Treatment Modalities of Radiation

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Outline
- History of radiation therapy
- How radiation works
- Types of radiation
- Review treatment timeline for a patient
- Discuss radiation safety precautions
- Review early and late side effects of radiation
- Discuss management of side effects
- Review role of oncology nurse

Radiation therapy timeline

- 1895 Roentgen discovers radiographs
- 1898 Marie Curie discovers radium
- 1900 Villard identified radiation as emitting alpha, beta and gamma radiation
- 1903 Report in literature that skin cancer was treated with radiation
- 1903 Bergonie and Tribondeau describe radiosensitivity of proliferating cells.
• 1930 Coutard proposed fractionation treatment
• 1934 Frederic & Irene Joliot discovered artificial radioactivity
• 1930-1950’s Radiation for Hodgkin’s disease
• 1970’s Brachytherapy implantation
• 1975-1980 Glioblastoma (GBM)
• 1977 Breast conservation therapy

• 1981 Inoperable cancer treated with concurrent chemotherapy and radiation
• Late 1990’s IMRT Radiation
• 1999 PCI (prophylactic cranial whole brain irradiation) for patients with small cell lung cancer
• 2004 Neoadjuvant treatment for rectal cancer
• 2007 Hypofraction for early stage breast cancer
• 2017 Hypo fractionated treatment for prostate cancer

Radiation Oncology Timeline
Radiation oncology: a century of achievements
Jacques Bernier, Eric J. Hall & Amato Giaccia
Nature Reviews Cancer 4, 737-747 (September 2004)

Who gets radiation therapy
• Cancer patients
• 50% of cancer patients will receive radiation at some point
• Most commonly treated diagnoses include breast cancer, prostate cancer, lung cancer, head and neck cancer and metastatic cancers
Indications for Radiation therapy

- Definitive (head and neck cancer)
- Neoadjuvant (rectal cancer)
- Adjuvant (breast cancer)
- Palliative (metastatic prostate cancer to bones)
- Sequential or concurrent or definitive

Radiation for benign disease

- Pituitary adenomas
- Acoustic neuromas
- Keloid scars
- Heterotopic ossification prevention

Types of Radiation Beams

- Ionizing radiation is produced by electron, photon, proton, neutron and ion beams
- Beams are produced by linear accelerators
Linear accelerators

- Microwave technology speeds up electrons
- Electrons collide with a tungsten heavy metal target
- This then produces photons that penetrate deeper into the body at a target.
- Electron beams eliminate the collision with the tungsten target and then penetrate superficially

External beam radiation

- X-rays given with Linear Accelerators: electrons and photons
- Cobalt-60 machines: Gamma rays photons produced by nuclear decay
- Large particle machines or cyclotrons can produce neutrons and protons

- High energy x-ray or particles transmitted in the form of waves or particles through a material (tissue)
- Energy produced will disrupt anatomic structures.
- Direct damage of cells (protons)
- Damage causes formation of free radicals and reactive oxidation and subsequent cell death (especially in M phase)
- Mitotic cell death in single and double-stranded helix so death occurs upon attempts to divide

- Normal cells can recover in between fractions
- Damage must cause more damage than cell's ability to repopulate
RADIATION DOSING

• **Dosing or measurement of amount of radiation exposure per fraction is known as a** Gray (Gy)

• Small dose daily over several weeks
• Higher dose over shorter period of time
• Single fraction

Radio sensitive cells

• Breast tissue
• Bone marrow cells
• Mucosal lining of small intestines
• Sebaceous glands of skin
• Immune response cells
• All stem cell populations
• Lymphocytes

Radio-resistant cells

• Cardiac tissue
• Large arteries
• Large veins
• Mature blood cells
• Neurons
• Muscle cells

• **Highly sensitive:**
  - Seminomas (25-30 Gy)
  - Lymphomas (25-35 Gy)

• **More radio-resistant**
  - Head and Neck Cancers (70 Gy)
  - Prostate Cancers (70-74 Gy)
  - Glioblastomas (60 Gy)
Radiosensitizers

- Hyperbaric oxygen
- Carbogen
- Nicotinamide
- Nitroimidazole and its analogs (nimorazole, etanidazole, nimorazole)
- Hypoxic cell cytostatic agents (Misonidazole, Triapicamine)
- Membrane active agents (propanil, lidocaine, chlorpromazine)
- Radiosensitizing nucleosides (5-Fluorouracil, Fluorodeoxyuridine)
- Bromodeoxyuridine, Iodoxuridine, Hydrazoroxine, (Lomustine), Fluoradine
- Triethylenemethane sulphonate (Tamoxifen)
- Suppression of sulphhydril groups (N-Ethylmaleimide, Diamide and Ethylmercaptan)
- Hypothermia

Novel radiosensitizers (paclitaxel, docetaxel, irinotecan)

Radio protectors

- Radioprotective amifostine, mesna
- Antioxidants
- Omega-3 fatty acids

Brachytherapy

- High dose
- Low dose

Temporary or permanent implantation

Radiopharmaceutical Therapy

- Ingested (Oral iodine- 131)
- Injected (IV Strontium)
- Instilled (peritoneal)
Flow process

• How do we get from start to finish?

Timeline

1. Consultation
2. Simulation
3. Contouring
4. Planning
5. Quality assurance
6. Set up
7. Delivery of RT
8. Weekly On-treatment visits and prn visits
9. Follow up visits and scans
### Consultation
- Disease process and treatment options
- Performance status
- Experience with radiation (family, friends, internet)
- Co-morbid conditions
- Identify potential contraindications (lupus, scleroderma, IBD)
- Education of process
- Informed consent
- Coordination of care

### Simulation Planning
- Simulation  Localization (loc)  Planning Scan  Mapping Scan
- Custom planning approach placing patient in a reproducible position using a CT scan
- Along with:
  - Marks and or Tattoos
  - Molds, Guards, Blocks, Boluses
  - Masks or head holders  Vacuum bags (Vac-Locs)

### Planning
- Fusion with MRI or PET/CT
- Contouring of target structures
- Organs at risk identification
- What is tolerance to radiation of nearby structures
- Prescribe number of treatments
- Prescribe dose per fraction
- Prescribe energy of radiation
- Prescribe total dose of radiation

### Contouring
- Identify target structures
- Identify and shield organs at risk
Radiation Safety Precautions

- Radiation exposure related to distance of radioactive source
- External beam: patient is not radioactive so no risk to patient, family, personnel or public
- Shielding (lead, monitoring badges) for patient and personnel
- Brachytherapy: prostate 6 feet away from pregnant women and do not hold small children or babies in lap for 4 months

Nursing Roles in Symptom Management of Radiation Side Effects

- Identify cancer treated, timeline and side effects related to treatment site
- Identify side effects (consider what other variables are causing side effects) - often MULTIFACTORIAL and TINCTURE of time to improve
Fatigue

- Causes include anemia, nutritional deficits, dehydration, pain, poor sleep quality, psychological stressors (family stressors, work stressors, financial stressors, depression, anxiety, confusion), concurrent treatment, medications, infections, hypothyroidism, renal dysfunction, disease progression)

Treating fatigue

- Identify source (educate patient on multifactorial issues)
- Exercise
- Rest periods
- Good sleep hygiene
- Pacing one-self
- Delegation of activities/tasks
- Nutrition and hydration
- Recharge (meditate, fun or relaxing activities)

Radiation Dermatitis

- Reaction can begin within 1-4 weeks and can last for 2-4 weeks after finishing treatment
- Cause: loss of basal layer of cells causing shedding of epidermis and loss of sweat and sebaceous glands
### RTOG Radiation Dermatitis Grading

- **0** No change
- **1** Erythema; dry desquamation, epilation
- **2** Bright erythema, moist desquamation, edema
- **3** Confluent moist desquamation, pitting edema
- **4** Ulceration, hemorrhage, necrosis

### Treatment options

- General skin care for patients undergoing radiation therapy includes:
  - Keep the irradiated area clean and dry
  - Wash daily with lukewarm water and mild soap
  - Apply unscented, moisturizer, which you know that your skin tolerates (such as Cetaphil, Lubriderm, Eucerin, Keri, Vaseline Intensive Care, Aquaphor).

- Please **DO NOT** apply any lotion, cream etc. to the skin, which will be irradiated 3 hours before your radiation treatment. If you forget and do so occasionally, please **DO NOT SCRUB IT OFF**, as you may tear your skin.

- Please **DO NOT** apply sun screen/block to the radiation treatment field prior to daily radiation therapy.

- Wear loose-fitting clothes to avoid friction injuries.

- Avoid skin irritants such, as perfumes and alcohol-based lotions.

- Avoid using tape on the irradiated skin, as this can tear the skin.
• Avoid metal-based topical products, such as zinc oxide creams or deodorants containing aluminum salts.

• Avoid corn starch or baby powder in skin folds.

• Avoid sun exposure.

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Product Selection for Dermatitis

• Prophylactic steroids (mometasone)
• Petroleum-based ointment (Aquaphor, Vaseline, Cerave)
• Aloe vera
• Sucralfate
• Hyaluronic acid silver dressing
• Silver sulfadiazine
• Vitamin A and E ointment/cream
• TheraCare
• Trolamine (Biafene)
• Aloe vera gel or plant
• Chamomile, almond oil, emu oil, olive oil

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Duration of Radiation Dermatitis

• Occurs 2-3 weeks from start of treatment and can last 2-3 weeks

• Late effects include telangiectasia, atrophy, fibrosis, edema and ulceration (greater than 90 days out from radiation)

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• Telfa dressings
• Vaseline soaked gauze
• Pain control
• Moisture control
• Refer back to Radiation Oncology versus Urgent Care if infection is suspected.
**Gastrointestinal Side effects**

- Anorexia, nausea, vomiting, esophagitis, mucositis, dysphagia
- Appetite stimulants (steroids, megesterol, CBD)
- Anti-emetics
- Small, frequent meals, soft foods or liquids
- Avoid strong odors
- Treat constipation
- Calorie dense meals
- Sip sip nibble nibble nibble nudge nudge nudge

**GI**

- Diarrhea (several semi formed BMs each day OR watery BMs):
  1. Start a BRAT diet for 1-2 days until the diarrhea improves.
  2. Low fiber diet
  3. If diarrhea continues despite the low fiber diet, start over the counter Imodium-AD. Take ONLY 1 PILL with each episode of diarrhea, no more than 8 pills in a 24 hour period.

**GI**

- Diphenoxylate-atropine: Lomotil
- Avoid bismuth (dark stools)
- Note if on recent antibiotics? Rule out c.diff before starting on anti-diarrheals to avoid development of toxic megacolon

**Perianal care**

- Sitz baths
- Non-scented baby wipes
- Moisture barriers
  - petroleum jelly
  - zinc oxide
Other effects to consider

- Increased cerebral edema (headaches, nausea, vomiting, and neurologic changes)
- Mucositis (oral, esophageal)
- Pneumonitis
- Myelosuppression
- Alopecia
- Sexual dysfunction
- Reproductive organs
- Cystitis

Late Toxic Effects

- Cognitive changes with memory loss
- Lymphedema
- Axillary lymphedema 2-10% with surgery alone
- Axillary lymphedema 13-18% with adjuvant radiation added

Ischemic Heart Disease

- Review of literature show no increased risk of death of women due to ischemic heart disease who received chest wall or breast radiation since 1980 due to advances in shielding the heart
- Education: tobacco cessation, cholesterol, blood pressure and weight control.

Radiation induced malignancies

- Rare
- Rare
- Can occur 10-15 years later
Late Toxic Effects

- Skin: fibrosis, dryness, pigment changes, telangiectasias, contracture
- Pain of tissue
- Loss of hair and sweat gland function
- Fat necrosis of tissue
- Bone: loss of bone density, osteoradionecrosis

Pulmonary fibrosis

- Fibrosis: usually clinically silent and can be seen on CT
- Oxygen use may be needed if patient has severe COPD
- Did they receive pulmonary toxic drugs (bleomycin, oxaliplatin?)

Radiation pneumonitis

- Pneumonitis
- Can be seen 1-12 months after radiation
- Usually mild or self-limited
- Can be severe with cough, dyspnea, fever, hospitalization
- Can be treated with steroids