

## RADIATION ONCOLOGY AT THE UTMC ELEANOR N. DANA CANCER CENTER



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## Review of Clinical Sites, Staging, Treatment Planning

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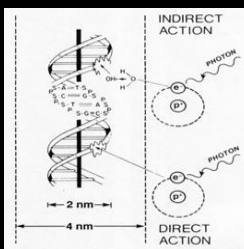
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## Objectives (topics to cover)

- A few fundamentals of radiobiology (clinical considerations)
- Treatment planning
- Quick overview of staging/work-up and treatment of
  - Lung cancer
  - Breast cancer
  - Prostate cancer
  - H&N cancer

## RADIOBIOLOGY

### How Does Radiation Therapy Work?



- Biologic effects of radiation are from DNA damage
- Direct DNA damage is when an electron interacts with DNA
- Indirect DNA damage is when an electron interacts with water to produce a hydroxyl radical which in turn damages the DNA

## Acute/Late Effects of RT

- Dependent upon
  - Volume treated
  - Total dose delivered
  - Dose per fraction
  - Time span over which treatment delivered
  - Other prior or concurrent therapies
  - Tissue types within field

## 4 Rs of Radiobiology

(Explains the Benefits of Fractionation)

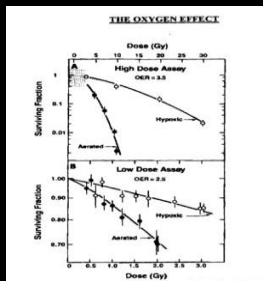
- Repopulation                      normal tissue
- Repair                                normal tissue
- Redistribution                    tumor
- Reoxygenation                  tumor

## Repair (of sublethal damage)

- simply the repair of double-strand DNA breaks
- refers to the increase in cell survival when a dose of radiation is split into 2 fractions separated by time
- Dose-Rate Effect
  - When the radiation dose rate is reduced, a reduction in cell killing occurs because sublethal damage repair occurs during the protracted exposure

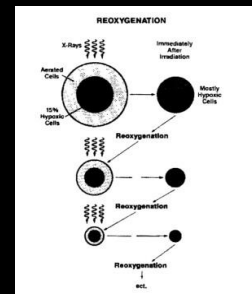
## Re-oxygenation

- Oxygen effect:
  - Cells are much more sensitive to killing by radiation in the presence of oxygen



## Re-oxygenation

- Tumors have both aerated and hypoxic cells
- A given dose of x-rays kills a greater proportion of aerated cells than hypoxic cells
- surviving cells (presumably the hypoxic cells) re-oxygenate themselves after a period of time



## Repopulation (tumor)

- Surviving cancer cells go into overdrive and divide faster and faster
- Protracting radiation for too long can result in reduced cancer cure
- We use altered fractionation to overcome this problem

## Altered Fractionation

- Hyperfractionation:
  - use of smaller doses per treatment (1.1-1.2 Gy) allows higher total doses in a given time, without increasing late side effects
  - Radiosensitization through cell cycle redistribution
  - Increases acute effects

## Altered Fractionation

- Accelerated fractionation:
  - Reduction in overall treatment time reduces chance for tumor repopulation
  - Increase probability of tumor control
- Different ways to accelerate radiation
  - Twice daily
  - Concomitant boost
  - Increasing total dose per week (6 fxns/week)

## Dose Escalation

- Increase total dose (standard fractionation)
- Hypofractionation
  - “Biologically effective dose”
  - Increases EFFECTIVE dose by increasing dose/fxn
  - SRS/SBRT

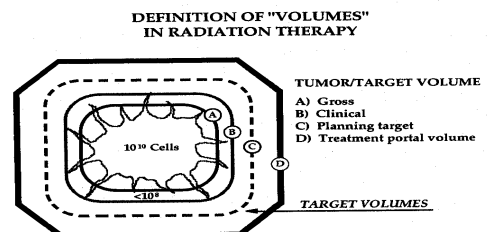
# TREATMENT PLANNING

## Definitions

- GTV-gross tumor volume
- CTV-clinical tumor volume
- ITV-internal tumor volume
- PTV-planning target volume
- Block margin

## Target Delineation

- GTV: visible tumor as seen on CT or other imaging studies
- CTV: visualized tumor plus regions at risk such as microscopic extension of disease and nodal chains
- PTV: expanded CTV to include setup errors, patient motion, linear accelerator alignment errors, and other uncertainties
- **Delineation of GTV, CTV, and PTV are even more important for IMRT** as the delineated contours are used as direct input to computer optimization algorithm as it attempts to produce dose distributions that conform to target while sparing normal tissues



**Figure 3.7.** Definition of tumor volume and target volumes. Target volume includes tumor volume, potential areas of local and regional microscopic disease around tumor, and margin of surrounding normal tissue. (Reprinted with permission from Perez CA, Brady LW, Roti Roti JL. Overview. In: Perez CA, Brady LW, eds. Principles and Practice of Radiation Oncology, 3rd ed. Philadelphia: Lippincott-Raven, 1998.)

## STAGING

## STAGING

- Varies depending on cancer type (& correlate with prognosis)
- Incorporates attributes that define tumor behavior
- Most commonly used system is the TNM staging (others include: FIGO (Gyn), Ann Arbor classification (lymphoma), small cell, pediatric)
- T = tumor size or anatomic extent
- N = number of lymph nodes involved or levels of locoregional nodes involved
- M = metastases beyond locoregional site
- Grade (sarcoma) and patient age (thyroid) may be incorporated
- Treatment decisions are based on stage at presentation, performance status (ECOG or KPS), age, grade of tumor, and histology

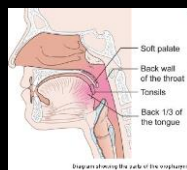
## STAGING

- Staging may be
  - clinical (physical exam, biopsy, endoscopy, imaging studies)
  - pathologic (surgical resection/microscopic exam)

## H&N Cancer

## Oropharynx

- Subsites: soft palate, palatine tonsils, tonsillar pillars, BOT (lingual tonsils), pharyngeal wall
- Anatomic boundaries
  - Sup: plane of superior surface of soft palate
  - Inf: superior surface of hyoid (floor of vallecula)



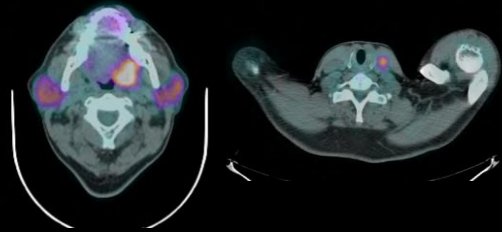
## Staging of Oropharyngeal Cancer

- T1:  $\leq 2$ cm in greatest dimension
- T2:  $>2$ cm but  $\leq 4$ cm
- T3:  $>4$ cm
- T4a: Invades larynx, deep/extrinsic muscle of tongue, medial pterygoid, hard palate or mandible
- T4b: Invades lateral pterygoid, pterygoid plates, lateral nasopharynx, skull base, encases internal carotid artery
- N1: Single ipsi LN  $\leq 3$ cm
- N2a: Single ipsi LN  $>3$ cm but  $\leq 6$ cm
- N2b: Multi ipsi LNs  $\leq 6$ cm
- N2c: Bilateral or contralateral LNs all  $\leq 6$ cm
- N3: LN  $>6$ cm
- III: T3N0, T1-3N1
- IVA: T4aN0-1, T1-4aN2
- IVB: T4b, N3
- IVC: M1

## Work Up

- History & physical examination
- Biopsy
- Flexible fiberoptic laryngoscopy
- CT neck/chest (or PET/CT)
- Dental evaluation
- IR for feeding tube

## PET/CT



## Current Standard of Care Treatment

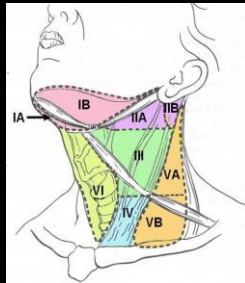
- IMRT to primary site and bilateral neck
  - PTV1 = 6930 cGy/210 cGy
  - PTV2 = 5940 cGy/180 cGy
  - PTV3 = 5610 cGy/170 cGy (or 5400 cGy)
- Concurrent sensitizing systemic therapy
- +/- induction chemotherapy (cases of bulky primary or N3 disease)

## Planning RT

- IMRT used to improve sparing of adjacent critical structures
- Planning:
  - GTV1: Primary tumor and involved LNs
  - CTV1: GTV1 + ~ 1 cm
  - CTV2: High-risk subclinical disease, first echelon LNs
  - CTV3: low-risk subclinical disease (contralateral neck)
  - OAR: salivary structures, oral cavity, left/right inner ear, larynx, esophagus-inlet (including constrictor muscles), mandible, spinal cord
  - PTVx = CTVx + set-up margin

## LN At Risk

- Level IB (submandibular nodes): Ipsilateral in all cases except primary palate tumors which do not extend to the tonsil or base of tongue
- Parapharyngeal nodes: Ipsilateral in all cases
- Levels II-IV: all cases, bilaterally
- Level V (posterior cervical): all cases when level II-IV are involved
- Retropharyngeal nodes: ipsilateral all cases – both if tumor crosses midline



## Planning Priorities and Coverage

### Priorities

1. Cover PTV with prescription
2. Spare critical normal structures
3. Parotid sparing (particularly contralateral if need to sacrifice ipsilateral)

### Coverage

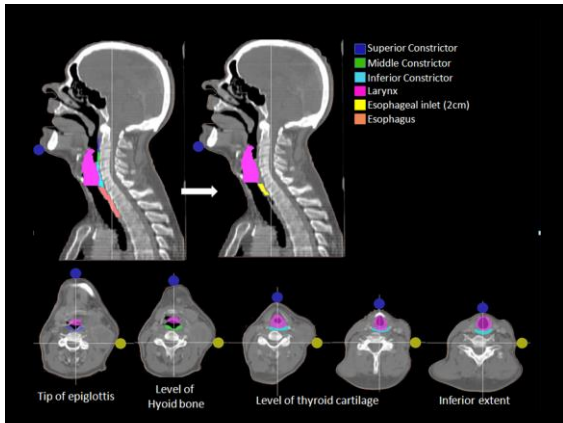
- ≥93% isodose line should cover 100% PTV1
- ≤20% of any planning target volume to receive >110% of the prescribed dose
- Hot spots 110-117% typical with IMRT

## Summary – Dose Constraints

### Key points

- Xerostomia can be reduced by limiting the mean dose to 26Gy for one parotid gland,  $\leq 39$ Gy to the noninvolved submandibular glands and  $\leq 30$ Gy to the oral cavity
- Late dysphagia can be reduced by keeping the mean dose  $\leq 50$ Gy to the non-involved pharyngeal constrictor muscles and the larynx
- Hearing loss might be reduced by limiting the dose to the inner ear to  $<45-54$ Gy
- Late temporal lobe radiation necrosis could decline if the temporal lobes are treated with a maximum dose of  $<60$ Gy, or if 1% of the temporal lobe volume receives  $<65$ Gy
- By limiting the maximum dose to the optic nerve and chiasm to 54 Gy, the risk of late radiation-induced optic neuropathy can be minimized
- Reductions in dose to the salivary glands and mandible are likely to translate into reduced incidence of xerostomia and osteoradionecrosis for patients with HNC

Wang et al. Organ Sparing Radiation Therapy for Head and Neck Cancer. Nat Rev Clin Onc 2011.

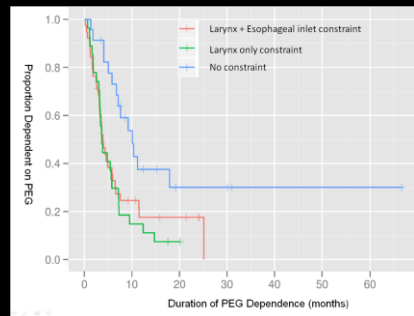


## Larynx/Pharyngeal Constrictor Sparing IMRT

Study	n	Site	Dysphagia end point	Dosimetric factors correlated with dysphagia
Feng et al. (2007) <sup>10</sup>	36	OP/NP	VF, UW, QOL	PCMs (mean dose, V50, V60, V65) and larynx (mean dose, V50)
Levendig et al. (2007) <sup>11</sup>	56	OP	H&N 35	Superior and middle PCMs (mean dose)
Jensen et al. (2007) <sup>12</sup>	25	Pharynx	H&N 35	Supraglottic larynx (median dose, V60, V65)
Teguh et al. (2008) <sup>13</sup>	81	OP/NP	H&N 35	Superior and middle PCMs (mean dose)
Teguh et al. (2008) <sup>14</sup>	20	OP	FEES	Superior PCMs (mean dose)
Cağlar et al. (2008) <sup>15</sup>	96	All	VF	Inferior PCMs (mean dose, V50, D60) and larynx (mean dose, V50, D60)
Caudell et al. (2010) <sup>16</sup>	83	All	VF	Inferior PCMs (mean dose, V50, V65) and larynx (mean dose, V55, V65, V70)
Dix et al. (2009) <sup>17</sup>	53	All	H&N 35	Middle PCMs (mean dose, V50) and supraglottic larynx (mean dose)
Feng et al. (2010) <sup>18</sup>	73	OP	VF, UW, QOL	PCMs (mean dose, V50, V60, V65) and larynx (mean dose, V50)
Esbiruch et al. (2004) <sup>19</sup>	26	All	VF	PCMs (mean dose, V50) and the glottic and supraglottic larynx (mean dose, V50)

Abbreviations: All, all subites; D60, minimum dose received by 60% of a structure; FEES, fiberoptic endoscopic evaluation of swallowing; H&N 35, European Organization for Research and Treatment of Cancer Head and Neck 35 swallowing toxicity score; IR, irradiation; PCMs, pharyngeal constrictor muscles; OP, oropharynx; UW, QOL, University of Washington Quality of Life Scale; V50, volume receiving  $\geq 50$ Gy; V65, volume receiving  $\geq 65$ Gy; V70, volume receiving  $\geq 70$ Gy; VF, videofluoroscopy.

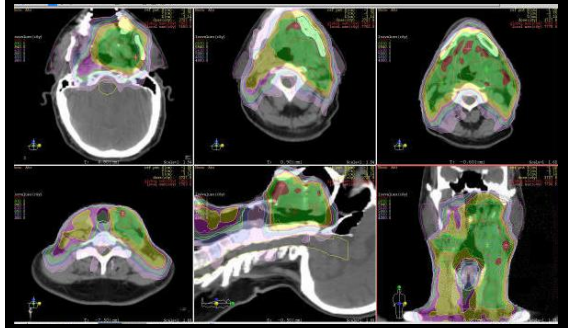
## PEG Dependence vs. Use of L/E Constraint

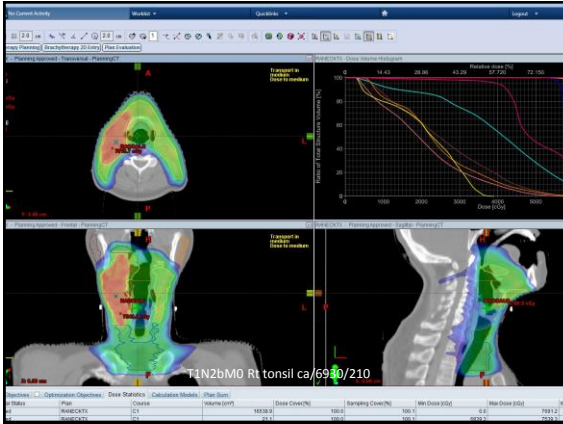


## Use of the L/E OAR

In daily IMRT planning, the larynx and esophageal-inlet can be delineated as a single organ at risk, with a planning objective of mean dose  $\leq 50$  Gy. This single constraint limits the dose to the larynx, esophagus and PC muscles, expediting recovery from swallowing dysfunction

## Parotid-Sparing IMRT

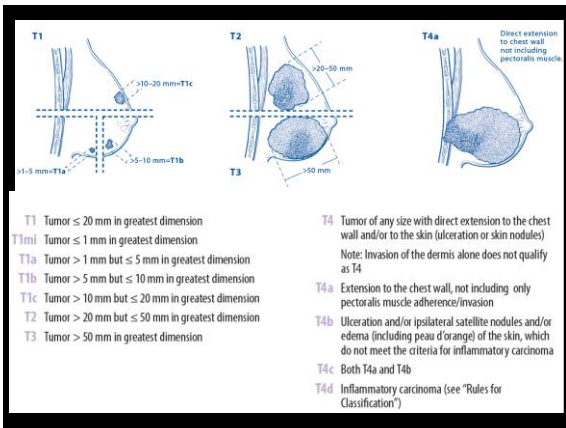




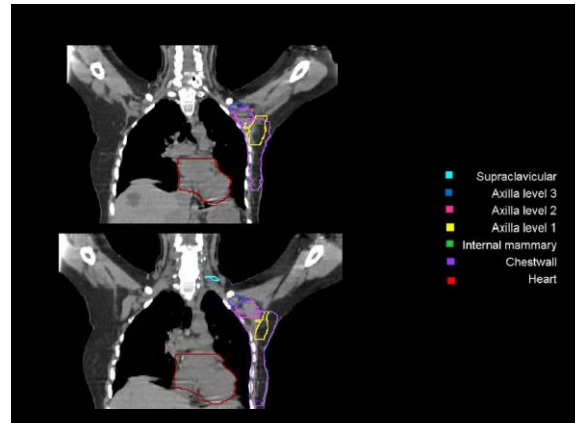
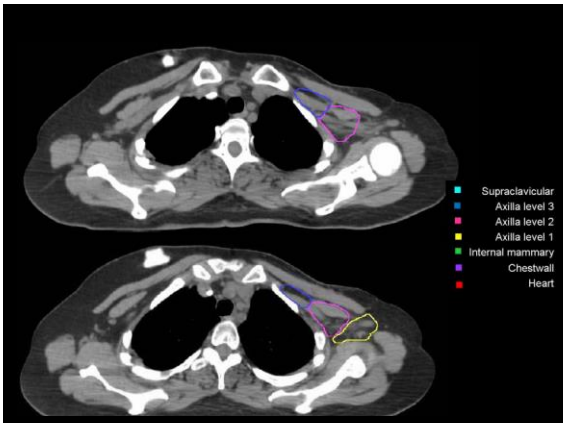
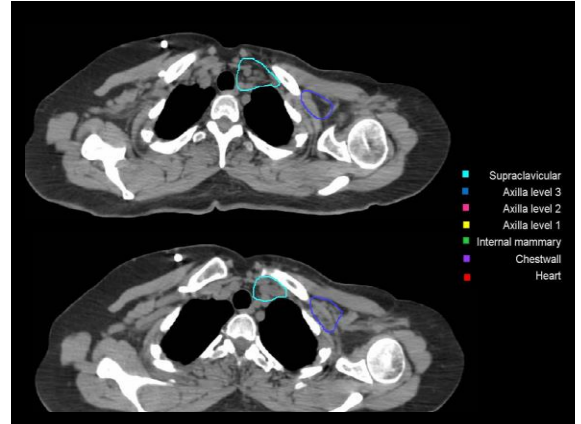
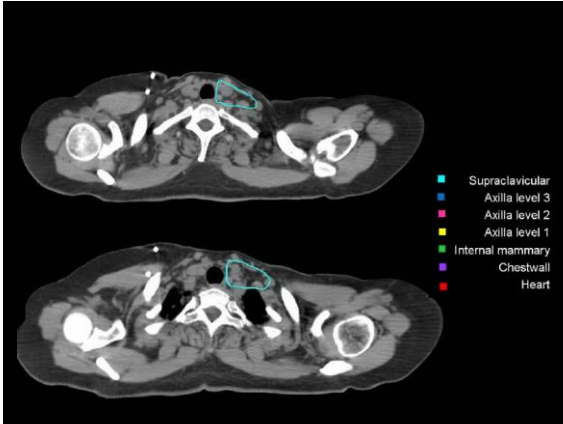
# BREAST CANCER

- ## Important for Diagnosis
- Clinical exam
  - Bilateral diagnostic mammogram
  - U/S of breast + axilla
  - U/S-guided or stereotactic biopsy of suspicious breast lesions or calcifications
  - Biopsy of axilla for clinically positive LNs
  - MRI of the bilateral breasts (as indicated)

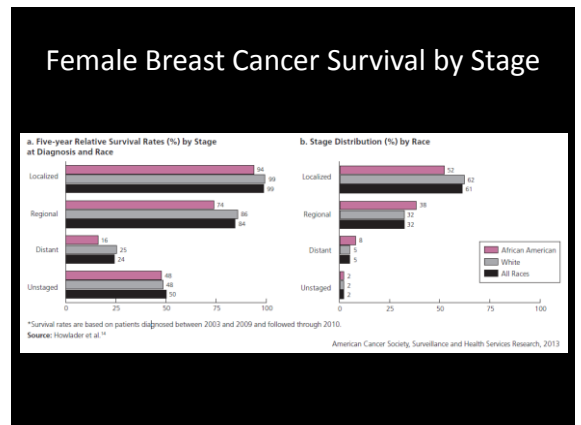
# STAGING



- ## Clinical Nodal Staging
- N0** No regional lymph node metastases
  - N1** Metastases to movable ipsilateral level I, II axillary lymph node(s)
  - N2** Metastases in ipsilateral level I, II axillary lymph nodes that are clinically fixed or matted; or in clinically detected\* ipsilateral internal mammary nodes in the absence of clinically evident axillary lymph node metastases
  - N2a** Metastases in ipsilateral level I, II axillary lymph nodes fixed to one another (matted) or to other structures
  - N2b** Metastases only in clinically detected\* ipsilateral internal mammary nodes and in the absence of clinically evident level I, II axillary lymph node metastases
  - N3** Metastases in ipsilateral infraclavicular (level III axillary) lymph node(s) with or without level I, II axillary lymph node involvement; or in clinically detected\* ipsilateral internal mammary lymph node(s) with clinically evident level I, II axillary lymph node metastases; or metastases in ipsilateral supraclavicular lymph node(s) with or without axillary or internal mammary lymph node involvement
  - N3a** Metastases in ipsilateral infraclavicular lymph node(s)
  - N3b** Metastases in ipsilateral internal mammary lymph node(s) and axillary lymph node(s)
  - N3c** Metastases in ipsilateral supraclavicular lymph node(s)



ANATOMIC STAGE/PROGNOSTIC GROUPS			
Stage 0	Tis	N0	M0
Stage IA	T1*	N0	M0
Stage IB	T0	N1mi	M0
	T1*	N1mi	M0
Stage IIA	T0	N1**	M0
	T1*	N1**	M0
	T2	N0	M0
Stage IIB	T2	N1	M0
	T3	N0	M0
	T0	N2	M0
Stage IIIA	T1*	N2	M0
	T2	N2	M0
	T3	N1	M0
	T3	N2	M0
Stage IIIB	T4	N0	M0
	T4	N1	M0
	T4	N2	M0
Stage IIIC	Any T	N3	M0
Stage IV	Any T	Any N	M1





# Work-up

**CLINICAL STAGE**

**WORKUP**

- History and physical exam
- CBC, platelets
- Liver function tests and alkaline phosphatase
- Diagnostic bilateral mammogram; ultrasound as necessary
- Pathology review<sup>8</sup>
- Determination of tumor estrogen/progesterone receptor (ER/PR) status and HER2 status<sup>8</sup>
- Genetic counseling if patient is high risk for hereditary breast cancer<sup>8</sup>
- Breast MR<sup>9</sup> (optional), with special consideration for mammographically occult tumors
- Consider fertility counseling if indicated<sup>8</sup>
- For clinical stage IIB, consider additional studies only if directed by signs or symptoms:<sup>1</sup>
  - Bone scan indicated if localized bone pain or elevated alkaline phosphatase
  - Abdominal ± pelvic diagnostic CT or MRI indicated if elevated alkaline phosphatase, abnormal liver function tests, abdominal symptoms, or abnormal physical examination of the abdomen or pelvis
  - Chest diagnostic CT (if pulmonary symptoms present)
- If clinical stage IIA (T3, N1, M0) consider:
  - Chest diagnostic CT
  - Abdominal ± pelvic diagnostic CT or MRI
  - Bone scan or sodium fluoride PET/CT<sup>1</sup> (category 2B)
  - FDG PET/CT<sup>1</sup> (optional, category 2B)

Stage I  
T1, N0, M0  
or  
Stage IIA  
T0, N1, M0  
T1, N1, M0  
T2, N0, M0  
or  
Stage IIB  
T2, N1, M0  
T3, N0, M0  
or  
Stage IIIA  
T3, N1, M0

# NCCN Treatment Guidelines

**LOCOREGIONAL TREATMENT OF CLINICAL STAGE I, IIA, OR IIB DISEASE OR T3, N1, M0**

Lumpectomy with surgical axillary staging (category 1)<sup>1,2,3</sup>

- ≥4 positive<sup>a</sup> axillary nodes → Radiation therapy to whole breast with or without boost<sup>1</sup> (by photons, brachytherapy, or electron beam) to tumor bed (category 1), infraclavicular region and supraclavicular area. Strongly consider radiation therapy to internal mammary nodes<sup>4</sup> (category 2B). Radiation therapy should follow chemotherapy when chemotherapy is indicated.
- 1-3 positive axillary nodes → Radiation therapy to whole breast with or without boost<sup>1</sup> (by photons, brachytherapy, or electron beam) to tumor bed (category 1) following chemotherapy when chemotherapy is indicated. Strongly consider radiation therapy to infraclavicular region and supraclavicular area (category 2B). Strongly consider radiation therapy to internal mammary nodes<sup>4</sup> (category 2B). Radiation therapy should follow chemotherapy when chemotherapy is indicated.
- Negative axillary nodes → Radiation therapy to whole breast with or without boost<sup>1</sup> (by photons, brachytherapy, or electron beam) to tumor bed or consideration of partial breast irradiation (PBI) in selected patients.<sup>10</sup> Radiation therapy should follow chemotherapy when chemotherapy is indicated.

or

Total mastectomy with surgical axillary staging<sup>1,2,3</sup> (category 1) ± reconstruction<sup>6</sup>

- See [Locoregional Treatment \(BINV-3\)](#)
- or
- If T2 or T3 and fulfills criteria for breast-conserving therapy except for size<sup>2</sup> → Consider [Preoperative Chemotherapy Guideline \(BINV-10\)](#)

# NCCN Treatment Guidelines

**LOCOREGIONAL TREATMENT OF CLINICAL STAGE I, IIA, OR IIB DISEASE OR T3, N1, M0**

Total mastectomy with surgical axillary staging<sup>1,2</sup> (category 1) ± reconstruction<sup>6</sup>

- ≥4 positive axillary nodes<sup>a</sup> → Postchemotherapy radiation therapy to chest wall (category 1) ± infraclavicular and supraclavicular areas.<sup>10</sup> Strongly consider radiation therapy<sup>10,11</sup> to internal mammary nodes (category 2B).
- 1-3 positive axillary nodes → Strongly consider postchemotherapy radiation therapy to chest wall ± infraclavicular and supraclavicular areas.<sup>10</sup> If radiation therapy is given, strongly consider internal mammary node radiation therapy<sup>10,11</sup> (category 2B).
- Negative axillary nodes and tumor >5 cm or margins positive → Consider radiation therapy to chest wall ± infraclavicular and supraclavicular nodes. Strongly consider radiation therapy<sup>10</sup> to internal mammary nodes (category 2B).
- Negative axillary nodes and tumor ≤5 cm and close margins (<1 mm) → Consider postchemotherapy radiation therapy<sup>10</sup> to chest wall.
- Negative axillary nodes and tumor ≤5 cm and margins ≥1 mm → No radiation therapy.

# Radiation Treatment as Part of a Breast Conservation Approach

## 7 RCTs Showing LC Benefit for RT following Lumpectomy

Study	Patients	Randomization	Follow up	IBTR	BCR
NSABP B-06	1851 stage I-II	Mastectomy vs. Lumpectomy vs. Lump + RT	20 yrs	39%	14%
Britain	400	Lump vs. Lump + RT	20 yrs	49.8%	28.6%
Uppsala	381	Lump vs. Lump + RT	10 yrs	24%	8.5%
Milan III	570, <70, ≤2.5cm	BCS vs. BCS + RT	10 yrs	23.5%	5.8%
Scottish	585 stage I-II	Lump vs. Lump + RT	5.7 yrs	24.5%	5.8%
Finnish	264 pts	Lump vs. Lump + RT	12 yrs	27.2%	11.6%
Ontario	837	Lump vs. Lump + RT	10 yrs	40%	18%

EBCTCG meta-analysis of 10,801 women in 17 RCTs, the addition of RT to Lumpectomy reduced LR by ~50%  
 \*\*\*1 breast cancer death avoided by 15 yrs for every 4 recurrences prevented by 10 yrs

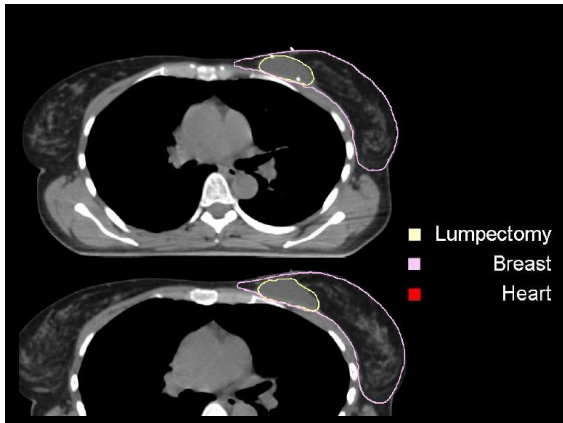
## Summary of RT Benefit

- 2/3 risk reduction in ipsilateral breast cancer recurrence with XRT
- 20-30% reduction in local recurrence risk
- 5% benefit in overall survival from metaanalysis
- 4:1 Ratio frequently cited meaning prevent 4 local recurrences, avoid 1 breast cancer related death

## Immobilization: Breast Board



## CT simulation for Breast Cancer



## Whole Breast Tangent Fields



Can we shorten the treatment course?

## Standard vs Accelerated WBRT Canadian Trial

•T1-2N0  
•Majority T1 and >50 y.o  
•No Boost

50 Gy/25 fx

42.5 Gy/16 fx

12-Y Results:  
•Same LC  
•Same OS  
•Same cosmesis

Whelan, SABCS 2007

## Hypofractionated RT for Breast Cancer

- “Conventionally fractionated” RT schedules deliver therapy over 5–6 weeks, often followed by 1–2 weeks of boost therapy
- Recent studies have demonstrated equivalent tumor control and cosmetic outcome in specific patient populations with shorter courses
- “Choosing Wisely” - “Don’t initiate whole breast radiotherapy as a part of breast conservation therapy in women age  $\geq 50$  with early stage invasive breast cancer without considering shorter treatment schedules”

## ACCELERATED PARTIAL BREAST IRRADIATION

### What about partial breast irradiation?

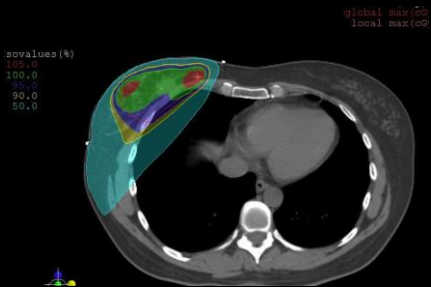
- APBI = Accelerated Partial Breast Irradiation
  - Whose eligible?
    - T1, N0,  $> 60$ , unicentric, ER+
  - Accelerated = Treatment length 6 weeks  $\rightarrow$  1 week
  - Treatment is twice a day
  - Partial Breast = Coverage of tumor bed plus a margin

### Breast Brachytherapy = Internal radiation

- Balloon placed in lumpectomy cavity
- Central catheter is hollow so radioactive source on wire can travel into center of balloon
- APBI: 34 Gray in 10 fractions BID
- 3.4 Gray per dose, 6.8 Gray per day



### APBI – Axial View



## LUNG CANCER

## NSCLC Work-Up

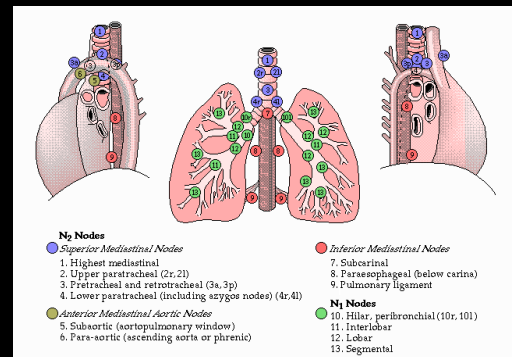
- H & P
- Labs
- Imaging:
  - CT chest/abdomen, PET/CT
  - MRI Brain
- Pathologic confirmation of disease
  - Thoracentesis for pleural effusions
  - Bronch for central lesions, CT-guided bx for peripheral
- Mediastinoscopy or bronch bx to confirm CT or PET + nodes
- Pulmonary function testing

## Staging: T-Stage

- T1- 3cm or less, completely surrounded by lung or visceral pleura, no involvement more proximal than the lobar bronchi
- T2- Greater than 3cm, involvement of visceral pleura, involvement of main stem bronchi >2cm from carina, atelectasis or obstructive pneumonitis involving less than the entire lung
- T3- Involvement of chest wall, diaphragm, mediastinal pleura or parietal pericardium, involvement of mainstem bronchi <2cm from carina, atelectasis or obstructive pneumonitis involving entire lung
- T4- Involvement of carina, trachea, esophagus, vertebrae, mediastinum, heart, great arteries; separate tumor nodule in same lobe or malignant pleural effusion

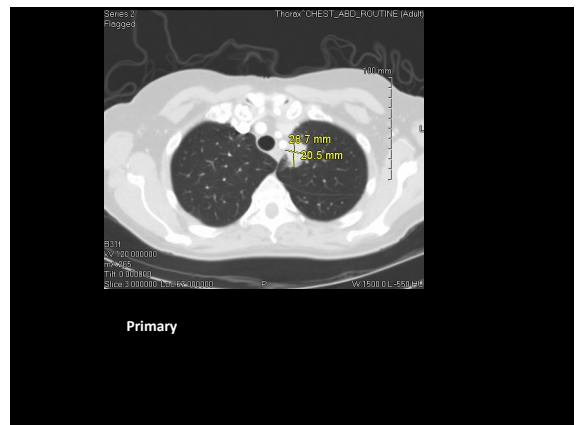
## N- Stage

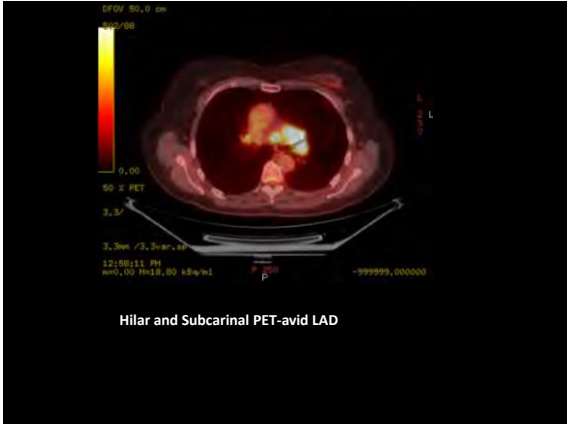
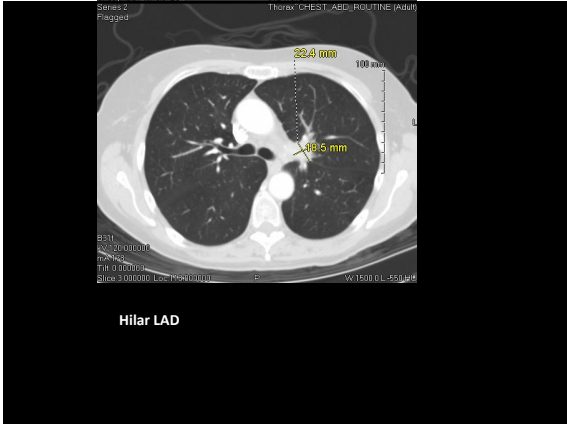
- N1- Ipsilateral peribronchial or hilar lymph nodes (Nodal stations 10-14)
- N2- Ipsilateral mediastinal or subcarinal lymph nodes (Nodal stations 1-9)
- N3- Contralateral mediastinal or hilar lymph nodes, Ipsilateral or contralateral scalene or supraclavicular lymph nodes



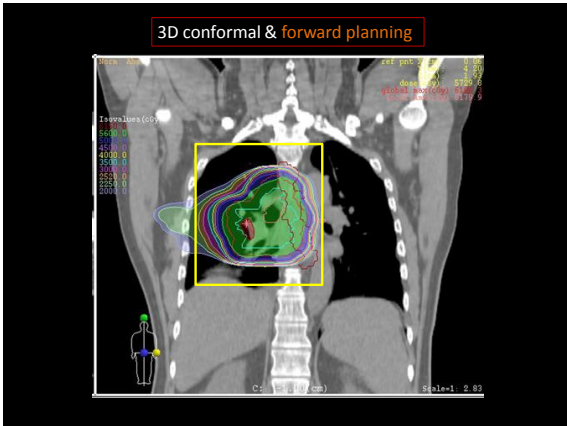
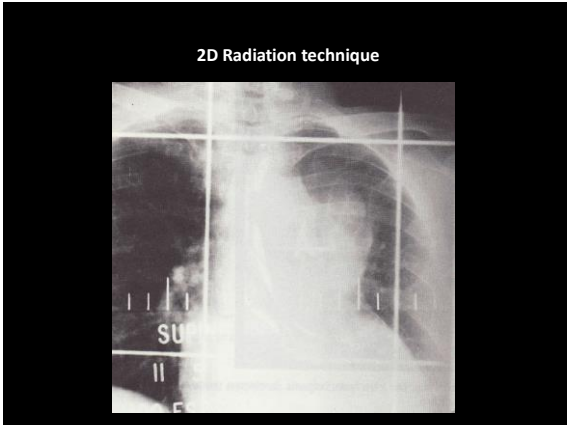
## Stage Grouping

- IA T1N0M0
- IB T2N0M0
- IIA T1N1M0
- IIB T2N1M0
- IIB T3N0M0
- IIIA T3N1M0
- IIIA T1-3N2M0
- IIIB T4NxM0
- IIIB TxN3M0
- IV TxNxM1





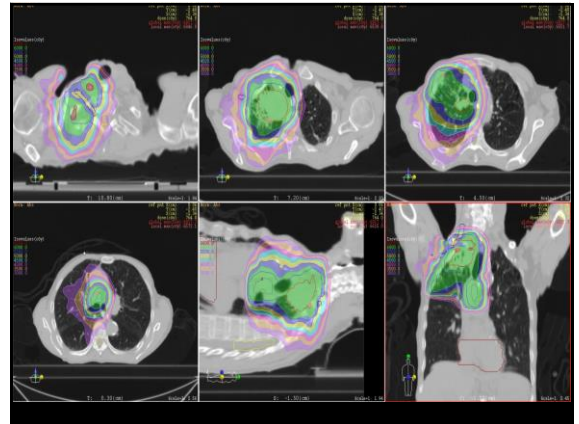
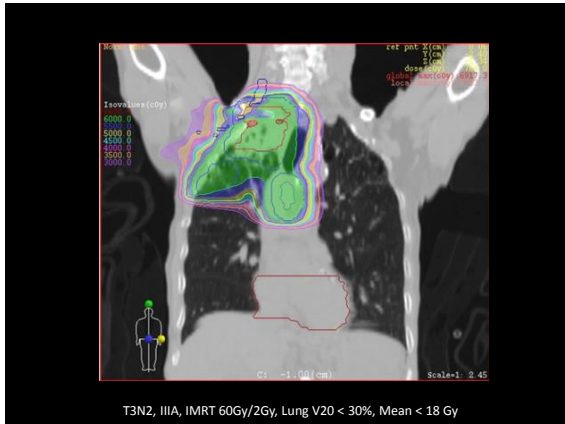
# Evolution of Treatment Planning & Delivery for Lung Cancer



# IMRT

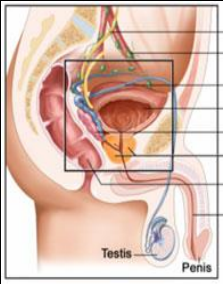
## Intensity-Modulated Radiation Therapy

### Inverse Planning



- ### Summary of Management of Stage III Lung Cancer
- IIIA
    - Neoadjuvant chemoRT → surgical resection
    - Definitive chemoRT
  - IIIB
    - Definitive chemoRT

## PROSTATE CANCER

- ### Prostate Cancer: Epidemiology
- #1 non-cutaneous cancer in men and 2<sup>nd</sup> leading cause of death (behind lung cancer)
  - 1/6 men diagnosed in their lifetime and 1/36 die of disease
  - Median age at diagnosis is 70
  - ~85% multifocal disease
  - Almost always (>95%) adenocarcinomas, also see small cell carcinomas
- 

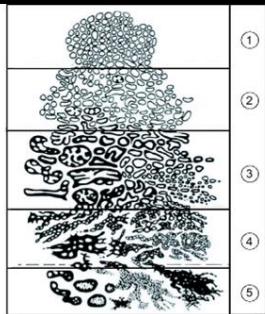
### Diagnosis and Work-Up

NCCN National Comprehensive Cancer Network<sup>®</sup> NCCN Guidelines Version 3.2012 Prostate Cancer

INITIAL PROSTATE CANCER DIAGNOSIS	Imaging Recommendations
<ul style="list-style-type: none"> <li>• DRE</li> <li>• PSA</li> <li>• Gleason primary and secondary grade</li> </ul>	<p>Bone scan<sup>a</sup> if T1 and PSA &gt;20 or T2 and PSA &gt;10 or Gleason score ≥8 or T3, T4 or symptomatic</p> <p>Pelvic CT or MRI<sup>b</sup> if T3, T4 or T1-T2 and nomogram indicated probability of lymph node involvement &gt;20%</p> <p>All others: no additional imaging</p>

<sup>a</sup>Life expectancy >5 y or symptomatic

# Understanding Gleason Score



# TNM Staging

NCCN National Comprehensive Cancer Network  
**NCCN Guidelines Version 3.2012**  
**Prostate Cancer**

Table 1. TNM Staging System For Prostate Cancer

Primary Tumor (T)		Regional Lymph Nodes (N)	
<b>Tx</b>	Primary tumor cannot be assessed	<b>Nx</b>	Regional lymph nodes were not assessed
<b>T0</b>	No evidence of primary tumor	<b>N0</b>	No regional lymph node metastasis
<b>T1</b>	Clinically inapparent tumor neither palpable nor visible by imaging	<b>N1</b>	Metastasis in regional lymph node(s)
<b>T1a</b>	Tumor incidental histologic finding in 5% or less of tissue resected	<b>Nx</b>	Regional nodes not sampled
<b>T1b</b>	Tumor incidental histologic finding in more than 5% of tissue resected	<b>N0</b>	No positive regional nodes
<b>T1c</b>	Tumor identified by needle biopsy (e.g., because of elevated PSA)	<b>N1</b>	Metastases in regional nodes(s)
<b>T2</b>	Tumor confined within prostate*	<b>Mx</b>	Distant metastasis (M*)
<b>T2a</b>	Tumor involves one-half of one lobe or less	<b>M0</b>	No distant metastasis
<b>T2b</b>	Tumor involves more than one-half of one lobe but not both lobes	<b>M1</b>	Distant metastasis
<b>T2c</b>	Tumor involves both lobes	<b>M1a</b>	Non-regional lymph nodes(s)
<b>T3</b>	Tumor extends through the prostatic capsule**	<b>M1b</b>	Bone(s)
<b>T3a</b>	Extracapsular extension (unilateral or bilateral)	<b>M1c</b>	Other site(s) with or without bone disease
<b>T3b</b>	Tumor invades the seminal vesicle(s)		
<b>T4</b>	Tumor is fixed or invades adjacent structures other than seminal vesicles, bladder, levator muscles, and/or pelvic wall.		

# TNM Staging

NCCN National Comprehensive Cancer Network  
**NCCN Guidelines Version 3.2012**  
**Prostate Cancer**

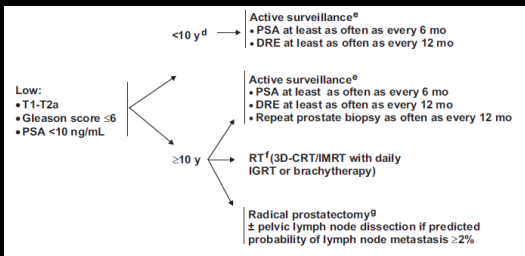
ANATOMIC STAGE/PROGNOSTIC GROUPS \*

Group	T	N	M	PSA	Gleason
I	T1a-c	N0	M0	PSA < 10	Gleason ≤ 6
	T2a	N0	M0	PSA < 10	Gleason ≤ 6
	T1-2a	N0	M0	PSA X	Gleason X
IIA	T1a-c	N0	M0	PSA < 20	Gleason 7
	T1a-c	N0	M0	PSA ≥ 10 < 20	Gleason ≤ 6
	T2a	N0	M0	PSA < 20	Gleason ≤ 7
IIB	T2b	N0	M0	PSA < 20	Gleason ≤ 7
	T2b	N0	M0	PSA X	Gleason X
	T2c	N0	M0	Any PSA	Any Gleason
III	T1-2	N0	M0	PSA ≥ 20	Any Gleason
	T1-2	N0	M0	Any PSA	Gleason ≥ 8
IV	T3a-b	N0	M0	Any PSA	Any Gleason
	T4	N0	M0	Any PSA	Any Gleason
	Any T	Any N	Any M	Any PSA	Any Gleason

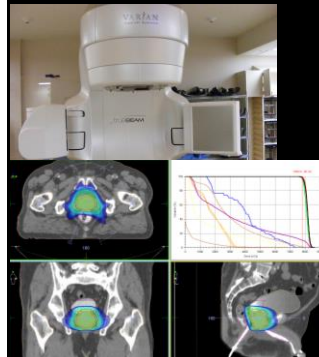
# Risk Stratification

- Sources and Studies vary slightly on exact definitions
- Basic Principle
  - Takes into account: Gleason score, PSA, T stage
  - Highest grade of any single of risk factor up-stages your risk
  - T Stage
    - T1-T2 = Low Risk
    - T2-b/c = Intermediate Risk
    - T3 = High Risk
  - Gleason
    - ≤ 6 = Low Risk
    - 7 = Intermediate Risk
    - ≥ 8 = High Risk
  - PSA
    - ≤ 10 = Low Risk
    - 10-20 = Intermediate Risk
    - ≥ 20 = High Risk

# Low Risk: NCCN Treatment Recommendations



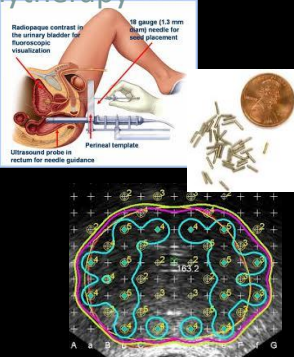
# External Beam Radiation Therapy



- Uses high energy photons to treat a targeted area of the body
- Does not hurt, cause hair loss or nausea
- Does not make you radioactive
- Treatment done using low dose beams from various angles
- Images will be taken daily to ensure treatment set up accurate
- Each treatment takes 15-20 minutes
- Given over 5.5 to 9 weeks of daily treatments

## Brachytherapy

- Uses a trans-rectal ultrasound to visualize the prostate
- Needles are inserted into the prostate gland through the perineum
- Tiny radioactive seeds are then permanently implanted
- Dose given off over approximately 6 months
- Procedure takes about 2 hours
- Discharged home the same day



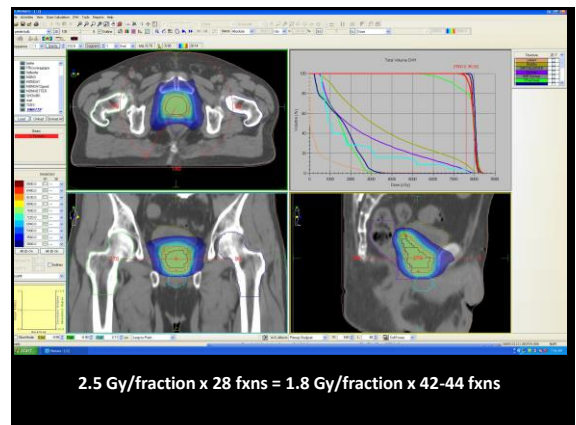
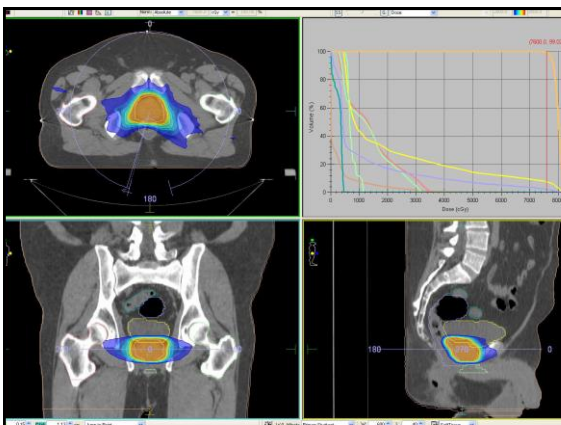
## Comparing Modalities

- Kupelian, 2004 IRJOB
  - Pooled Analysis of Cleveland Clinic and Memorial Sloan Kettering
  - 2,991 consecutive Patients
    - ✦ RP vs EBRT <72 Gy vs EBRT >72 Gy vs Seeds vs Combo (EBRT+Seeds)
  - Patients in RP group younger with more favorable characteristics
- 5 year biochemical PFS
  - RP: 81%
  - <72 Gy: 51%
  - >72 Gy: 81%
  - Seeds: 83%
  - Combo 77%
- Conclusion: Treatments equivalent as long as >72 Gy used for EBRT

## In general . . .

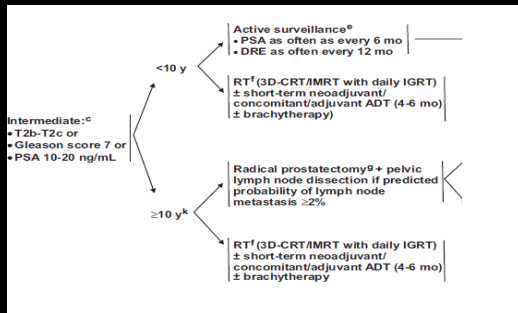
- In clinic, when we discuss outcomes for Low Risk Prostate for
  - Radical Prostatectomy
  - External Beam Radiation
  - Permanent Seed Implants
- We counsel patients that these approaches are basically thought to have equivalent outcomes but often quite difference side effect profiles. . .

## Treating Prostate Cancer with Minimal Side Effects

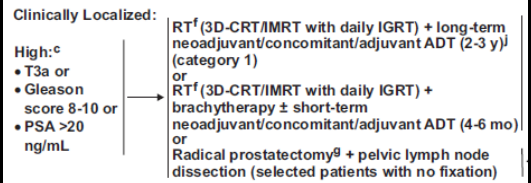




## Intermediate Risk: NCCN Treatment Recommendations

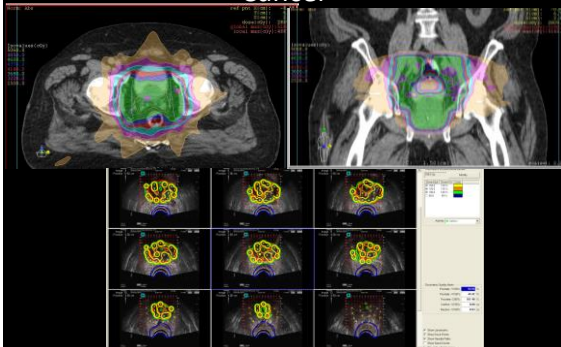


## High Risk: NCCN Treatment Recommendations



\* Radiation therapy may be needed post-operatively for high risk disease if there are positive surgical margins or evidence of extra-prostatic extension

## Radiation Therapy for High-Risk Prostate Cancer



## Questions?

