peripheral
- Treated with **60 Gy in 3 fractions** (over 1.5-2 weeks)
- 5Y-LC **93%**, 5Y-lobar control 80%, **31%** distant failure
- 5Y-DFS 26%, 5Y-OS 40%
- Toxicity: Grade 3 in 13%, Grade 4 in 4%, Grade 5 in 0%



Adjust Dose Based on Location

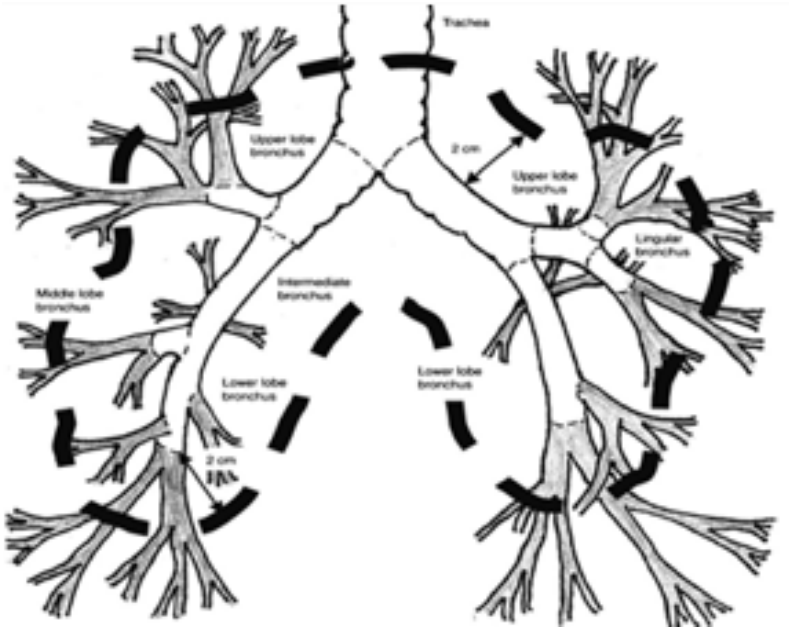


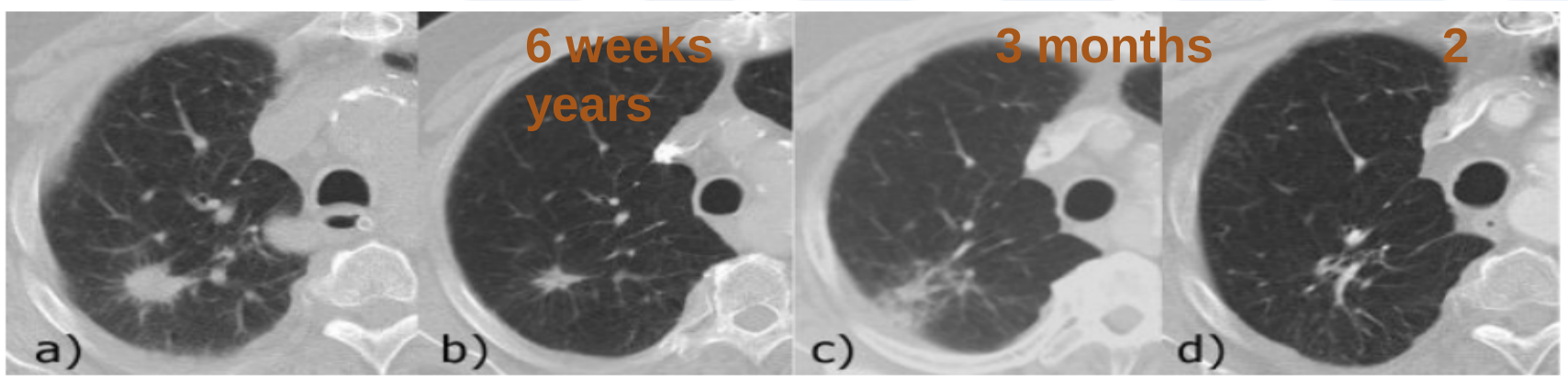
Table 2. Commonly Used Doses for SABR

Total Dose	# Fractions	Example Indications
25-34 Gy	1	Peripheral, small (<2 cm) tumors, esp. >1 cm from chest wall
45-60 Gy	3	Peripheral tumors and >1 cm from chest wall
48-50 Gy	4	Central or peripheral tumors <4-5 cm, especially <1 cm from chest wall
50-55 Gy	5	Central or peripheral tumors, especially <1 cm from chest wall
60-70 Gy	8-10	Central tumors

Dutch VU Series (Senthi, 2012)

- 676 pts, T1-2, risk-adapted SBRT (ideal location 20x3, very peripheral 12x5, central 7.5x8)
- 3Y-LC **90%**, 3Y-OS 53%, MS 41mo, 66% of relapses were distant mets
  - Among operable patients, 3Y-OS 85%
- Acute Toxicity: fatigue ~30%, chest wall pain ~10%, nausea ~10%, cough/dyspnea 5%
- Late Toxicity: G3 pneumonitis 3%, rib fracture 2%, chronic pain ~2%

SBRT Treatment Response



WHEN TO USE RADIATION INSTEAD OF SURGERY?

Considerations

- Not all tumors are surgically operable
- Not all patients are medically operable
- The expected surgical morbidity may not be worth the expected gains.
- Some patients may not want surgery

SBRT vs. Surgery for Early Stage NSCLC

- **No completed randomized trials**
- Survival numbers from nonrandomized cohorts of patients are difficult to compare with surgery because of **selection bias** (radiation pts are generally medically inoperable or older with worse PS, and often don't undergo full mediastinal staging)

- We do have some data though, and…

SBRT may be better!

Pooled Analysis of STARS and ROSEL Randomized Trials (Chang, Lancet Oncol 2015)

- 58 pts, operable T1-2a (<4 cm) N0 M0 NSCLC
- Randomized to lobectomy vs SBRT.
- SBRT → ↑ **3Y-OS** (79→95%) and ↓ G3-5 toxicity (48→10%). No difference in RFS (~83%)

Why?

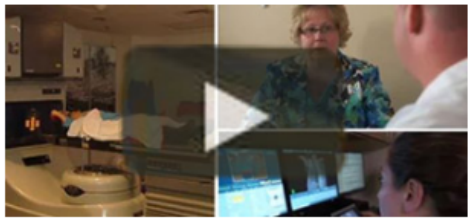
- Surgery has higher M&M
- Abscopal effect from RT?

NCCN Guidelines

- All lung cancer patients should be evaluated by a multidisciplinary team
- SBRT is recommended for patients who are medically inoperable or refuse surgery
- SBRT is an appropriate option for patients with high surgical risk.

We Should All Strive to Overcome our Biases

Patient Education Materials from ASTRO



Patient Videos

ASTRO has created a series of videos to help patients better understand what to expect when receiving radiation therapy for cancer.

Patient Brochures

ASTRO created brochures to help people diagnosed with cancer and their families learn more about the treatment options available.

Radiation Therapy Presentations

ASTRO has created two PowerPoint presentations for members to use as a resource for presentations to health care professionals and the general public

https://www.astro.org/Patient-Education.aspx

Impact of Radiotherapy on Survivorship

"Survivorship begins at the time of diagnosis"

National Survivorship NCCN Guidelines Version 1.2013

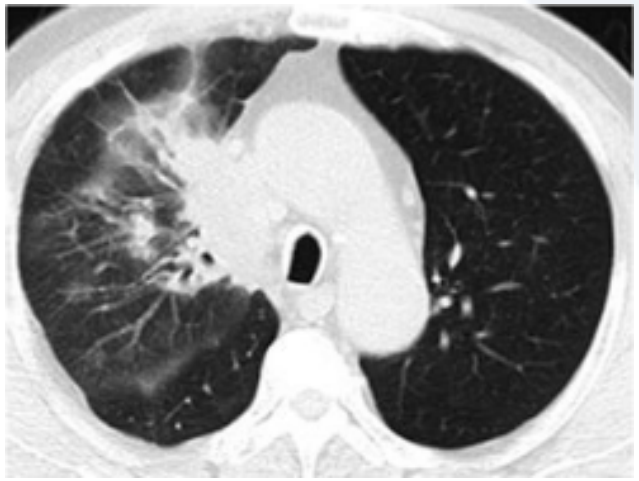
3DCRT/IMRT Toxicity

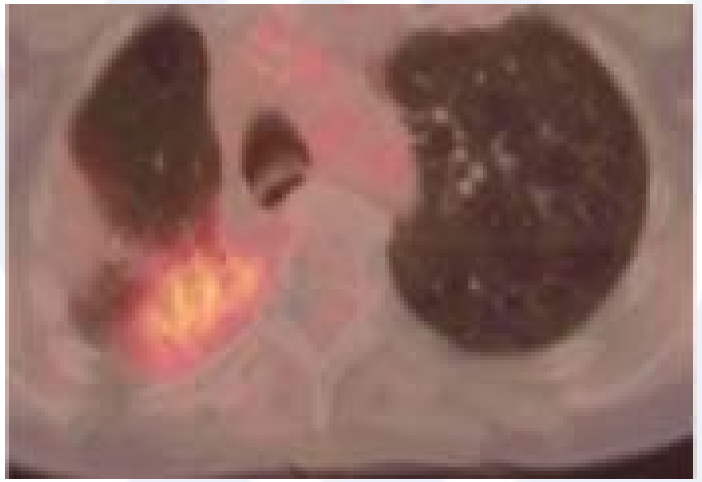
Risk and severity of different toxicities depends mainly on the location and size of primary tumor and involved lymph nodes, type of concurrent chemotherapy, performance status of patient, and RT technique

- **Acute Toxicity:**
  - Fatigue:
    - Treat with exercise & pulm rehab before, during and after Tx.
    - Look for other treatable causes (anemia, depression, infection, etc)
  - Acute esophagitis:
    - Starts 3-4 weeks into treatment
    - Distinguish from thrush and acid reflux
    - Treat with magic mouthwash (viscous lidocaine, Mylanta, Benadryl), and opioids
    - +/- prophylax with PPI and Diflucan
  - Dry, nonproductive cough
    - Effect in the trachea and or bronchi
  - Skin desquamation/dermatitis

Radiation Pneumonitis

- **NOT an acute toxicity – it is delayed/subacute, usually 1-12 mo after RT**
- Radiographic pneumonitis is common (~66%), clinic symptoms less so (10-20%)
- Sx: nonproductive cough, DOE, chest pain, malaise, +/- fever
- Px: May be normal, or involve crackles, pleural rub, or dullness to percussion
- Imaging: CT may show patchy alveolar ground glass or consolidative opacities. PET may show some metabolic activity.
- A diagnosis of exclusion: distinguished from recurrence and infection



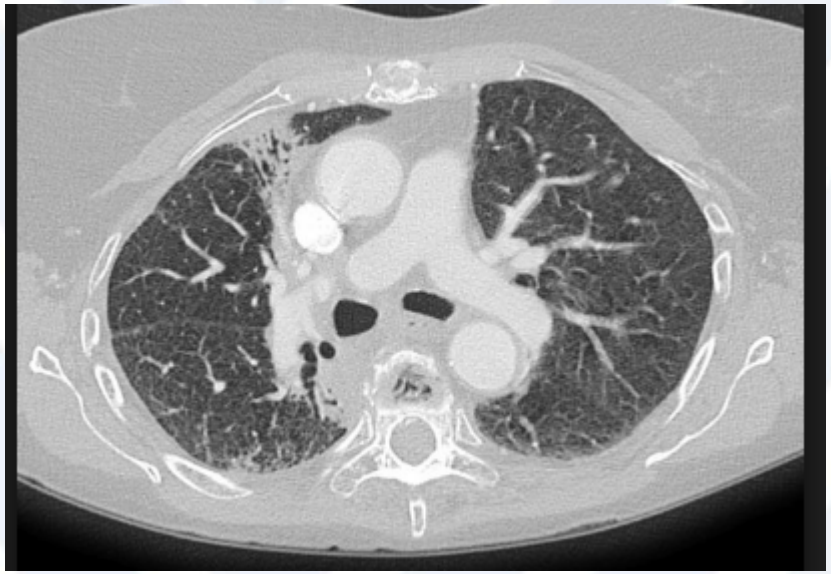


- Symptoms are usually self limiting, but can be alleviated with prednisone 1 mg/kg/d (at least 40-60mg daily) for 2 weeks → gradual taper over 3-12 weeks
- For minimally symptomatic patients → re-evaluate symptoms, CXR and PFTs at regular intervals (q4-6 weeks), and only initiate Tx if PFTs drop by >10%

Late Radiation Toxicity

Lung Fibrosis:

- Most clinical pneumonitis → fibrosis in the region of the previous pneumonitis.
- Imaging: A **visible line** that correlates to isodose distribution is diagnostic
- Can → major QOL impact
- No treatment (? prevention)



Rib fracture (2-3%)

- in high dose area
- median 18mo after Tx

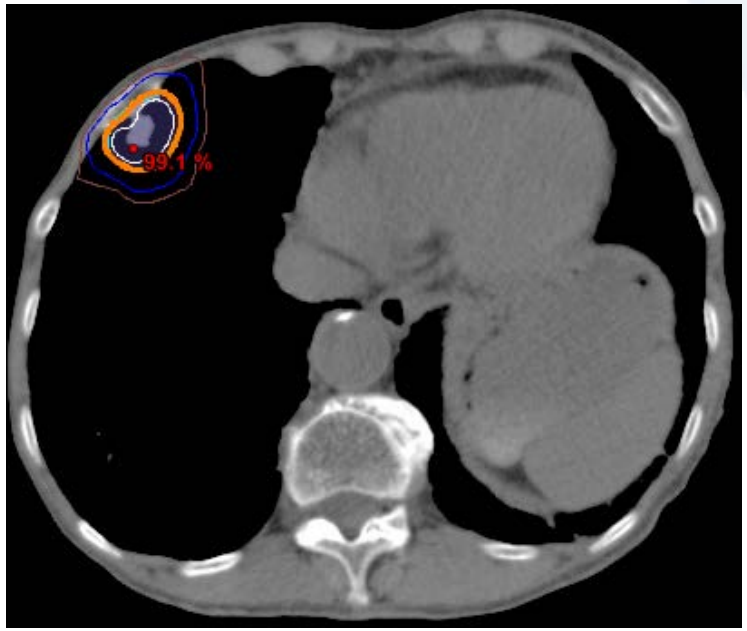
Esophageal Stricture (1-2%)

- Can occur 3-4 years s/p RT
- Treated with dilation

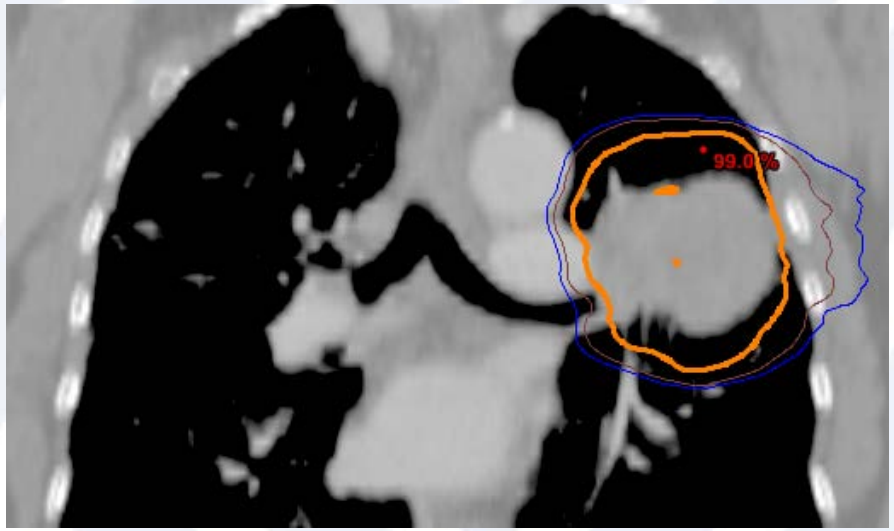
Radiation injury to the heart

- Pericarditis, ischemia, effusions, etc

Potential SBRT Toxicity Depends on Tumor Site



- Fatigue
- Rib fracture, neuropathic pain
- Skin Erythema/fibrosis



- Fatigue
- Pneumonitis, atelectasis hemoptysis, fibrosis
- Rib fracture, neuropathic pain

Questions?