Radiation Treatment for Breast and Prostate Cancer

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Disclosures

- Employed by the US Army. The slides and discussion are my own views/opinion and do not represent the opinion/views of the government, DoD, US Army, or Madigan Army Medical Center.
Outline

- History of radiation
- Brief physics and biology review
- Conditions treated with radiation therapy
- Logistics of radiation therapy – typical course of therapy
- Radiation planning – various techniques and considerations
- Short term side effects
- Long term side effects
- Follow up/surveillance
History of Radiation

- Xrays discovered in 1895 by Wilhelm Roentgen
- One of the first pictures of an xray was of his wife’s hand.
- Within 3 years radiation was used to treat cancers
History of Radiation

- Early uses of radiation:
  - Skin conditions such as acne
  - Removal of unwanted hair
  - Treatment of tonsils and adenoids
  - Scalp treatment for ringworm
  - Treatment of enlarged thymus
Radiation Physics
Radiation Physics

- Common types of radiation used for therapy:
  - Photon
  - Electron
  - Proton
  - Neutron
  - Carbon ion
  - Radioisotopes
Radiobiology

- Radiation causes cell damage by 2 main mechanisms which ultimately lead to cell death via apoptosis or, more commonly, during mitosis
  - Directly causes double stranded DNA breaks – 1/3
  - Generates free radicals in cells which then cause DNA damage – 2/3
- Normal cells can repair radiation damage within 6 hours
## Estimated New Cases

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prostate</td>
<td>174,650</td>
<td>268,600</td>
</tr>
<tr>
<td>Lung &amp; bronchus</td>
<td>116,440</td>
<td>111,710</td>
</tr>
<tr>
<td>Colon &amp; rectum</td>
<td>78,500</td>
<td>67,100</td>
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<tr>
<td>Urinary bladder</td>
<td>61,700</td>
<td>57,130</td>
</tr>
<tr>
<td>Melanoma of the skin</td>
<td>57,220</td>
<td>39,260</td>
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<tr>
<td>Kidney &amp; renal pelvis</td>
<td>44,120</td>
<td>37,810</td>
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<tr>
<td>Non-Hodgkin lymphoma</td>
<td>41,090</td>
<td>33,110</td>
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<tr>
<td>Oral cavity &amp; pharynx</td>
<td>38,140</td>
<td>29,700</td>
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<tr>
<td>Leukemia</td>
<td>35,920</td>
<td>26,830</td>
</tr>
<tr>
<td>Pancreas</td>
<td>29,940</td>
<td>25,860</td>
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<tr>
<td><strong>All Sites</strong></td>
<td><strong>870,970</strong></td>
<td><strong>891,480</strong></td>
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</tbody>
</table>

## Estimated Deaths

<table>
<thead>
<tr>
<th>Cancer Type</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lung &amp; bronchus</td>
<td>76,650</td>
<td>66,020</td>
</tr>
<tr>
<td>Prostate</td>
<td>31,620</td>
<td>41,760</td>
</tr>
<tr>
<td>Colon &amp; rectum</td>
<td>27,640</td>
<td>23,380</td>
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<tr>
<td>Pancreas</td>
<td>23,800</td>
<td>21,950</td>
</tr>
<tr>
<td>Liver &amp; intrahepatic bile duct</td>
<td>21,600</td>
<td>13,980</td>
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<tr>
<td>Leukemia</td>
<td>13,150</td>
<td>12,160</td>
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<tr>
<td>Esophagus</td>
<td>13,020</td>
<td>10,180</td>
</tr>
<tr>
<td>Urinary bladder</td>
<td>12,870</td>
<td>9,690</td>
</tr>
<tr>
<td>Non-Hodgkin lymphoma</td>
<td>11,510</td>
<td>8,460</td>
</tr>
<tr>
<td>Brain &amp; other nervous system</td>
<td>9,910</td>
<td>7,850</td>
</tr>
<tr>
<td><strong>All Sites</strong></td>
<td><strong>321,670</strong></td>
<td><strong>285,210</strong></td>
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</tbody>
</table>
Conditions Treated With Radiation

- Cancerous:
  - Brain tumors
  - Head/Neck cancers
  - Breast cancer – typically used after surgery to reduce the risk of recurrence
  - Lung cancer
  - Gastrointestinal – esophagus, stomach, pancreas, rectum, anus
  - GU – bladder, prostate – used as definitive treatment or after surgery to reduce the chance of recurrence.
  - Gyn – endometrial, cervical, vulvar
  - Soft tissue tumors – sarcomas
  - Skin cancer
Conditions Treated With Radiation

- Benign conditions
  - Heterotopic ossification prevention
  - Dupuytren’s/Ledderhose disease
  - Plantar Fasciitis
  - Keloids
  - Pigmented villonodular synovitis (PVNS)
  - Pterygium
  - Benign tumors
  - Graves’ ophthalmopathy
  - Peyronie’s disease
  - Trigeminal neuralgia
Logistics of Radiation Therapy

- CT simulation – “dry run” or planning scan
- Radiation planning – 1-2 weeks
- Treatment - typically daily treatments, M-F, for several weeks
  - Breast cancer: 1-6 weeks
  - Prostate cancer: 1-8 weeks
- Treatment generally takes 10-15 minutes a day
- In general, radiation therapy is very safe and well tolerated with low risk of severe complications
- Many patients can work full time and exercise during radiation therapy – i.e. minimal disruption to their daily activities
CT Simulation/Radiation Planning Scan
Radiation Planning
Radiation Planning
Radiation Planning

- prostate
- Hydrogel spacer
- rectum
Radiation Planning
Treatment Techniques for Breast Cancer

- Whole breast radiation is standard for most patients
- Partial breast radiation for select women
Radiation Techniques for Prostate Cancer

- External beam radiation therapy for 1-8 weeks
Radiation Techniques for Prostate Cancer

- Brachytherapy
Short-Term Side Effects

Side effects from radiation are limited to the area treated

- **Breast Cancer** –
  - Fatigue/tiredness
  - Skin redness, darkening, desquamation (peeling), pain/discomfort on the skin
  - Fullness/tightness in the breast/chest wall

- **Prostate Cancer** –
  - Fatigue/tiredness
  - Bladder: urinary frequency, urgency, pain with urination
  - Bowel: soft/loose stools or diarrhea
Mid treatment

Last day

Last day

Three weeks post-radiation
Long Term Side Effects

- Breast Cancer
  - Mild-moderate cosmetic changes. Majority of women report good-excellent cosmetic outcome
  - Residual skin darkening or telangiectasias (visible red blood vessels)
  - Breast pain, swelling, increase/decrease in breast size
  - Rib fracture
  - Lung inflammation (<1%)
  - Heart disease – rare, dose dependent
  - Radiation-related cancer (<1%) – develops years later
  - Lymphedema (lymph node dissection is biggest risk) – dependent on surgery, BMI/weight, whether the lymph nodes were treated with radiation, etc.
  - Radiation can increase complications of future surgeries on the treated side
Long Term Side Effects

The UK Standardisation of Breast Radiotherapy (START) trials of radiotherapy hypofractionation for treatment of early breast cancer: 10-year follow-up results of two randomised controlled trials

Haviland JS et al. Lancet Oncology 2013
Long Term Side Effects

- **Prostate Cancer:**
  - Bladder symptoms: ~10-15% risk of mild-moderate persistent urinary bother symptoms such as frequency or urgency. May require medications. Incontinence is unlikely and not an expected complication.
    - More severe complications like persistent hematuria (blood in the urine) or urinary stricture is ~1-3%
  - Bowel symptoms: ~ 5% risk of bothersome rectal/bowel issues such as diarrhea, urgency with bowel movements, blood in the stool, etc
    - More severe complications are rare
  - Erectile dysfunction/sexual health: worsening erectile function in about 30-50% of patients over a few years.
Long Term Side Effects

Fig. 2. The cumulative incidence of grade $\geq 1$ (A) and $\geq 2$ (B) bowel toxicity and grade $\geq 1$ urinary incontinence (C) and grade $\geq 2$ urinary toxicity (D). Abbreviations: CI = confidence interval; HR = hazard ratio.
Long Term Side Effects

Fig. 3. Mean changes in bowel quality of life summary score (A) and urinary quality of life summary score (B) as a function of treatment arm. Data presented as mean ± standard error of the mean. The proportion of patients with detectable changes in bowel quality of life at the 3-point (B) or 10-point (C) threshold: (A) overall, CI = confidence interval, MID = minimally important difference; OR = odds ratio.

Fig. 4. Mean changes in urinary quality of life summary score (A) and urinary quality of life summary score (B) as a function of treatment arm. Data presented as mean ± standard error of the mean. The proportion of patients with detectable changes in bowel quality of life at the 6-point (B) or 15-point (C) threshold: (A) overall, CI = confidence interval, MID = minimally important difference; OR = odds ratio.

Hamstra DA et al. IJROBP 2017
Onset of Symptoms

- **Breast Cancer:**
  - At 1 month post treatment - most side effects have resolved.
  - Skin darkening can linger for months.
  - Breast edema, telangiectasias, and fibrosis can occur months to several years after treatment.
  - Lymphedema may occur months to several years later
  - Radiation pneumonitis/lung inflammation – typically 6 weeks to 6 months after treatment
  - Heart disease – typically years later
  - Radiation-related cancer – many years later
Onset of Symptoms

Prostate Cancer

Figure 4: Acute RTOG toxicity by timespoint and randomised treatment group

(A) Prevalence of bowel toxicity and (B) prevalence of bladder toxicity. RTOG = Radiation Therapy Oncology Group.

Grade 1 = grade 1 or worse adverse event. Grade 2 = grade 2 or worse adverse event. Grade 3 = grade 3 or worse adverse event.

Treatment/Management Options

- Breast Cancer:
  - Skin Care:
    - Erythema/redness – moisturizing creams such as A&D creams, eucerin, aquaphor, biafene, radiaguard, hydraguard, aloe, calendula, etc.
    - Desquamation – A&D, zinc oxide, bacitracin, medihoney, silvadene
    - Mometasone steroid cream shown to reduce rates of desquamation
    - Avoid skin friction/irritation
    - Non-stick dressings
  - Fibrosis or lymphedema:
    - Physical therapy
    - Lymphedema therapy
    - Massage therapy
    - Trental/Vit E for 6 months
  - Chronic pain
    - OTC pain medications, gabapentin
Prostate Cancer

During treatment:
- Medications such as tamsulosin, NSAIDS, tolterodine, or pyridium can be tried for urinary symptoms.
- Dietary changes or medications such as Imodium, proctofoam, or Anusol can be tried for bowel symptoms.

Long-term complications:
- Medications to help relax the bladder or improve urinary flow may be required.
- Intermittent use of Imodium.
- Radiation proctitis may require topical treatments from a gastroenterologist for rectal bleeding or may require medications such as sucralfate or steroid enema.
- Erectile dysfunction: Medications, vacuum devices, rings, injections, surgery, etc.
Ways to Minimize Complications

Breast Cancer:
- Breath hold when treating left side
- Hypofractionated treatment
- Partial breast radiation?
- Minimizing “hot spots” of radiation during planning
- Proton therapy?

Prostate Cancer:
- Use advanced radiation techniques
- Daily image-guidance with fiducials, beacons, CT scans, etc
- Rectal spacers – decreased rates of rectal irritation and erectile dysfunction.
- Maintain full bladder and empty rectum from treatment
Efficacy of Treatment

- Breast Cancer:
  - Locoregional recurrence rates are LOW in the modern era. For stage I-III breast cancer treated with lumpectomy/mastectomy, radiation, +/- systemic therapy such as chemo or anti-estrogen therapy the recurrence at 10 years is ~4% (in the breast or lymph nodes)

- Prostate Cancer treated curatively with radiation: 5-10 year biochemical control (PSA remains low) –
  - Many variables but risk group most important predictor:
    - Low risk - >90%
    - Intermediate - ~80-90%
    - High risk – 60-80%
  - Following radiation, it can take several years for the PSA to nadir
Surveillance

- Breast Cancer
  - Exam at least every 6 months for 5 years and then annually
  - Mammogram annually
  - Breast MRI in select women
  - CT, bone scan, or PET/CT scan as needed.

- Prostate Cancer
  - PSA every 6 months for 5 years and then annually
  - Imaging studies/scans as clinically indicated
Salvage Treatment

- What if my cancer comes back? Can I get more radiation?
- Breast cancer:
  - If cancer returns after lumpectomy and radiation – generally the recommendation is for a mastectomy
  - If cancer returns after mastectomy – surgical excision if possible followed by radiation if no prior radiation.
- Prostate cancer:
  - PSA rise of > 2 above the nadir is technically considered a cancer recurrence after definitive radiation.
  - Don’t be fooled by a PSA “bounce” – a temporary rise in PSA within a couple years of radiation.
  - Surgery, cryotherapy, HIFU, brachytherapy, systemic therapy such as androgen-deprivation therapy/anti-testosterone therapy.
Surgery After Radiation

Breast:
- Radiation can complicate reconstruction surgery or increase the risk of fibrosis/scaring or cause delayed/complicated healing.
  - Reconstruction is commonly done after radiation – surgeons may wait up to a year after radiation before completing reconstruction surgery.
  - Radiation can be delivered with a tissue expander/implant in place.

Prostate:
- Surgery can be performed after radiation but it’s more complicated and there is a higher risk of post-op complications.
- Surgery is rarely needed after radiation therapy.
Questions?