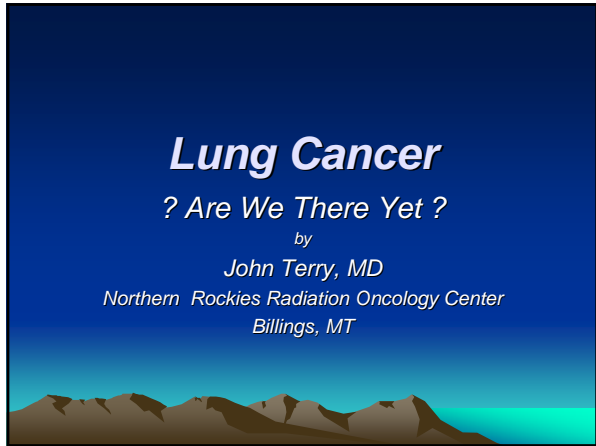


**Lung Cancer**  
*? Are We There Yet ?*  
by  
*John Terry, MD*  
*Northern Rockies Radiation Oncology Center*  
*Billings, MT*



---

---

---

---

---

---

---

---

**What do we know?**

- *Still the most common Cancer.*
- *Second most common in the U.S.*
- *5.5 Trillion Cigarettes made worldwide each year.*



---

---

---

---

---

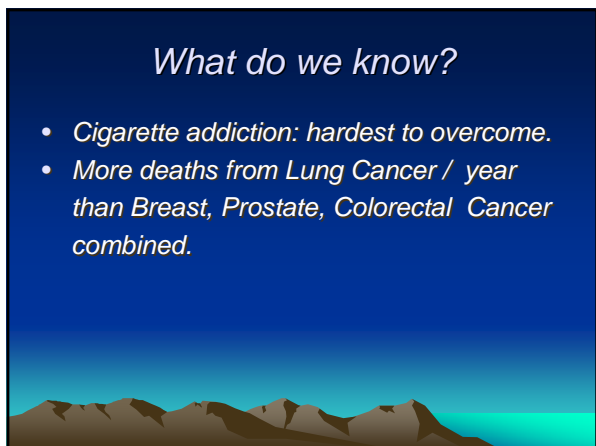
---

---

---

**What do we know?**

- *Cigarette addiction: hardest to overcome.*
- *More deaths from Lung Cancer / year than Breast, Prostate, Colorectal Cancer combined.*



---

---

---

---

---

---

---

---

## What do we know?

- *Cigarettes cause gene alterations.*
- *P53 mutations, and deletions on 3p,5q,9p, 11p, and 17p chromosomes greater in smokers.*
- *Many patients diagnosed with Lung Cancer have other serious medical conditions.*

---

---

---

---

---

---

---

---

## What do we do?

- *Treatment decisions require more than one Doc.*
- *Tumor Board format is perhaps the most common approach.*
- *If 10 doctors all agree, then it must be the right thing to do.?*
- *The nature of side effects for any therapy warrants careful decision making.*

---

---

---

---

---

---

---

---

## What do we do?

- *Each physician contributing to the treatment plan has a unique perspective.*
- *The role of radiation is to deal with the local issue of tumor injury via high energy x-ray.*
- *The obligation is to treat, but to leave a small footprint.*
- *“ You guys are just spot welders.”*

---

---

---

---

---

---

---

---

## The Process

- *"I scan... Therefore I am."*
- *The ability to accurately treat the tumor volume depends upon where you are in 3D space.*
- *Treatment decisions are a synthesis of scan results, path reports, referring doc input, and the old-fashion H&P.*
- *"2 heads are better than one."*

---

---

---

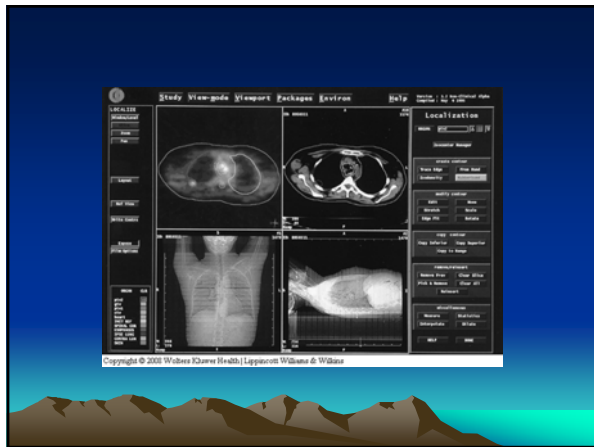
---

---

---

---

---



---

---

---

---

---

---

---

---

## The Process

- *Radiation planning in this era is based on CT, MRI, Bone Scan, and PET scanning.*
- *Image fusion with CT, MRI, or PET defines the 3D domain where the tumor lives, and the closest neighbors.*
- *The key is to reduce collateral damage.*
- *The Secret of Life? "Put the radiation where the tumor is."*

---

---

---

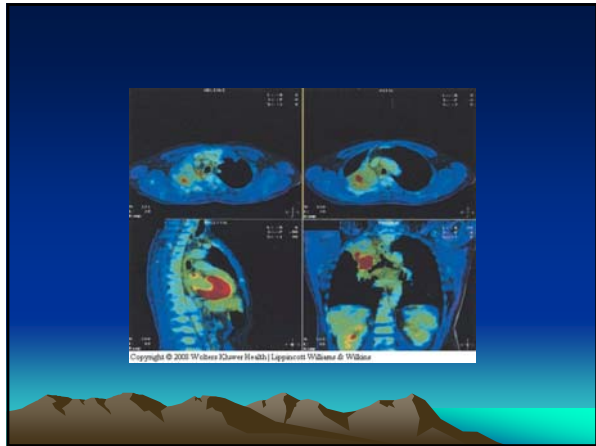
---

---

---

---

---



---

---

---

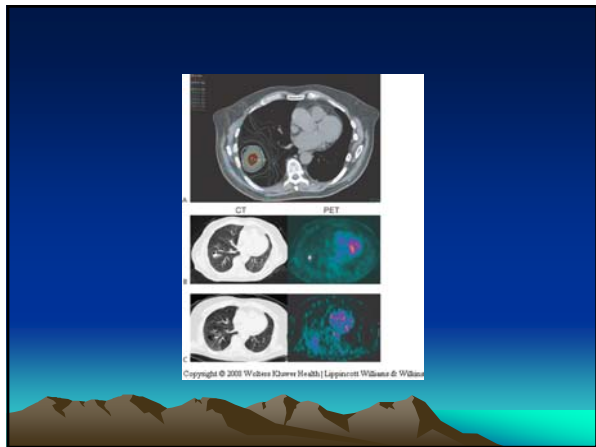
---

---

---

---

---



---

---

---

---

---

---

---

---

## Speaking in Tongues

- Radiation Oncology works in the Metric System.
- It started out as R. Then it was RAD, Now it is Gray or centi-Gray.
- Measuring what is neither seen nor felt.
- DRR, DVH, GTV, PTV, ROI, MLC.....
- Accounting for everything in the path of the X-Ray beam.

---

---

---

---

---

---

---

---

## Everybody Needs a Plan

- Computer planning begins with CT imaging of the lung tumor volume.
- Download the images to the planning computer.
- Outline the tumor, both lungs, heart, spinal cord, etc...
- Many different plans are done, pick only the best.

---

---

---

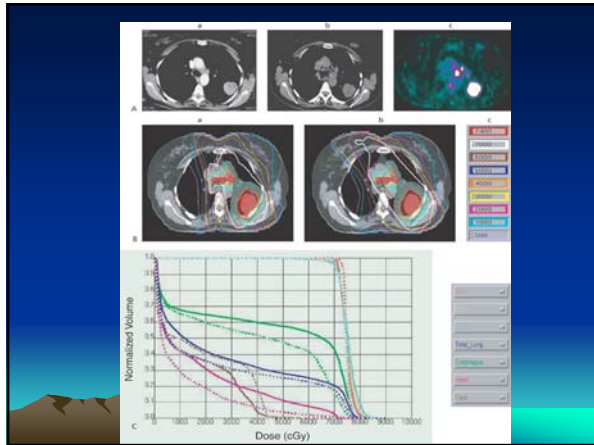
---

---

---

---

---



---

---

---

---

---

---

---

---

## Physics is Phun

- It's the thickness that counts.
- Chest thickness is muscle, bone, lung, and air.
- X-ray energy: 6MV, 23MV. MV = million volt.
- Average CT X-Ray energy = Thousand volt range.

---

---

---

---

---

---

---

---

## Geometry

- 360 degrees to choose from.
- Multiple angles with the best fit.
- Pick a point of rotation in the center of the chest.
- Most treatment plans have opposed fields.
- As few as 2, to as many as 9 fields may be used.
- It's the shortest distance between 2 points.

---

---

---

---

---

---

---

---



Copyright © 2008 Wolters Kluwer Health | Lippincott Williams & Wilkins

---

---

---

---

---

---

---

---

## Geometry

- *Fields are custom shaped.*
- *Again, reduce collateral damage.*
- *Keep lung volumes to < 30% of the total volume.*
- *Don't miss the tumor!!*

---

---

---

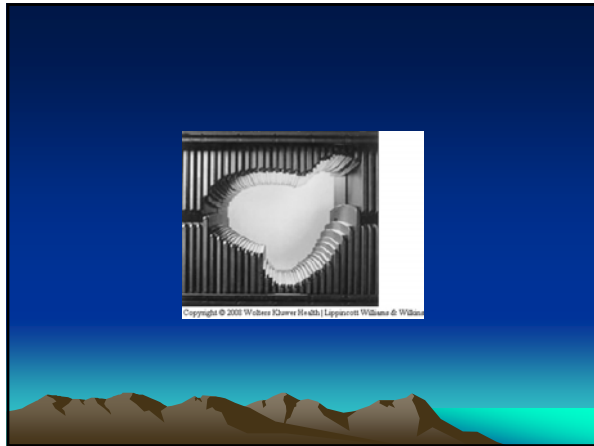
---

---

---

---

---



---

---

---

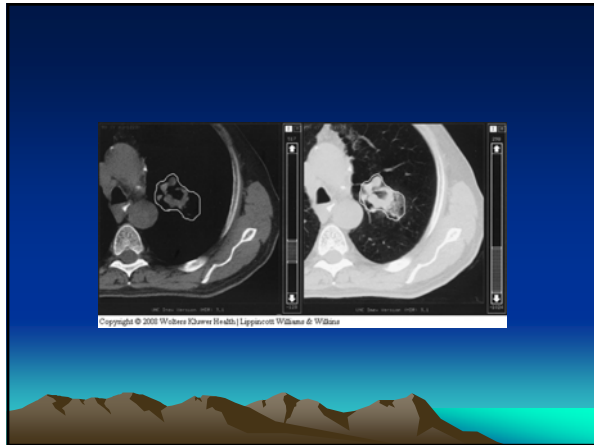
---

---

---

---

---



---

---

---

---

---

---

---

---

### The Grind

- *Treatment is usually once daily, 5 days per week.*
- *Daily dose fractions: 180-200 cGy are the standard for Non-Small Cell Carcinoma.*
- *Twice daily treatment has regained favor for Small Cell Carcinoma.*
- *Treatment options are Stage dependent.*

---

---

---

---

---

---

---

---

## Who Gets What.

- Stage 1 and 2 Non-Small Cell: Surgery.
- Selected Stage 3 may be candidates for Surgery alone.
- Unresectable Stage 3: Combined modality therapy.
- Small Cell Limited Stage: Twice Daily radiation with Chemotherapy.

---

---

---

---

---

---

---

---

## How Much Radiation?

- Just enough.
- Common total dose ranges?
- Non Small Cell: 6000 – 7000 cGy to the primary tumor mass.
- 5000 cGy to regional lymph nodes.
- Limited stage Small Cell: 4500 cGy using twice daily fractionation. 150 cGy BID separated by 6 hours.

---

---

---

---

---

---

---

---

## PCI

- For Complete Responders.
- CR = Greater than 50% tumor size reduction.
- Radiation dose to the whole brain.
- Dose: 3000 cGy / 15 fractions.
- RTOG trial comparing 2500 cGy / 10 fractions, 3600 cGy / 18 fractions, and 3600 cGy / 24 fractions.

---

---

---

---

---

---

---

---

## PCI

- *It's primary purpose is to reduce relapse in the brain.*
- *No clear survival advantage.*
- *Length of survival increases the risk of brain relapse.*
- *Autopsy data 2 years after treatment revealed 80 % With CNS mets without prior PCI.*

---

---

---

---

---

---

---

---

## No Worries?

- *Not exactly.*
- *Spinal Cord dose constrained to < 5000 cGy.*
- *Esophageal dose constraint: < 6000 cGy.*
- *Total Lung Volume constraint: < 30%.*
- *Heart constraint: < 5000 cGy.*
- *Combined Modality: Significant contribution to esophagitis / stricture.*

---

---

---

---

---

---

---

---



---

---

---

---

---

---

---

---

## No Worries ?

- Radiation pneumonitis prevention is of greatest concern in Combined Modality therapy.
- Radiation spinal cord injury is now rare as the result of CT based treatment planning.
- Radiation therapy in patients with COPD, must be carefully considered regarding Risk / Benefit Ratio.

---

---

---

---

---

---

---

---

---

---

---

---

**Table 23.4 THE LONG-TERM TOXICITY OF COMBINED CHEMORADIATION THERAPY**

Agent	Toxicity	Mechanism	References
Bleomycin	Pneumonitis/fibrosis	Unclear but related to total drug dose and effects on pulmonary macrophages. Type I and II alveolar cells, effectively replaced by the administration of radiation.	33,147,209
Actinomycin D	Neuropathy	Altered nerve function post-treatment leads to decreased metabolism of agents, including actinomycin, which in turn worsens the neuropathy.	152,211
Docetaxel	Cardiomyopathy	There is an additive interaction between docetaxel and radiation with regard to radiation effects occurring. Primary radiation effect is on the endothelial cell, whereas docetaxel affects the connective tissue fibers of the myocardium.	29,77,137,138
Methotrexate	Lymphocytopenia	Methotrexate may cause this syndrome on its own. Radiation effects on the blood-brain barrier and the choroid plexus can alter methotrexate clearance, leading to higher levels in the brain. Effects are increased when both modalities are used.	6,116,221,226

Copyright © 2005 Wolters Kluwer Health | Lippincott Williams & Wilkins

---

---

---

---

---

---

---

---

---

---

---

---

**Table 23.5 OUTCOME OF TREATMENT IN LOCALLY ADVANCED NON-SMALL CELL LUNG CANCER**

Treatment	Study	Authors	Design	No. of Patients	RT (Gy) and CT Treatment	Median Survival (mo)	2- to 5-year Survival (%)				
RT alone	Sullivan et al. 1992	Sullivan et al. 1992	Phase III	77	60 Gy	9.6	13.0				
								77	60 Gy	11.4	21.5
								154	60 Gy	12	14.6
CT	Sullivan et al. 1992	Sullivan et al. 1992	Phase III	78	Cis + Vb → 60 Gy	13.2	26.73				
								78	Cis + Vb → 60 Gy	13.9	23.8
RT	Kornak et al. 1991	Kornak et al. 1991	Phase III	158	W/Cis + 60 Gy	13.2	17.4/8.9				
								158	Cis + Vb → 60 Gy	14.8	—
								316	W/Cis + 60 Gy	15.5	14.9/13.8
CT/RT	Mok et al. 1991	Mok et al. 1991	Phase II	102	Weekly P + C + 43 Gy → P + C	15.3	32.2				
								102	Cis + 60 Gy	15.6	34.2

RT: radiation therapy; CT: chemotherapy; Cis: cisplatin; Vb: vinorelbine; W: mitomycin; C: carboplatin; P: paclitaxel; C: carboplatin; N: nivolumab.  
Copyright © 2005 Wolters Kluwer Health | Lippincott Williams & Wilkins

---

---

---

---

---

---

---

---

---

---

---

---



## Basic and New

- *IMRT > Intensity Modulated Radiation Therapy.*
- *IGRT > Image Guided Radiation Therapy.*
- *Respiratory Gaiting. Don't hold your breath.*
- *Proton Therapy. Charged Particles used to reduce dose to surrounding tissue.*

---

---

---

---

---

---

---

---

## Protons / Lung Cancer

- *Brag Peak advantage. ( Bunker Buster )*
- *Delivers most of it's energy in the target.*
- *Excellent normal tissue/organ sparing.*
- *Awaiting Multi-Center Trials.*
- *Many of the large teaching centers are installing proton accelerators.*
- *Proton Center cost: > Standard facility.*

---

---

---

---

---

---

---

---

## Job Security

- *In the Biotech world dwells the potential to force us into retirement*
- *" We are awash in potential targets."*
- *This has rapidly expanded the spectrum of moving to molecular targeting unique to only abnormal / malignant tissue.*
- *Individual targeting = side effect reduction.*
- *These agents may reduce the need for high dose radiation.*

---

---

---

---

---

---

---

---

## Job Security

- *New device: able to filter the chemical communication of a new malignancy to blind it's presence to the Immune System.*
- *Potential to ID Lung and other primary tumor types before they are clinically detectable.*
- *Cross application for viral filtration for HIV, HCV, Ebola, Ortho-pox, Marburg, Bird flu.*

---

---

---

---

---

---

---

---

## Free Advice

- *Don't Smoke.*
- *Sit in a sterile dark room.*
- *Wait an hour after eating before you go swimming.*
  
- *Never believe anyone giving Free Advice.*

---

---

---

---

---

---

---

---

## ARE WE THERE YET?

- *Closer.*
- *Hope? Yes.*
- *When. Soon.*
- *Why. Honor and Glory.*
- *Also. Because it's there.*

---

---

---

---

---

---

---

---