Introduction to Radiation Oncology

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Name	Role	Relationship	Company
Kara Romano, MD	Consulting	Consulting	Merck
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Activity Code: 24723

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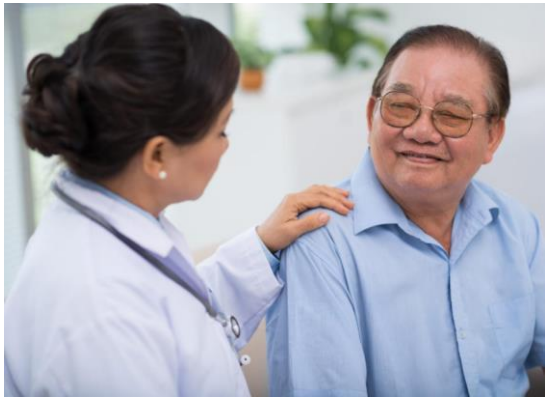
Introduction to Radiation Oncology



Learning Objectives

1. Explain how radiation therapy (RT) is incorporated into multidisciplinary cancer care.
2. Describe basic principles of radiation oncology, applicable to any field in medicine.
3. State common indications of radiation therapy in the curative and palliative treatment of patients with cancer.
4. Identify different modalities of radiation delivery including photon, electron, proton and brachytherapy.
5. Discuss acute and long term side effects of radiation.
6. Describe how common diagnostic studies including basic labs, pathology reports, and standard imaging modalities are applied to care of patients with cancer.
7. Incorporate ethical, social and diversity perspectives to provide culturally sensitive health care to all patients.

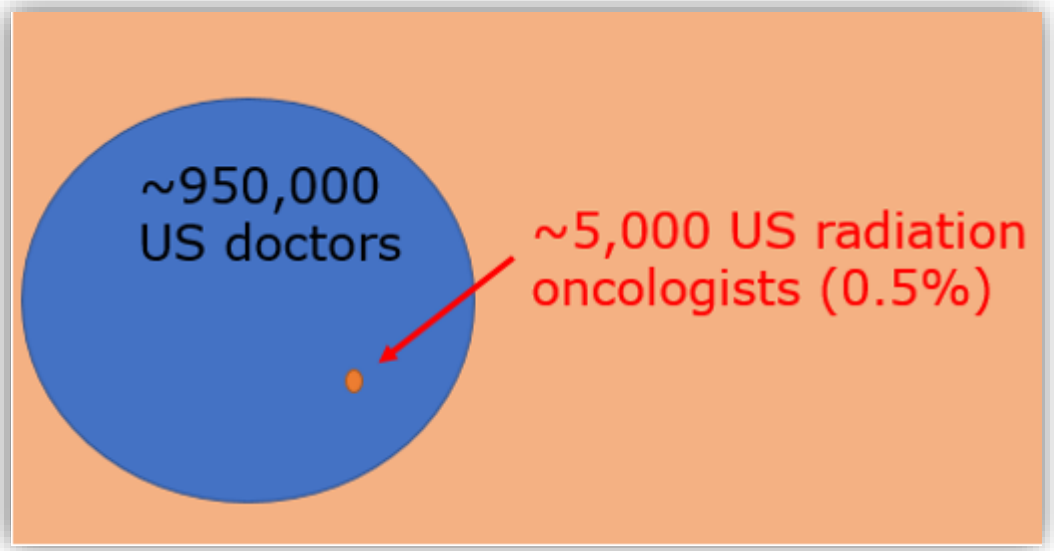
Questions to address:

- Basic terminology (what does Gy mean, cGY, external beam (and the kinds) etc), What IS radiation? How is it delivered?
- How often is radiation given? Is it given daily/cumulative dose? How long does it take to give a dose of RT?
- What does a timeline look at? What departments do you work with? Where do patients get radiation (UVA facilities)? Also, where do most RESEARCH subjects get treated?
- What are some ‘general’ side effects for patients treated with radiation (what would CRCs look for in clinic notes)
- What kind of radiation procedures are offered (such as Brachy, IORT)

Outline

- Overview
  - Why do we use radiation?
  - How does radiation work?
  - How is radiation delivered?
  - Where do patients get treated?
  - Side effects?

Radiation Oncology is a small field



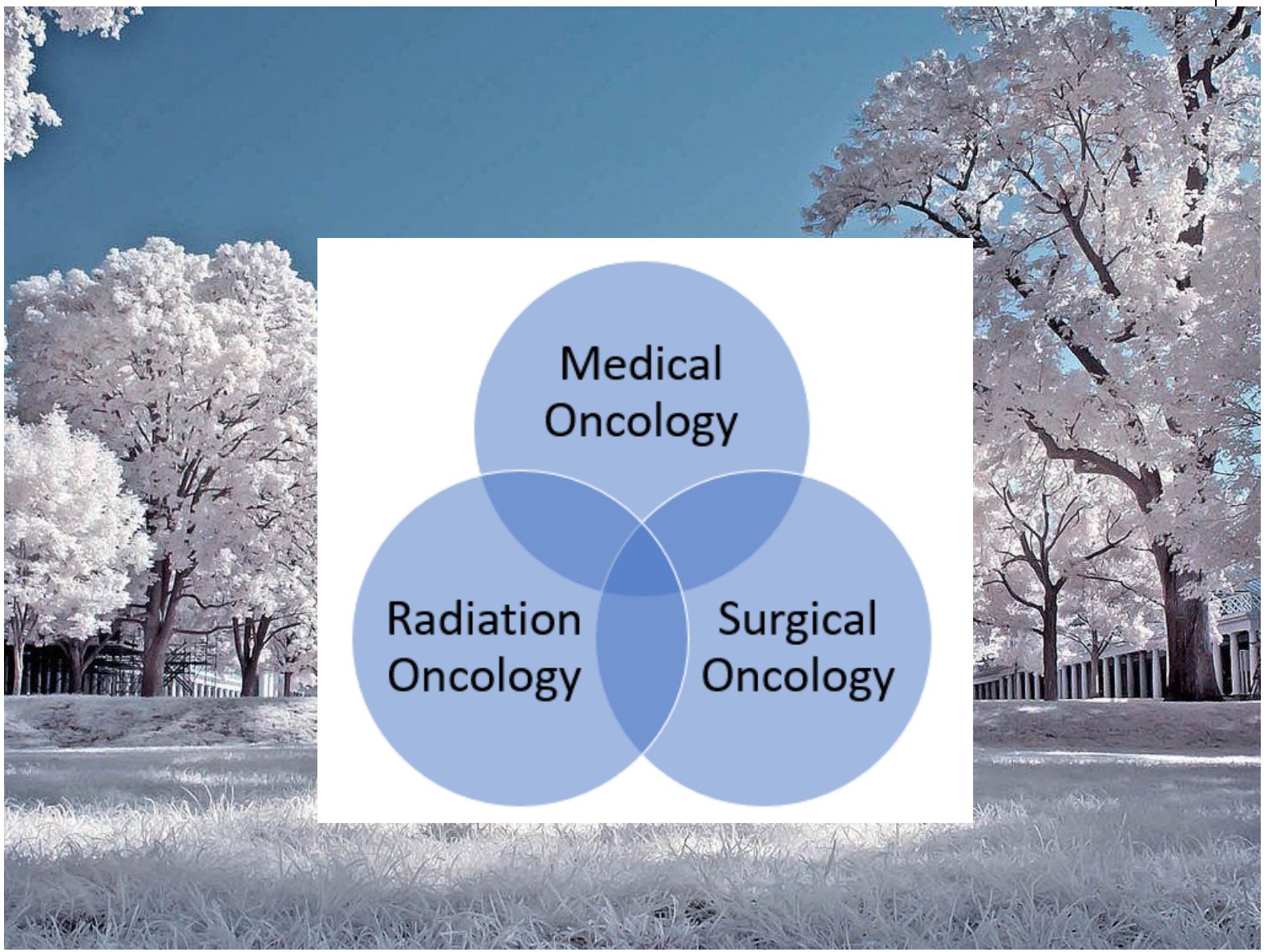
Virtually no one envisions themselves as a radiation oncologist when they apply to medical school; most people have never heard of it!

However –

- ~ 50% of patients with cancer receive radiation therapy
- ~ 40% of cancer cures are achieved with it
- And providers who get some exposure to Rad Onc as a specialty tend to like it!

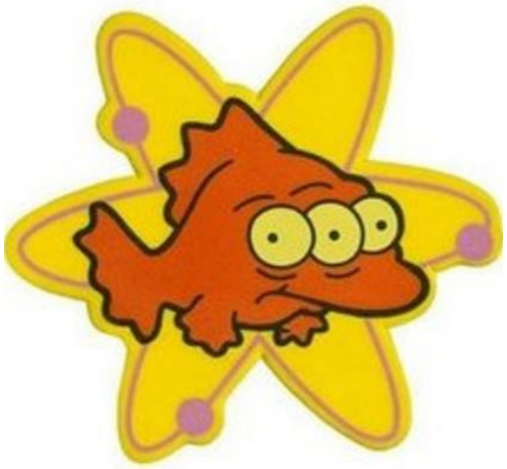
Malcolm Mattes, MD - Introduction to Radiation Oncology; Baskar et al. 2021

Radiation Oncology at UVA



When people hear the word “radiation”…

They often think …



However, the medical use of radiation therapy is very different …

Indications for Radiation Therapy

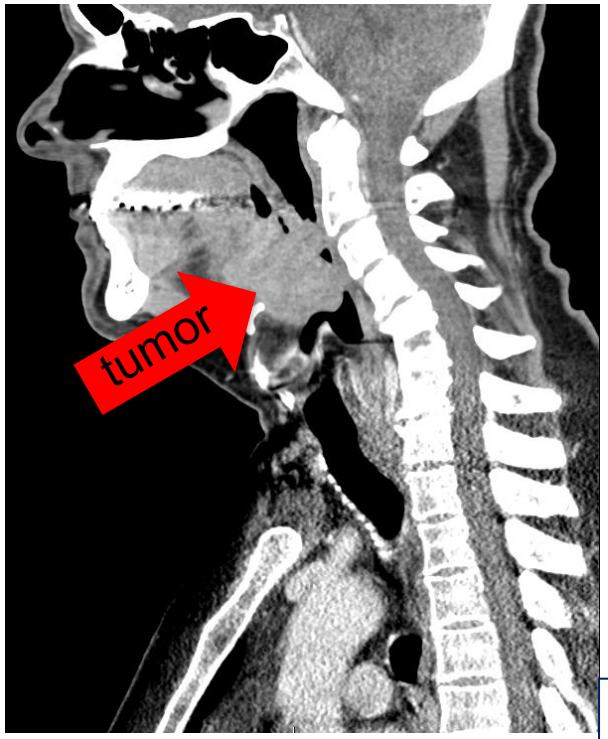
- Radiation is an important component of **curative treatment** either alone or in combination with surgery, chemotherapy, and immunotherapy

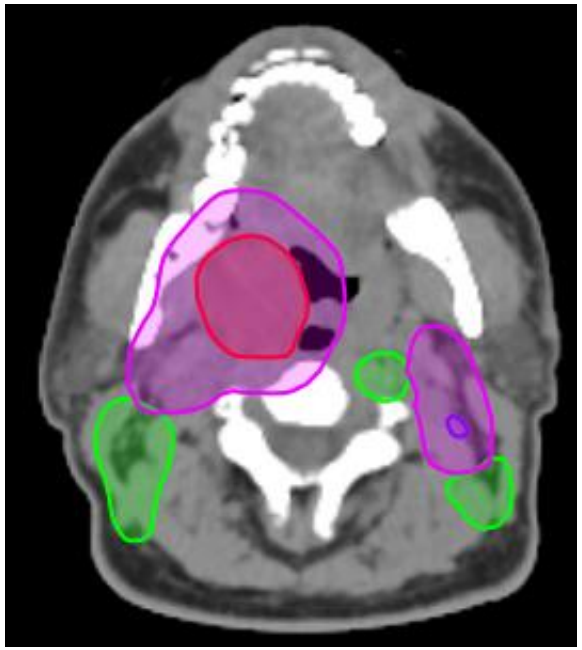
- Radiation is a very effective **palliative treatment** of symptoms from advanced cancers that are no longer curable

- Radiation, like surgery, is mainly site specific for **local/regional therapy**

- Whether used for curative or palliative intent, radiation can provide **quality of life** benefits that may not be possible with other treatment modalities

What we actually do…





Consult

Image review

Outpatient Clinic

Multidisciplinary Tumor Board

Treatment Planning

CT Simulation

Contouring

Planning

QA checks

Treatment

Weekly management

Follow Up

Radiation as a Complement to Surgery

- **Adjuvant RT:** post-operative treatment to eradicate microscopic tumor cells in a post-op tumor bed or nodal region

- **Neo-adjuvant RT:** pre-operative treatment can downstage a tumor and make it more amenable to surgical resection

- **Some examples include:**
  - Breast cancer
  - Soft tissue sarcoma
  - Malignant brain tumors
  - Uterine cancer
  - Rectal cancer
  - Esophageal cancer

Definitive Radiation Instead of Surgery

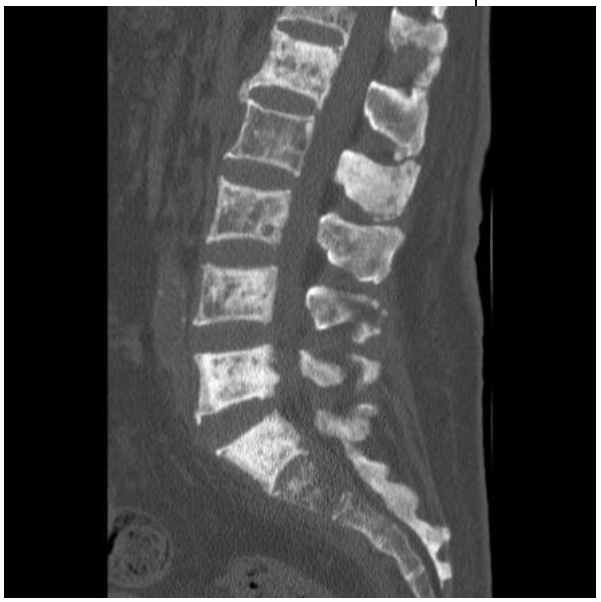
- **Definitive RT:** in some cases radiation is used instead of surgery with a comparable probability of cure

- **Potential reasons include:**
  - Not all tumors are surgically resectable
  - Not all patients are medically operable
  - Some cancer surgeries are very morbid
  - Organ preservation is desirable

- **Some examples include:**
  - Prostate cancer
  - Cervical cancer
  - Larynx cancer
  - Anal cancer
  - Lung cancer
  - Local consolidative therapy for oligo-metastatic cancer

Palliative RT for Incurable Cases

- Indications for **palliative RT** include:
  - **Pain**
    - Bone metastases
  - **Neurologic Symptoms**
    - Spinal cord compression
    - Brain metastases
  - **Bleeding**
    - GYN, bladder, lung
  - **Obstruction**
    - Superior Vena Cava syndrome (SVC)
    - Airway
    - Esophagus
    - Bile ducts



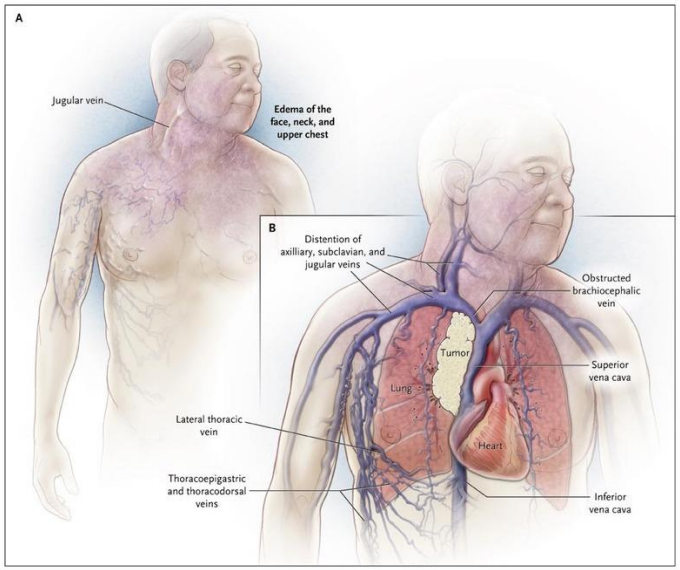
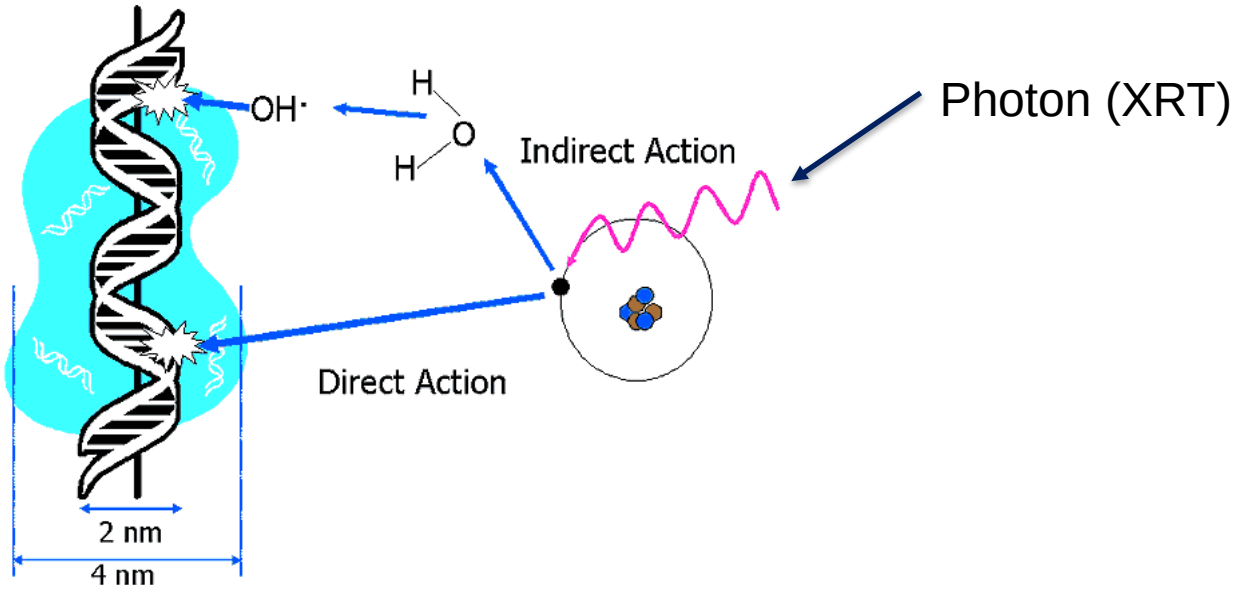


Photo credit: Radiopedia, NEJM 2007

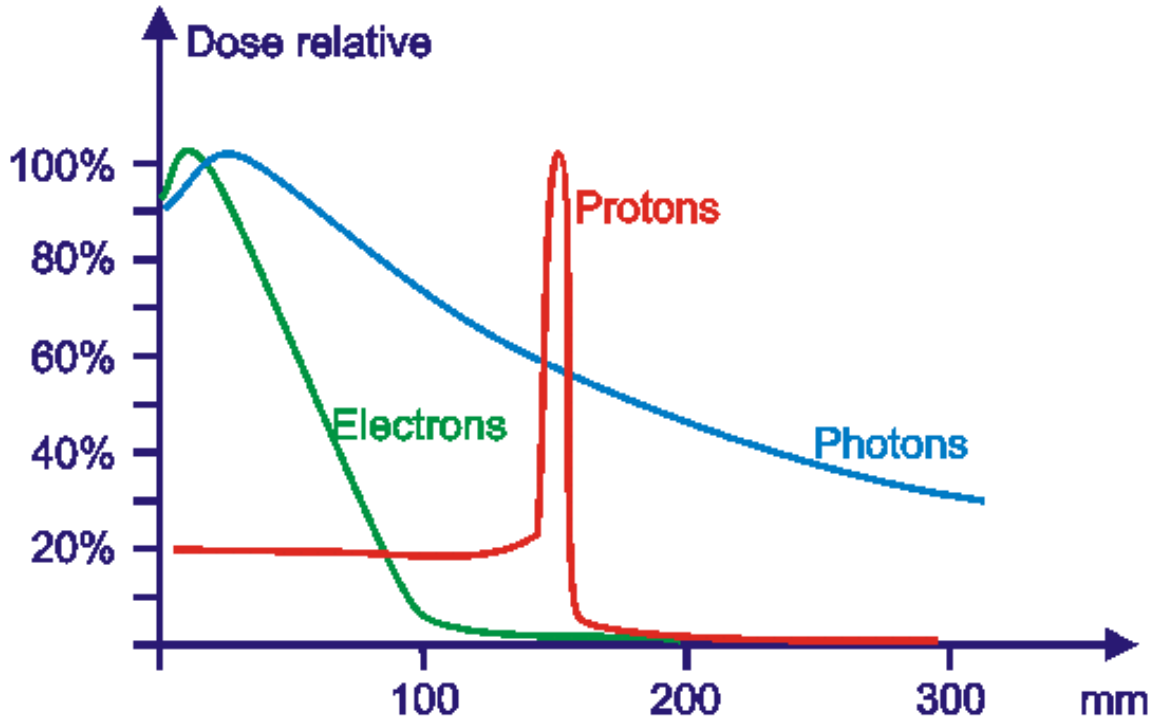
How Does Radiation Work?

- RT is the medical use of ionizing radiation (IR) to kill cancer cells
- IR damages DNA through formation of free radicals and reactive oxygen species



- Cancer cells are more susceptible to RT due to impaired DNA repair pathways

Modes of Radiation Delivery



How does the RT get to the patient?

Radiation Treatment Delivery

External Beam Radiation Therapy (EBRT)

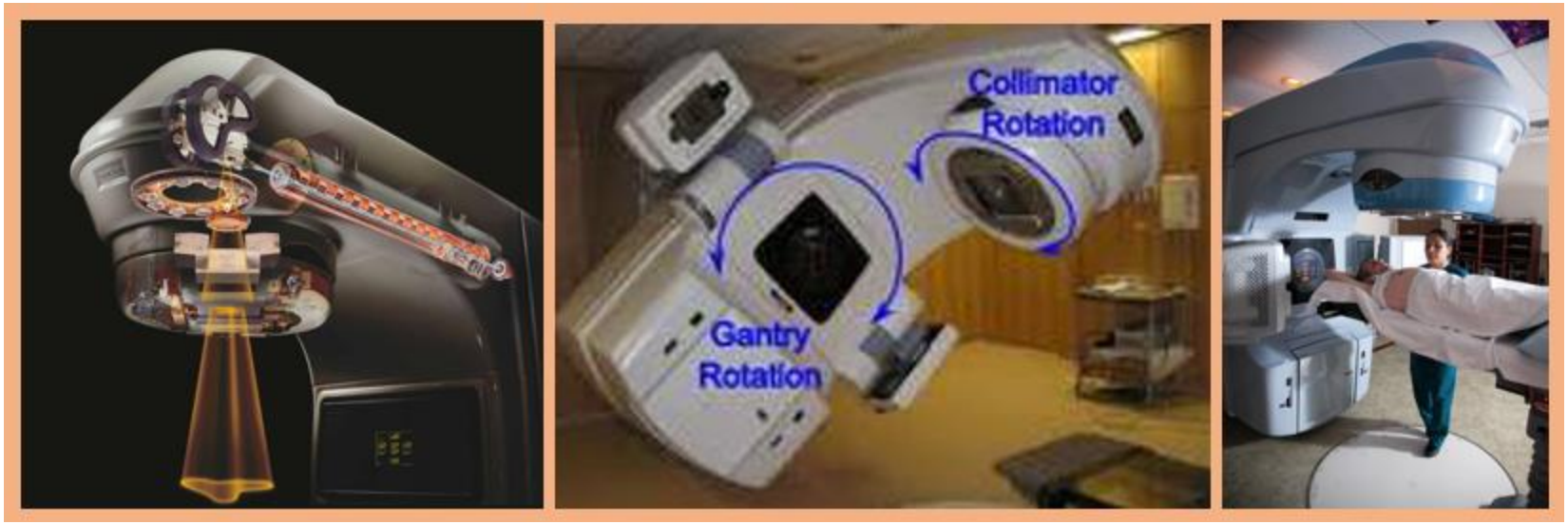
Dual Energy linear Accelerator
https://www.radiologyinfo.org/en/info.cfm?pg=linac

Brachytherapy

Brachytherapy Suite (photo: Lydia Levinson, MS)

External Beam Radiation Therapy

- Delivers high energy X-rays (photons) or electrons
- Non-invasive
- Rapid treatment delivery (minutes)



External Beam Radiation Therapy

Machines:

- TrueBeam
- Tomotherapy

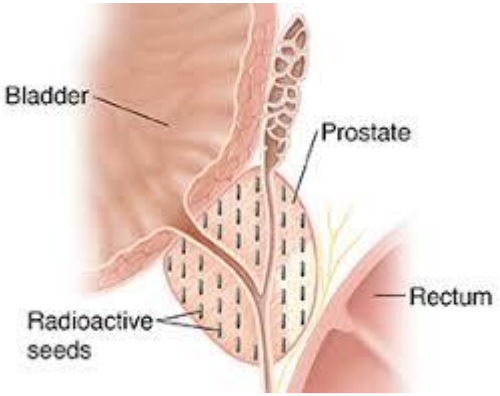
Types/Modalities:

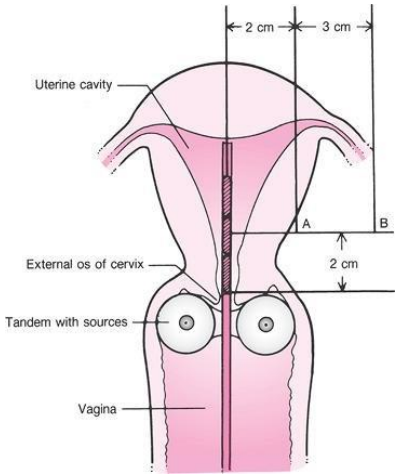
- 2D – old
- 3D
- IMRT
- SBRT/SABR
- Gamma Knife (GKRS) or “radiosurgery”

Brachytherapy

brachy-

1 a learned borrowing from Greek meaning “short,” used in the formation of compound words: *brachycerous*.





Brachytherapy: the temporary or permanent application of small, sealed radioactive sources in close proximity to or within the target region

Radiation Dosing

- RT is the treatment of cancer using high energy X-rays

- Radiation Oncologists prescribe radiation dose (Gy) like other physicians prescribe drugs in units of milligrams.

- **Gray (Gy)** is the unit of RT dose
  - Gy = amount of energy deposited per unit mass of tissue (J/kg)
  - 1 Gy = 100 centigray (cGy)
  - The dose from 1 cGy roughly = 1 CT scan

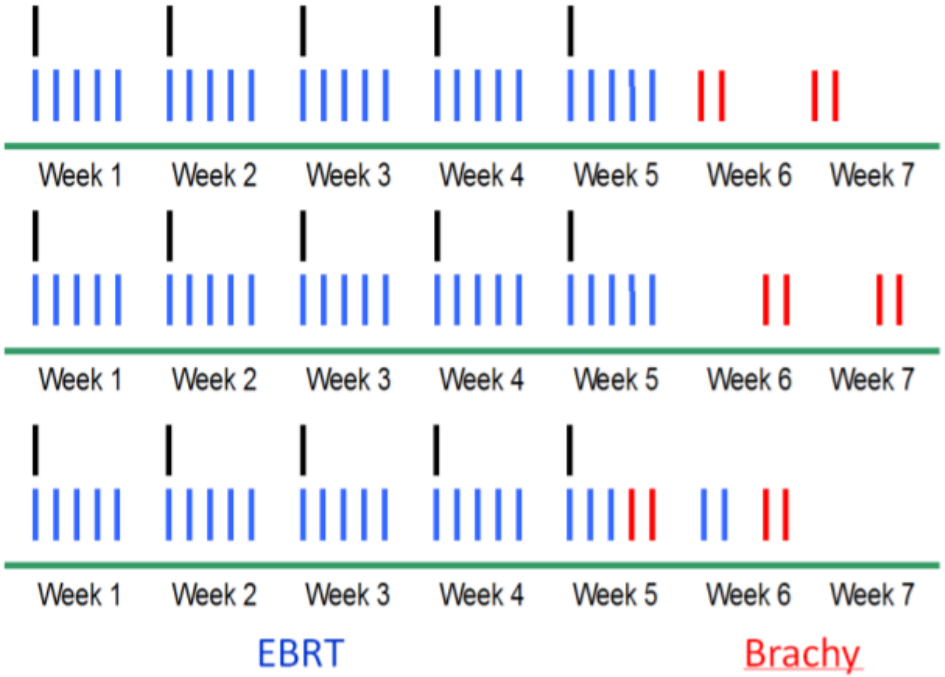
- Dose prescription depends on:
  - Goal of treatment (curative > palliative)
  - Amount of disease (gross > microscopic)
  - RT sensitivity of tumor (eg. sarcoma vs lymphoma)
  - RT sensitivity of surrounding normal tissue

Radiation Dosing

- Most patients receive multiple fractions (Fx) of RT during their treatment course

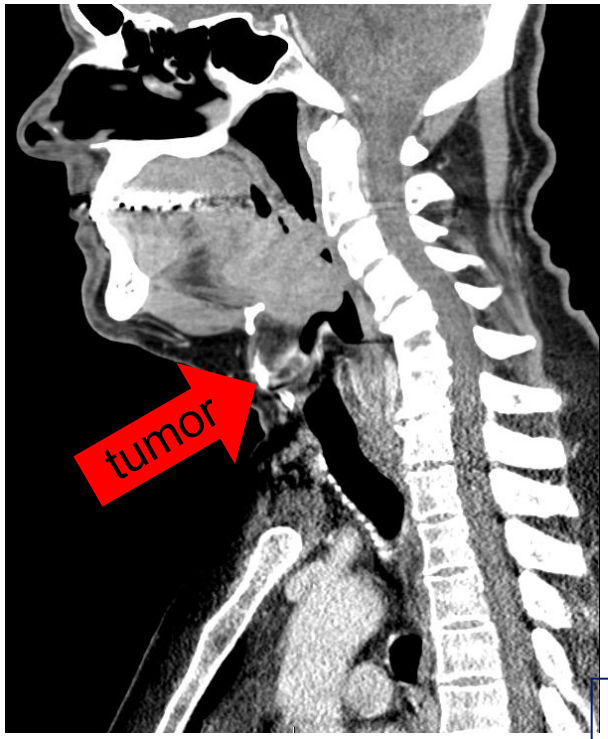
- RT is typically delivered once-daily, 5 days/week, 30 – 45 minutes/day

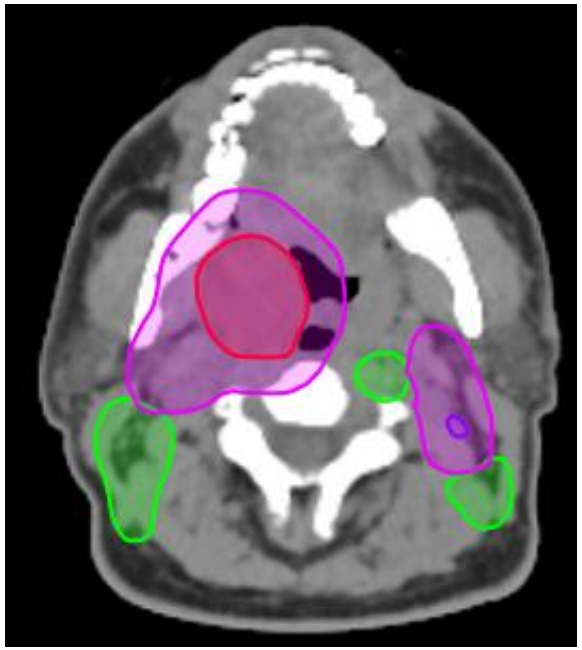
- Fractionation decreases the risk of toxicity by allowing for DNA repair in normal tissue



EMBRACE II protocol

What we actually do…





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Follow Up

UVA Rad Onc Clinics

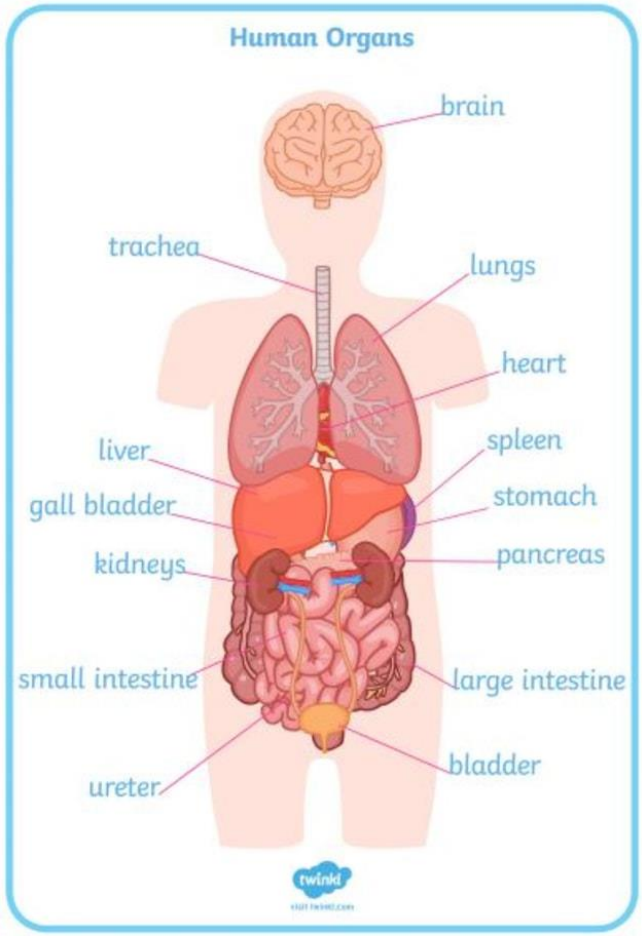
- Emily Couric

- Moser
- Culpeper
  - Limited clinical trials

- Gainesville
  - Community satellite
  - No current clinical trials

Radiation Toxicity

- Site specific toxicity
  - CNS
    - Fatigue, hair loss, nausea, memory loss
  - Thoracic
    - Esophagitis, pneumonitis, rib fracture, fistula
  - Breast
    - Dermatitis, lymphedema
  - Head & Neck
    - Dermatitis, mucositis, dry mouth
  - GI
    - Proctitis, cystitis
  - GU
    - Proctitis, cystitis, erectile dysfunction
  - GYN
    - Proctitis, cystitis, sacral insufficiency fracture, sexual dysfunction



https://www.twinkl.com/teaching-wiki/human-body-organs

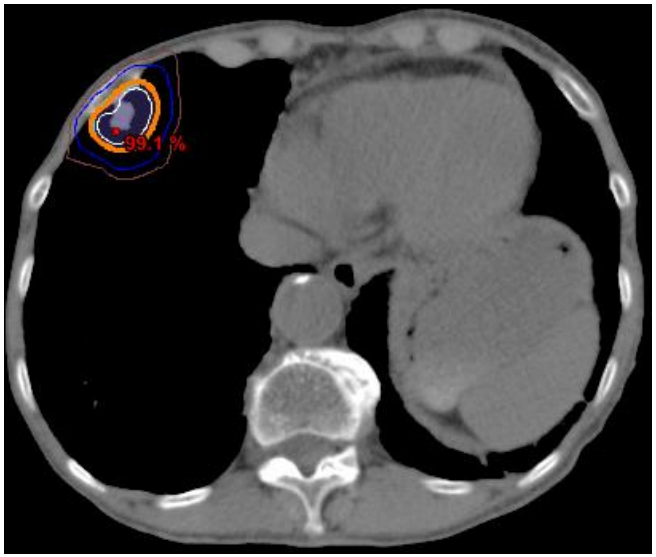
Radiation Toxicity

What are the short term risks of lung SBRT?

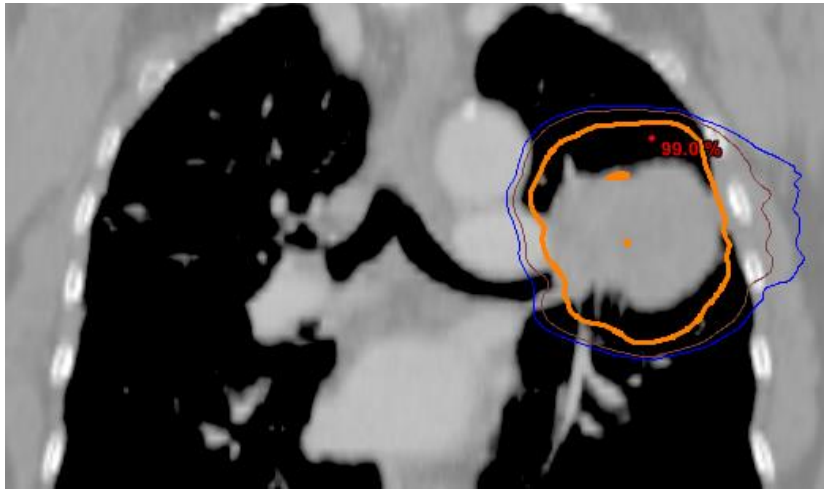
A. Infection
B. Pneumonitis
C. Bleeding
D. Lower extremity swelling
E. Immunosuppression

Acute Radiation Toxicity

Radiation Toxicity Depends on Tumor Site



- Fatigue
- Rib fracture, chest wall pain
- Skin Erythema/fibrosis



- Fatigue
- Pneumonitis
- Hemoptysis
- Fibrosis, Atelectasis
- Rib fracture, chest wall pain

Toxicity: Radiation Pneumonitis

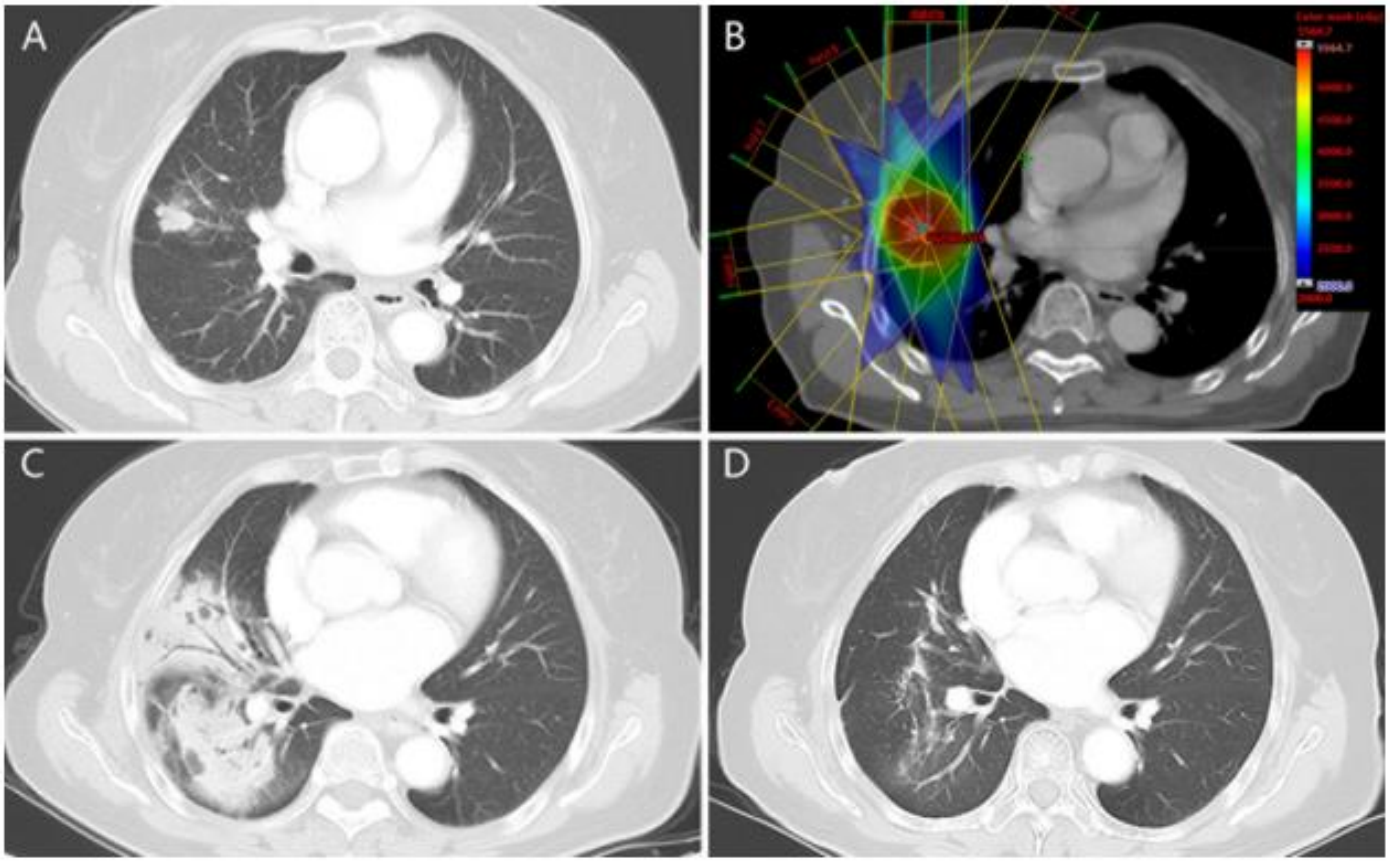
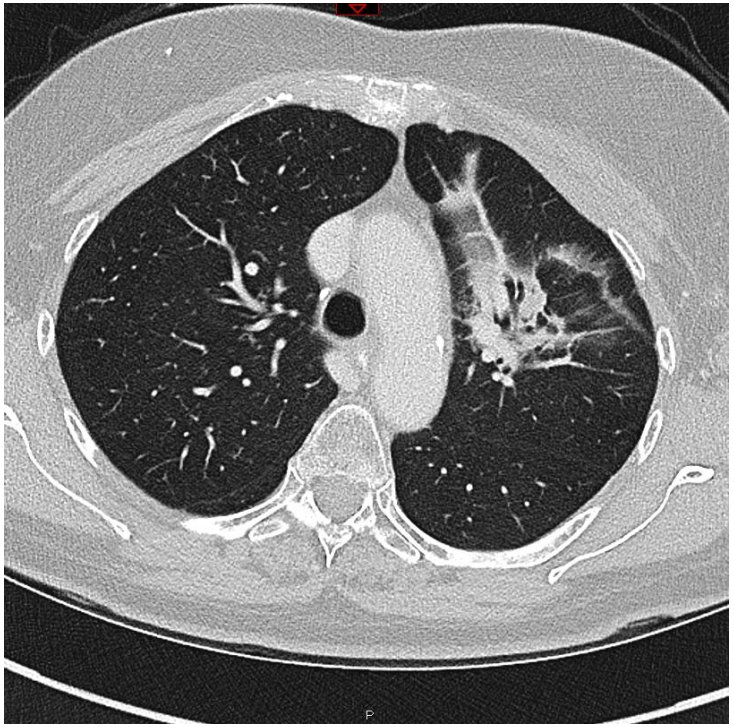


Fig. 1. Representative images of patient 6 who developed grade 3 RP after receiving concurrent Osimertinib and thoracic radiotherapy. A. Primary lesion before radiotherapy. B. Isodose curve of the treatment plan. C. Three months after radiotherapy. D. Two weeks after methylprednisolone.

Jia et al. Radiotherapy and Oncology 2020

Late Radiation Toxicity

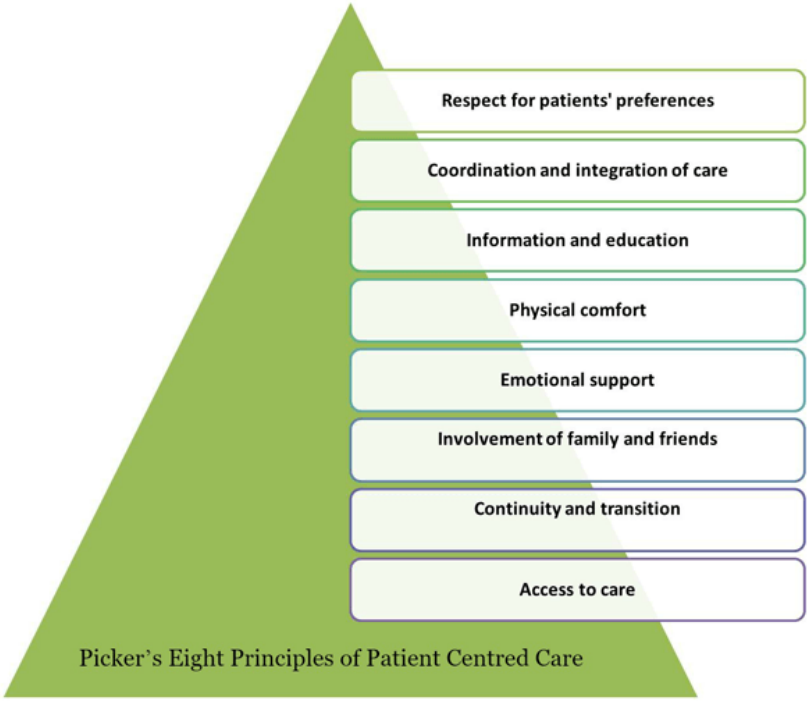
- Lung Fibrosis
  - Develops in high dose region
  - Often see visible lines that correlate with the isodose line distribution
  - Most often asymptomatic
  - Can impact lung function
- Rib fracture (2 – 3%)
- Esophageal stricture (1 – 2%)
- Cardiac complications (rare)
  - Pericarditis, ischemia, effusions, etc



CT Chest: ground glass opacities in the RT field

Outcomes and Patient Centered Care

- The 5-year local control with lung SBRT is > 90%
- The 5-year overall survival is ~ 60 – 70% (consider co-morbidities)



- An individual's specific health needs and desired health outcomes are the driving force behind all health care decisions and quality measures

- **Patients are partners with their health care providers**

LO 7

Cervical Cancer – Toxicity of RT

What toxicity do you counsel the patient to expect?

A. Diarrhea
B. Nausea
C. Pre-mature menopause
D. Dysuria
E. Pelvic insufficiency fracture
F. Secondary malignancy

Cervical Cancer – Toxicity of RT

Acute

- Fatigue
- Skin irritation/hemorrhoids
- Diarrhea/colitis
- Urinary urgency/frequency/dysuria
- Nausea

Late (10 – 15% Grade 3+)

- Ovarian dysfunction/pre-mature menopause
- Chronic changes in bowel/urinary habits
  - Rectosigmoid stenosis (~3%)
  - Rectal bleeding (~3%)
  - Ureteral stenosis
  - Hematuria
- Vaginal stenosis
  - dyspareunia/post-coital bleeding
- Pelvic insufficiency fracture

Procedure (T&O) related

- Uterine perforation (<3%)
- Vaginal laceration (<1%)
- DVT (<1%)

Summary

- Radiation Oncology is a key component of **multidisciplinary cancer care** providing local/regional therapy for both curative and palliative treatment
- Radiation is used to treat a wide **variety** of both malignant and benign conditions from head to toe and in all ages
- There are multiple different modalities of radiation delivery including photon, electron, proton and brachytherapy – each with new and evolving technology!
- Systemic Therapy and Radiation Therapy have great **potential** together
  - Non-invasive, complimentary, synergistic
- Radiation Oncology is a dynamic, engaging, and extremely fulfilling specialty

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