Central Nervous System

Epidemiology
- Most are metastatic
- Primary tumors relatively rare

Etiology—Unclear, suspected:
- Exposure to vinyl chloride in gliomas
- Epstein Barr virus in CNS lymphomas

CNS Signs and Symptoms
- Related to location within the brain and include
  - Headaches
  - Seizures
  - Visual deficits
  - GI symptoms: N/V, loss of appetite
  - Changes in personality, mood, cognitive capacity and concentration
- CT, MRI and biopsy (if possible) to diagnose
CNS Histology

- Adult
  - Most common primary is Glioma
    - Astrocytoma
    - Glioblastoma multiforme
- Others
  - Schwannomas
  - Ependymomas
  - meningiomas
- Pediatric (most common ped. solid tumors)
  - Astrocytomas (1)
  - Medulloblastoma (2)
    - cerebellum
    - PNET
    - Propensity to seed into spinal canal
    - Craniospinal irradiation

Primary CNS Tumors

- Staging
  - Uses a grading system
  - G1-G4
    - Grade is most important prognostic indicator
    - No lymphatics in CNS

CNS Treatment of Choice

- Surgery, if location allows
- Radiation therapy post op
- Chemotherapy for high grade gliomas
  - Temozolomide
CNS Radiation—Whole Brain

- Supra-orbital ridge
- Just below the EAM
- At least 1 cm of flash (shine) around anterior, superior and posterior
- Alternative: SRS
- Controversy about which is best option

CNS Radiation Partial Brain

- VMAT/IMRT
- Protons
- Partial brain 3DCRT
  - Tumor and 1-3 cm margin
- TD 5/5
  - Whole Brain 5,000 cGy
  - Partial Brain 6,000 cGy
  - Spinal Cord 4,500-5,000 cGy
  - These are based on TD 5/5
  - Assumes a 5% incidence of complications at a 5 year period

Cancers of the Head and Neck (H&N)

- Will cover:
  - Oral Cavity
  - Pharynx
  - Larynx
  - Sinus
  - Salivary Glands
H & N

• Epidemiology
  – About 3% of all cancers in the U.S.
  – Twice as common in men
  – Generally > 50 years old
  – NCI estimated 52,000 men diagnosed in 2012

• Etiology
  – Smoking and drinking
  – Betel nut in oral cavity
  – Salted foods in nasopharyngeal ca.
  – Poor hygiene
  – Radiation exposure
  – Epstein-Barr virus
  – HPV

Signs and Symptoms

• Oral cavity
  – Leukoplakia
  – Swelling of the jaw under dentures
  – Pain or bleeding

**Most common site of distant mets for H&N cancers is lung**
Signs and Symptoms

- Pharynx
  - Dysphagia
  - Odynophagia
  - Otalgia
  - Pain in neck area

- Larynx
  - Dysphagia
  - Odynophagia
  - Otalgia

Signs and Symptoms

- Paranasal Sinuses and Nasal cavity
  - Cannot clear sinuses
  - Chronic sinus infections
  - Epistaxis
  - Headaches
  - Pain or swelling in the eyes or upper teeth

- Salivary Glands
  - Swelling or pain under the chin or jaw bone that is not relieved

Histology, Staging and Common Sites

- Most H&N cancers are squamous cell carcinomas
- TNM staging
- Knowledge of the lymphatic system and where drainage occurs is important for the registry exam
- Most cancers of the paranasal sinuses occur in the maxillary sinus
- The parotid gland is the most common site of salivary gland ca.
Treatments H&N Cancer

- Treatments often depend on the size and location of the tumor
- Cosmesis and function are important factors
- Treatment for advanced H&N cancer uses chemotherapy (cisplatin)

- Oral cavity
  - Surgery for smaller lesions < 1.5 cm
  - XRT for positive margins and neck nodes
  - Lip cancers can be treated with electrons

- Nasopharynx
  - Surgery typically not viable
  - ChemoRT

- Oropharynx
  - Robotic surgery
  - XRT for early stage disease
  - ChemoRT for advanced disease
Treatments H&N Cancer

• Hypopharynx/Larynx
  – Surgery
  – XRT for early lesions
  – XRT post op for larger lesions

Treatments H&N Cancer

• Salivary gland
  – Surgery
  – Radiation

• Maxillary Sinus
  – Surgery
  – Radiation

Thyroid Cancer

• Papillary is most common form

• Treatment
  – Surgery
  – I-131
Doses

• Most are IMRT
• Lip, oral cavity, oropharynx, hypopharynx
  – XRT only 66-74 Gy
  – Post-op 60-66 Gy
• Nasopharynx
  – 66-70 Gy

• Glottis and Supraglottis
  – 70-74 Gy
  – Post-op 60-66 Gy

**Any s’clav fields = 45-50 Gy

Breast Cancer

Epidemiology
• Most common malignancy in women
• 2nd leading cause of cancer deaths
• Upper outer quadrant

Etiology
• Gender
• More common in older women
• Obesity
• Hormone therapy
• Long menstrual history
• Genetics—BRCA1 and BRCA2
• Many others

Breast Cancer—Signs and Symptoms

• 3 step detection system
  – Monthly self exam
  – Yearly clinical exam
  – Yearly mammogram after 40
    • Sentinel node biopsy
    • Knowledge of breast lymphatic drainage is important for registry exam

• Symptoms
  – Lump or mass felt on palpation
  – Nipple discharge or retraction
  – Paget's disease
  – Lymphadenopathy
  – Arm edema

**can spread to brain, lung, liver and bone
Breast Lymphatics

Histology

- TNM Staging
- Infiltrating Ductal carcinoma is most common 70-80%
- Second is infiltrating lobular carcinoma 5-10%
- Other rare types exist
- Inflammatory breast cancer 1:100 breast cancers
  - Peau d’orange
  - Warmth
  - Painful, tenderness
  - Diffuse induration
  - Very deadly

Treatments

- Surgery
  - Lumpectomy sentinel node biopsy
- Chemo
  - Doxorubicin (Adriamycin) is cardio-toxic
- Hormones
  - Depends on receptor status (ER/PR/Her-2)
- Radiation
  - Whole breast tangents
  - Boost with electrons of photons
  - Extensive lymphatic disease may require s’tav and P&H radiation
  - Accelerated Partial Breast Irradiation 10 treatments, BID 5 days
  - Hypofractionated Schedules
Sentinel Node Biopsy

NCCN Guidelines

1. Negative nodes—XRT to whole breast with or without boost or partial breast irradiation
2. 1–3 nodes—XRT to WB w or w/o boost strongly consider s'clav & infraclav and IM nodes
3. ≥4 nodes—XRT to WB w or w/o boost, s'clav & infraclav and strongly consider IM nodes

NCCN Doses (In general)

1. 180-200 cGy per fraction
2. New Hypofractionated regimens
3. Boost to 6000-6600 cGy
   - Electrons or smaller photon fields
   - 2.0 Gy per day
(Whole) Organs At Risk TD 5/5

- Heart  40 Gy  Pericarditis
- Lung   14-17.5 Gy Pneumonitis
- Brachial Plexus  55-60 Gy  Nerve Damage

Lung Cancer

- Epidemiology
  - Most common cancer in U.S. (sexes combined)
  - Incidence for both sexes declining,
    - Decline just begun in women
  - Most deaths from cancer (sexes combined)

- Etiology
  - Smoking
  - Radon
    - Others
      - Second hand smoke
      - Asbestos (mesothelioma)
      - Occupational exposures
        - Rubber
        - Metals et c.

Clinical Presentation—Lung Cancer

- Difficult to differentiate between tumor and COPD
- Presenting features are associated with
  1. Local disease in bronchopulmonary tissues
  2. Regional extension to lymph nodes, chest wall and neurologic structures
  3. Distant dissemination
- Cough in 75% of early disease
  - Severe and unremitting 40%
- Hemoptysis 60%
- Dyspnea 15%
  - Can spread to:
    - Central lymph nodes
    - Liver
    - Brain
    - Bones
    - Adrenal glands
    - Kidneys
    - Contralateral lung

Common Histologies—Lung Cancer

- Non Small Cell
  - 7 out of 8 are Non-Small Cell
  - Squamous: tumor located centrally
  - Adenocarcinoma: tumor located in bronchioles, alveoli
  - Large cell: peripheral, smaller bronchi; aggressive

- Small Cell
  - About 1:8
  - Oat cell: occur centrally
  - Met rapidly
  - Always from smoking

- Others
  - Mesothelioma
  - Pancoast tumors
  - Horner’s syndrome

Radiation Therapy

- Current Standard Generally Includes
  - Concurrent, sequential or alternating chemotherapy and radiation
  - 6000-6600 cGy at 180-200 cGy per day
  - 4500 cGy BID for small cell lung cancer
  - IGRT increasing
  - Respiratory gaiting
  - ABC
  - SBRT for Stage I lesions

Staging and Treatment—Lung Cancer

- TNM staging used
- Post op chemoradiation
- For Small Cell: Consider PCI 2500 cGy in 10 fractions
OAR and TD 5/5—Lung Cancer

- Cord: 4500-5000 cGy
- Normal Lung: 2000 cGy
- Heart: 4300 cGy
- Esophagus: 5000 cGy
- Bone Marrow: 2500 cGy
- Skin: 5500 cGy
- Liver: 3500 cGy
- Bone: 6500 cGy

Esophageal Cancer

- Epidemiology:
  - 18,000 cases per year
  - About 15,000 deaths
  - 1% of all cancers
  - More in men
  - More in Asia

- Etiology:
  - Smoking and drinking
  - Caustic injuries
  - Diets low in fruits and vegetables
  - Pre-existing conditions
    - Barrett’s
    - Achalasia
    - Plummer Vinson

Signs and Symptoms—Esophageal

- Dysphagia
- Odynophagai
- Weight loss
- Hematemesis
- Hemoptysis
- Hoarse voice
Common Histology—Esophageal

- Adenocarcinoma
  - Occurs in the distal esophagus
  - More common in the US
    - Obesity
    - Acid reflux
    - Barrett’s

- Squamous Cell Carcinoma
  - Proximal esophagus
  - Drinking
  - Smoking

Barrett’s
**Treatment of Choice—Esophageal**

- TNM staging
- 2 most common treatments
  - Definitive Chemoradiation
  - Neoadjuvant pre-op chemoradiation

**NCCN Doses—Esophageal**

- Radiation Alone
  - AP/RPO/LPO to avoid cord
  - IMRT
  - 65 Gy
- With chemo 50.4 Gy
- Multiple regimen depending on location

**OAR and TD 5/5—Esophageal**

- Heart
  - TD 5/5 = 4000 (whole)
  - TD 5/5 = 4500-5000
- Cord
  - TD 5/5 = 2000-3000 cGy (whole)
- Lung
  - < 60% should receive < 30 Gy
- Liver
- Kidney
  - At least 2/3 of one kidney should < 20 Gy
Colorectal

• Epidemiology
  – In XRT we mostly see rectal
  – Third most common cancer in men and women
  – Incidence decreasing
    • Screening and awareness
  – More common in men

• Etiology
  – > 50 years old
  – Obesity, poor diet, lack of exercise, red processed meat, alcohol, smoking
  – Hereditary
  – History of polyps
  – Inflammatory bowel disease


Signs and Symptoms—Colorectal

• Symptoms not evident in early disease
  – Screening after 50
    • colonoscopy
• More advanced disease
• Rectal bleeding, blood in stool, change in bowel habits
• Cramping, lower abdominal pain


Common Histology—Colorectal

• Most are adenocarcinoma
  – Glandular organ
• Staging
  – TNM
  – Duke’s
  – Modified Astler Coller
Treatment—Colorectal

- For large and small tumors, surgery is treatment of choice
- Rectal
  - Surgery with adjuvant radiation and chemo
  - Techniques
    - Usually prone, belly board to displace the bowel
    - 3 field technique; PA/RT Lat/Lt Lat
    - IMRT
    - Pelvic lymphatic consideration is important
NCCN Doses—Rectal

- 3 field 4500 cGy
- 180 per fx
- Boost to 5000-5500 Gy

OAR and TD 5/5—Colorectal

- Small bowel is the major OAR when irradiation the pelvis
- Small bowel should receive less than 45 Gy
- Fields designed to minimize bowel exposure
- Achieved through positioning, bladder distention, multiple shaped fields and field weighting
- PA field used to spare anterior organs and bowel
- TD 5/5 Small Bowel 45 Gy
Anal Cancer

- Epidemiology
  - 1-2% of cancers in the US
  - Mostly in women
  - Increasing in men
  - HPV

- Etiology
  - Anal intercourse
    - Genital warts, genital infections, HPV
  - Immunosuppression
  - Smoking

Signs and Symptoms—Anal Cancer

- Bleeding
- Pain
- Palpation of a mass
- Pruritus and itching, but not as common

Histology—Anal Cancer

- Squamous Cell Carcinoma
- TNM staging used
Treatment—Anal Cancer

• Combination chemo and XRT is treatment of choice
• IMRT or AP/PA
• Inguinal node consideration is important

NCCN Doses and OAR TD 5/5—Anal Ca.

• 45 Gy
• Boost to 60 Gy to spare small bowel

• Small Bowel 45Gy
• Large Bowel 45Gy
• Rectum 60 Gy
• Femoral Head 52 Gy

Pancreatic Cancer

• Epidemiology
  – 3% of new cancers annually
  – 6% of cancers deaths
  • 4th most
  – Most patients die within first year of diagnosis
  • 6% 5 year survival
  • 30% more in men
  • Highest in African Americans

• Etiology
  – > 50 years old
  – Smoking
  – Obesity
  – Poor diet
  – Genetics
  – Diabetes

Signs and Symptoms—Pancreatic

- Early symptoms are usually non-existent
- Contributes to the diseases lethality
  - Spreads before caught
- Symptoms may include:
  - Mild abdominal discomfort
  - Back pain
  - Jaundice
  - Weight loss
  - N/V in advanced disease

Histology—Pancreatic Cancer

- Most are adenocarcinomas
  - Glandular organ
- TNM staging
- Numerous lymphatics in that region
  - Contributes to early local and distal metastases

Treatment of Choice

• Surgery
  – Cephalic pancreatoduodenectomy
    • Whipple procedure
  – Only 20% of patients are candidates for surgery
  – Experienced surgeon is essential
• Post chemo and/or radiation

Whipple

NCCN Doses—Pancreatic Cancer

• 45-54 Gy
  – IMRT SBRT, 3 field AP and Lateral 3DCRT
• IORT in some cases 10-20 Gy electrons
  – Boost to 50.4 Gy with EBRT
OAR and TD5/5—Pancreatic

- Kidneys: 1800-2300 cGy
- Liver: 3000-3500 cGy
- Small Bowel: 4000-4500 cGy
- Cord: 4500-4700 cGy
- Stomach: 5000 cGy

Bladder Cancer

- Epidemiology
  - Occurs 4 times more in men
  - 4th most common cancer in men

- Etiology
  - Smoking
  - Chronic bladder infections
  - Second hand smoke
  - Fat diet
  - Workers in rubber, dye, leather industries
  - Arsenic in water
Signs and Symptoms—Bladder Cancer

- Most common is painless hematuria
- Vesical irritability
- Frequency
- Urgency
- Hematuria
- Dysuria

Histology—Bladder Cancer

- TNM Staging combined with grading
- Transitional cell carcinoma is most common
  - Also common in ureteral cancer

Treatment—Bladder Cancer

- Most common for early stage disease is transurethral resection of bladder tumor (TURBT)
  - Followed by intravesical chemo
    - BCG mitomycin-C and interferon
- Invasive disease requires radical cystectomy
- XRT therapy less common, inoperable patients
  - 4 field box pelvis, treat with empty bladder
  - IMRT
NCCN Doses—Bladder Cancer

- Whole bladder 40-45 Gy with or without pelvic nodes
  - Boost to 66 Gy, excluding healthy bladder if possible
- Pre-op low dose radiation
- Chemotherapy: Cisplatin

OAR and TD 5/5—Bladder Cancer

- Bladder 65 Gy
- Rectum 60 Gy
- Femoral head 52 Gy

Prostate Cancer

- Epidemiology
  - Most common cancer in American men
  - 2nd most deaths
    - PSA and Screening
- Etiology
  - The only known risk factors are age and race
    - > 50
    - African American or Jamaican men
Signs and Symptoms—Prostate Cancer

• Early signs and symptoms are rare
• More advanced disease symptoms are related to urinary function
  – Frequency (at night), difficulty starting or stopping
  – Blood and pain
  – Bone pain
    • Most common site of metastasis is bone

Histology—Prostate Cancer

• TNM Staging
  – Gleason Score for disease extent
• Most common disease is adenocarcinoma (glandular)
Treatment—Prostate Cancer

• Early disease
  — EBRT, brachytherapy, surgery
  • OR, wait and see, especially in older men
• More advanced disease
  — Hormone, EBRT, chemotherapy

NCCN Doses

• Today, IMRT, protons or arc therapy is the standard in XRT
• IGRT is necessary when treating to doses of 78-81 Gy
  — Cone beam CT
  — kV/kV imaging
  — Ultrasound
  — Fiducial matching
• 1.8-2.0 Gy/day (SBRT, Hypofractionated)

OAR and TD 5/5—Prostate Cancer

  — Rectum 65 Gy
  — Bladder 60 Gy
  — Femur 52 Gy
Testicular Cancer

• Epidemiology
  – Overall occurrence is rare
  • NCI estimates 7,900 new cases 2013
  • 370 deaths
  • However, is the most common cancer in men aged 20-39 years old
  • Seminomas are very curable

• Etiology
  – Undescended testicles
  – Abnormal development of the testes
  – Family risk
  – Pesticides
  – Previous testicular cancer

Signs and Symptom--Testicular

• Painless swelling or lump
• Dull ache accompanied by a pulling sensation in the scrotum
• Gynecomastia (rare)

Histology—Testicular

• Seminomas are most common
  – Arise from germ cells
  – TNM staging
  – Knowledge of lymphatics is important
Treatment—Testicular

- Ultrasound performed to determine density of mass
- Inguinal orchiectomy
- No biopsy, why?
- Treatment after orchiectomy depends on stage
  - Observation
  - Chemo
  - Radiation—very radiosensitive

NCCN Doses and Side Effects—Testicular

- 2000-3000 cGy
- AP/PA post orchiectomy
  - Para-aortic and iliac nodes
  - “Dog leg field”
  - Clam shell
  - Not as common today
- Generally well tolerated
- N/V, diarrhea; usually controlled with meds
- Long term effects occurs with wide fields >2500 cGy
- Sperm bank!

Seminoma Fields—(Dog Leg on Left)
### Female GYN Cancers

**Incidence (greatest to least common)**
- Endometrial
- Ovarian
- Cervical
- Vulvar
- Vaginal

**Mortality (greatest to least deadly)**
- Ovarian (5th in women)
- Cervical
- Endometrial

### Female GYN Cancers

**Etiology**
- Ovarian
  - Older age
  - Issues relating to hormonal exposure
    - Late menopause
    - Late or few pregnancies
    - Breast cancer
    - Family history
    - Poor diet
    - Hormone replacement therapy

- Endometrial
  - Older women
  - Obesity
  - High fat and calorie diet
  - Increases in estrogen
Female GYN Cancers

- Etiology
  - Cervical Cancer
    - Increased detection: Pap smear
    - Poor younger women at higher risk
    - Early sexual activity
    - Multiple partners
    - HPV
    - Multiple pelvic infections
    - Husbands with penile cancer

Female GYN Cancers

- Etiology—Vulvar
  - Diabetes
  - STDs
  - Poor hygiene
    - Melanoma sometimes occurs

- Etiology—Vaginal
  - Exposure to DES in utero
    - Diethylstilbestrol, was used to prevent miscarriage
Female GYN Cancers—Signs and Symptoms

• Endometrial
  • Vaginal bleeding
  • Odorous discharge

• Ovarian
  – Early symptoms are non-specific and contribute to the mortality rate
  – Early detection is difficult, but ovarian cancer is actually curable if caught early

Female GYN Cancers—Signs and Symptoms

• Cervical
  • Post coital bleeding
  • Heavy menstrual periods
  • Discomfort during intercourse
  • Abnormal HPV
  • Odorous discharge
  • Pelvic pain
  – ***Similar symptoms for vaginal

• Vulva
  – Suspicious lump
  – Exophytic mass
  – Most common in labia majora
  – Chronic irritation
Histology—GYN Cancers

- Endometrial
  - Adenocarcinoma
- Ovarian
  - Epithelial tumors
- Cervical
  - Squamous cell carcinoma
- Vulva
  - Squamous cell carcinoma
- Vaginal
  - Squamous cell
- Staging for GYN
  - FIGO
  - TNM

Treatment—Endometrial

- Surgically staged
- Brachy alone 2100 cGy in 3 fractions
- EBRT with brachy boost
  - 50 Gy with IMRT
  - 18 Gy boost in 3 fractions
- OAR and TD 5/5
- Bladder and Rectum < 65-75 Gy
- Small bowel < 45-50 Gy

Treatment—Ovarian

- Chemo and Surgery
- No XRT generally
Treatment—Cervical

• Early disease TAH
• More extensive disease can be treated with EBRT and brachy to as much of a total dose 80-85 Gy
• Cisplatin
• OAR and TD 5/5
  — Same as endometrial

Treatment—Vulva and Vagina

• Vulvar
  — Post op XRT
  — 50 Gy
  — Boost 15-20 Gy
    • May be electrons
    • Bolus
      — Skin reactions
      — Sitz bath
    • Inguinals
• Vaginal
  — Radiation and surgery
  — 45-50 Gy EBRT
  — Boost with implants to 65-85 Gy
  — Vaginal cylinders

Miscellaneous

• The following slides pertain topics in oncology that we don’t often see in Radiation Oncology but may appear in the Registry Exam
Skeletal

• Most skeletal tumors are metastatic
• Osteogenic sarcomas or Osteosarcomas are the most common primary bone tumor
  – Occur mostly in adolescents and young adults
  – Radioresistant
• Ewings Sarcoma
  – Occur mostly in 2nd decade in life
  – Surgery, chemo and radiation can be used
• Myeloma
  – Disease of the bone marrow
  – No cure, multiple lesions = multiple myeloma
    • Lytic lesions

Soft Tissue Sarcomas

• Tumors of connective tissues
  – Muscles, ligaments, fat, cartilage, etc.
  – Extremities, Head and Neck, retroperitoneum
  – Grow longitudinal within compartments in extremities
  – Distant spread hematogenously to the lung
  – 2-3 cm margins
  – High doses
  – Radioresistant

Some Sarcomas

• Leiomyosarcoma—smooth muscle
• Liposarcoma—fat tissue
• Chondrosarcomas—cartilage
• Rhabdomyosarcoma—striate muscle
  – Occurs in children
  – Often near the eyes
Lymphomas

- Hodgkin’s
  - Reed Sternberg Cells
  - Spreads in predictable manner
  - Defective T-Cells
  - 1/3 experience B symptoms
    - Fever
    - Night sweats
    - Weight loss
- Ann Arbor staging system
- Treatment: Chemo and Radiation, mantle field, extended field, total nodal
- Younger patients—lymphomas are the 3rd most common cancer in children

Non-Hodgkin’s Lymphoma

- Many subtypes
- No Reed Sternberg cell
- Unpredictable spread
- Primarily in older patients
- Treatment depends on disease

Skin Cancer

- 3 main types
  - Basal Cell Carcinoma—most common cancer in US but not required to be reported
    - Most common, most curable
  - Squamous Cell carcinoma
    - Less common but less curable
  - Melanoma
    - Least common but least curable
    - Surgery and treatment of choice
      - Radioresistant
- Exposure to UV A and B rays and occupational exposures
Skin Cancer

• Radiation Therapy
  – Can treat SCC or BSC with surgery and electrons
  – Depends on patient wishes and location
  – 100 SSD
  – Protect nasal cavities, oral cavities with lead shielding, covered in wax to prevent scatter
  – Bolus to bring dose closer to lesions
    • Superflab, wet gauze, rice bags, water bags, “super stuff”

Mycosis Fungoides

• Common form of Cutaneous T-Cell lymphoma
• Total Skin Electrons
  – Stanford Technique
  – 6 fields AP/PA and 4 obliques
Leukemia

- Most Common Pediatric Malignancy
- Malignancy of blood forming components
- 4 main types ALL, AML, CLL, CML
  - ALL most common in children
  - Philadelphia Chromosome in CML
- Chemo
- Bone marrow transplant sometimes required
  - Craniospinal irradiation and TBI pre-BMT
  - Most desirable donors are identical twins

Thank You!

GOOD LUCK!

Other References

- Washington & Leaver: Principles and Practice of Radiation Therapy, 3rd Edition
- National Comprehensive Cancer Network
  - www.nccn.org