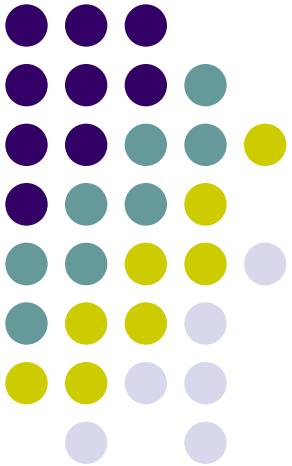
Basics of RADIATION ONCOLOGY



Angela Davre PA-C

I have no financial interests or associations to disclose

Learning objectives:

- What is radiation therapy?
- How is radiation used for therapy?
- Treatment process
- Some side effects of radiation therapy & management

My Job

- As a PA/NP:
  - Help with consultation for patients
  - Help manage side effects of radiation therapy
  - FUs and surveillance
- Know basics of radiation therapy – share this knowledge with patients
- Radiation therapy is complex – will try to answer questions but I may not have all the answers

CANCER

- Uncontrolled division of abnormal cells
- Common types
  - Non-melanoma skin cancer
  - Lung (NSCLC, SmCLC)
  - Breast
  - Prostate
  - Colorectal
- Other abnormal growths
  - Meningioma
  - Adenoma
  - Fibroma
  - Hemangioma
  - Lipoma
  - Heterotopic ossifications

•Bladder
•Melanoma
•Lymphoma
•Kidney
•Leukemia

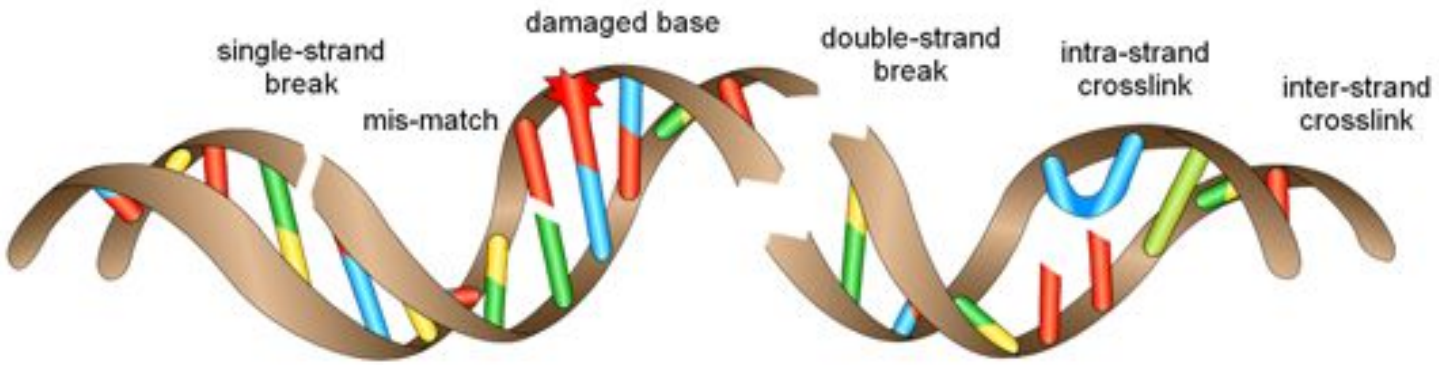
•Nevi
•Neuromas
•Osteochondromas
•Papillomas
•Myoma

RADIATION THERAPY
What is it?

- Ionizing radiation for treatment of cancer
  - Radiation with high enough energy to remove electrons from an atom, creating free radicals/ions – damage DNA
- Types of radiation
  - **Electron**
  - **Photon** (high energy gamma or x-rays)
  - Proton (decreased cumulative radiation – decreased exit dose)
  - Neutron
  - Ion beams (minimize damage to surrounding healthy tissues)

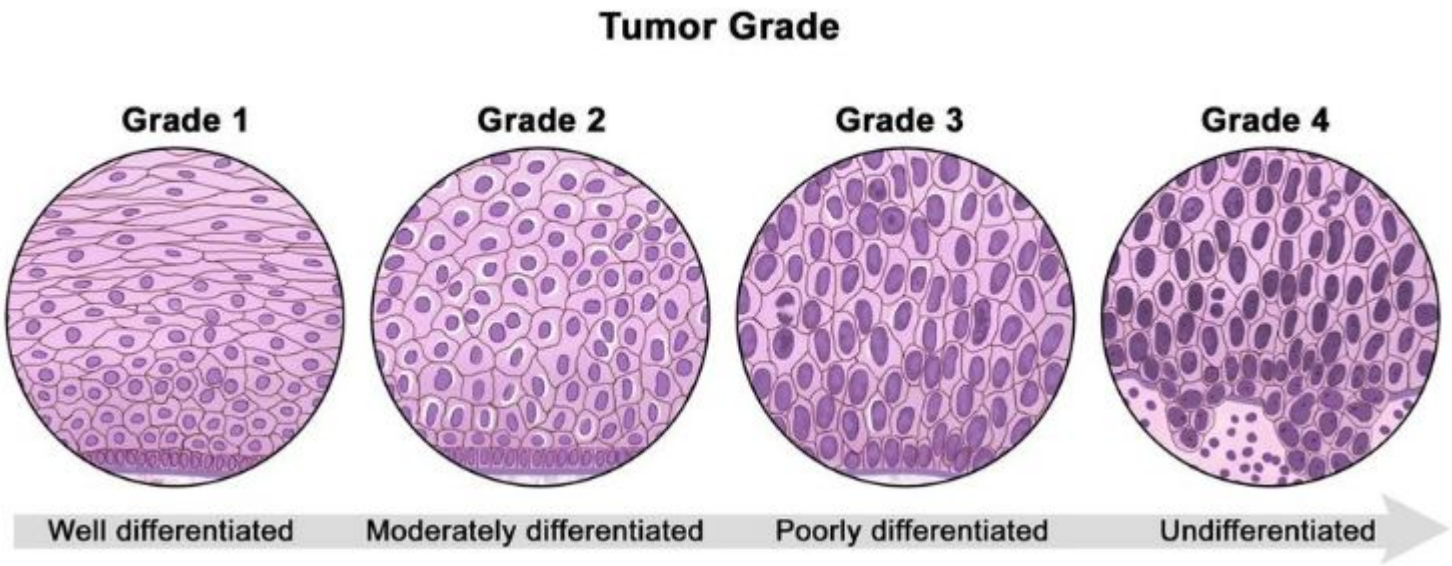
RADIATION THERAPY
What is it? (cont'd)

- Mechanism of action
  - Formation of free radicals cause DNA breaks
    - ssDNA break – other strand can be used as a template for repair
    - dsDNA break – most detrimental

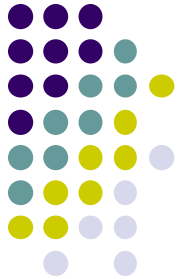


Response to Radiation

- Normal cells: differentiated
  - Have mechanisms for DNA repair
- Cancer cells: well/moderately/poorly/undifferentiated
  - Increasing grade = decreasing ability to repair DNA damage



Common Sequence of Events

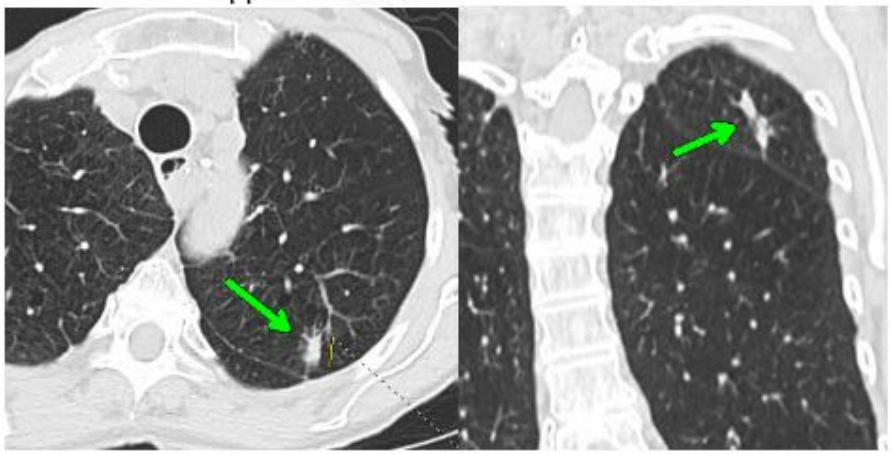


- Diagnosis (physical exam, imaging, biopsy)
- Consultation
- Simulation (mask, mold/vac bag, [tattoos], CT, lasers)
- Contouring
- Planning
- QA (quality assurance)
- Filming
- BEAM ON!
- Weekly OTVs
- FU visits and surveillance scans

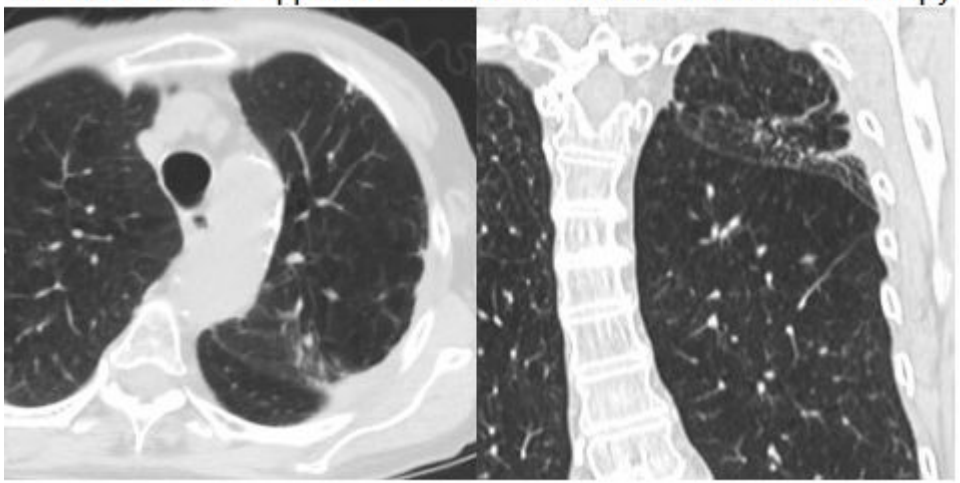
Purpose

- Curative
  - Alone or in combination with systemic treatment and/or surgery
  - Non-metastatic cancers: breast, lung, prostate, H&N, etc.
  - Benign tumors: meningioma, vestibular schwannoma, etc.

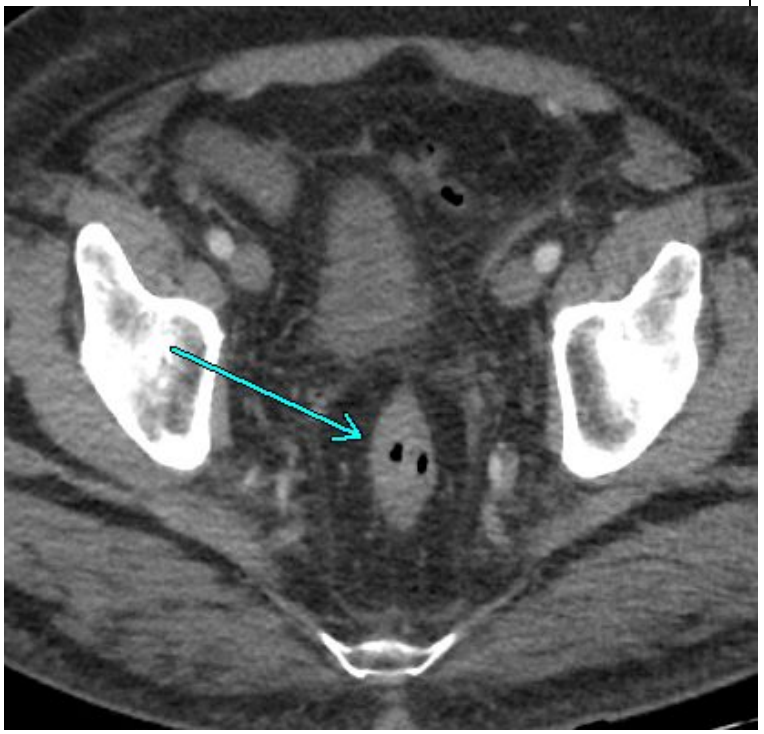
4/8/2024 LEFT upper lobe lesion



10/21/2025 LEFT upper lobe lesion resolved after radiation therapy

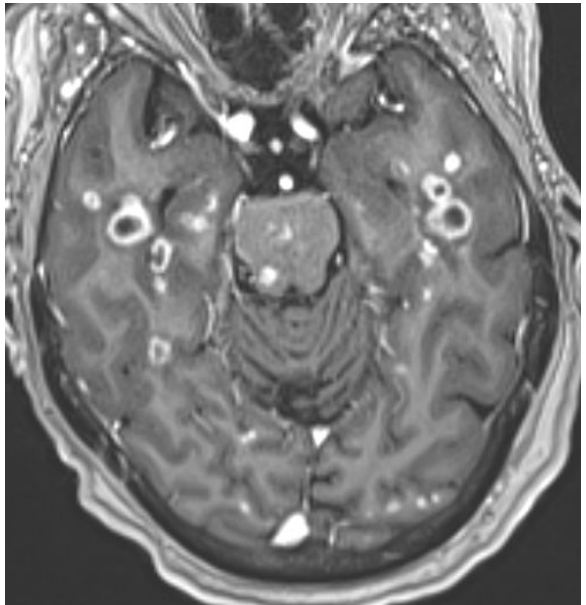


TNT



Purpose (cont'd)

- Palliative
  - Brain metastases
  - Primary brain cancer
  - Pain from primary or metastasis/es
  - Impending fracture
  - Cord compression



Purpose (cont'd)

- Other
  - Post-surgical keloid prevention (1 fx)
  - Osteoarthritis (2-3 fx/wk for 6; can be repeated)
  - Post-surgical prevention of heterotopic ossification formation (1 fx)
  - Trigeminal neuralgia
  - Splenomegaly
  - Plantar fasciitis after medication failure

Diagnosis

- Incidental
  - Imaging
  - Labs (myeloma, lymphoma, leukemia, prostate, etc.
  - Self exam (SBE, lymphadenopathy, etc.)
- Surveillance imaging/procedure
  - Mammogram
  - Low dose screening CT lung (smokers)
  - Colonoscopy
- Symptoms
  - Blood in stool
  - SOB/cough/hemoptysis/CP
  - Neurologic changes
- Miscellaneous
  - PSA
  - Anemia

Prostate Specific Antigen (ng/mL)

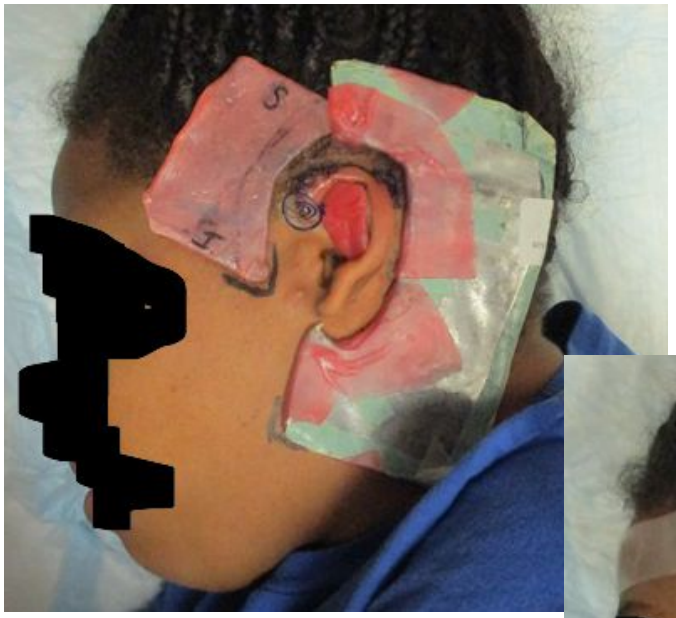
Date	Value
05/28/2025	60.10 (H)
04/22/2025	27.30 (H)
02/25/2025	17.20 (H)
02/18/2025	13.30 (H)
01/28/2025	11.20 (H)
12/31/2024	7.36 (H)
11/15/2024	8.53 (H)
10/18/2024	6.82 (H)
09/17/2024	5.97
08/20/2024	5.19
07/23/2024	3.00
06/25/2024	2.36
05/28/2024	2.28

Consultation

- Pertinent H&P
- Treat the patient, not the imaging –
  NOT always the case for radiation therapy
  - Impending fracture
  - Impending airway compromise
  - Impending cord compression

Simulation

- Immobilization
  - Thermoplastic mask
  - Vac bag
- Non-diagnostic CT



Wax-lined lead placed to prevent radiation from penetrating where it shouldn't

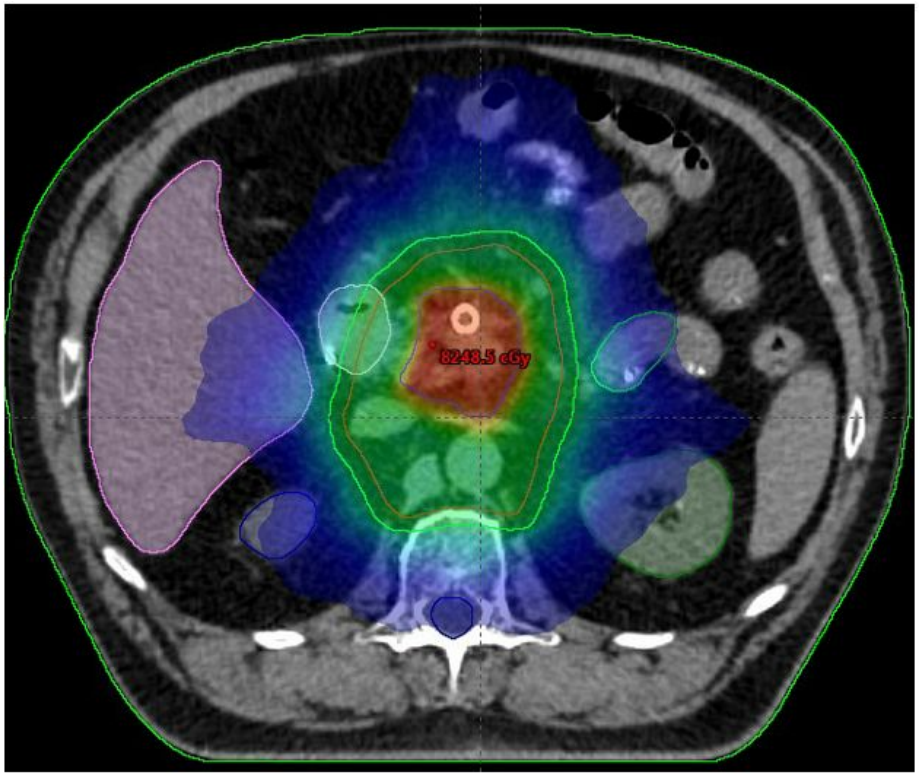
Patient lays in a vac-loc molded to the face and shoulders

Contouring

- Fusion: non-diagnostic CT fused with existing diagnostic imaging (CT, MRI, PET)
- Outline vital structures (heart, hippocampus, kidneys, etc.)
- Outline target

Planning

- Work with dosimetrists who help design a radiation plan:
  - Giving the desired dose to the target/s
  - Minimizing dose to other organs/structures

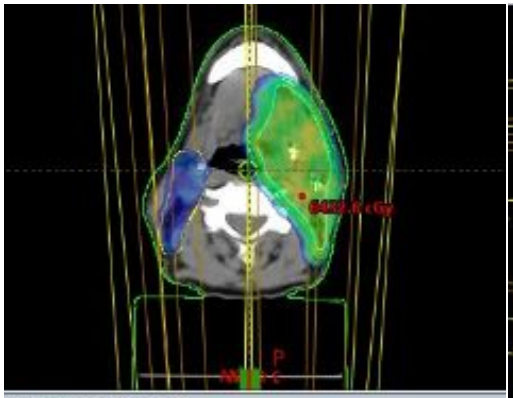


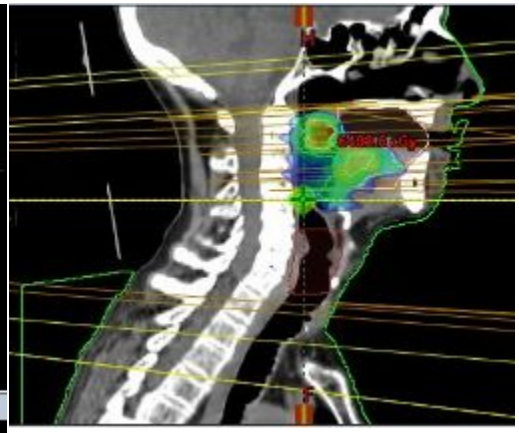
Prostate

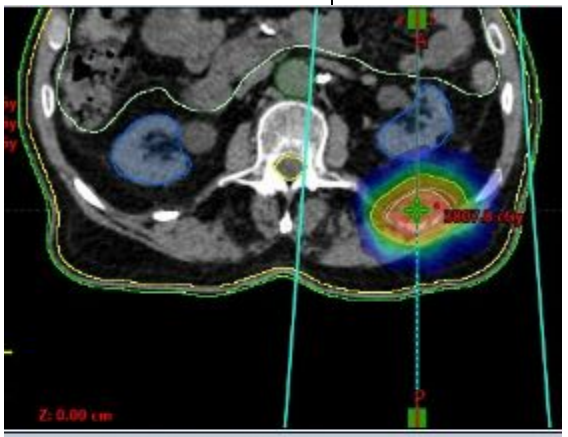
Dose
7690 cGy
7690.2
7000 cGy
6000 cGy
5040.0
5040 cGy
A
R
P
Z: 0.00 cm
PelvProstate - Treatment Approved - Frontal - TX_SEMAR 10-6-25
H
R
L
F
Y: 0.00 cm

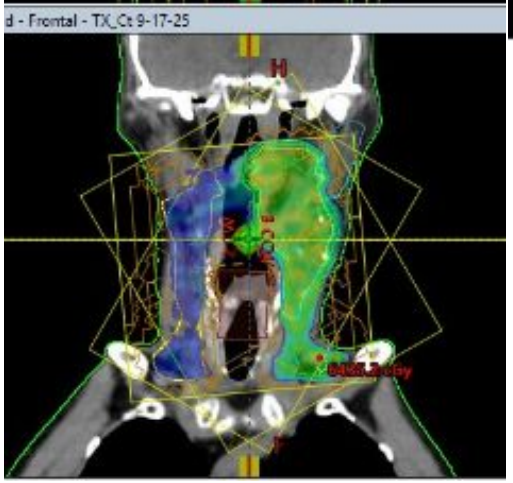
H
F

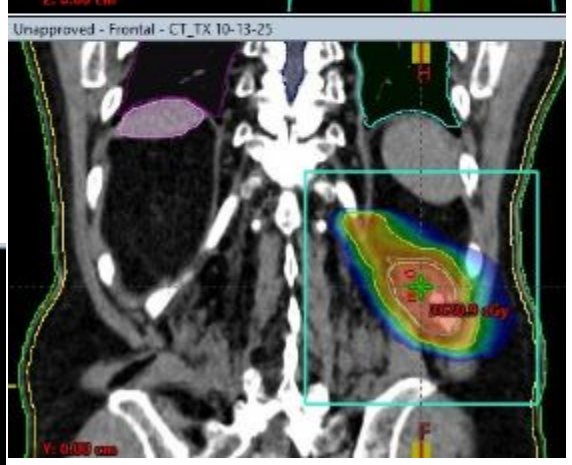
Oropharynx & Rib Met

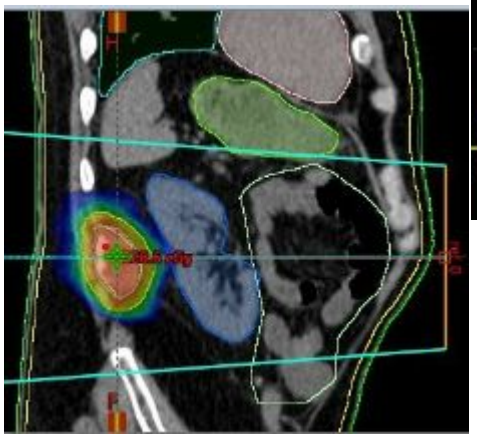




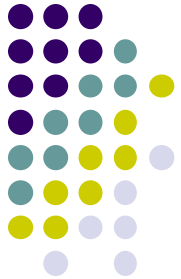






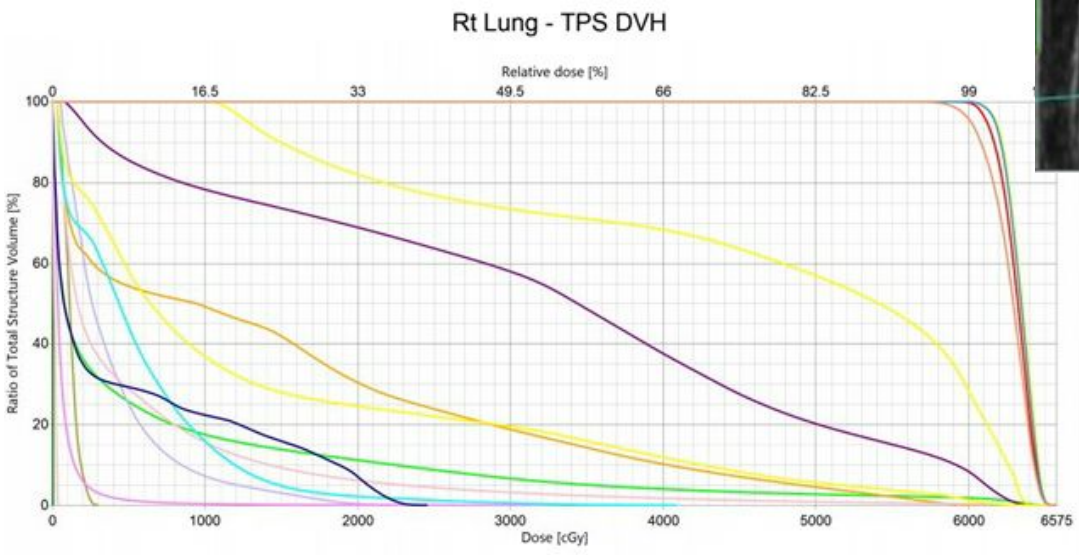


QA (quality assurance)

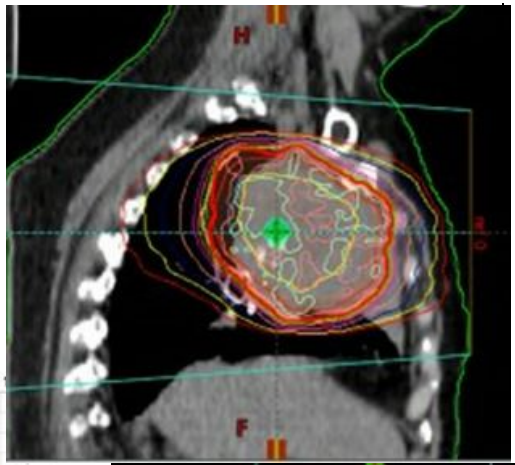


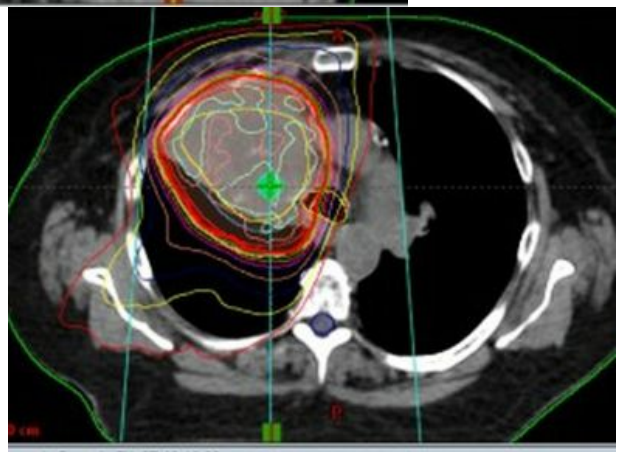
- Correct patient & correct diagnosis
- Dosimetry plan adequately treats the target
- Dosimetry plan meets limit criteria for normal tissue
- Machines are calibrated
- During treatment, imaging is used to confirm precise delivery
- Daily/weekly/quarterly/annual QA by physics makes sure the linacs, cameras/microphones, etc are working correctly

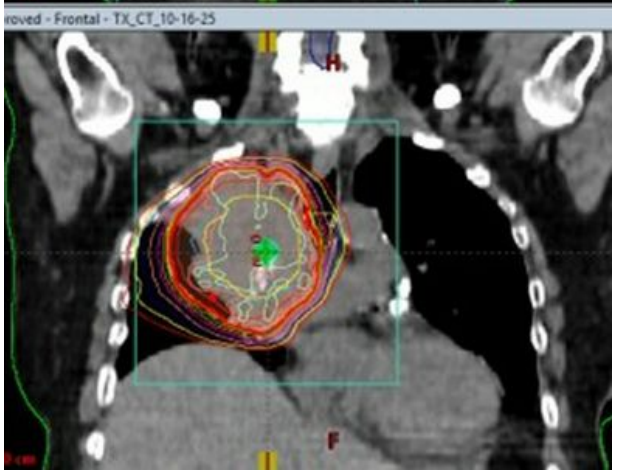
Dose Histogram



Structure Color	Rt Lung	Coverage	Sampling Coverage (%)	Volume (cc)	Min Dose (cGy)	Max Dose (cGy)	Mean Dose (cGy)
	BODY	100.00	100.25	25798.33	0.0	6574.3	635.5
	Brachial Plex_LT	100.00	99.85	20.74	29.8	300.1	115.6
	Brachial Plex_RT	100.00	99.96	20.35	50.7	2375.0	390.5
	Carina	100.00	99.97	14.73	1038.1	6404.6	4537.7
	CaudiaEquina	100.00	100.83	3.60	0.0	0.5	0.3
	CTV_6000	100.00	100.00	320.63	5854.0	6571.0	6307.7
	Esophagus	100.00	100.07	34.16	27.3	6057.8	1467.9
	GTV_6000	100.00	100.01	138.57	5991.4	6571.0	6339.5
	Heart	100.00	100.00	665.08	23.9	6514.8	538.2
	ITV_6000	100.00	100.00	186.85	5991.4	6571.0	6331.6
	Liver	100.00	100.01	1795.00	0.0	3139.2	67.3
	Lung_L	100.00	100.00	1625.06	23.1	4083.5	545.9
	Lung_R	100.00	100.01	891.50	72.4	6485.5	3168.7
	Lungs-CTV	100.00	100.01	2474.96	23.1	6485.5	1395.9
	PTV_6000	100.00	100.00	459.79	5476.5	6574.3	6267.5
	SpinalCord	100.00	99.87	45.15	0.0	2452.7	490.5
	Stomach	100.00	100.19	358.93	0.0	36.5	11.9





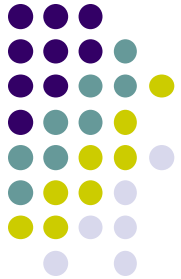


Filming

Filming = “Dry run”

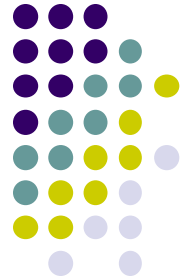
- To ensure the patient sets up/positions correctly for the anticipated treatments
- No radiation delivered

BEAM ON!



- Involves radiation therapists: specialists who set up patients & deliver the radiation as planned
- MD and physicists may need to be present, depending on the type of radiation being delivered

BEAM ON!
Basic Types of Radiation Therapy



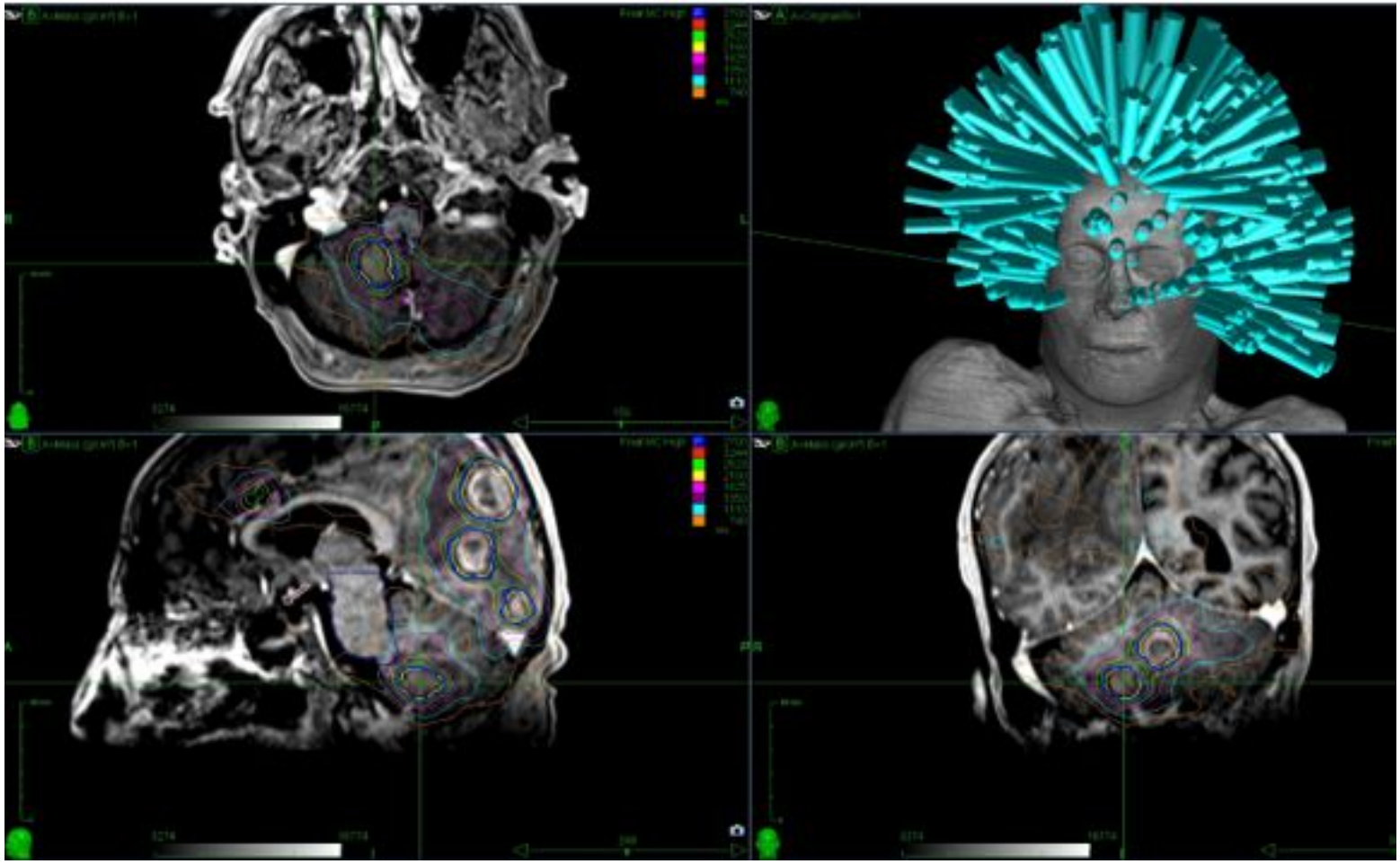
- External Beam
  - Conventional (3D CRT/IMRT) – most common
    - 3D – not as precise (quick planning, often palliative)
    - IMRT – precise but requires more treatment planning time & expense
  - SBRT/SRS – more precise, more planning time, more expense
    - Highly targeted, conforms to the target
    - Low dose radiation from many angles all converging on the target resulting in high does at the target and low (clinically insignificant) to surrounding tissues
    - Hypofractionation – fewer treatments (normally 1-5) with higher target dose & very tight margins to lesion
  - Proton (tumors near sensitive organs, did not respond well to previous radiation therapy, deep-seated tumors)
- Brachytherapy: radiation placed into tissues
- Radiopharmaceuticals (i.e. I-131,Ra-223, Lu-177) – radiation oncologist vs nuclear medicine

Linear Accelerator

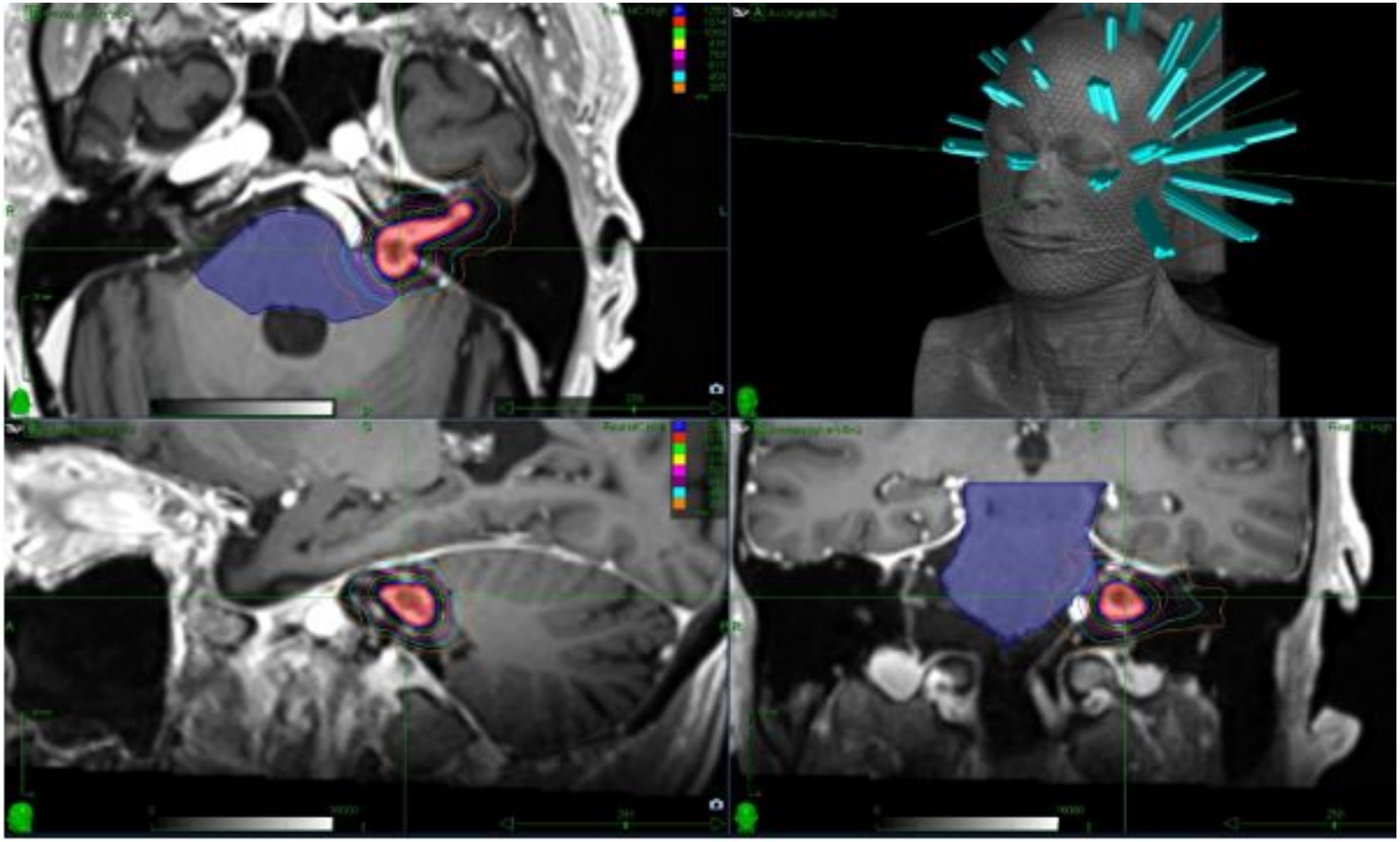
- Linac

CyberKnife

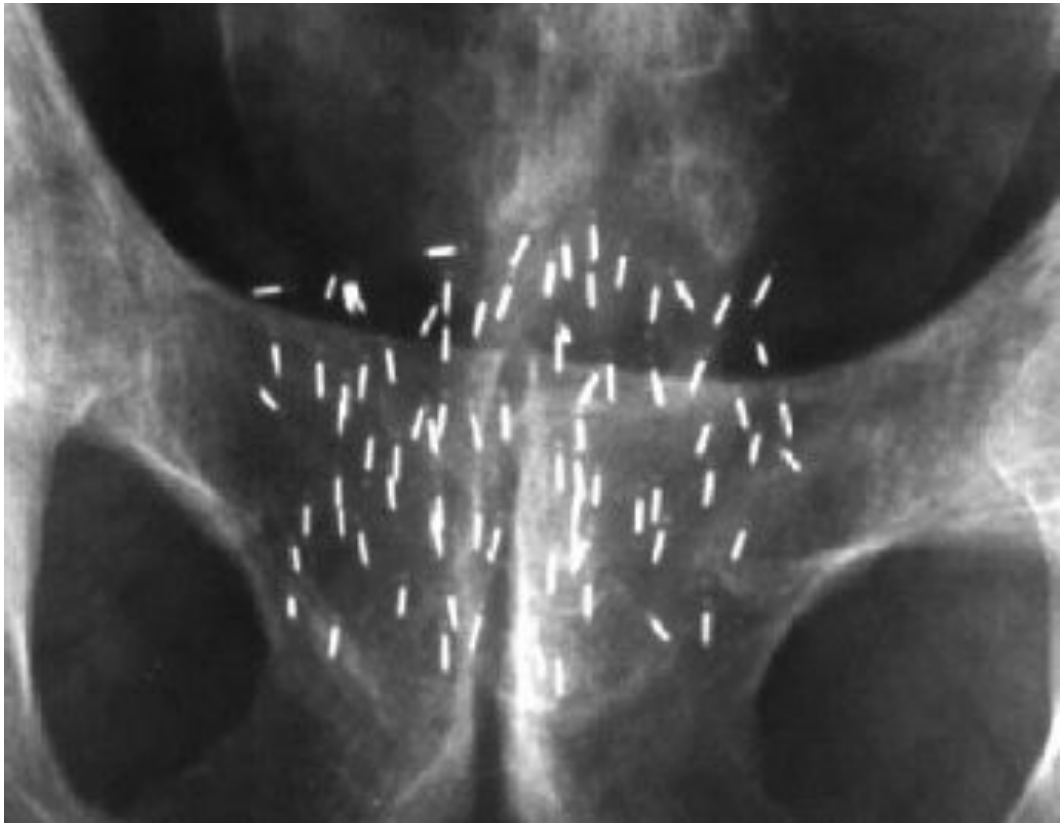
SRS/Cyberknife
Brain metastases



SRS/Cyberknife
Vestibular Schwannoma



Prostate Seed Implant

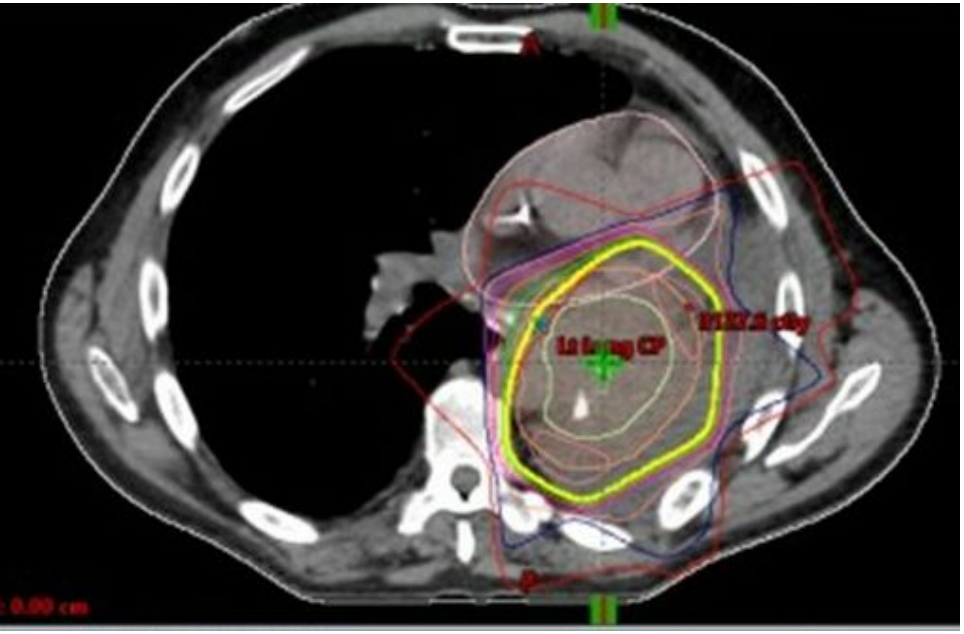


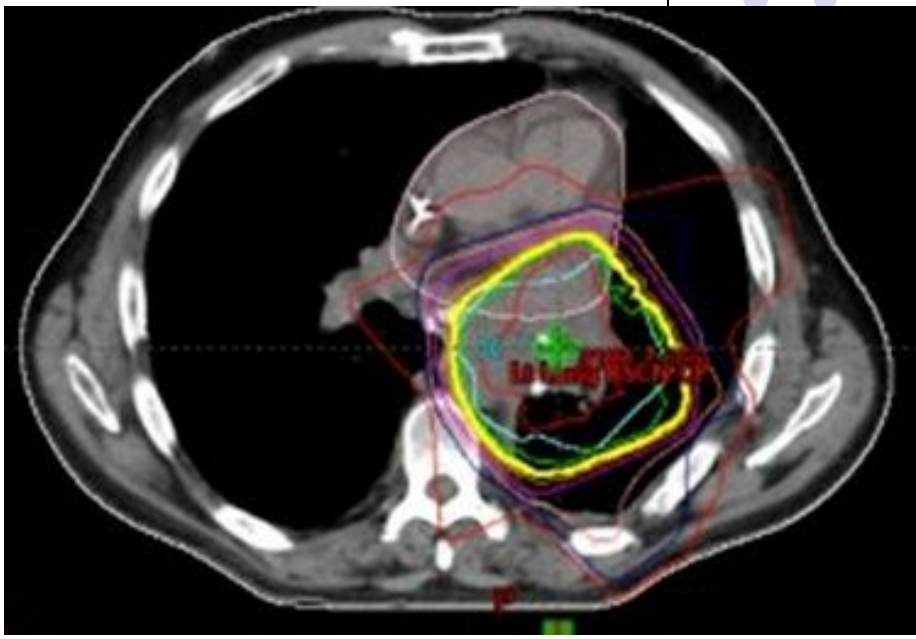
Replanning

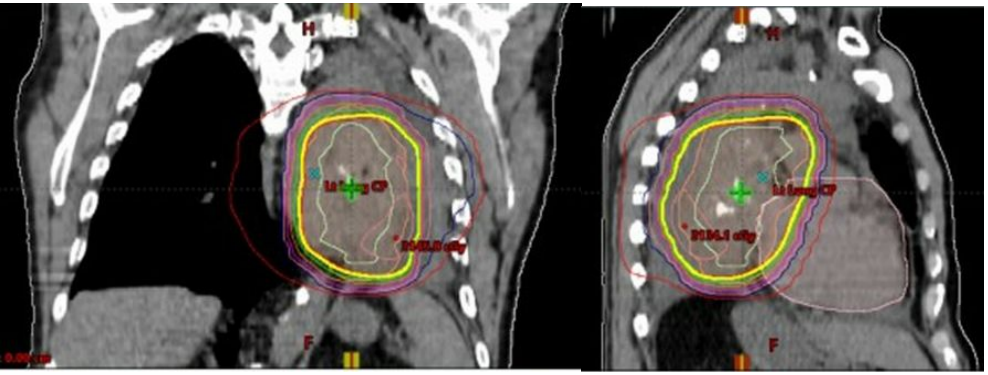
Sometimes necessary

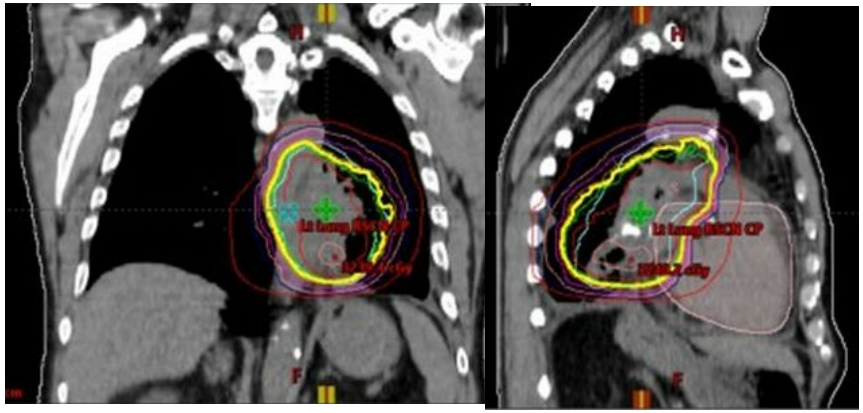
- Significant increase/decrease, shape change in target
- Change of anatomy (trach/chest tube placement/removal, etc)

Lung: Replan

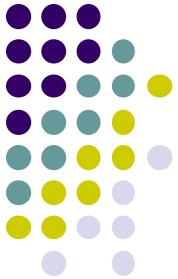








Weekly OTVs



- Seen to assess and manage side effects
- Side effects are specific to the area/s of treatment
- Management of common side effects
  - Skin: skins creams (deep moisturizing, protectant/barrier, *burn)
  - Diarrhea: diet, loperamide, diphenoxylate/atropine, etc.
  - Nausea: ondansetron, metoclopramide, prochlorperazine, etc.
  - Dysuria/frequent urination/UTIs: phenazopyridine, tamsulosin, oxybutynin, mirabegron, antibiotics, etc.
  - Headache/memory: dexamethasone, memantine, etc.
  - Xerostomia: salt or baking soda rinses, Biotene, pilocarpine

https://www.texasoncology.com/getmedia/caf0f4a6-21a0-4e1b-9fa2-3ece7b7a00f3/42567-TXO-Radiation-Book.pdf

Commonly Prescribed Medications in Radiation Oncology

12th Edition

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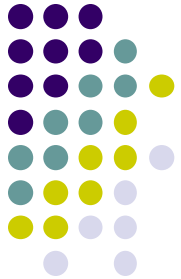
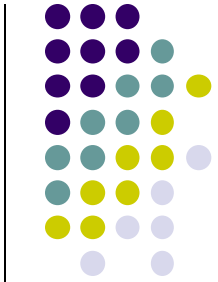
Management of common SEs



SKIN

- Key treatment is keeping the skin moisturized
  - REMEDY Moisturize – 1.5% dimethicone
  - REMEDY Prevent – silicone cream
  - Aquaphor
  - Mepitel – silicone impregnated film
  - Silvadene – silver sulfadiazine
  - Mometasone
- Barrier cream/ointment

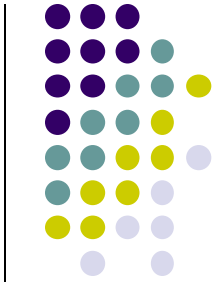
Management of common side effects (cont'd)



Radiation-Induced DIARRHEA

- Low fiber diet: refined grains, apple sauce, bananas, cooked/peeled veggies, etc.
- Soluble fiber: Metamucil, Benefiber, etc.
- Bland/lean proteins: fish, poultry, eggs, etc.
- Probiotics
- Loperamide = Imodium
- Diphenoxylate/atropine = Lomotil

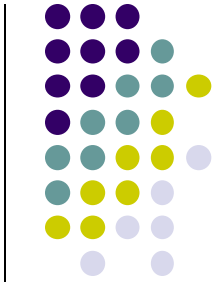
Management of common side effects (cont'd)



NAUSEA

- Ondansetron (Zofran)
- Prochlorperazine (Compazine)
- Metoclopramide (Reglan)
- Promethazine (Phernergan)
- Lorazepam (Ativan)
- Dexamethasone (Decadron)
- Granisetron (Kytril)
- Dronabinol (Marinol)

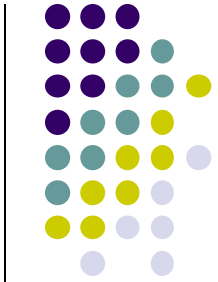
Management of common side effects (cont'd)



URINARY

- Common ABX
  - Bactrim DS
  - Nitrofurantoin
  - Cipro/Levo
- Overactive bladder
  - Tolterodine
  - Oxybutynin
  - Solifenacin
  - Hyoscyamine

Management of common side effects (cont'd)



HEADACHE

- APAP/NSAIDs
- Dexamethasone

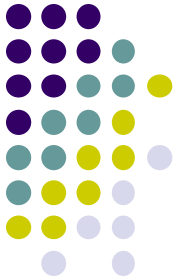
MEMORY

- Memantine x6 months post-radiation brain

POOR HEALING

- Pentoxifylline 400 mg TID + Vitamin E 1000 IU qd
- Bevacizumab (Avastin)
- HBO

Management of common side effects (cont'd)



MUCOSITIS

- Baking soda or salt water mouthwashes
- Carafate (Sucralfate) suspension
- Magic mouthwash

THRUSH

- Fluconazole
- Nystatin swish & swallow

XEROSTOMIA

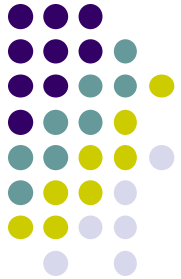
- Pilocarpine (Salagen)
- Biotene oral rinse
- Sugar free lemon drops or Red Hots (after appropriate healing)

**PAIN MANAGEMENT: NSAIDs, APAP, opioids, gabapentin, etc

PAIN

- How much time do you have?!
- Commonly used:
  - NSAIDS, APAP
  - Hydrocodone (short & long-acting)
  - Oxycodone (short & long-acting)
  - Morphine (short & long-acting)
  - Methadone (low dose & long-acting)
  - Fentanyl patch (long-acting)

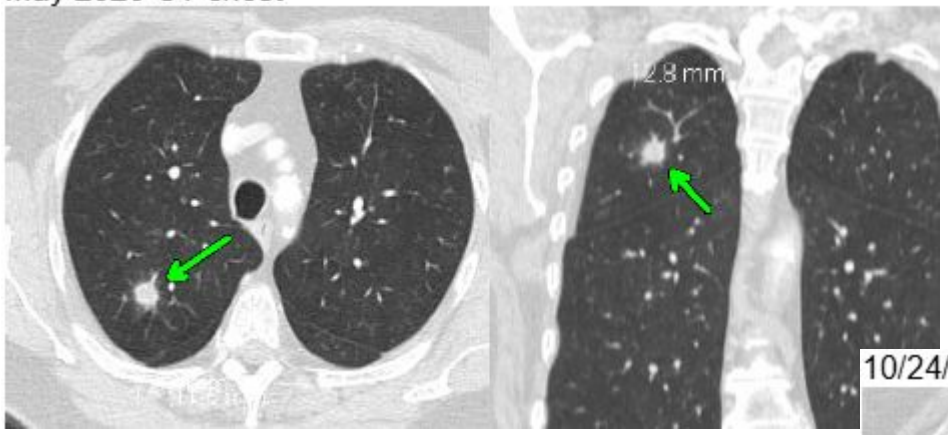
FU/Surveillance



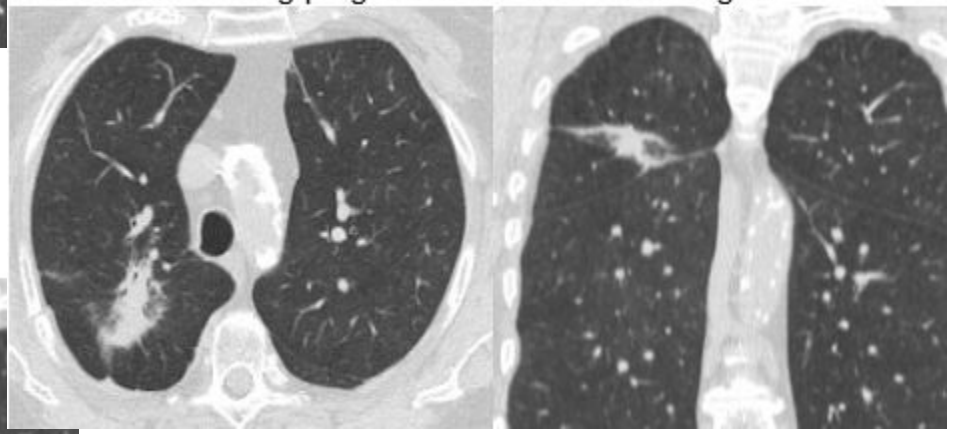
- Follow-ups depend on diagnosis
- Common long-term follow-ups
  - Head and neck
  - Prostate
  - Lung
  - Breast cancer
  - Brain metastases (SRS)
  - Meningioma

Radiation Fibrosis

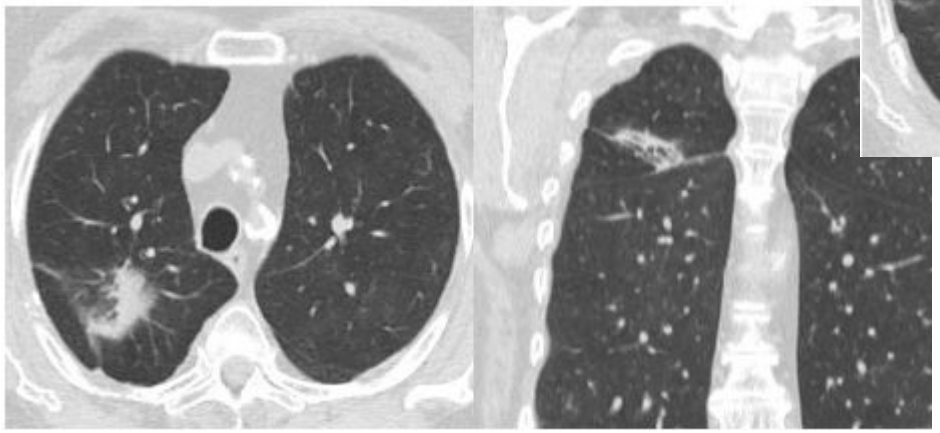
May 2020 CT chest



10/24/2025 showing progression of radiation changes

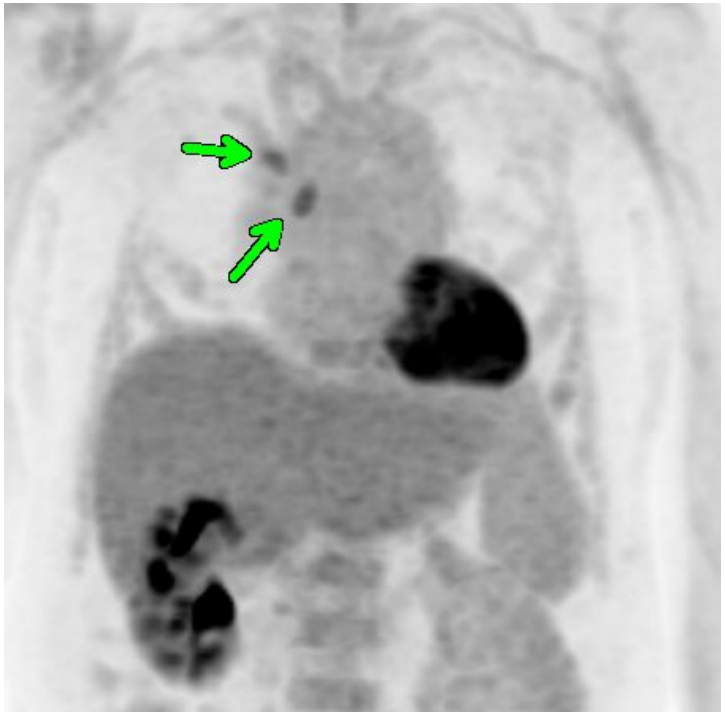


4/11/2025



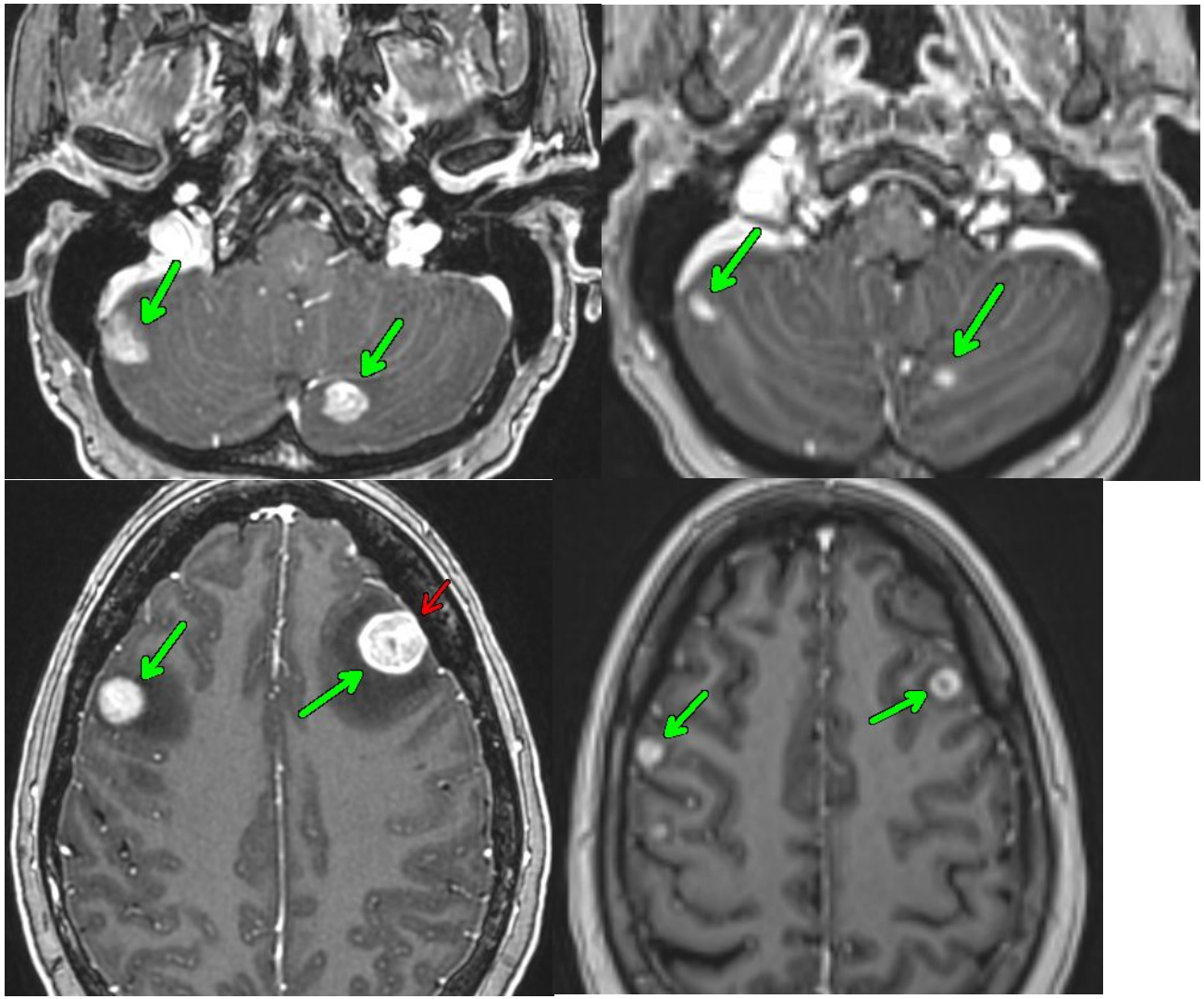
Response to Chemoradiotherapy - NSCLC

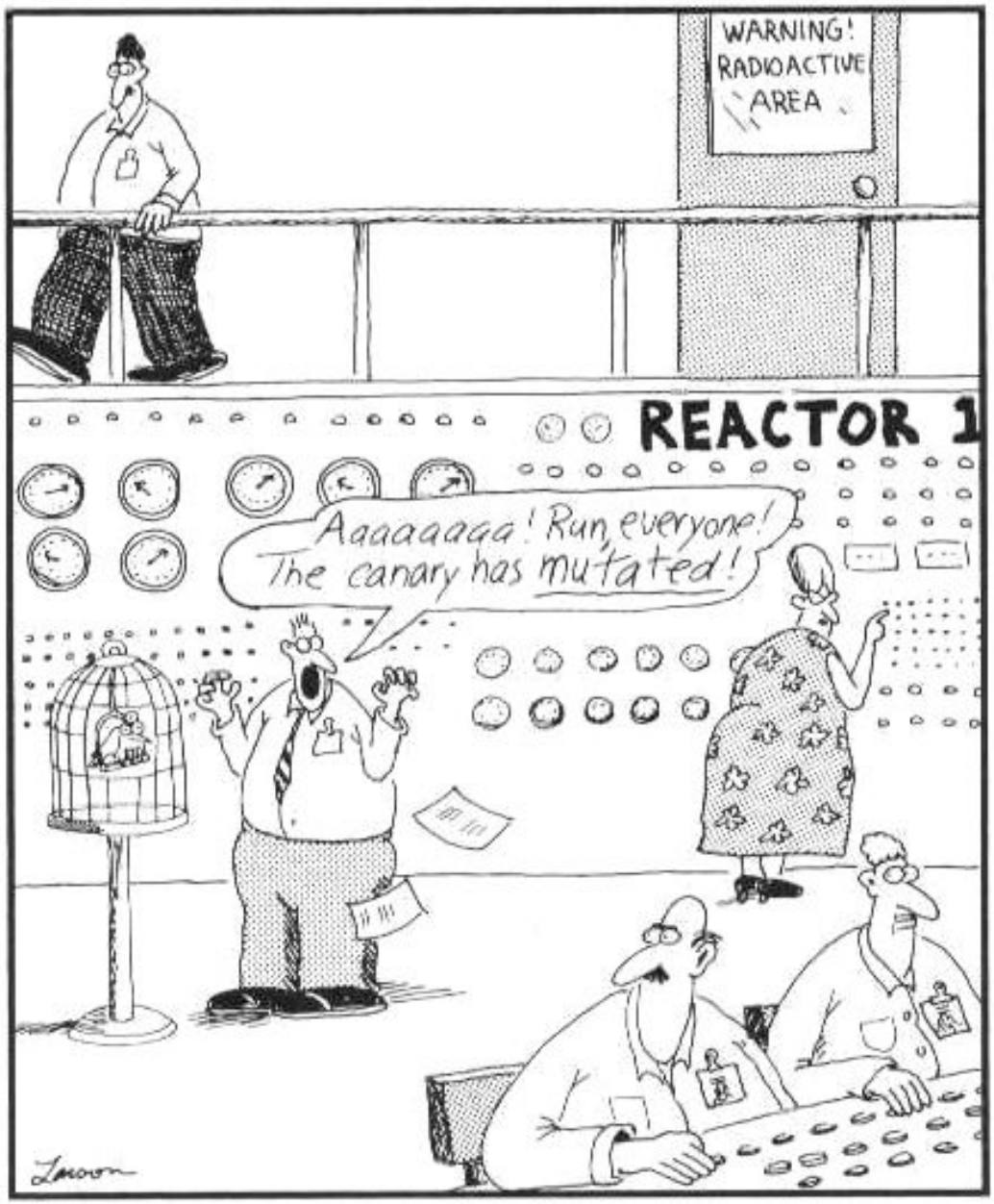
Pre-treatment PET scan

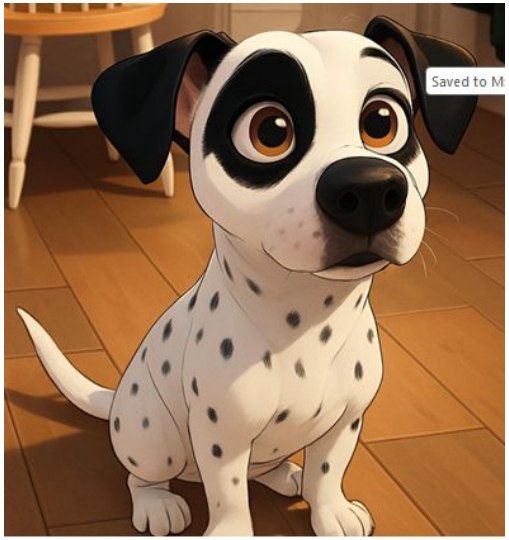


11 weeks post-treatment PET scan

Brain metastases from breast cancer




WARNING!
RADIOACTIVE
AREA
REACTOR 1
Aaaaaaaaa! Run, everyone!
The canary has mutated!

Questions?

Jordi and I would like to thank you for your time!