Central Nervous System

Epidemiology
- Most are metastatic
- Primary tumors relatively rare
  - NCI estimates 2013
    - 23,000 new
    - 14,000 deaths

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
CNS

• 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

CNS Radiation Partial Brain

- IMRT
- 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

• 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
- 2\textsuperscript{nd} 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 exists
- 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’clav and PAB radiation
  – Accelerated Partial Breast Irradiation 10 treatments, BID 5 days

Sentinel Node Biopsy
NCCN Guidelines

• Lumpectomy with surgical axillary staging

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

NCCN Doses (In general)

• 180-200 cGy per fraction
• New Hypofractionated regimens
• 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:
    – Cervical 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
    • Alw
    • 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

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
  - NCI estimates 18,000 new cases in 2013
  - 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
OAR and TD 5/5--Esophageal

• Heart
• Cord
• Lung
• Liver
• Kidney

• TD 5/5 = 4000 (whole)
• TD 5/5 = 4500-5000
• TD 5/5 = 2000-3000 cGy (whole)
• < 60% should receive < 30 Gy
• 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

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
  - 2\textsuperscript{nd} 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—Testiculular

• 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

Female GYN Cancers

• Etiology
  – 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 coidal 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 extermitities
  - 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
  –