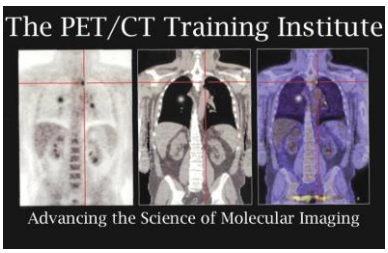

"SPECT CT REVIEW COURSE"

(75 Hrs. Category A Credits)

SYLLABUS

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The PET/CT Training Institute, Inc.

Overview: This 75 hr online self-study Aschronous Learning Management System course will cover various topics of SPECT, CT, and SPECT/CT. SPECT/CT combines two complementary advanced imaging technologies- Single Photon Emission Computed Tomography (SPECT) and Computed Axial Tomography (CT) into a single gantry scanner that can acquire SPECT and CT data simultaneously. The simultaneous overlapping of acquisition of SPECT and CT data enables new opportunities for physicians who need diagnostic imaging of patients with cancer, brain disorders, and heart disease, among other diseases and neurological issues.

This course will cover topics of SPECT/CT, ranging from technical developments to clinical applications. Technical developments will include understanding basic SPECT and CT approaches to attenuation correction and motion correction. This course will provide a broad overview of clinical applications of both SPECT and CT within the body and brain.

The intended advantage of this course for Technologist is to allow only one technologist to perform both scanning procedures.

Audience: The target audience for this online course is primarily Imaging Technologist.

Contents

Module I: Fundamentals of SPECT

- Lecture 1: SPECT Terminology (90 minutes)

Keywords: Glossary, Molecular Imaging Terms, Nuclear Terms

Objectives:

- Discuss Glossary of Molecular Imaging Terms
- Discuss Glossary of Nuclear Terms
- Define Terms from "A" to "Z"

Part I Glossary of Molecular Imaging Terms

Content:

I. "A"

1. Affinity
2. ALARA
3. Alpha (α) (alpha radiation)
4. Alzheimer's disease
5. Amino acid
6. Aneurysm
7. Angiography
8. Annihilation
9. Antibody
10. Antigen
11. Arrhythmia
12. Atherosclerosis
13. Atrophy
14. Automated external defibrillator
15. Automatic internal cardiac defibrillator
16. Axillary lymph node dissection
17. Axillary lymph nodes
18. Axillary lymph nodes, dissection
19. Axon

II. "B"

1. Becquerel(Bq)
2. Before disorder
3. Benign
4. Beta-amyloid plaque
5. Beta-minus
6. Beta-plus
7. Biological half-life
8. Biological pathway
9. Bioluminescent imaging
10. Biomarker
11. Biopsy
12. Blood-brain barrier

13. Bone marrow
14. Bone scan
15. Brachytherapy
16. Bradycardia
17. Breast-specific gamma imaging

III. "C"

1. C-11-PIB
2. Carcinoembryonic antigen (CEA)
3. Cardiac catheterization
4. Cardiac sarcoidosis
5. Cardiomyopathy
6. Cartilage
7. Cervix
8. Chemotherapy
9. Co-registration
10. Cold kit
11. Colorectal
12. Colorectal cancer
13. Computed tomography
14. Computerized tomography (CT)
15. Congenital
16. Congestive heart failure
    a. systolic
    b. diastolic
17. Contamination
18. Contrast agent (contrast media or contrast material)
19. Coronary artery disease
20. Cryosurgery
21. CT
22. Curie (Ci)
23. Curietherapy

IV. "D"

1. Decay
2. Degenerative
3. Dementia
4. Diagnostic imaging (diagnostic scan)
5. Diastolic
6. Differential diagnosis
7. Differentiated thyroid cancer
8. Diffuse
9. Dosimetry
10. Ductal carcinoma in situ (DCIS)
11. Ducts

V. "E"

1. ECG stress test
2. Echo stress test
3. Echocardiography
4. Effective dose
5. Effective half-life
6. Ejection fraction

7. Electrocardiography
8. Electrodessication and curettage
9. Electromagnetic radiation
10. Electron
11. Embolism
12. Endocrine
13. Enzyme
14. EMEA
15. Epilepsy
16. Equivalent dose or Dose equivalent
17. Esophageal
18. Estrogen receptor-positive breast cancer
19. Estrogen, estrogen receptor
20. Exercise treadmill testing
21. External radiotherapy

VI. "F"

1. FDA (Food and Drug Administration)
2. FDG (Fluorodeoxyglucose)
3. Fluorescence imaging (fluorescent molecular tomography [FMT])
4. Fluorine
5. Fluoroestradiol (FES)
6. Fluorothymidine (FLT)
7. Follicular thyroid cancer
8. Free radical
9. Frontotemporal dementia
10. Frontotemporal disorders
11. Fusion imaging

VII. "G"

1. Galenic
2. Gallbladder
3. Gamma(γ)
4. Gamma camera
5. Gastric
6. Gastrointestinal (GI) tract
7. Generator
8. Glial cell
9. GMP
10. Gray (gy)
11. Gynecology

VIII. "H"

1. Half-life
2. Heart attack
3. Heart failure
4. Hippocampus
5. Hodgkin's disease
6. Hurthle cell thyroid cancer
7. Hybrid imaging
8. Hypothyroidism

IX. "I"

1. I-123 MIBG scintigraphy
2. I-131 radiotherapy
3. Imaging agent (imaging probe, radiotracer)
4. Imaging biomarker (see biomarker)
5. Imaging device
6. Imaging probe (imaging agent)
7. Immunotherapy
8. Incidental cancers
9. IND (Investigational New Drug (dossier))
10. Indium-111-octreotide
11. Internal radiotherapy
12. Intracavity radiation
13. Intraoperative radiation
14. Intravenous (IV)
15. Ionizing radiation
16. Irradiation
17. Isotope

X. "L"

1. Label
2. Labeling
3. larynx
4. Lewy body dementia
5. Ligand
6. lobules
7. localize
8. lumpectomy
9. lymph
10. lymph node biopsy
11. lymph nodes
12. lymph vessels
13. lymphatic system
14. lymphocyte
15. lymphoma
16. lymphoscintigraphy

XI. "M"

1. Magnetic resonance imaging (MRI)
2. Magnetic resonance spectroscopy (MRS)
3. Malignant
4. Masectomy
5. Matrix metalloproteinase (MMP)
6. Mediastinoscopy
7. Melanin
8. Melanocytes
9. Melanoma
10. Metabolic
11. Metabolic radiotherapy
12. Metabolism
13. Metabolites
14. Metastasize
15. Micro- (PET, MR, CT, SPECT)
16. Microbubbles

17. Mild cognitive impairment (MCI)
18. Millisieverts (mSv)
19. Molecular imaging (MI)
20. Molecular markers
21. Molecular radiotherapy (MRT)
22. Molecular ultrasound
23. Monoclonal antibody
24. Monoclonal antibody imaging
25. MR spectroscopy
26. Myelin
27. Myocardial infarction (MI)
28. Myocardial perfusion imaging
29. Myocardial perfusion scan (MPI)
30. Myocarditis

XII. "N"

1. Nanometer
2. Nanoparticle
3. Nanotechnology
4. National Oncologic PET Registry (NOPR)
5. NDA (New Drug Application (dossier))
6. Nerve
7. Nervous system
8. Neurodegenerative diseases
9. Neuroendocrine
10. Neuroimaging
11. Neuroimaging probes
12. Neutron
13. Neutron therapy
14. Neurotransmission
15. Neurotransmitter
16. Non-Hodgkin lymphoma (NHL)
17. Non-invasively
18. Noninvasive
19. Nuclear cardiology
20. Nuclear functional study
21. Nuclear medicine/nuclear imaging
22. Nucleus
23. Nuclide

XIII. "O"

1. Obsessive-compulsive disorder
2. Oncology (or cancerology)
3. Opacity
4. Optical imaging
5. Orphan drug
6. Ovary

XIV. "P"

1. Pancreas
2. Papillary thyroid cancer
3. Parkinson's disease (PD)
4. Peripheral artery disease (PAD)

5. PET
6. PET/CT
7. Pharmacodynamics
8. Pharmacogenetics
9. Pharmacokinetics
10. Pharmacological stress test
11. Pharynx
12. Photodynamic therapy
13. Photon
14. Pick's disease
15. Plaque
16. Plaque, beta-amyloid
17. Positron
18. Positron emission mammography (PEM)
19. Positron emission tomography (PET)
20. Posology
21. Post-traumatic stress disorder (PTSD)
22. Prevalence
23. ProstaScint® scan (PSMA Study)
24. Prostate gland
25. Prostate-specific antigen (PSA)
26. Prostate-specific membrane antigen (PSMA) study
27. Prostatectomy
28. Proton
29. Proton therapy

XV. "R"

1. Rad
2. Radiation
3. Radiation therapy
4. Radioactive half-life (or period)
5. Radioactivity
6. Radiochemical
7. Radiochemist
8. Radiochemistry
9. Radioelement
10. Radioimmunoscintigraphy (RIS) (monoclonal antibody imaging)
11. Radioimmunotherapy (RIT)
12. Radioiodine
13. Radioisotope
14. Radiologist
15. Radionuclide (radioactive atomic nucleus)
16. Radiopharmaceutical
17. Radiopharmacist
18. Radiopharmacy
19. Radiophysician
20. Radiotherapist
21. Radiotherapy
22. Radiotracer
23. Re-staging
24. Rectum
25. Rem
26. Reporter-gene systems

27. Risk-stratification

XVI. "S"

1. Sarcoma
2. Scanner
3. Schizophrenia
4. Scintigraphy
5. Sealed source
6. Sentinel lymph node
7. Sentinel node biopsy
8. Side-effects or undesirable effects
9. Sievert(Sv)
10. Source
11. Specific activity
12. Specific concentration
13. Specific/specificity
14. SPECT
15. Spleen
16. Stage
17. Stress perfusion study
18. Stroke
19. Sudden cardiac death
20. Synapse
21. Systolic

XVII. "T"

1. Tachycardia
2. Targeted or vectorized radiotherapy
3. Technetium-99m-Sestamibi (MIBI)
4. Technetium-99m-sulfur-colloid (Tc-99m-colloid)
5. Thymus
6. Thyroid
7. Thyroid gland
8. Tomographic reconstruction
9. Tomography
10. Transient ischemic attack
11. Translational medicine
12. Tumor
13. Tumor marker

XVIII. "U"

1. Ultrasound
2. Urethra
3. Uterus

XIX. "V"

1. Vector
2. Ventricular remodeling

XX. "X"

1. X-rays

XXI. "Y"

1. Yttrium-90 labeled octreotide

Part II Glossary of Nuclear Terms

Content:

II. "B"

1. Barn
2. Barrier
3. Baryon
4. Base load power plants
5. Becquerel
6. BEIR
7. BER II
8. Beta decay
9. Beta-minus decay
10. Beta particle
11. Beta-plus decay
12. Beta radiation
13. Betatron
14. BfS
15. Biblis A
16. Biblis B
17. Binding energy
18. Biosphere
19. Blanket
20. BMBF
21. BMU
22. Body burden
23. Body counter
24. Body dose
25. Boiling water reactor
26. Bone seeker
27. Boron counter
28. Borosilicate glass
29. Bq
30. Breeding
31. Breeding factor
32. Breeding gain
33. Breeding process
34. Breeding ratio
35. Breeding reactor
36. Bremsstrahlung
37. Bubble chamber
38. Build-up factor
39. Burnup
40. BWR

III. "C"

1. C-14
2. Calder Hall
3. CANDU
4. Canister
5. Capacity factor
6. Capacity operating hours
7. Carbon-14
8. Castor
9. CEA
10. Centrifuge

11.Cerenkov radiation
12.Chain reaction
13.Chernobyl
14.Chop and Ieach
15.Chromatography
16.Ci
17.Cladding
18.Classification of elements
19.Closed-circuit cooling systems
20.Closed-circuit ventilation
21.Cloud chamber
22.Coal equivalent
23.Coated particles
24.Cogeneration
25.Coincidence
26.Collective dose
27.Commission on Radiological Protection
28.Committed dose
29.Compact storage basins
30.Company for Industrial Plants and Nuclear Safety
31.Compton effect
32.Condensing basin
33.Containment
34.Contamination
35.Control rod
36.Controlled area
37.Convention on Third Party Liability in the Field of Nuclear Energy
38.Conversion coefficient, internal
39.Conversion electron
40.Conversion
41.Conversion, radioactive
42.Converter reactor
43.Coolant
44.Cooling pond
45.Cooling tower
46.Core
47.Core catcher
48.Core meltdown
49.Core meltdown retention basin
50.Cosmic radiation
51.CP-1
52.Critical
53.Critical experiment
54.Criticality
55.Criticality accident
56.Criticality, prompt
57.Criticality safety
58.Critical mass
59.Critical size
60.Crud
61.Curie
62.Cyclotron

IV. "D"

1. DAtF
2. Dating, radioactive
3. Daughter and grandchild nuclides
4. DBE
5. Decay
6. Decay basin
7. Decay chains, natural
8. Decay constant
9. Decay time
10. Decommissioning of nuclear power plants
11. Decontamination
12. Decontamination factor
13. Degree of enrichment
14. Delayed critical
15. Demineralised water
16. Depleted uranium
17. Depletion
18. Depth dose
19. Depth dose, relative
20. Design basis accident
21. Detection limit
22. Deterministic radiation effect
23. Deuterium
24. Deuteron
25. Deutsches Atomforum (German Atomic Forum)
26. DIDO
27. Diffusion separation process
28. Direct cooling
29. Directional dose equivalent
30. Direct radiation
31. Disaster control plans
32. Discussion date
33. Dispersion calculations
34. Disposal precaution
35. Dissolution device
36. Dissolver
37. District heating power plant
38. Diversity
39. Dodecane
40. Dollar
41. Doppler effect
42. Dose
    a. Dose equivalent
    b. Effective dose
    c. Absorbed dose
    d. Committed dose
    e. Skin dose
    f. Equivalent dose
    g. Local dose
    h. Personal dose
    i. Directional dose equivalent
    j. Personal dose equivalent

k. Ambient dose equivalent

43. Dose build-up factor
44. Dose coefficient
45. Dose effect curve
46. Dose-effect relation
47. Dose equivalent
48. Dose equivalent rate
49. Dose limit value
50. Dose rate
51. Dosimeter
52. Dosimetry
53. Doubling time
54. Dry cooling tower
55. Dry storage
56. DTPA

V. "E"

1. ECCS
2. Ecology
3. Ecosystem
4. Efficiency
5. Electromagnetic isotope separation
6. Electromagnetic radiation
7. Electron
8. Electron capture
9. Electron equilibrium
10. Electron volt
11. Element
12. Element, artificial
13. Elementary charge
14. Elementary particles
15. Emergency core cooling system
16. Emission
17. Emission height
18. Enclosed radioactive substances
19. Energy
20. Energy balance record
21. Energy carrier
22. Energy conversion
23. Energy requirement
24. Energy reserves
25. Energy units
26. Engineered storage
27. Enriched uranium
28. Enrichment
29. Enrichment chains
30. Enrichment factor
31. Enrichment method
32. ENS
33. Environmental load
34. Environmental monitoring
35. EPR
36. Equilibrium, radioactive

37. Equipment availability factor
38. ERAM
39. Euratom basic safety standards
40. Eurochemic
41. European Pressurized Water Reactor
42. eV
43. EVA
44. Evacuation plans
45. Examination threshold
46. Excess reactivity
47. Excitation energy for nuclear fission
48. Excited state
49. Exclusion area
50. Excursion
51. Exhaust air path
52. Experimental reactor
53. Experimentation channel
54. Exposure path
55. Extraction
56. Extractor

VI. "F"

1. Fail safe
2. Fallout
3. Fast breeder reactor
4. Fast fission factor
5. Fast reactor
6. FBR
7. FE
8. Federal Office for Radiation Protection
9. Fertile material
10. Film dosimeter
11. Final energy
12. Financial security
13. Fissile material
14. Fissile material flow control
15. Fissility
16. Fission
17. Fission chamber
18. Fission gas
19. Fission gas plenum
20. Fission neutron
21. Fission neutron yield
22. Fission product poison
23. Fission products
24. Fission yield
25. Fission, spontaneous
26. Fission, thermal
27. Fissium, simulated
28. FMRB
29. FORATOM
30. FR 2
31. FRG-1

32. FRG-2
33. FRH (Forschungsreaktor Hannover)
34. FRJ-1
35. FRJ-2
36. FRM
37. FRM II
38. FRMZ (Forschungsreaktor Mainz)
39. Fuel
40. Fuel comparison
41. Fuel cycle
42. Fuel element
43. Fuel element, irradiated
44. Fuel element, spent
45. Fuel reprocessing
46. Fuel rod
47. Fuel, ceramic
48. Fusion

VII. "G"

1. Gamma quantum
2. Gamma radiation
3. Gas amplification
4. Gas centrifuge process
5. Gas-cooled reactor
6. Gaseous diffusion process
7. Gas flow counter
8. Geiger-Müller counter
9. Geometrically safe
10. GeV
11. GKN-1
12. GKN-2
13. Glass dosimeter
14. Glove Box
15. Gonad dose
16. Gorleben
17. Gray
18. Ground radiation
19. GRS
20. GW
21. Gwe
22. Gy

VIII. "H"

1. Hafnium
2. Half-life
3. Half-life, biological
4. Half-life, effective
5. Half-value thickness
6. Halogen-quench Geiger tube
7. Handling of radioactive substances
8. Harrisburg
9. HAW
10. HDR
11. Head-end

12. Heavy hydrogen
13. Heavy water
14. Heavy-water reactor
15. HEPA filter
16. Heterogeneous reactor
17. HFR
18. High-temperature reactor
19. Homogeneous reactor
20. Hot
21. Hot cell
22. Hot laboratory
23. Hot workshop
24. HTR
25. Hydrogen bomb
26. Hydrogen sulphide process
27. Hyperons

IX. "I"

1. IAEA
2. ICRP
3. ICRU
4. IK
5. ILL
6. Imission
7. Incident
8. Incident/accident levels
    a. Level S
    b. Level E
    c. Level N
    d. Level V
9. Incident precautions
10. Incident probability analysis
11. Incident sequence analysis
12. Incorporation
13. Indicator
14. Inert gas
15. INES
16. Informationskreis KernEnergie
17. Ingestion
18. Inhalation
19. Inherently safe
20. INIS
21. In-pile
22. Intake
23. Integrity under aircraft crash
24. Interaction
25. Interaction, strong
26. Interaction, weak
27. Interim storage facilities for fuel elements
28. Interim storage of spent fuel elements
29. Intermediate load power plant
30. International Commission on Radiological Protection
31. Intervention threshold

32. Intervention
33. Iodine filter
34. Ion
35. Ion dose
36. Ion exchanger
37. Ionization chamber
38. Ionization
39. Ionizing radiation
40. IRPA
41. Isobars
42. Isodose curve
43. Isomers
44. Isotones
45. Isotope
46. Isotope enrichment
47. Isotope exchange
48. Isotope laboratory
49. Isotope separation
50. Isotopic abundance
51. Isotopic abundance, natural
52. Isotopic dilution analysis
53. ITER

X. "J"

1. JET (Joint European Torus)

XI. "K"

1. KBR
2. K-capture
3. KERMA
4. Kerntechnischer Hilfsdienst
5. Kerosene
6. keV
7. Key measurement point
8. KFÜ
9. KGR
10. KHG
11. Kilogram, effective
12. KKB
13. KKE
14. KKG
15. KKI-1
16. KKI-2
17. KKK
18. KKN
19. KKP-1
20. KKP-2
21. KKR
22. KKS
23. KKU
24. KKW-Nord
25. K-meson
26. KMK

27. KNK-II
28. Konrad
29. K-radiation
30. KRB-A
31. KRB-B
32. KRB-C
33. KTA
34. KTG
35. KWG
36. KWL
37. KWO
38. KWW

XII. "L"

1. Large-scale research facilities
2. LAW
3. LD50
4. Leach rate
5. Lepton
6. LET
7. Lethal dose
8. Liability convention
9. Liability for nuclear facilities
10. Licensing procedure
11. Life time, mean
12. Light water reactor
13. Linac
14. Line losses
15. Linear accelerator
16. Linear amplifier
17. Linear energy transfer
18. Linear heat generation rate
19. Liquid scintillation counter
20. LMFBR
21. Load ranges of power plants
22. LOCA
23. Local dose
24. Long-lived radionuclides
25. Long-time dispersion factor
26. Loop
27. Lost concrete shielding
28. Lost energy
29. Low-temperature rectification
30. LSC
31. LWR

XIII. "M"

1. Magnetic lens
2. Magnox
3. Magnox reactor
4. Maintenance
5. MAK
6. Manipulator

7. Marking
8. Mass, critical
9. Mass defect
10. Mass number
11. Mass spectrograph, mass spectrometer
12. Material balance area
13. Material, depleted
14. Material, enriched
15. Material, unaccounted for
16. MAW
17. Max Planck Institute for Plasma Physics
18. Maximum capacity
19. Maximum credible accident
20. MBA
21. MCA
22. µCi
23. MCI
24. Mechanical-draft cooling tower
25. Megawatt
26. Meson
27. MeV
28. Microcurie
29. Millicurie
30. Millirem
31. 30-millirem concept
32. Mixed oxide
33. Mixer settler
34. Moderation
35. Moderator
36. Molecule
37. Monazite
38. Monitor
39. Monitoring area
40. Monte-Carlo Method
41. MOX
42. mrem
43. MTR
44. MUF
45. Mülheim-Kärlich
46. Multiple disaggregation
47. Multiple-channel analyser
48. Multiplication factor
49. MW
50. MWd
51. MWd/t
52. MWe
53. MWth
54. Myon
55. MZFR

XIV. "N"

1. Natural draught cooling tower
2. Natural uranium

3. nCi
4. NEA
5. Neutrino
6. Neutron
7. Neutron activation analysis
8. Neutron density
9. Neutron, fast
10. Neutron flux density
11. Neutron, intermediate
12. Neutron, slow
13. Neutron source
14. Neutrons, delayed
15. Neutrons, epithermal
16. Neutrons, prompt
17. Neutrons, thermal
18. Non-destructive testing
19. Non-energetic consumption
20. Non-proliferation Treaty
21. Normal operation and anticipated operational occurrences
22. NPP
23. NPT
24. NRC
25. NSSS
26. Nuclear chemistry
27. Nuclear energy
28. Nuclear event
29. Nuclear facility
30. Nuclear fission
31. Nuclear fuel
32. Nuclear fuel cycle
33. Nuclear fusion
34. Nuclear materials
35. Nuclear material monitoring
36. Nuclear medicine
37. Nuclear parent
38. Nuclear poison
39. Nuclear power plant
40. Nuclear power plants in Europe
41. Nuclear power plants in Germany
42. Nuclear power plants, world-wide
43. Nuclear power plants, world-wide, reactor types
44. Nuclear reactor
45. Nuclear reactor telemonitoring system
46. Nucleon
47. Nucleus
48. Nuclide chart
49. Nuclide

XV. "O"

1. Off-gas treatment
2. Oklo
3. Open radioactive substances
4. Operating experience with nuclear power plants

5. Operating hours
6. Operating manual
7. Organ committed dose
8. Organ dose
9. „Otto Hahn“
10. Output, specific
11. Overheating

XVI. ”P”

1. Pair generation
2. Paris Convention
3. Partial body dose
4. Particle accelerator
5. Partition wall process
6. Party responsible for radiation protection
7. Peak load power plants
8. Pebble bed reactor
9. Pellet
10. Pen dosimeter
11. Period
12. Personal dose
13. Persons exposed to radiation in their work
14. Phosphate glass dosimeter
15. Photo-cathode
16. Photo-effect
17. Photon
18. PHWR
19. 2 pi-counter
20. 4 pi-counter
21. Pi meson
22. Pinch effect
23. Pion
24. Plasma
25. Plateau
26. Plutonium
27. Poison
28. Poisoning
29. Pollux
30. Pool reactor
31. Positron
32. Power generation from nuclear plants in Europe
33. Power generation, Germany
34. Power generation, nuclear power plants in Germany
35. Power generation, nuclear power plants world-wide
36. Power reactor
37. ppb
38. ppm
39. Pressure tube reactor
40. Pressure vessel
41. Pressurized water reactor
42. Primary energy
43. Primary energy consumption, Germany
44. Primary energy reserves

45. Proliferation
46. Proportional counter
47. Proton
48. Pulsed column
49. Pulsed reactor
50. Pure element
51. PUREX
52. PUREX process
53. PWR

XVII. "Q"

1. Quality assurance
2. Quality factor

XVIII. "R"

1. R
2. Rad
3. Radiation
4. Radiation biology
5. Radiation, characteristic
6. Radiation chemistry
7. Radiation damage in human beings
8. Radiation damage, biological
9. Radiation damage, early symptoms
10. Radiation damage, physical-chemical
11. Radiation detector
12. Radiation effect, stochastic
13. Radiation-exposed persons
14. Radiation exposure, average in Germany
15. Radiation exposure, building material, Germany
16. Radiation exposure, civilization-related, Germany
17. Radiation exposure, comparability, natural/civilization-related
18. Radiation exposure, cosmic
19. Radiation exposure, dose limits, Germany
20. Radiation exposure, medical, Germany
21. Radiation exposure, natural
22. Radiation exposure, nuclear power plants, Germany
23. Radiation exposure, occupational, Germany
24. Radiation exposure, power plants
25. Radiation exposure, terrestrial
26. Radiation hygiene
27. Radiation medicine
28. Radiation physics
29. Radiation protection
30. Radiation protection areas
31. Radiation protection officer
32. Radiation syndrome
33. Radiation weighting factors
34. Radio diagnostics
35. Radio iodine
36. Radioactive isotope
37. Radioactive substances
38. Radioactivity

39. Radioactivity, induced
40. Radioactivity, natural
41. Radiocarbon
42. Radiochemistry
43. Radioecology
44. Radio-element
45. Radiogram
46. Radiography
47. Radioisotope generator
48. Radiology
49. Radiolysis
50. Radionuclide
51. Radionuclides, cosmogenic
52. Radionuclides, primordial
53. Radio-photoluminescence
54. Radioscopy
55. Radiotherapy
56. Radiation effect in the case of very high whole-body irradiation
57. Radiotoxicity
58. Radium
59. Radon
60. Range, medium free
61. Rasmussen report
62. Ratemeter
63. RBMK
64. RBW
65. rd
66. RDB
67. Reactivity
68. Reactor
69. Reactor coolant
70. Reactor coolant circuit
71. Reactor control
72. Reactor, fast
73. Reactor, gas-cooled
74. Reactor pressure vessel
75. Reactor protection system
76. Reactor risk study
77. Reactor Safety Commission, Germany
78. Reactor time constant
79. Reactor types, world-wide
80. Reactor, thermal
81. Receiving point
82. Recording threshold
83. Redundancy
84. Reference nuclide
85. Reference threshold
86. Reflector
87. Relative biological effect
88. rem
89. Reprocessing Plant Karlsruhe
90. Reprocessing
91. Research reactor

92. Residual heat
93. Residual risk
94. Rest-energy
95. Rest mass
96. Risk
97. Risk study
98. roentgen
99. Rupture protection

XIX. "S"

1. Safeguard
2. Safety barriers
3. Safety report
4. Saturated steam
5. Scattering
6. Scattering, inelastic
7. Inelastic scattering of a neutron
8. Scintillation counter
9. Scintillator
10. Scram
11. Secondary coolant
12. Secondary cooling system
13. Secondary energy
14. Seismic qualification
15. Self-absorption
16. Self-heating
17. Sellafield
18. Semi-conductor counter
19. Separating plant
20. Separation factor
21. Separation nozzle process
22. Separative work
23. Shield, biological
24. Shielding
25. Shield, thermal
26. Shim rod
27. Shipper/receiver difference
28. Short-lived radionuclides
29. Short-time dispersion
30. Shutdown reactivity
31. Shutdown rod
32. Sievert
33. Single failure
34. Skin dose
35. Skyshine
36. SNR-300
37. Soft tissue
38. Solidification
39. Solvent extraction
40. Source material
41. Spallation
42. Spark chamber
43. Spin

44. SSK
45. State collecting facilities
46. Steam bubble coefficient
47. Stellarator
48. Stochastic radiation effect
49. Storage ring
50. Subcritical arrangement
51. Subcritical mass
52. Suitable for ultimate waste disposal
53. Supercritical arrangement
54. Supercritical reactor
55. SUR-100
56. Synchro-cyclotron
57. Synchrotron

XX. "T"

1. Tail-end
2. Tandem accelerator
3. Target
4. TBP
5. Temperature coefficient of reactivity
6. Terrestrial radiation
7. Thermal breeding reactor
8. Thermal column
9. Thermionic conversion
10. Thermoluminescence dosimeter
11. Thermonuclear reaction
12. THORP
13. Three Mile Island
14. Threshold detector
15. Threshold dose
16. THTR-300
17. Time-of-flight analyzer
18. Tissue equivalent
19. Tissue weighting factor
20. TLD
21. Tokamak
22. Traceability limit
23. Tracer
24. Transients
25. Transmutation
26. Transport of radioactive substances
27. Transuranium element
28. Tributyl phosphate
29. TRIGA
30. Trip
31. Tritium
32. Triton
33. TUSA

XXI. "U"

1. Ultimate waste disposal, Germany
2. Ultimate waste disposal, direct

3. UNSCEAR
4. Uranium
5. Uranium, depleted
6. Uranium, enriched
7. Uranium hexafluoride (UF6)
8. Uranium mining, global
9. Uranium resources
10. Uranium separative work
11. Uranyl nitrate
12. Useful energy
13. UTA (Uranium separative work)
14. Utilization ratio

XXII. "V"

1. VAK
2. Van de Graaff generator
3. Vitrification
4. Vitrification plant Karlsruhe
5. Void effect

XXIII. "W"

1. WAK
2. Waste heat
3. Waste management
4. Waste processing
5. Waste water path
6. Waste, radioactive
7. Waste, radioactive, classification
8. Waste, radioactive, from nuclear power plants
9. Waste, radioactive, volume
10. Waste, radioactive, volume reduction
11. Weighting factor
12. Wet cooling tower
13. Wet steam
14. Wet storage
15. Whole-body dose
16. Wigner effect
17. Wigner energy
18. Wipe test

XXIV. "X"

1. Xenon poisoning
2. X-radiation
3. X-ray treatment

XXV. "Y"

1. Yellow cake

XXVI. "Z"

1. Zero effect
2. Zero power reactor
3. Zircaloy

XXVII. Annex

- Lecture 2: Introduction to Survey Meters (60 minutes)

Keywords: Types of gaseous detectors, Survey Meters, Pocket Dosimeters, Cutie Pie, Dose Calibrators, Construction Principles of Gas- Filled Detectors, Ionization chambers, Proportional counters, Geiger-Mueller (GM) counters, Survey Meter Quality Control, The Ludlum Model 14C, Advantage and disadvantages of ionization detectors

Objectives:

- Discuss construction principles of gas filled detectors and the operating regions of gas filled detectors
- Explain the various types of gas filled detectors and the general features of gas filled detectors
- Describe the relationship between applied voltage and ion pairs
- Discuss the various modes of operations of the ionization detectors and the advantage and disadvantages of ionization detectors
- Review the operations of a proportional counter and the quality control program for a Survey Meter
- Review how to perform a survey and how to read a G-M Scale
- Define of the operating principles of a Survey Meter
- Illustrate various forms used in the PET Lab for recordkeeping

Content:

I. Types of gaseous detectors

1. Survey Meters
2. Pocket Dosimeters
3. Cutie Pie
4. Dose Calibrators

II. Construction Principles of Gas-Filled Detectors

1. Gas-filled detectors
2. Construction
3. Types of gas-filled detectors
    a. Ionization chambers
    b. Proportional counters
    c. Geiger-Mueller (GM) counters
4. Instrumentation
5. Gas-Filled Detectors – Components
    a. Indirect Ionization Process
    b. Direct Ionization Process
    c. Radiation detection
6. Operating Regions of Gas-Filled Detectors
    a. Region I - recombination
    b. Region II - ionization
    c. Region III - proportional
    d. Region IV - limited proportional
    e. Region V - Geiger-Mueller
    f. Region VI - continuous discharge
7. Saturation Current
8. Other Aspects of Gas-Filled Detectors
    a. Accuracy of measurement
    b. Wall thickness
    c. Sensitivity

9. General features of gas detectors
10. Proportional Counters
    a. Distinguishing Alpha & Beta
    b. Alpha & Beta-Gamma Plateau
    c. Gas-Flow Proportional Counter
11. Geiger Mueller Detectors
    a. Advantages/Disadvantages of ionization detectors
    b. Modes of operation
    c. Interaction rate
    d. Dead time
    e. Paralyzable or nonparalyzable
    f. Current mode operation
    g. Detection efficiency
12. Ionization chambers
13. GM counters

III. Survey Meters

1. Definition and history of creation
2. Types of Survey Meters
    a. GM counters
3. Basic Design of the Gaseous
4. Specific Types of Gaseous Detectors
    a. The Geiger Counter/G-M Detector
5. Reading the GM Scales
    a. Sample readings - GM Detector
    b. Proper Surveying Technique
    c. Important Points to Remember Regarding GM Detectors

IV. Survey Meter Quality Control

1. Differences between ionization chambers and Geiger-Muller counter
2. Two types of survey instruments
    a. Two types of survey instruments: Ionization chamber or referred to as a cutie-pie
    b. A Geiger-Mueller counter
3. The Quality control procedures for survey instruments
    a. Check batteries
    b. Calibration
    c. Constancy
4. A portable survey instrument

V. Operators Manual of the Ludlum Model 14C Survey Meter

1. General
2. Specification
3. Description of Controls and Functions
4. Operating Procedurs
    a. Reading the Meterface Dial
5. Calibration
    a. Detector Operating Point
    b. Setting Overload
    c. Range Calibration
6. Maintenance
7. Theory of Operation
    a. Input
    b. Amplifier

c. Discriminator
d. Audio
e. Digital Analog Convertor
f. Seale Ranging
g. Meter Drive
h. Fast/Slow Time Constant
i. Low Voltage Supply
j. High Voltage Supply
k. Overload
l. Low Battery Alarm
m. Switching

8. Safety Considerations and Warning Marking
9. Cleaning the Instrument
10. Parts List
    a. Model 14C Survey Meter
11. Drawings

VI. Survey Meter Calibrations

1. Check Applicable Items
2. Records
3. Procedure for Calibrating Survay Instruments

VII. Procedures for Area Surveys

1. Ambient Dose Rate Surveys
2. Removable Contamination Surveys (Wipes)
3. Records

VIII. Radiation Detection Instrumentation

1. Survay Instruments
2. Other Radiation Detection Instruments
    a. Wipe Test Procedure
    b. Dose Calibrator
    c. Decay-in-Storage Form
    d. Survey Meter
    e. Interpreting survey meter readings

IX. Pocket Dosimeters

1. Cross-section of the Pocket Dosimeter
2. Scale As Seen Through the Eyepiece
3. Operational Properties of Pocket Dosimeters
4. General Comments Regarding Pocket Dosimeters

X. Ionization Chambers or Cutie Pie

1. Reading Ionization Chamber Scales
2. Characteristics of Ionization Chamber Detector
3. General Comments Regarding Ionization Chambers

XI. Sample Area Survey Forms

➢ Lecture 3: Introduction to Dose Calibrators (Part I & II) (90 minutes)

Keywords: Radioisotope Calibrators, Dose Calibrators, Types of Gaseous Detectors, Survey Meters, Pocket Dosimeters, Cutie Pie, Construction Principles of Gas-Filled Detectors, Ionization Chambers, Proportional Counters, Geiger-Mueller (GM) Counters, Components of Gas-Filled Detectors, Operating Regions of Gas-Filled Detectors, Saturation Current, Accuracy of Measurement, Wall Thickness, Sensitivity, Advantages/Disadvantages of Ionization Detectors, Modes of Operation, Interaction Rate, Dead Time, Paralyzable or Nonparalyzable, Detection Efficiency

Objectives:

- Discuss construction principles of gas filled detectors and the operating regions of gas filled detectors
- Explain the various types of gas filled detectors and the general features of gas filled detectors
- Describe the relationship between applied voltage and ion pairs
- Discuss the various modes of operations of the ionization detectors and the advantage and disadvantages of ionization detectors
- Review the operations of a proportional counter
- Define the use of a dose calibrator
- Illustrate the dose calibrator quality control program

Part I

Content:

I. Purpose of Radioisotope Calibrators (or Dose Calibrators)

II. Principles of Operation

III. Operation Considerations

IV. Reported Problems

Part II

Content:

I. Types of gaseous detectors

1. Survey Meters
2. Pocket Dosimeters
3. Cutie Pie
4. Dose Calibrators

II. Construction Principles of Gas-Filled Detectors

1. Gas-filled detectors
2. Construction
    a. Ion Pairs
    b. Anode
    c. Cathode
    d. Power Source
    e. Amplifier
    f. Counter
3. Types of gas-filled detectors
    a. Ionization chambers
    b. Proportional counters
    c. Geiger-Mueller (GM) counters
4. Instrumentation

5. Gas-Filled Detectors – Components
    a. Indirect Ionization Process
    b. Direct Ionization Process
    c. Radiation detection
6. Operating Regions of Gas-Filled Detectors
    a. Region I - recombination
    b. Region II - ionization
    c. Region III - proportional
    d. Region IV - limited proportional
    e. Region V - Geiger-Mueller
    f. Region VI - continuous discharge
7. Saturation Current
8. Other Aspects of Gas-Filled Detectors
    a. Accuracy of measurement
    b. Wall thickness
    c. Sensitivity
9. General Features of Gas Detectors
10. Advantages/Disadvantages of Ionization Detectors
    a. Ion chamber
    b. Proportional counter
    c. GM tube
11. Modes of Operation
    a. In pulse mode
    b. In current mode
12. Interaction Rate
13. Dead Time
14. Paralyzable or Nonparalyzable
15. Current Mode Operation
16. Detection Efficiency

III. Dose Calibrators

1. Definition of a Dose Calibrator
2. Basic Design of a Dose Calibrators
3. Dose Calibrator Quality Control
    a. Accuracy
    b. Constancy
    c. Linearity
    d. Geometric calibration
4. Procedure for Calibrating A Dose Calibrator
5. Constancy Test Procedures
6. Linearity Test Procedures
    a. Decay Method
    b. Shield Methods
7. Calibration of the Dose Calibrator
8. Geometry Test Procedures
9. Accuracy Test Procedures

IV. Sample of Dose Calibrator Forms and Tests Data

- Lecture 4: Introduction to Scintillator Detectors (60 minutes)

Keywords: Scintillation Detector, Collimators, Parallel Hole, Pinhole, Converging, Divergin, Crystal, Imaging Devices, Quality Control, Acquisition Types, Gamma Camera

Objectives:

- Discuss the operations of a scintillation detector and the components of a scintillation device
- Review energy discrimination capabilities
- Describe the properties of collimators
- Explain the various crystals used in imaging
- Review imaging devices and basic quality control of a gamma camera
- Define acquisition types used in nuclear medicine
- Illustrate gamma cameras on the market today

Content:

I. Scintillation Detector

5. First Scintillation Camera
6. Fluors
7. The Operations of a Scintillation Detector
    a. Energy discrimination capabilities
8. Basic Components of a Scintillation Detector
    a. Crystal
    b. PMT
    c. Preamp
    d. Pulse-Height Analyzer (PHA)
    e. Counter
9. Example

II. Collimators

1. Collimator Characteristics
2. Collimators differ in the following parameters
    a. Photon Energy Imaged
    b. Resolution
    c. Sensitivity
3. Collimator Variations
    a. Parallel hole
    b. Converging
    c. Diverging
    d. Pinhole
    e. Fan beam
4. Properties of Collimators
5. Main Types of Collimators
    a. Parallel Hole
    b. Pinhole
    c. Converging
    d. Divergin
6. Collimator Efficiency
    a. Septal thickness
    b. Collimator thickness
7. Collimator Comparisons
8. Multihole collimators

9. Equation for a parallel-hole collimator

III. Crystals used in scintigraphic imaging

1. Introduction
2. Good Characteristics for a Crystal
3. Types of Crystals
    a. Organic
    b. Inorganic
    c. NaI (Tl)
    d. BGO (Bismuth germanate)
    e. BaF2 (Barium fluoride)
    f. CsI:TI (Cesium iodide activated by Thallium)
    g. GSO (Gadolinium silicate doped with cerium)
    h. CWO: Cadmium Tungstate (CdW04)

IV. Imaging Devices and Quality Control

1. Anger Camera
2. Crystal Characteristics
    a. Hygroscopic
    b. Fragile
    c. Temperature sensitive
3. Photon Detection Process
4. Proportionality
5. Photomultiplier Tube
6. Positioning Logic Network
7. Pulse Height Analyzer
8. Uniformity Quality Control
    a. Uniformity Sources
    b. Uniformity Image
9. Resolution Quality Control
    a. Sensitivity
    b. Factors that Influence the Resolution
    c. Intrinsic Resolution
    d. Spatial Resolution
    e. Collimator Resolution
    f. Scatter Resolution
    g. Resolution Phantom
    h. Resolution Image

V. Acquisition Types

1. Dynamic Image
2. Static Image
3. Whole-body Image
4. Gated Image
5. SPECT Image (Single Photon Emission Computed Tomography)

VI. Gamma Cameras on the Market Today

1. Forte
2. Single Head Genesys
3. Dual Head Genesys
4. Siemens LEM Portable
5. Argus
6. Vertex Classic

7. Spectrum Dynamics
8. e.cam (Single / Dual Head)
9. c.cam
10. Siemens E-CAM (Single & Dual Head)
11. Philips/ADAC Cardio MD
12. Siemens Orbiter
13. SMV
14. Siemens DIACAM
15. Toshiba
16. MEDX InteCam: GE Starcam
17. Phillips Cardio 60
18. C-PET / C-PET Plus
19. Cardio MD
20. Vertex Cardio (Cardio 60)
21. Allegro (PET)
22. Vertex Solus
23. SINGLE HEAD SYSTEM

➢ Lecture 5: Gamma Decay, Positron Decay, and Electron Capture (60 minutes)

Keywords: Atomic theory, Gamma Ray, Photons, General Gamma Decay Equation, Specific Ionizations, Type of Radiation, Positron (⍰+) Emissio, Protons, Annihilation processes, Positron Decay Equation, Electron Capture (EC)

Objectives:

- Review the pioneers of early Greek atomic theory
- Discuss how gamma rays are formed, the properties of gamma rays and common sources of gamma rays
- Calculating gamma ray equations, gamma ray isomeric transformation equations, positron nuclear transformation equations and electron capture nuclear transformation equations
- Review gamma ray specific ionizations
- Explain annihilation and resultant processes
- Describe the properties of positrons
- Review comparison of ionization events
- List biologically useful positron emitters
- Define electron capture
- Illustrate the properties of electron capture and common radioisotopes that decay via electron capture

Content:

I. Atomic theory

10. Early Greek atomic theory
    a. Democritus
    b. Aristotle
11. Modern atomic model
    a. John Dalton
    b. Adding Electrons to the Model
    c. Thompson
    d. The Rutherford model
    e. Bohr's model
    f. Bohr - Rutherford diagrams
    g. Isotopes and Radioisotopes

II. Gamma Rays

1. Photons
    a. Properties of Photon (x and) Radiation
    b. Gamma photons and Electromagnetic Radiation
2. The Electromagnetic Energy Spectrum
    a. Cosmic
    b. X-rays and Y-rays
    c. UV
    d. Visible
    e. IR
    f. Microwaves
    g. RF
3. General Gamma Decay Equation
4. Radionuclides that Emit Gamma Radiation
5. Important Facts to Remember
6. Gamma Ray Specific Ionizations
    a. Type of Radiation
7. Protection from Any Form of Radiation
    a. Time
    b. Distance
    c. Shielding

III. Positron (+) Emission

10. Protons
11. Properties of Positrons
    a. Charge
    b. Mass
    c. SI and LET
12. Energy Requirement for Positron Emission

IV. Annihilation and resultant processes

4. Positron Interaction in Matter
5. Annihilation Radiation
6. Positron Decay Equation
7. Biologically Useful Positron Emitters

V. Electron Capture (EC)

10. The Properties of Electron Capture
11. Electron Capture Transformation
12. Electron Capture Decay Equation
13. Radionuclides That Decay by Positron Emission or EC

VI. Important Note

- Lecture 6: NM Radiopharmacy (Part I & II) (150 minutes)

Part I (90 minutes)

Keywords: Radiopharmaceuticals, Radioactive drug, Imaging agents, In-vivo function agents, Agents for in-vitro studies, Therapeutic agents, Nuclear research reactors, Medical Isotopes, Stable and Unstanle Isotops, Radionuclide, Radioactive transmutation, Radioactivity, Measuring Radioactivity, Naturally and Artificially

Radionuclides, Methods of Production of Radioisotopes, Radioisotope Generators, Production of Radiopharmaceutical Preparatio, Categories of Radiopharmaceuticals, Ready-to-use radiopharmaceuticals, Instant kits for preparation of Tc99m product, Kits requiring heating, Products requiring significant manipulation, Prepared Products Radiopharmaceuticals, Iodine-123 (I-123), Iodine-131 (I-131)

Objectives:

- Discuss the history and growth of radiopharmaceuticals
- Review general concepts of medical isotopes
- Describe radionuclide, discovery of radioactivity and characteristic of nuclear radiation
- Review measuring radioactivity and categories of radionuclides In nuclear medicine
- Define radioisotope generators
- Explain what is a radiopharmaceutical
- Describe production of radiopharmaceutical preparations
- List of categories of radiopharmaceuticals in nuclear medicine
- Illustrate of prepared products radiopharmaceuticals

Content:

I. Introduction

12. Radiopharmaceuticals (Radioactive drug)
13. The concept of "Hospital Radiopharmacy"
14. The SPECT camera
15. Radiopharmaceuticals groups
    a. Imaging agents
    b. In-vivo function agents
    c. Agents for in-vitro studies
    d. Therapeutic agents
16. A list of commonly used radiopharmaceuticals

II. History and Growth

8. Nuclear research reactors

III. Medical Isotopes "General Concepts"

13. Isotops
14. Stable and Unstanle Isotops
    a. Stable isotop
    b. Unstabl isotop

IV. Radionuclide

8. Radionuclide
    a. Definition
    b. Radioactive transmutation
9. Radioactivity
    a. The type of decay
10. Discovery of Radioactivity
11. Characteristic of nuclear radiation
    a. Alpha Rays
    b. Beta Rays
    c. Gamma Rays
    d. Isomeric Transition (IT)
12. Measuring Radioactivity
    a. The electron-volt (abbreviated eV)
    b. Radiation Units and Conversion Factors
    c. Exposure

d. Air Kerm
e. The Absorbed Dose
f. The biological impact and Dose Equivalent
g. Relative Biological Effectiveness and Effective Dose
h. Measuring Dose and Three Ways to Express Radiation Exposure
i. Annual Limit of Intake (ALI)
j. Radioactive Half-life
k. Formulas for Half-life
l. Supplies of Radioisotopes

V. Categories of Radionuclides In Nuclear Medicine

14.Naturally and Artificially Radionuclides
15.Naturally Occurring Radionuclides
a. Primordial radionuclides
b. Secondary radionuclides
c. Cosmogenic radionuclid
16.Methods of Production of Radioisotopes
a. Thermal Neutron Reactor-produced
b. Cyclotron-produced
c. Fission reactor-produced
d. Generator-produced

VI. Radioisotope Generators

1. Ideal Generator Systems
2. Radiopharmaceutical Production – Generators
3. Mo/Tc Generator: Principles of Operation
4. The Sn-113/In-113m Generator
5. Generator principals
6. Precursors for synthesis
7. Performance of the production system
8. Radionuclidic purity
   a. Chromatography
   b. Thin-layer chromatography (TLC)
   c. Liquid Chromatography (LC)
   d. High Pressure Liquid Chromatography (HPLC)
   e. Solid-Phase Extraction (SPE)
9. Chemical purity
10. Enantiomeric purity
11. pH
12. Sterility
13. Critical Organ

VII. Radiopharmaceutical

1. Typical Structure of a Radiopharmaceutical
   a. Ligand
   b. Carriers
   c. Carrier-free

VIII. Production of Radiopharmaceutical Preparation

1. Sterilization
2. Addition of Antimicrobial Preservatives
   a. Warning/Caution
3. Identity Tests

4. Half-life Measurement
5. Labelling
6. Storage

IX. Categories of Radiopharmaceuticals In Nuclear Medicine

1. Ready-to-use radiopharmaceuticals
    a. I-123 capsules
    b. I-131 hippuran
    c. Ga-67 citrate
    d. Tl-201 chloride
    e. Xe-133 gas
    f. Tc-99m pertechnetate
2. Instant kits for preparation of Tc99m product
    a. DTPA
    b. GH
    c. HDP
    d. MDP
    e. Mebrofenin
    f. MIAA
    g. MAA
    h. PYP
3. Kits requiring heating
    a. MAG3
    b. Sestamibi
    c. Sulfur colloid
    d. Teboroxime
4. Products requiring significant manipulation

X. Prepared Products Radiopharmaceuticals (Part I)

1. Iodine-123 (I-123)

a. Production
b. Medical applications
c. Recommended Dosage and Administration Instructions
d. General Precautions
e. Precautions: Carcinogenesis, Mutagenesis, Impairment of Fertility
f. Precautions: Pregnancy Category C
g. Precautions: Pediatric Use
h. Radiation Safety
i. How Supplied
j. Disposal
k. Clinical Pharmacology: Mechanism of Action
l. Pharmacokinetics: Absorption, Distributio, Elimination

2. Iodine-131 (I-131)

a. Phisical Data
b. Production
c. Radioactive decay
d. Treatment and prevention
e. Medical use
f. Post-treatment isolation
g. External Radiation
h. Therapetic: For Oral Use Only

Part II (60 minutes)

Keywords: Prepared Products Radiopharmaceuticals, Gallium 67 (Ga-67), Thallium 201 (TI-201), Xenon-133 (Xe-133), Tc-99m pertechnetate (Tc-99m), Disofenin, Instant Tc-99m kits, DTPA (diethylenetriaminepenta-acetic acid), Tc-99m glucohelptonate (GH), Hydroxydiphosphonate (HDP), Methyl-diphosphonate (MDP), Mebrofenin, Macroaggregated Albumin (MAA), Pyrophosphate (PYP), Tc-99m Kits requiring heating, Mercaptoacetyltriglycine-3 (MAG3), Sestamibi, Sestamibi, Products requiring significant manipulation, Sodium Chromate Cr 51, Tc-99m labeled RBC

Objectives:

- Discuss the Preparedness Products Radiopharmaceuticals
- Review the Instant Tc-99m Kits
- Describe Tc-99m Kits requiring heating
- Define Products requiring significant manipulation

Content:

I. Prepared Products Radiopharmaceuticals (Part II)

1. Gallium 67 (Ga-67)

a. Description
b. Chemical Structure
c. Mechanism
d. General Uses in Medicine
e. Technique
f. Imaging in Lymphoma
g. External Radiation
h. Dosage and Administration
i. Principal Display Panel: Gallium Citrate Ga 67 Injection, Diagnostic

2. Thallium 201 (TI-201)

a. Description
b. Production
c. Physical Characteristic
d. Decay Scheme of Tl-201
e. Clinical Pharmacology
f. Indications and Usage
g. Dosage and Administration
h. Radiation Dosimetry
i. Thallous Chloride Tl 201 Injection, Diagnostic

3. Xenon-133 (Xe-133)

a. Description
b. Clinical Pharmacology
c. Indications and Usage
d. Dosage and Administration
e. Direction for Dispensing
f. Activity Measurements
g. Storage

4. Tc-99m pertechnetate (Tc-99m)

a. Description
b. Physical Characteristic
c. External Radiation
d. Clinical Pharmacology
e. Indications and Usage
f. Dosage and Administration

II. Instant Tc-99m kits

17. Disofenin

a. Description
b. Physical Characteristic
c. Clinical Pharmacology
d. Indications and Usage
e. Precautions
f. Dosage and Administration
g. Instructions for Preparation of Technetium Tc99m Disofenin

18. DTPA (diethylenetriaminepenta-acetic acid)

a. Description
b. Chemical Structure
c. Accepted
d. Physical Characteristic
e. Clinical Pharmacology
f. Indications and Usage
g. Contraindications and Warnings
h. General Precautions
i. Dosage and Administration
j. Usual adult and adolescent administered activity
k. Radiation Doses to Hospital Personnel
l. Shelf life
m. Storage
n. Commonly used brand name

19. Tc-99m glucohelptonate (GH)

a. Description
b. Composition
c. Indication
d. Clinical Pharmacology
e. Dosage and Administration
f. Pediatric Patients
g. Instruction for Preparation of Tc-99m GH
h. Packaging and storage
i. Note
j. Preparation of dosage form
k. Stability

20. Hydroxydiphosphonate (HDP)

a. Description
b. Clinical Pharmacology
c. Indications and Usage
d. Contraindications and Warnings
e. General Precautions
f. Dosage and Administration: General Instructions
g. Preparation for Use
h. Unit Dose Preparation

21. Methyl-diphosphonate (MDP)

a. Description
b. Clinical Pharmacology
c. Indications and Usage
d. Contraindications and Warnings
e. General Precautions
f. Dosage and Administration

g. Storage
h. Preparation
i. Disposal

22. Mebrofenin

a. Description
b. Clinical Pharmacology
c. Indications and Usage
d. Dosage and Administration
e. Preparation
f. Storage

23. Macroaggregated Albumin (MAA)

a. Commonly used brand name
b. Category
c. Indications
d. Pharmacology/Pharmacokinetics
e. Absorption
f. Distribution
g. Shelf life
h. Elimination
i. Dosage and Administration
j. Storage
k. Direction for Preparation

24. Pyrophosphate (PYP)

a. Indications and Usage
b. Warnings
c. Clinical Pharmacology
d. General Precautions
e. Bone Imaging
f. Cardiac Imaging
g. Dosage and Administration
h. Blood Pool Imaging
i. Instruction for Preparating
j. Storage

III. Tc-99m Kits requiring heating

9. Mercaptoacetyltriglycine-3 (MAG3)

a. Indications and Usage
b. Clinical Pharmacology
c. General Precautions
d. Dosage and Administration
e. Instruction for Preparation
f. Recommended Method for Determination of Radiochemical Purity of TechneScan MAG3
g. Sample Analysis and Counting

10. Sestamibi

a. Dosage and Administration
b. Image Acquisition
c. Instruction for Preparation

11. Sulfur Colloid

a. Indications and Usage
b. Dosage and Administration
c. Drug Preparation and Administration
d. Prepare Technetium Tc 99m Sulfur Colloid Injection by the following aseptic procedure

IV. Products requiring significant manipulation

1. Sodium Chromate Cr 51

a. Category
b. Indications
c. Physical Properties
d. Pharmacology/Pharmacokinetics
e. Mechanism of action/Effect
f. Half-life
g. Injection USP
h. Packaging and storage

2. Tc-99m labeled RBC

a. Clinical Pharmacology
b. Indications and Usage
c. General Precautions
d. Dosage and Administration
e. Storage
f. Instructions for the Preparation of Technetium Tc 99m-Labeled Red Blood Cells
g. Calculate labeling

Module II: Basics of Radiation Safety

➢ Lecture 1: Cellular Anatomy and Physiology (60 minutes)

Keywords: Organic and inorganic chemistry, Cellular Anatomy and Physiology, Cellular Reproduction, Mitosis, Meiosis, Mutations, Carbohydrates, Lipids, Nucleic Acids, Proteins, DNA and RNA, Enzymes

Objectives:

- Discuss the basics of organic and inorganic chemistry
- Review Cellular Anatomy and Physiology
- Describe Cellular Reproduction
- Define Mitosis, Meiosis and Mutations

Content:

I. Organic and Inorganic Chemistry

1. Biochemistry
2. Macromolecules
3. Four Major Categories of Compounds
    a. Carbohydrates (Breads and Starch)
    b. Lipids (Fats)
    c. Nucleic Acids (DNA and RNA)
    d. Proteins (Meat and Nuts)
4. Carbohydrates “Carbs”
    a. Function of Carbohydrates
    b. Simple Sugar: Glucose
    c. Table Sugar

d. Starch: Complex Sugar

5. Lipids – Fats, Oils and Waxes
    a. Function of Lipids
    b. Formation of Lipids
    c. Saturated and Unsaturated fats
    d. Cholesterol
7. Nucleic Acids
    a. DNA
    b. Nucleotides
    c. Complementary bases
    d. RNA
    e. In the Nucleus
8. Proteins
    a. Function of Proteins
    b. Amino Acids
    c. Denaturation
    d. Enzymes
    e. Lock and Key Model

II. Cellular Anatomy and Physiology

1. Cell structure
2. Introduction to Cellular Anatomy
3. Composite Cell
4. The Cell Organelles
5. Cell Membrane
6. Cytoplasm
7. Endoplasmic Reticulum
8. Ribosomes
9. Golgi Apparatus
10. Mitochondria
11. Lysosomes
12. Peroxisomes
13. Microfilaments and microtubules
14. Centrosome
15. Cilia and flagella
16. Vesicles
17. Nucleus, nuclear envelope
18. Nucleolus
19. Chromatin

III. Cellular Reproduction

1. Mitosis
    a. Interphase
    b. Prophase
    c. Prometaphase
    d. Metaphase
    e. Anaphase
    f. Telophase
    g. Cytokinesis
2. Meiosis
    a. In Males
    b. In Females
3. Mutation

a. Gregor Mendel
b. Genotype
c. Alleles
d. Celera Genomics
e. Scientific Breakthroughs

- Lecture 2: Cellular Effects of Radiation Exposure (60 minutes)

Keywords: Effects of Radiation, Radiolysis of Water, Free Radicals, Biochemical Damage (DNA Damage, Chromosome Damage, Membrane Damage), Cell Cycle, Bergonie and Tribondeau Law, Response Curves, Dose Response Relationship, Linear Nonthreshold Dose Response, Target Theory and Cell Survival Curves, Cell Death

Objectives:

- Discuss Direct and Indirect Effects of Radiation Exposure
- Describe Biochemical Damage from Ionizing Radiation
- Review Cell Cycle
- Explain the Law of Bergonie and Tribondeau and Radiolysis of Water
- Define Dose Response Relationship
- Explain Target Theory and Cell Survival Curves
- Analyze the Types of Dose Response Curves and Cell death

Content:

I. The Effects of Radiation on the Cell at the Molecular Level

1. Direct Effects
2. Indirect Action
   a. Radiolysis of Water
   b. The Lifetimes of Free Radicals
   c. Free Radicals

II. Biochemical Reaction with Ionizing Radiation

1. DNA
2. DNA Demage
3. Chromosome Damage
4. Membrane Damage

III. Cell Cycle

IV. Bergonie and Tribondeau Law

1. Radiosensitivity
2. Direct Effects
3. Chromosomal Damage
4. Indirect Action
5. Radiolysis of Water

V. Linear Nonthreshold Dose Response

1. Dose Response Curves
2. Dose Response Relationship
   a. Linear
   b. Nonlinear
   c. Threshold
   d. Nonthreshold
3. Linear Nonthreshold Dose Response

4. Factors Effecting the Dose Models and Theories

VI. Target Theory and Cell Survival Curves

1. Target Theory
   a. Foundation of the Target Theory
2. Cell Survival Curve
   a. Factors Contributing to the Probability of Cell Death
   b. Different Cell Survival Curves
   c. Cell Death
   d. Cell Death Factors
   e. Factors that make Cells Less Radiosensitive

VII. Summary

➢ Lecture 3: Effects of Initial Exposure to Radiation (60 minutes)

Keywords: Biological Effects of Radiation, Relative Biological Effectiveness (RBE), Action of Radiation, Radiation Sickness, Cancer, Genetic Effects, Tissue and Organ Radiosensitivity, Skin Effects, Tissue Types, Acutely Responding and Late-responding Organs, Hematologic and Cytogenetic Effects, Effects of radiation on specific tissues and organs, Acute Radiation Syndromes, Phases of Acute Radiation Syndromes (Response Stage), Dose Response Curve, Cell Sensitivity, Response Stage, Radiation Syndrome

Objectives:

- Describe the effects of radiation at the cellular and molecular level
- Review the cell cycle
- Discuss the relative tissue and organ radiosensitivities
- Review the effects of radiation on specific tissue and organs
- Review hematological effects of radiation
- Review the cytogenetic effects of radiation
- Discuss the dose response curves
- Review the Acute Radiation Syndromes
- Discuss the Response Stages

Content:

I. Justification

1. Conditions of Potential Biological Effects and Damages caused by radiation
   a. Quality of Radiation
   b. Quantity of Radiation
   c. Received Dose of Radiation
   d. Exposure Conditions (Spatial Distribution)
2. Relative Biological Effectiveness (RBE)
3. Biological Effects of Radiation
   a. Types Effects (Radiation Sickness, Cancer, Genetic Effects)
   b. Direct and Indirect Action
   c. Short and Long Term Effects
   d. A High Dose
   e. Data on Radiation Exposure to Humans
   f. Risk Assessment of Cancer

II. Relative Tissue and Organ Radiosensitivity

1. Skin Effects
2. Tissue Types
    a. Vegitative intermitotic tissue cells (VIMs)
    b. Differentiating intermitotic cells (DIMs)
    c. Multiple connective tissue cells (MCTs)
    d. Reverting postmitotic cells (RPMs)
    e. Fixed post mitotic cells (FPMs)
3. Organs Types
    a. Acutely Responding Organs
    b. Late-responding Organs

III. Effects of radiation on specific tissues and organs

1. Early and Late Effects
2. Skin
    a. Atrophy
    b. Fibrosis
    c. Scarring
    d. Telangiectasia
3. Oral Mucosa
    a. Marked Erythema
    b. Patch Mucositis
4. Salivary Glands
5. Submandibular Glands
6. Gastrointestinal Tract
7. Central Nervous and Peripheral Nervous System
    a. Brain
    b. Spinal Cord
    c. Peripheral Nerves
8. Lung
9. Kidney
10. Heart
11. Liver
12. Bladder

IV. Hematologic and Cytogenetic Effects

1. Hemopoietic System
    a. Bone marrow
    b. Circulating blood
    c. Lymph nodes
    d. Spleen
    e. Liver
    f. Thymus
2. Types of Marrow
    a. Red
    b. Yellow
3. Stem Cells
    a. Radiation dose
    b. Stem cell sensitivity
4. Structural changes
5. Chromosomal aberration
    a. Types of Chromosomal Aberrations
    b. Factors that Influence the Repair of Chromosomal Aberrations

c. Karyotype

V. Acute Radiation Syndromes

1. Conditions of Radiation Exposure
2. Phases of Acute Radiation Syndromes (Response Stage)
   a. Prodromal
   b. Latent period
   c. Manifest illness
   d. Recovery or Death
3. Effects of Medical Intervention on the Acute Radiation Syndrome.
4. Consequences of Acute Radiation
5. Acute Exposure
6. Dose Response Curve
7. Radiation Doses and Expected Effects
8. Commonly Encountered Radiation Doses
9. Radiation Effects on Embryo/Fetus
10. Cell Sensitivity
11. Response Stage
12. Bone Marrow Syndrome
    a. Signs and Symptoms of Bone Marrow
13. Gastrointestinal Syndrome
    a. Signs and Symptoms of Gastrointestinal
14. Central Nervous System Syndrome
    Signs and Symptoms of Central Nervous System
15. Elements of acute radiation syndrome
    a. Gastrointestinal
    b. Hematopoietic
    c. Vascular

➢ Lecture 4: Effects of Long Terms Exposure to Radiation (60 minutes)

Keywords: Epidemiology, Limitations on Epidemiologic Studies, Types of Epidemiologic Studies, Hiroshima-Nagasaki, Atomic Bombings, Low Levels of Irradiation, Effects of Radiation, Estimation of Risk, Risk Models, Cancer, Radiation Sensitivity, Latent Effects, Dose Rate Effects, Thyroid and Breast Cancers, Age Dependency, Somatic Effects, Genetic Effects, Effects on the Embryo, Fetal Irradiation, Linear No-Threshold Hypothesis, Life Span Shortening, Stochastic and Non-stochastic Effects, Hormesis

Objectives:

- Discuss epidemiology, limitations on epidemiologic studies and population used as sources
- Describe Hiroshima-Nagasaki atomic bombings and radiation induced malignancies
- Explain different risk models
- Define the dose rate effects; the genetic effects of radiation; the effects of radiation to the fetus and life span shortening
- Review stochastic and non-stochastic effects and radiation hormesis

Content:

I. Epidemiology

1. The Science of Epidemiology
2. Population Used as Sources
   a. Atomic bomb survivors

b. Medically exposed patients
c. Occupationally exposed personnel
d. Populations who receive high natural background exposure

3. Limitations on Epidemiologic Studies
4. Types of Epidemiologic Studies
   a. Retrospective studies
   b. Prospective studies
5. Hiroshima-Nagasaki atomic bombings and radiation induced malignancies
6. Populations Exposed to Very Low Levels of Irradiation
   a. DOE's hanford facility
   b. Portsmouth naval nuclear shipyard
   c. Tri-state study of leukemia deaths
   d. Utah residents exposed to fallout
   e. Project "Smoky"
   f. Three-Mile Island
7. Effects of Radiation
   a. Increased birth defects in the F1 generation
   b. Increased F1 mortality
   c. Infertility
   d. Accelerated aging
   e. Altered immune function
   f. Diseases other than neoplasm

II. Estimation of Risk

1. "Low level" Radiation Exposure
2. Risk Models
   a. The relative or multiplicative risk model
   b. The absolute or additive risk model
   c. Excess risk
3. Cancer
   a. Cancer risk estimates
   b. Stochastic and non-stochastic effects
4. Risks of Low-Level Radiation
   a. General conception
   b. Variable radiation sensitivity
   c. Latent effects
   d. Radiation-induced cancers
   e. High background of "spontaneous" cancers

III. Dose Rate Effects

1. Thyroid and Breast Cancers
   a. Linear-, Non-threshold estimation of risks at low doses
   b. Linear extrapolation of risk estimation
2. Age Dependency
3. Treatment of Hyperthyroid Disease in Humans with 131I Radioiodine (Na131I)
4. Expression of Radiosensitivity
   a. Absolute risk
   b. Relative risk
5. Somatic Effects

IV. Genetic Effects of Radiation

1. Radiation damage to chromosomes
   a. Direct damage

b. Indirect damage
2. Estimation of Genetic Effects

V. Effects on the Embryo
1. Justification
2. Radiation Effects on the Embryo
   a. Radiation dose
   b. Dose-rate
   c. Stage of gestation
3. Triad of effects of radiation on the embryo
   a. Growth retardation
   b. Embryonic, fetal or neonatal death
   c. Congenital malformation
4. Embryo is Radiosensitive
5. 10 Day Rule
6. Fetal Irradiation

VI. Linear No-Threshold Hypothesis (LNT)

VII. Life Span Shortening

VIII. Stochastic (random) and Non-stochastic (not random) Effects

IX. Hormesis

➢ Lecture 5: Radiation Protection of Personnel (60 minutes)

Keywords: Radiation and Radioactivity, Ionizing and Non-Ionizing Radiation, Radiation Protection Programs, Radiation protection procedures, Dose Limiting, A-L-A-R-A , Protective Clothing, The Work Place, Manipulations of Radioactive Materials, External Radiation Protection, Shielding, Inverse Square Law, Internal Radiation Protection, Radioactive Waste Disposal, Radioactive Spills, Survey Procedures or Monitoring, Dosimetry, Radiation Badges, Dosimetry Reports, PET Nuclear Medicine Technology, Hot Lab Technique, F-18 FDG PET; Minimization of Radiation Exposure, Fetus, Staff, Patients, Families and the General Public

Objectives:
- Discuss the rationale for radiation protection and radiation protection programs
- Explain personnel dosimeters, dosimetry reports, and duties of the Radiation Safety Officer (RSO)
- Describe how the PET/CT Technologist can decrease their radiation exposure during the patient preparation and scanning sequences
- Define and calculate the dose limiting recommendations for PET/CT personnel
- Review the basic structural shielding construction and list the items that influence this construction
- Illustrate the Inverse Square Law and how using distance can decrease radiation exposure

Content:

I. The Rationale for Radiation Protection
1. Radiation and Radioactivity
2. Ionizing and Non-Ionizing Radiation
   a. Sources of ionizing radiation

II. Radiation Protection Programs

1. Regulators
    a. International Commission on Radiological Protection (ICRP)
    b. National Council on Radiation Protection and Measurements (NCRP)
    c. Nuclear Regulatory Commission (NRC)
    d. "Agreement State" Radiation Protection Agencies
2. Regulatory Authority
    a. Nuclear Regulatory Commission (NRC)
    b. Agreement State
    c. Radiation Safety Program

III. Radiation protection procedures

1. Units of Radiation Exposure
    a. Roentgen (R)
    b. Rad (radiation absorbed dose)
    c. Rem (roentgen equivalent man)
2. Radiation protection standards
    a. Radiation dose limit
    b. Principle of "ALARA"
3. General Handling Precautions
    a. Protective Clothing
    b. The Work Place
    c. Manipulations of Radioactive Materials
4. External Radiation Protection
    a. Time
    b. Distance
    c. Shielding
5. Internal Radiation Protection
    a. Mode of Entry into Body
    b. Routes of Intake, Transfers and Excretion
    c. Tissue Damage and Health Effects
6. Waste Disposal Guidelines
    a. Disposal
    b. Precautions on Waste Disposal
7. Precautions for Radioactive Spills
    a. Major Spills
    b. Minor Spills
    c. Key to Success
8. Survey Procedures or Monitoring
    a. Precautions on Dosimetry
    b. Radiation Badges
    c. Individuals Requiring Radiation Safety Training
    d. Annual Radiation Dose Limits
    e. Radiation Warning Signs
    f. Record Retention
    g. Criteria for Personnel Monitoring
    h. Survey Meter Quality Assurance
    i. Medical Events: Administrative Criteria
    j. Medical Events: Dose Criteria
    k. Reporting Medical
9. PET
    a. Higher Exposure Rate Constants
    b. Higher Dose Rate From Patients
    c. PET Shielding: Tenth Value Layers

d. Shorter Physical Half-Life
e. Shorter Half-Life: Lower Dose

IV. Minimization of Radiation Exposure to Staff

1. Sources of exposure for staff
2. Measures to Reduce Personnel Dose
   a. Time, distance and shielding
   b. Laboratory technique
   c. Administrative and procedural controles
3. Laboratory technique
   a. Good Hot Lab Technique
   b. NOT To Do in the Hot Lab
4. Maximize Distance
   a. Inverse Square Law (1/r2)
5. Utilize Shielding
   a. PET Barrier Materials
   b. Typical Hot Lab L-Block Shield
   c. Other Shielding Methods
   d. X-Ray Protective Equipment
   e. Mobile Shields
   f. Tongs to Maximize Distance
   g. Syringe Shields
6. Procedural Controls
   a. Automated dose dispensing and Calibration
   b. Elimination or automation of “flush” during patient administration
   c. Rotation of personne

V. Minimization of Radiation Exposure to Patients

1. Reducing PET/CT Patient Does
   a. Optimize administered radioactivity
   b. Reduce CT mAs
   c. Increase “pitch”
   d. Technique charts to minimize CT exposure to pediatric patients and small adults
2. Corrective Actions
   a. Increasing staff awareness and retraining
   b. Addition of policies or procedures
   c. Modification of existing policies and procedures
   d. Addition of engineering controls
   e. Termination of staff

VI. Minimization of Radiation Exposure to Families and the General Public

1. Regulatory Requirements
2. “Patient Release” Guidelines
3. Annual Dose Limit to Non-Radiation Workers

VII. Principles of PET/CT Shielding Calculati ons

1. Occupational Exposure Protection of the Worker
2. F-18 FDG PET
   a. Studies
   b. Exposure factors
   c. Dose Factors
3. PET Isotope Data
4. Exposure

5. Shielding
    a. Bench top shield
    b. Vial shields
    c. Syringe shields
    d. Structural shielding
6. Shielding of Sources
7. Shielding Material and Transmission
8. PET Clinic Layout
    a. Typical PET room
    b. Distances to be used in shielding calculations
    c. Calculation for Room Above an Uptake Room
    d. PET Clinic Shielding
    e. Wall Shielding

VIII. Radiation Exposure to the Fetus

1. Prevention of Unintentional Fetal Exposure
2. Fetal Doses
3. The Pregnant or Potentially Pregnant Radiation Worker
    a. Risks prenatal radiation exposure
    b. Occupational dose limit
    c. Notification of employer about pregnancy
    d. Mutual Responsibilities
4. Methods to Reduce Occupational Exposure for the Pregnant Worker
5. Radiation Safety Officer (RSO)

IX. Internet Resources

➢ Lecture 6: Measuring Patient Dose from Computed Tomography (CT) Scanner (60 minutes)

Keywords: Computerized Tomography, X Rays, CT Scan, Computed Tomography (CT), Basic Principle of CT, Data Acquisition (DAS), Spiral or Helical Scanning, Helical CT Scanning, CT Gantry, CT Scanner Geometry, CT Scanner Components, Ionization Chamber, Absorbed Dose, Measurement Patient Dose, Computed Tomography Dose Index (CTDI), Dose Length Product (DLP), Effective Dose, Radiation Units, Radiological Protection, Dosimetry in CT, CT dose index, CTDI in air, Thermoluminescent Dosimeters (TLDs), CTDI in Acrylic Phantoms, CTDI in Perspex Phantoms, Multiple Scan Average Dose (MSAD), Reduction of Patient Dose, Size Specific Dose Estimate (SSDE), Contact Shields

Objectives:

- Discuss what is CT and basic principle of CT
- Review CT Scanner Geometry
- Describe dose distribution within the patient
- Review measurement of patient dose
- Define Dosimetry Quantity in CT
- Describe CT Dose Index (CTDI), Thermoluminescent Dosimeters (TLDs), Dosimetry - CTDI in Acrylic Phantoms
- Explain Multiple Scan Average Dose (MSAD)
- Illustrate Dose Length Product and Reduction of Patient Dose

Content:

I. Computerized Tomography

1. Definition of Tomography
   a. Tomography imaging
2. Background
3. X Rays
4. X Ray Tube Principles
5. Understanding the Image
   a. Conventional X-ray Images
   b. Attenuation
6. Understanding Basic factors
   a. Attenuation
7. Image Densities
8. Convectional X-ray and CT

II. CT Scan

1. Prototype CT Scaner
2. Present CT Scaner
3. Computed tomography
4. Basic principles
   a. Slice / Cut
   b. Matrix
   c. Poxel
   d. Voxel
   e. Digital Image
   f. CT numbers
   g. Visual image & Gray Scale
5. Phases of CT imaging
   a. Scanning the patient
   b. Data Acquisition (DAS)
   c. Image reconstruction
   d. Image Display
   e. Image archival (recording)
6. The Data Acquisition System
   a. Gantry
   b. X-ray tube
   c. X-ray detectors (sensors)
7. CT generations are based on
   a. Beam geometry
   b. X-ray tube trajectory (shift)
   c. Number of detectors
8. Tomographic acquisition
9. Reasons for Using CT
   a. Advantages of the spiral (Volume) CT scanner
   b. Hounsfield units
   c. CT Numbers or Hounsfield Units
   d. CT Numbers
10. Spiral or Helical Scanning
    a. Helical CT Scanning
    b. Helical (spiral) Scan Principle
    c. Helical CT Scanners
    d. Helical (spiral) CT
    e. Pitch
11. Modern CT scanner

a. CT Gantry
b. External and Internal structure

III. CT Scanner Geometry

1. CT Scanner Components
2. Principle of operation
3. Gantry
4. CT Tubes
5. Detectors
6. Table
7. Image Display
8. FOV
9. Image manipulation
10. Windowing
11. Image manipulation

IV. Ionization Chamber

10. Absorbed Dose
11. Dose Distribution within the Patient
    a. Radiation Dose for a single slice
12. Measurement Patient Dose
13. Computed Tomography Dose Index (CTDI)
    a. Weighted CTDI
    b. Volume CTDI
14. Dose Length Product (DLP)
15. Effective Dose
16. Radiation Units
    a. Absorbed dose in CT
    b. Radiation risk in CT

V. Radiological Protection and Dosimetry in CT

1. Radiation Dosimetry
2. Dosimetry Quantity in CT
3. CT dose index
    a. CTDI100
    b. CTDIw
    c. CTDIvol
4. Dosimetry - CTDI in air
    a. Pencil Ionization Chamber Method Of Measuring CT
    b. CT Phantom & Ionization Chamber
    c. Measurement of CTDI
5. Thermoluminescent Dosimeters (TLDs)
6. Dosimetry - CTDI in Acrylic Phantoms
7. Dosimetry - CTDI in Perspex Phantoms

VI. Multiple Scan Average Dose (MSAD)

3. MSAD
4. CTDI and MSAD
    a. Factors affecting absorbed dose: Z-axis
5. CTDI/MSAD method

VII. Reduction of Patient Dose

4. CTDIvol and Patient Dose

5. Factors Affecting Patient Dose
    a. KVp
    b. mAs
    c. Pitch
    d. Collimation
    e. Bed Index
    f. Beam Geometry
    g. Detector Setup
    h. Other: repeats, shielding, alignment, patient size...etc..
6. The effect of KV on Dose
7. Pitch and Dose
8. Size Specific Dose Estimate (SSDE)
9. Dose Length Product
10. Summary of CT Dose Quantities
11. Reduction of Patient Dose
    a. Contact Shields

Module III: Advance SPECT/CT

➢ Lecture 1: Fundamentals of SPECT/CT principles (60 minutes)

Keywords: SPECT, Single photon emission computed tomography, Planar Imaging, Collimator, Parallel Hole, Pinhole, Converging, Diverging, Gray Scal and Color Display, Filters, Low Pass and High Pass Filters, Quality Control (QC), Uniformity correction, Patient motion, Center of rotation, Acquisition Modes, Circular and Body Contour Orbit, Attenuation correction, Quality Assurance, Computed Tomography, CT, CT Image, Scanner Generations, Slip Ring Technology, CT Number, Single Slice and Multi Slice CT, Spiral CT, Advantages and Disadvantages, SPECT/CT Scanner, GE Hawkeye, SIEMENS Symbia

Objectives:

- Discuss advantages of SPECT and SPECT/CT compared to Planar imaging
- Describe a few collimators used in SPECT
- Review Gray scales and Color displays
- Determine low pass filters and describe their functions
- List QC tests perform for SPECT
- Illustrate SPECT acquisition modes
- Explain attenuation corrections
- Define the difference between Quality Control and Quality Assurance

Content:

I. SPECT

1. SPECT - Single Photon Emission Computed Tomography
2. Study
    a. Radioisotope
    b. Emission energy (KeV)
    c. Half-life
    d. Radiop harmaceutical
    e. Activity (MBq)
    f. Rotation (degree s)
    g. Projections

h. Image resolution
i. Time per projection (s)

3. Planar Imaging and SPECT
   a. Difference between Planar imaging and SPECT
   b. Scan of the brain in the 3D world
   c. Example MR and SPECT datasets loaded directly
   d. Scan of the heart in the SPECT 3D world

II. Collimator

1. Definition
2. Collimators Used in SPECT
3. Types of Collimator
   a. Parallel Hole
   b. Pinhole
   c. Converging
   d. Diverging

III. Gray Scal and Color Display

1. Advantage of Color Scales
2. Advantage of Gray Scale

IV. Filters

17. Low Pass Filters
    a. Hanning
    b. Butterworth
18. High Pass Filter

V. Quality Control (QC) PERFORMED IN SPECT

1. Uniformity correction
2. Patient motion
3. Center of rotation

VI. SPECT Acquisition Modes

6. SPECT acquisition
   b. Step and shoot mode (SSM)
   c. Continuous mode (CM)
   d. Continuous Step and shoot mode (CSSM)
7. Cardiac SPECT
8. Circular and Body Contour Orbit
   a. Circular Orbit
   b. Body Contour Orbit

VII. Attenuation correction

1. Definition
2. Correcting for attenuation problems

VIII. Quality Assurance and Quality Control

1. Quality Assurance
2. Quality Control

IX. Fundamentals of CT

1. Computed Tomography (CT)

2. CT Image
3. Scanner Generations
    a. 1st Generation
    b. 2nd Generation
    c. 3rd Generation
    d. 4th Generation
    e. 5th Generation
    f. 6th Generation
    g. 7th Generation
4. Slip Ring Technology
5. CT Number
    a. Hounsfield scale
    b. Windowing
6. Single Slice and Multi Slice CT
    a. Row of detectors
    b. Slice thickness
7. Spiral CT
8. Advantages and Disadvantages of CT

X. Advantages and Disadvantages of SPECT

XI. SPECT/CT Scanner

1. History
2. Hybrid SPECT/CT – two approaches
    a. 1st approach - GE Hawkeye
    b. 2nd approach - SIEMENS Symbia
3. Slow and High Speed
4. Advantages
5. Sources of Error and Artefacts
6. Attenuation Correction
7. Conclusions
8. Refernce

XII. SPECT (continued)

1. Image Acquisition
    a. Cardiac Image Acquisition
2. Orbits
3. Transverse Image Reconstruction
4. Filtered Backprojection
5. Filter Kernels
6. Interactive Reconstruction
7. Attenuation Correction
8. SPECT Collimators
9. Multihead SPECT Cameras
10. SPECT Performance
11. Spatial Resolution
12. Comparison with Conventional Planar Scintillation Camera Imaging
13. Magnification Factors
14. Multienergy Spatial Registration
15. Cor Calibration
16. Uniformity
17. Camera Head Tilt

- Lecture 2: Basic Instrumentation of SPECT/CT (Part I & II) (150 minutes)

Part I: SPECT component (60 minutes)

Keywords: SPECT, SPECT/CT, Single Photon Emission Computerized Tomographic, Basic Instrumentation, Scintillation Gamma Camera, Collimators, Performance, Image Formation, Computer hardware, Quality Control, Clinical Applications, Acquisition, Underlying and Physical Reconstruction, Transverse Image, Three-Dimensional Displays, Hard Copy, Hybrid SPECT/CT, PET-SPECT-CT Scanner, Advantages and Disadvantages

Objectives:

- Discuss SPECT acquisition modes
- Determine attenuation corrections
- Define the difference between Quality Control and Quality Assurance
- Discuss SPECT QC
- Brief review of SPECT Instrumentation principles
- Discuss various Iterative SPECT reconstruction algorythms
- Sample clinical applications of SPECT/CT
- Analysis of SPECT imaging

Content:

I. Introdution to SPECT

1. SPECT - Single Photon Emission Computerized Tomographic
2. SPECT/CT

II. Instrumentation of the SPECT

1. Gamma Scintillation Camera Components
   a. Photomultiplier Tubes (PMT)
   b. High Voltage Power Supply
   c. Preamplifier
   d. Amplifier
   e. Gain Control
   f. Pulse Height Analyzer
   g. Spectrometers
2. Detector Types: Scintillation
   a. PM Tubes
   b. Photodiode
3. Position Circuitry
4. Collimators
   a. Parallel-Hole Collimator
5. SPECT Cameras
6. SPECT Performance
   a. Spatial resolution
   b. Magnification factors
   c. Multienergy spatial registration
   d. Alignment of projection images to axis-of-rotation
   e. Uniformity
   f. Camera head tilt
7. Factors Affecting Image Formation
   a. Distribution of radiopharmaceutical
   b. Collimator selection and sensitivity
   c. Spatial resolution
   d. Energy resolution

e. Uniformity
f. Count rate performance
g. Spatial positioning at different energies
h. Center of rotation
i. Scattered radiation
j. Attenuation
k. Noise

8. Image Formation

III. The SPECT/CT Computer hardware

1. Host Computer
2. Array Processor
3. Data Acquisition System (DAS)
4. Amplifier
5. ADC
6. Sample/Hold Unit (S/H)

IV. SPECT Gamma Camera Quality Control

1. Frequency of Quality Control on a Gamma Camera
   a. Physicist
   b. Technician
2. Gamma Camera
3. Measures of Gamma Camera Performance
4. Uniformity
   a. Uniformity correction
   b. Tomographic uniformity
   c. Calculate Integral uniformity (IU)
   d. Calculate Differential uniformity (DU)
5. Collimator Efficiency
   a. Energy Resolution
   b. Count Rate Performance
   6. QC Performed in SPECT
   a. Uniformity correction
   b. Patient motion
   c. Center of rotation
7. Tomographic Resolution
8. Patient Motion
9. Cor Calibration
10. Center of Rotation
11. Camera Head Tilt

V. Clinical Applications of SPECT/CT

1. Cardiac
2. Bone
3. Renal
4. Gastric
5. Hepatobiliary
6. Thyroid
7. Pulmonary
8. Brain

VI. Gamma Camera Acquisition types

1. Static

2. Dynamic
3. Whole-body
4. SPECT
5. Gated SPECT
6. Dynamic SPECT
7. Whole-body SPECT
8. Coincidence imaging
9. List Mode SPECT/CT

VII. SPECT Image Acquisition

1. SPECT Data Acquistion Modes
   a. Orbits
   b. Step and shoot (SSM)
   c. Continuous (CM)
   d. Continuous Step and shoot (CSSM)
2. Continuous Acquisition
   a. Hybrid SRECT/CT
3. Long Acquisition
4. Long Acquisition
5. Other Factors
   a. Size of the image pixels
   b. Average number of counts collected for each pixel
   c. Number of views obtained

VIII. SPECT Reconstruction

1. Filtered Back Projection (FBP)
   a. Filter kernels
2. Iterative Reconstruction (IR)
   a. Iterative method
3. Nine Point Smoothing
4. Filtering
   a. Transformation of Domains
   b. Frequency Domains
   c. Filter Kernels
   d. Filtered Back Projection
   e. Filters: Low Pass and High Pass
5. Transverse Image Reconstruction
6. Signal and Noise
7. Attenuation correction

IX. Transverse Image Reconstruction

1. Image Reorientation
   a. Transaxial Images
   b. Longitudinal Images
   c. Oblique Images
2. Cardiac Reorientation
   a. Vertical Long-axis Slices
   b. Horizontal Long-axis Slices
   c. Short-axis Slices

X. Three-Dimensional Displays

1. Categories of Displays
   a. Volume Rendering

b. Surface Rendering
2. Color and Gray scales
3. Perfusion Quantification
4. Polar maps
5. Three-Dimensional Cardiac Displays

XI. Hard Copy

1. Hard Cope Formats
2. Image Recordinf Sistems (Laser Printers)
   a. Solid State Laser Printers
   b. GAS Laser Printers
3. Image Storage Media
   a. Magnetic Tapes
   b. Magneto-Optical Disk (MOD)
   c. CD
4. Communication
   a. Picture Archival Communication System (PACS)

XII. Todays hybrid SPECT/CT Scanners

XIII. PET-SPECT-CT Scanner - the next step in technology evolution

XIV. Advantages and Disadvantages of SPECT

Part II: CT component (90 minutes)

Keywords: CT Physics and Instrumentation, X-rays, X-ray Tube, Production of X-rays, Computed Tomography (CT), CT System, Instrumentation and Operation, Collimation, Rotation Speed, Pitch, Incensement, Multislice Helical CT Systems, Image Data Acquisition, Patient Orientation, Coordinate System, Isocenter, Scannable Range, Scan FOV, Scanning Methods, Topogram Regular Scan, Multislice CT, Axial Scan, Conventional and Spiral/Helical CT, Axial CT, Volume CT, Multislice Effectiveness, Spiral CT, Low–Dose, Attenuation Correction, Contrast Media, Quality Control, Basic Technologist skills, Dosimetry, Radiation Dose, Radiopharmaceuticals

Objectives:

- Describe the physics processes involved in the production of x-rays and the role of each component in the x-ray tube
- Discuss the role of proper adjustment of x-ray tube voltage and current in CT
- Name the principle parts of a CT scanner and the function of each CT scanner component
- Describe how a helical CT scanner operates and the component changes that made this technology possible
- Describe how CT image data are acquired and processed
- Describe the calculation process of Hounsfield units
- Describe ct number values assigned to various tissues and how these values are assigned into meaningful display windowing
- List parameters set by the operator for CT use and describe the effect of each on the images
- Discuss the CT image quality issues
- List the origin of CT image artifacts and describe their prevention
- Discuss appropriate parameters for the acquisition of low-dose CT for PET attenuation correction
- Describe the parameters and image characteristics required for a diagnostic-quality CT scan
- Discuss the integration of CT procedures into the combined PET/CT examination

- Discuss occupational radiation exposure from operating a CT scanner
- Discuss patient radiation exposure from a CT scanner
- Describe CT quality control program
- Discuss CT quality control
- Discuss basic SPECT/CT technology
- Describe SPECT/CT architecture
- Discuss the technical skills to operate a SPECT/CT system
- Discuss the advantages of SPECT/CT
- Discuss the effects of CT based attenuation correction in SPECT/CT
- Discuss new and current radiopharmaceuticals used in SPECT/CT
- Compare today's SPECT/CT systems

Content:

I. CT Physics and Instrumentation

1. Physics of X-rays
    a. Bremsstrahlung Radiation
    b. Characteristic x-rays
2. X-ray Tube and the Production of X-rays
    a. X-ray Tube Design
    b. Technique
    c. Voltage Variation
    d. KVP in CT
    e. Advantages and Disadvantages of Voltage Variation
    f. Current Variation
    g. Advantages and Disadvantages of Current Variation
    h. Current Variatio
    i. MA of Tube Current
    j. S –Time of Exposure
    k. Focal Spot
    l. X-ray Filter
    m. Filtration Material
    n. Filtration Change

II. Principles of Computed Tomography

1. CT Scanner Design - CT System
    a. Computer work station
    b. Image processing computers
    c. Electronic cabinets
    d. Gantry
    e. Patient imaging table
2. Computed Tomography Instrumentation and Operation
    a. Gantry and Gantry Control
    b. CT Detectors
    c. The X-ray Tube
    d. High Voltage Generator (HVG)
    e. DAS
    f. Console
    g. Host Computer
    h. Array Processor
    i. ADC
    j. Sample/Hold Unit (S/H)
    k. Storage
    l. Scan Controller

3. Collimation
    a. Advantages of thinner collimation
    b. Compromises of thinner collimation
4. Rotation Speed
5. Pitch
6. Incensement
7. Multislice Helical CT Systems
8. Image Data Acquisition
    a. Data Acquisition System (DAS)
9. CT Image Reconstruction
10. CT Display
11. Control Console
    a. Set scan parameters
    b. Set scan mode
    c. IRS (Image reconstruction System)
    d. Review and archive images
    e. Post-processing
12. Coordinate System
13. Isocenter
14. Patient Orientation
    a. Head First
    b. Feet First
    c. Patient Couch
15. Scannable Range
16. Scan FOV
    a. DFOV – Displayed Field of View

III. Scanning Methods

1. Surview
    a. AP
    b. Lat
    c. Surview
    d. Scanogram
    e. Topogram
2. Conventional CT
    a. Axial
    b. Start/stop
3. Volumetric CT
    a. Helical or spiral CT
    b. Continuous acquisition

IV. Topogram Regular Scan

1. Topogram (Scout)
    a. AP Scout
    b. LAT Scout
2. CT Data Acquisition

V. Fundamentals of Multislice CT

1. Axial Scan
    a. Spiral
    b. Axial CT
2. Conventional and Spiral/Helical CT
    a. Advantage of Spiral Imaging Over Conventional - Speed

b. Digital Projection
3. Axial CT
4. Volume CT
   a. Pitch
   b. Advantages of Volume C
5. Multislice Effectiveness
   a. Dual Slice Detector Optimized for 2 Slice Acquisition
   b. Quad Detector Technology
   c. Variable Wide Area Detector
   d. Quad Technology
   e. Slip Ring Twchnology
   f. Singl Slice and Multi Slice CT
6. Spiral CT
   a. Display of Volumetric Image Data
   b. Image Quality
   c. High and Low Contrast
   d. Image Noise
7. Low–Dose CT for SPECT Attenuation Correction
   a. Attenuation
8. Integrated SPECT/CT Protocols
   a. CT Protocols
9. Diagnostic CT
   a. Abdomen CT
   b. Chest CT
   c. Neck CT
10. Contrast Media
   a. CT Contrast Agents
   b. Administration
11. Advantages and Limitations of CT
12. Goals of CT
13. Density Information
   a. Hounsfield scale
14. Windows Settings
15. CT Images Quality
16. Isotropic Imaging
17. Post Processing Options
18. Pixel Size
   a. Reconstruction
   b. Pixel and Voxel
   c. Vocal Size Depends
19. Image Display
   a. Computed Gray Scale and CT Numbers
   b. CT Image
   c. CT Number
   d. Image Recording Systems (Laser Printers)
   e. Heard Copy
   f. Image Storage Media
   g. Communication

VI. CT Quality Control

1. General QC Tests: Image Quality
   a. Noise and Field Uniformity
   b. CT Number Linearity

c. Low Contrast Detectability
d. Spatial Resolution
e. Display and Hard Copy Image Quality

2. General QC Tests: Dosimetry
   a. CTDI
   b. Patient Dosimetry
3. Alignment Laser Accuracy
4. Table Incrementation Accuracy and Collimation (Axial Scan)
5. Table Incrementation Scanned Volume Helical Pitch Accuracy
6. KVP Accuracy
7. Hale-Value Layer
8. Exposure Reproducibility and Linearity
9. Radiation Profile Width
10. Slice Sensitivity Profile
11. Image Quality Measures
    a. Noise and Field Uniformity
    b. CT Number Linearity
    c. Low Contrast Detectability
    d. Spatial Resolution
    e. Reconstruction times
    f. Scout view accuracy
12. Phantoms and Test Tools
13. Display and Heard Copy Image Quality
14. Dosimetry Measurement: CTDI
15. CT Equipment Quality Control Program
16. Acceptance Testing
    a. Considerations for Acceptance Tests
    b. Essential Tests
    c. Optional Tests
    d. Alternative Tests
17. Annual ACR Requirements
18. Monthly to Semi-annual Tests Per AAPM
19. Continuous Quality Control
    a. Continuous Quality Control Tests
    b. Daily Tests AAPM
    c. AIDS to Daily QC
20. AUTOQA Lite Overview
21. CT Radiation Safety

VII. Basic SPECT/CT Technology

VIII. General overview of SPECT/CT System Architecture

IX. Overview of basic SPECT/CT Protocols

X. Basic Technologist skills to operate a SPECT/CT System

XI. Advantages of SPECT/CT

XII. Effects of CT Based Attenuation Correction in SPECT/CT

XIII. Diagnostic quality CT Studies

XIV. CT Internal Radiation Dose Dosimetry

XV. Estimated Radiation Dose from a SPECT/CT Procedure

XVI. SPECT/CT Radiopharmaceuticals

XVII. Comparing today's SPECT/CT systems

1. SPECT/CT

XVIII. Conclusion

- Lecture 3: SPECT Acquisition (Part I & II) (120 minutes)

Part I (60 minutes)

Keywords: Imaging techniques, Image Acquisition, basic Parameters, Gamma rays, Gamma cameras, Radiation Energy Considerations, Detection, Attenuation, Inorganic scintillators, Nuclear Medicine Imaging Systems, PMT calibration, Anger position network, Detection window in context, Types of events, Signal-to-noise ratio (CNR), Digital Images, PIXEL Correlation, Collmator, Scintillator, Photomultiplier Tubes (PMTs), Scintillator and Photomultiplier Tube assemblies, SPECT Data Acquisition

Objectives:

- Discuss Image Acquisition
- Define Image Acquisition basic Parameters
- Review of Imaging Systems in Nuclear Medicine
- Explain SPECT Data Acquisition

Content:

I. Introdution

1. Two varieties of the imaging techniques

II. Image Acquisition

III. Image Acquisition basic Parameters

1. Gamma rays
2. Gamma cameras: components and systems
    a. Two Types of Tomography
3. Radiation Energy Considerations
    a. X-ray CT
    b. Nuclear Medicine
4. Detection: Interactions of high energy photons with matter
    a. Photoelectric effect
    b. Compton scattering
    c. Pair production
    d. Coherent (Rayleigh) scattering (typically ignore)
5. Attenuation
    a. Attenuation coefficients
    b. Mass attenuation coefficient μm
    c. Example Calculation
6. Inorganic scintillators
7. Scintillation Detection

8. Gamma camera operation
9. Gamma camera components
10. Operation
11. Nuclear Medicine Imaging Systems
12. PMT calibration
13. Anger position network
14. Pulse height analyser
    a. Pulse height analyser operating principle
    b. Pulse height analyser operation
    c. Pulse height analyser multiple-channel analyser
    d. Pulse height analyser thresholds
15. Detection window in context
16. Types of events
17. Gamma camera
    a. Energy resolution
    b. Detection efficiency
    c. Terms contributing to the detection efficiency
    d. Dead-time: Paralysable and Non-paralysable
    e. Spatial resolution
    f. Terms contributing to spatial resolution
18. Signal-to-noise ratio (CNR)
    a. Contrast and contrast-to-noise ratio
19. Digital Images
    a. The Structure of a Digital Image
    b. Pixel Bit Depth
    c. Eight-bit Pixel Depth
    d. The Effect of Bit Depth on the Image
    e. Pixel Size and Digital Image Detail
    f. Factors Affecting Pixel Size and Image Detail
    g. The Effect of Matrix Size on Pixel Size and Image Detail
    h. Image Matrix Size for the Different Imaging Modalities
    i. Effect of Field of View on Digital Image Detail
    j. The Numerical Size of a Digital Image
    k. Image Compression
    l. Position
20. PIXEL Correlation
21. Summarized
    a. Multiheaded gamma cameras
    b. Single photon emission computed tomography (SPECT)

IV. Nuclear Medicine Imaging Systems

1. Types of Scanners
2. Collmator
    a. Operating principle
    b. Collimator Blurring
    c. Energy Resolution
    d. Collimator design
        - Parallel-hole collimator
        - Converging collimator
        - Diverging collimator
        - Pinhole collimator
        - Slanthole collimator
        - Fan-beam collimator

3. Scintillator
   a. $NaI(Tl)$ characteristics
4. Photomultiplier Tubes (PMTs)
5. Scintillator and Photomultiplier Tube assemblies

V. Image Acquisition in Nuclear Medicine

1. Major imaging techniques
   a. Scintigraphy
   b. SPECT (Single Photon Emission Computed Tomography)
   c. PET (Positron Emission Tomography)

VI. SPECT Data Acquisition

1. Arc of Rotation
2. Imaging characteristics of SPECT
3. Image Formation
4. Dual Isotope Imaging
5. Sampling
6. Information Density
7. Static Studies
8. Whole-Body Imaging
9. Dynamic Studies
10. Windowing
11. Cine
12. Gated Acquisition
13. SPECT Acquisition
    a. Angular Samples
    b. Acquisition Time
    c. Rotation Mode
    d. Collimator Selection and Patient Setup
    e. Gated SPECT
    f. Whole body SPECT
    g. Preprocessing
14. Image Acquisition
    a. Peaking
    b. Multiple Energy Windows
15. Techniques to improve image quality post acquisitio

Part II (60 minutes)

Keywords: Nuclear Medicine Computer System, Image Acquisition, Cardiology, Bone scintigraphy, Brain perfusion, Hepatic and Splenic, Parathyroid, Bone Marrow Scan, CSF Leak, Esophageal Transit, Gastric Emptying, Gastroesophageal Reflux, MECKEL'S Diverticulum Study, Protein Loss, Salivogram, Lung Provision Scan, WBC Imaging, Tumor Scan, Renal TX or Native Kidney Scan, Example of Protocols

Objectives:

- Discuss Nuclear Medicine Computer System
- Define Image Acquisition in Cardiology, Bone scintigraphy, Brain perfusion, Hepatic and Splenic, Parathyroid, Bone Marrow Scan
- Review CSF Leak, Esophageal Transit, Gastric Emptying, Gastroesophageal Reflux, MECKEL'S Diverticulum Study, Protein Loss, Salivogram, Lung Provision Scan, WBC Imaging, Tumor Scan, Renal TX or Native Kidney Scan

- Explain Example of Protocols in university of wisconsin in USA

Content:

I. Nuclear Medicine Computer System

2. Components
    a. Camera head
    b. Interface
    c. Processing system
    d. Display

II. Image Acquisition in Cardiology

1. Cardiology
2. Dose
3. Position
4. SPECT imaging overall comments
5. Delay Time
6. Energy Windows
7. Collimator
8. Types of cameras: Detector head positioning
    a. Single headed system
    b. Dual headed system
9. Angular Sampling Range
10. Number of Projections
11. Orbit Type
12. Pixel Size
13. Acquisition Type
    a. ‘‘Step-and-shoot’’ method
    b. ‘‘Continuous’’ mode
14. Matrix
15. Acquisition Time
16. Gating
17. Acquisition parameters
18. Patient Protocols
    a. Same-day rest-stress Tc-99m acquisition
    b. Two-day stress Tc-99m acquisition
    c. Separate dual-isotope acquisition
    d. Stress/redistribution Tl-201 acquisition
    e. Stress/reinjection/redistribution Tl-201 acquisition

III. Bone scintigraphy

1. Bone scintigraphy
2. Radiopharmaceuticals and dose
3. Patient preparation
4. Imaging Procedure
5. Angiographic and early blood pool phase imaging
6. Delayed bone phase imaging

IV. Brain perfusion SPECT

22. Positioning of the patient
23. Imaging devices
24. Acquisition parameters
    a. Rotational radius
    b. Matrix

c. Angular sampling
d. Zoom
e. Acquisition mode
f. Total detected events
g. Total scan time

V. Hepatic and Splenic SPECT

1. Hepatic and Splenic SPECT
2. Radiopharmaceutical
   a. Liver–spleen imaging
   b. Liver blood pool imaging
   c. Hepatic artery perfusion imaging
   d. Splenic imaging
3. Image Acquisition
   a. Liver–spleen imaging
   b. Hepatic blood pool imaging
   c. Hepatic perfusion imaging
   d. Splenic imaging

VI. Parathyroid SPECT

1. Parathyroid SPECT
2. Radiopharmaceuticals
   a. 99mTc-sestamibi or 99mTc-tetrofosmin
   b. 99mTc-pertechnetate
3. Protocol/image acquisition
   a. Dual-phase 99mTc-sestamibi protocol
   b. SPECT protocols
   c. Dual-isotope 99mTc-sestamibi/99mTc-pertechnetate protocol
   d. Dual-isotope 99mTc-sestamibi/123I-iodide protocol

VII. Bone Marrow Scan

1. Radiopharmaceutical
2. Route of Administration
3. Patient Preparation
4. Equipment Setup
   a. Collimator
5. SPECT images
6. Patient Positioning
7. Procedure

VIII. CSF Leak

1. Patient Preparation
2. Radiopharmaceutical and Dose
3. Imaging Device
4. Imaging Procedure

IX. Esophageal Transit

1. Indications
2. Patient Preparation
3. Scheduling
4. Radiopharmaceutical and Dose
5. Imaging Device
6. Imaging Procedure

X. Gastric Emptying

1. Indications
2. Patient Preparation
3. Radiopharmaceutical and Dose
    a. Meal Includes
    b. Meal Preparation
    c. Alternate Meals Infants
    d. For Egg Allergy or Intolerance
4. Imaging Device
5. Data Acquisition
6. Routine Adult/Child
7. Infant

XI. Gastroesophageal Reflux

1. Indications
2. Patient Preparation
3. Imaging Device
    a. Gamma camera with LEHR collimation
4. Imaging Procedure
    a. Audults
    b. Infants

XII. MECKEL'S Diverticulum Study

1. Indications
2. Rationale
3. Patient Preparation
4. Scheduling
5. Radiopharmaceutical and Dose
6. Imaging Device
7. Imaging Procedure

XIII. Protein Loss

1. Indications
2. Patient Preparation
3. Scheduling
4. Radiopharmaceutical and Dose
    a. Preparation of Tc99m Dextran
5. Imaging Device
6. Imaging Procedure

XIV. Salivogram

1. Indications
2. Patient Preparation
3. Scheduling
4. Radiopharmaceutical and Dose
5. Imaging Device
6. Data Acquisition

XV. Lung Provision Scan

1. Indications
2. Patient Preparation
3. Scheduling

4. Radiopharmaceutical and Dose
5. Caution
6. Imaging Device
7. Imaging Procedure

XVI. WBC Imaging

1. Radiopharmaceutical
2. Equipment Setup:
   a. Collimator
   b. Computer setup
3. SPECT images
4. Patient Positioning
5. Imaging Procedure

XVII. Tumor Scan with Gallium

1. Indications
2. Radiopharmaceutical and Dose
3. Patient Preparation
4. Imaging Procedure
5. Data Acquisition
   a. Whole Body Imaging

XVIII. Relative GFR & ERPF: Renal TX or Native Kidney Scan

1. Indications
2. Patient Preparation
3. Scheduling
4. Radiopharmaceutical and Dose
5. Imaging Device
6. Acquisition Procedure
7. Imaging Procedure

XIX. Abscess Infection Imaging Procedure

16. Example of Protocols in university of wisconsin in USA

- Lecture 4: SPECT Quality Control (90 minutes)

Keywords: Gamma camera, Scintillation camera, Anger camera, Quality Contol (QC), Quality Assurance (QA), Image Types, Analog and Digital Images, Binary digits (Bits), Image Compression, Collimator, Photomultiplier Tubes (PMT's), Gamma Camera Characteristics, General Definitions, Test Equipment Conditions and Results, Quality Control procedures, Visual Inspection, Background level measurement, Photopeak and window setting, Sensitivity Measurement, Count Rate Performance, Sensitivity, Spatial Resolution, Linearity, Whole body scan Resolution, Intrinsic spatial resolution and linearity, System spatial resolution and linearity, Detector Head Tilt, Centre of Rotation (COR), Detector Alignment, High Count Field Uniformity, Tomographic Resolution, Rotational Uniformity, Reconstruction Phantom Studies, Main Features, Reconstruction Phantom Studies, Centre of Rotation (COR) Offset (x), Image Alignment in Y for Multihead SPECT Systems, Data Reconstruction - Attenuation Correction, System Uniformity, System Planar Sensitivity, Detector Shielding, System Alignment, Correction Tables, General Gamma Camera QC, Documentation, Record Keeping and Action Thresholds

Objectives:

- Discuss what is it a Quality Control (QC) and Gamma Camera QC
- Gives some guidelines regarding possible procedures to follow for troubleshooting and problem solving
- Describe Image Types, Fundamental component of Gamma Camera and Gamma Camera Characteristics
- Review General Definitions
- Determine Test Equipment Conditions and Results
- List and Examples Quality Control procedures and System Uniformity
- Explain System Planar Sensitivity, Detector Shielding, System Alignment and Correction Tables
- Illustrate General Gamma Camera QC
- Define Documentation, Record Keeping and Action Thresholds

Content:

I. Introduction

II. Quality Control (QC)

19.Definition
20.Quality Assurance (QA) and Quolity Control (QC)

III. Image Types

7. Analog and Digital Images
8. The Digital Advantage
   a. Functions of digital image
9. Human Digits
10. Comparing Human and Computer Digits
    a. Ten different digits
    b. Binary digits (Bits)
11. Writing Numbers in Bits
12. Range of Values for Numbers in Binary Form
13. Pixel Bit Depth
    a. Eight-bit Pixel Depth
    b. The Effect of Bit Depth on the Image
14. Pixel Size and Digital Image Detail
    a. Factors Affecting Pixel Size and Image Detail
    b. The Effect of Matrix Size on Pixel Size and Image Detail
15. Image Matrix Size for the Different Imaging Modalities
16. The Numerical Size of a Digital Image
17. Image Compression
    a. Lossless compression

IV. Gamma Camera

25. Definition
26. Fundamental components
    a. Sodium iodide crystal
    b. Array of photomultiplier tubes
    c. Collimator
    d. Computer
27. Scintillation Camera Function
28. Collimator
    a. Micro-cast Technology
    b. Micro-linear Technology
29. Collimator Quality
30. Types of Collimator
    a. Parallel hole collimator
    b. Slanthole collimators

c. Converging and Diverging Collimators
d. Fanbeam collimators
e. Pinhole collimators

31. Scintilation
    a. Scintillation Counter
32. Photomultiplier Tubes (PMT's)
    a. Pre-Amplifier
    b. Position logic circuit
33. Computer
    a. Analog to digital converter (ADC)

V. Gamma Camera Characteristics

VI. General Definitions

4. Absolute linearity
5. Central Field of View (CFO)
6. Detector
7. Differential linearity
8. Differential uniformity
9. Digital resolution
10. Energy resolution
11. Energy window
12. Foldover
13. Full width at half maximum (FWHM)
14. Full width at tenth maximum (FWTM)
15. Integral uniformity
16. Input count rate
17. Intrinsic
18. Linear interpolation
19. Observed count rate
20. Photopeak
21. Pixel
22. Scatter
23. Sensitivity
24. Spatial Linearity
25. Spatial resolution
26. Spectrum
27. Standard deviation
28. System
29. Test pattern
30. Useful Field of View (UFOV)

VII. Test Equipment Conditions and Results

1. Source Holders and Test Fixtures
2. Radiation Sources
3. Test Conditions
4. Reporting

VIII. Gamma Camera QC

1. System Description
2. System components
3. Performance parameters
   a. Contrast resolution

b. Contrast
c. Matrix size and time per frame

IX. Quality Control procedures

1. Visual Inspection
   a. Rationale
   b. Methodology
   c. Acceptable Performance
   d. Frequency
2. Background level measurement
   a. Rationale
   b. Methodology
   c. Acceptable Performance
   d. Frequency
3. Photopeak and window setting
   a. Rationale
   b. Methodology
   c. Acceptable Performance
   d. Frequency
4. Sensitivity Measurement
   a. Rationale
   b. Methodology
   c. Acceptable Performance
   d. Frequency
5. Count Rate Performance
6. Sensitivity
7. Spatial Resolution
   a. Methodology
   b. Intrinsic Spatial Resolution
      - Test Conditions
      - Test Equipment
      - Measurement Procedure
      - Calculations and Analysis
      - Reporting
   c. Intrinsic Energy Resolution
      - Test Conditions
      - Measurement Procedure
      - Calculations and Analysis
      - Reporting
      - Examples
   d. Extrinsic Spatial Resolution
8. Linearity
   a. Rationale
   b. Methodology
   c. Acceptable Performance
9. Whole body scan Resolution
   a. Rationale
   b. Methodology
   c. Acceptable Performance
10. Intrinsic spatial resolution and linearity
    a. Examples
11. System spatial resolution and linearity
    a. General comments

b. Examples
12. Detector Head Tilt
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
13. Centre of Rotation (COR)
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
14. Detector Alignment
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
15. High Count Field Uniformity
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
16. Tomographic Resolution
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
17. Rotational Uniformity
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
18. Reconstruction Phantom Studies
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
19. Main Features
20. Reconstruction Phantom Studies
    a. Rationale
    b. Methodology
    c. Acceptable performance
    d. Frequency
21. Centre of Rotation (COR) Offset (x)
    a. Exemples
22. Image Alignment in Y for Multihead SPECT Systems
    a. Exemples
23. Data Reconstruction — Attenuation Correction
    a. Exemples

X. System Uniformity

1. Methodology
2. Intrinsic Flood Field Uniformity
    a. Test Conditions

b. Test Equipment
c. Measurement Procedure
d. Calculations and Analysis
e. Integral Uniformity
f. Differential Uniformity
g. Reporting

3. Extrinsic uniformity
4. Acceptable Performance
5. Uniformity – Quantification
6. Uniformity – Not so Good
7. Low to High Count Rate Intrinsic Floods
8. Pre-Assigned Action Levels
9. Pre-Assigned Action Levels
10. Symmetric energy window — 99mTc
    a. Examples
11. Uniformity with and without a uniformity correction map
12. Asymmetric energy windows
    a. Out of balance PM tubes
    b. Crystal hydration
    c. ADC problem related to internal corrections
    d. Examples
13. Different radionuclides and photon energies
    a. Exemples
14. Uniformity — quantification
    a. Exemples
15. Corrections (linearity, energy, uniformity)
    a. Exemples
16. Cracked crystal — puncture/impact
    a. Crystal hydration
    b. Examples
17. Faulty PM tube preamplifier
18. Collimator
    a. Exemples
19. Artefacts arising from sources/phantoms
    a. Fillable flood sources
    b. General comments
    c. Exemples
20. Cobalt sheet sources
    e. General comments
    f. Exemples

XI. System Planar Sensitivity

1. Test Conditions
2. Test Equipment
3. Measurement Procedure
4. Calculations and Analysis
5. Reporting

XII. Detector Shielding

1. Test Conditions
2. Test Equipment
3. Measurement Procedure
4. Calculations and Analysis

5. Reporting

XIII. System Alignment

1. Test Conditions
2. Test Equipment
3. Measurement Procedure

XIV. Correction Tables

XV. General Gamma Camera QC

1. Duties of the Personnel for QC of Gamma Camera
2. Good Practice tests
    a. Visual Check of Energy Spectrum
    b. Background Activity Check
    c. Cine Review of SPECT Data
    d. Sinogram Review of Data
3. Daily QC Tests
    a. Low Count Extrinsic or Intrinsic Flood
    b. Visual Inspection of Collimators
4. Less Frequentt ESTS
    a. Resolution Phantoms
    b. Center of Rotation (COR) Test
5. Summary of SPECT QC Tests

XVI. Documentation, Record Keeping and Action Thresholds

➢ Lecture 5: SPECT/CT Protocols (90 minutes)

Keywords: SPECT/CT scan, Single photon emission computed tomography (SPECT), Computed tomography (CT), Types of SPECT, Nuclear Medicine, Dual-Modality Imaging Systems, Early Development, Image Registration, Attenuation Correction, Patient Table Design, Imaging, Hardware, Reconstruction, Protocols, Acquisition protocols, Technical staffing, General Procedures, Cardiac Image, Quality Control, Sources of Error, Display errors, Modern SPECT/CT Systems

Objectives:

- Discuss what is a SPECT-CT scan
- Brief review basic science
- Describe dual-modality imaging systems and early development of SPECT/CT
- Review fundamentals of SPECT/CT and general architecture of SPECT/CT devices
- List SPECT/CT imaging (Hardware)
- Determine processing, suggested protocols for SPECT/CT and SPECT/CT acquisition protocols
- Discuss technical staffing for SPECT/CT
- Explain general Nuclear Medicine SPECT/CT procedures
- Illustrate cardiac SPECT/CT Image
- Define quality control
- Describe modern SPECT/CT systems

Content:

I. Introduction

1. CT
2. Nuclear Medicine
3. Hybrid imaging

II. SPECT-CT scan

21.Definitions
   a. SPECT/CT scanner
   b. SPECT/CT registration
   c. SPECT/CT fusion
   d. The method of attenuation correction

22.SPECT and the SPECT/CT cascade

23.Single photon emission computed tomography (SPECT)

24.Computed tomography (CT)

25.Types of SPECT
   a. SPECT/low-doseCT
   b. SPECT/multi-slice spiral CT: Siemens Symbia T series
   c. SPECT/multi-slice spiral CT: Phillips Precedence
   d. SPECT/CT: Dedicated Cardiac Solid-state Ultrafast CZT Camera

26.Clinical SPECT/CT Devices

III. Basic Science

IV. Dual-Modality Imaging Systems

V. Early Development of SPECT/CT

VI. Fundamentals of SPECT/CT

1. Image Registration
2. Attenuation Correction
3. Patient Table Design

VII. General architecture of SPECT/CT devices

VIII. SPECT/CT Imaging (Hardware)

1. Additional Considerations for Introducing a New SPECT/ CT System
   a. Communication and Patient Monitoring Aids
   b. Patient Positioning Supports
   c. Environmental Noise
2. SPECT/CT Imaging
   a. Hawkeye (GE Healthcear)
   b. Precedence (Philips Healthcear)
   c. BrightView XCT (Philips Healthcear)
   d. Astonish (Philips Healthcear)
   e. Symbia T (Siemens Medical Solution USA)
3. SPECT/CT Imaging: Reconstruction
   a. Flash3D (Siemens Medical Solution USA)
4. Radiopharmaceutical

IX. Processing

5. SPECT reconstruction
6. Display

X. Suggested Protocols for SPECT/CT

4. CT Protocols for Inclusion in Noncardiac SPECT/CT Protocols
5. CT Protocols for Inclusion in Cardiac SPECT/CT Protocols

XI. SPECT/CT acquisition protocols

24.Image Acquisition

e. Field of view, positioning, and preacquisition preparation
f. Protocol for CT imaging
g. Protocol for SPECT emission imaging

XII. Technical staffing for SPECT/CT

XIII. General Nuclear Medicine SPECT/CT Procedures

6. 131 I-Iodide SPECT/CT in thyroid cancer
7. Neural crest and adrenal tumours
8. 111 In-octreotide SPECT/CT for assessing neuroendocrine tumours
9. Lymphoscintigraphy
10. Skeletal scintigraphy for staging malignant disease
11. Skeletal SPECT/CT in orthopaedics
12. 201Tl-chloride in cerebral masses
13. 99m Tc-depreotide in solitary pulmonary nodules
14. SPECT/CT in the preoperative localization of parathyroid adenomas
15. SPECT/CT for diagnosing infection and inflammation

XIV. Cardiac SPECT/CT Image

6. Myocardial perfusion imaging — CT based attenuation correction
7. Cardiac SPECT/CT Image Display
8. Cardiac SPECT/CTA for assessing the significance of coronary artery lesions
9. Added values of CT in patients with coronary artery disease
   a. Coronary artery calcium
   b. Coronary computed tomography angiography
   c. Pulmonary artery imaging in pulmonary embolism

XV. Quality Control

4. Equipment performance guidelines
5. Equipment quality control
6. Emergency procedures
7. Sources of Error
   a. SPECT/CT image fusion errors
   b. Display errors

XVI. Modern SPECT/CT Systems

1. Additional Considerations for Introducing a New SPECT/ CT System
   a. Patient Weight Capacity of Patient Imaging Pallet (Bed)
   b. Minimum Height of the Patient Imaging Pallet (Bed)
   c. Travel Length of the Patient Imaging Pallet (Bed)
   d. Auto Contour and Positioning Optimization
   e. Automated Collimator Con fi guration
   f. Type of CT Unit
   g. CT Tube Loading
   h. Laser Positioning Lights
   i. Automated Routine Quality Control Mode
   j. Size of CT Patient Bore
   k. Degree of Flexibility with the Gamma Camera Detectors

l. Integrated ECG Hardware Port and Output Display

2. BrightView X and XCT onerview and specifications (Philips)
    a. Camera Characterictics
    b. Patient table
    c. JETStream acquistion
    d. Total body
    e. Emission tomography
    f. Detector
    g. Collimator
    h. XCT perfomance
    i. BrightView X and XCT detector speciffication 3/4" crystal
    j. Environmental requirements for general equipment location
3. Philips BrightView XCT with Astonish
    a. Astonish reconstruction
    b. Dose reduction capabilities
4. Infinia Hawkeye Hybrid SPECT/CT
    a. System Description
    b. Clinical Applications
    c. 3/8” Detector Characteristics
    d. Infinia Detector Performance NEMA Specifications Summary
    e. Gantry
    f. Patient Table
    g. Acquisition System Features
    h. Acquisition Types
    i. HawkeyeTM CT Technology
    j. Real-Time Auto-Body Contouring
    k. Power Requirements
    l. Room Layout
    m. Environment
5. Symbia T Series SPECT/CT
    a. Best-in-Class CT
    b. Flash Reconstruction
    c. SMARTZOOM Collimation
    d. Cardio-Centric Acquisition
    e. Advanced Reconstruction
    f. Low-Dose CT AC
    g. WorkStream4D
    h. Automated Workflow
    i. Features
    j. SPECT Specifications
    k. CT System Hardware
    l. Minimum Room Size

- Lecture 6: SPECT Troubleshooting Artifacts (60 minutes)

Keywords: Artifact (error), Instrument and computer-related artifacts in nuclear medicine, Instrumentation errors, Energy Resolution, Collimator, Sources/phantoms, Cobalt sheet sources, Spatial Resolution and Linearity, Uniformity, Myocardial perfusion, Patient-based artifact, Patient motion, Image processing, Display, Gating, Cardiac, CT artifacts, Ring artifact, Noise, Beam hardening, Scatter, Metallic Materials, Out of

field, Hardware-based artifacts, Helical and Multisection CT Artifacts, Temperature and humidity, PECT/CT Artifact,

Objectives:

- Discuss what is an artifact (error)
- Review instrument and computer-related artifacts in nuclear medicine
- Describe patient-based artifact
- Explain image processing and display artifacts
- Brief review gating artifacts and cardiac artifacts
- Define CT artifacts
- Illustrate SPECT/CT Artifact

Content:

I. Artifact (error)

1. Definition
2. Medical imaging
3. Medical electrophysiological monitoring

II. Introduction

4. Artifact groups
    a. camera dependent artifacts
    b. radiopharmaceutical dependent artifacts
    c. patient-related artifacts

III. Instrument and computer-related artifacts in nuclear medicine

27.Artifacts associated with instrumentation errors
    e. Flood field non-uniformity
    f. Center-of-rotation (COR) error
    g. Detector-to-patient distance

28.Energy Resolution
    a. Static clinical study — energy peak shift — electrical grounding problem
    b. Dynamic clinical study — energy peak shift — electrical grounding problem
    c. Clinical study — unstable energy window setting
    d. Asymmetric energy window — crystal hydration
    e. Asymmetric energy window — malfunction of energy calibration
    f. Asymmetric energy window — ADC problem related to internal corrections

29.Collimator
    a. Collimator septa and hole alignment assessed by a distant point source low energy collimator problems
    b. Examples
        - The hot artefacts were caused by the asymmetry of the 123I energy window over the 99mTc photopeak in the presence of 99mTc
        - Asymmetric energy window — clinical example with 123I and 99mTc
        - Uniformity — 201Tl, defective linearity correction — clinical images and uniformity
        - Clinical bone scan — defective PM tube

30.Artefacts arising from sources/phantoms
    a. Fillable flood sources
        - Air bubble
        - Adherence of activity to the container at the filling site (algae)

31.Cobalt sheet sources
    a. New 57Co sheet source
    b. Intrinsic uniformity — geometry of point source and detector — source too close to detector

32.Spatial Resolution and Linearity

a. Intrinsic spatial resolution influence of digital matrix size

33. SPECT uniformity
    a. Non-uniformity at the centre of the axis of rotation
    b. Single head SPECT — ring artefacts — real data
    c. Dual head SPECT — partial ring artefacts
    d. Dual head SPECT — partial ring artefacts — clinical study
    e. With and without uniformity correction — single head
34. Myocardial perfusion SPECT
    a. With and without uniformity correction
    b. Dual head system — line source — incorrect COR in one head
    c. FBP streak artefacts — hot organ activity outside of organ of interest

IV. Patient-based artifact

4. Patient motion
    a. Upward creep of heart
    b. Soft Tissue Artifact
    c. Lateral chest wall fat attenuation
    d. Soft tissue attenuation
    e. Breast Attenuation
    f. Overlying visceral activity
    g. Myocardial Hot spots
    h. Apical variants
    i. Liver Activity
    j. Bowel Activity
5. Errors in Selecting Oblique Cardiac Axes and Subsequent Polar Map

V. Image processing and display artifacts

1. Filtering
2. Adjacent subdiaphragmatic activity
3. Scatter
4. Ramp filter artifact
5. Improper selection of the apex and base for polar map reconstruction
6. Errors in axis reorientation
7. Inadequate image display
8. Left bundle-branch block (LBBB)
9. Left ventricular hypertrophy

VI. Gating artifacts

VII. Cardiac artifacts

VIII. CT artifacts

1. Ring artifact
2. Noise
3. Beam hardening and Scatter
4. Metal artifact
5. Out of field “artifact”
6. Patient-based artifacts
    a. Motion artifact and Transient interruption of contrast
    b. Metallic Materials
        - Avoidance of metal artifacts by the operator
        - Software corrections for metal artifacts
    c. Patient Motion

- Avoidance of motion artifacts by the operator
- Built-in features for minimizing motion artifacts

d. Incomplete Projections

7. Physics-based artifacts
   a. Beam hardening
      - Cupping artifact
      - Streak and darks bands
      - Metal artifact/high-density foreign material artifact
   b. Correct streak artifacts
   c. Built-in features for minimizing beam hardening
      - Calibration correction
      - Beam hardening correction software
      - Avoidance of beam hardening by the operator
   d. Partial volume averaging
   e. Photon starvation
      - Automatic Tube Current Modulation
   f. Quantum mottle (noise)
   g. Aliasing in CT
8. Hardware-based artifacts
   a. Ring artifact
      - Avoidance and Software Corrections
   b. Tube arcing
   c. Out of field artifact
9. Helical and Multisection CT Artifacts
   a. Helical Artifacts in the Axial Plane: Single-Section Scanning
   b. Helical Artifacts in Multisection Scanning
   c. Cone Beam Effect
   d. Stair Step Artifacts
   e. Zebra Artifacts
10. Temperature and humidity

IX. PECT/CT Artifact

5. Artifacts on SPECT-CT Images
6. Causes of Artifacts on CT
7. Causes of Artifacts on SPECT/CT
8. Long Bones and Knees
9. Abdomen and Pelvis
10. Pitfalls in Radionuclide Bone Scintigraphy
    a. Artifacts on Radionuclide Planar Bone Scintigraphy
11. Cold Spots on a Bone Scan
12. Contamination
13. SPECT/CT Misregistration
14. Respiration During SPECT/CT
15. Arms Up or Down?
16. Highly Attenuating (Metal) Foreign Bodies or Contrast Agents
17. Patient Size and CT Noise
18. Limitations of the CT Scanner
19. Extraosseus Uptake on Bone Scintigraphy
20. Cardiac
21. Image Display
22. Image Interpretation and Reporting
23. Attenuation Correction and Artifacts: Artifacts of Soft Tissue Attenuation
24. Artifacts of Subdiaphragmatic Radiotracer Activity

25. Artifacts of Patient Motion
26. Artifacts of Misregistration
27. Effects of Normal Apical Thinning

➢ Lecture 7: SPECT/CT Case Studies (60 minutes)

Keywords: Clinical Impact of SPECT/CT, Anatomical localisation, Overall impact, Lymphoma / Tumours, Infection imaging, Bone imaging, Neuroendocrine tumours, MIBG scintigraphy, Parathyroid imaging, Thyroid cancer, Lymphoscintigraphy, Cavernous haemangioma and liver lesions, Brain disorders, Infinia Hawkeye, Siemens, Philips, Advantages of Philips, Full Iterative Technology (FIT)

Objectives:

- Discuss clinical impact of SPECT/CT
- Case Studies of Infinia Hawkeye 4
- Case Studies of Siemens
- Case Studies of Philips

Content:

I. Clinical Impact of SPECT/CT

4. Anatomical localisation
5. Overall impact of SPECT/CT
6. Lymphoma / Tumours
7. Infection imaging
8. Bone imaging
9. Neuroendocrine tumours
10. MIBG scintigraphy
11. Parathyroid imaging
12. Thyroid cancer
13. Lymphoscintigraphy
14. Cavernous haemangioma and liver lesions
15. Brain disorders

II. Infinia Hawkeye 4 Case Studies

5. SPECT/CT in bone scintigraphy
   a. Case 1
   b. Case 2
6. SPECT/CT in leukocyte scintigraphy
   a. Case 3
   b. Case 4
7. SPECT/CT in nuclear oncology
   a. Case 5
   b. Case 6
   c. Case 7
   d. Case 8
   e. Case 9
8. SPECT/CT in nuclear cardiology
   a. Case 10
9. SPECT/CT in general nuclear medicine
   a. Case 11

b. Case 12
c. Case 13

III. Siemens Case Studies

35.Partial Vertebral Compression Defined by xSPECT Bone
h. History
i. Diagnosis
j. Comments
k. Conclusion
l. Examination Protocol

36. Delineation of Femoral Lytic Lesions with xSPECT Bone in a Patient with Multiple Myeloma
a. History
b. Diagnosis
c. Value of xSPECT Bone Imaging
d. Examination Protocol

37.xSPECT Imaging in a Patient with Diffuse Skeletal Metastases: Quantification of tracer uptake within lumbar vertebrae
a. History
b. Examination Protocol
c. Analysis
d. Comments

IV. Philips Case Studies

10.Advantages of Philips BrightView XCT nuclear medicine system
a. Registration confidence with CoPlanar
b. Flexible breathing
c. High resolution – low dose
d. Nuclear medicine – tailored workflow
e. Fits the nuclear medicine space

11.Full Iterative Technology (FIT)

12.Cardiology
a. Trusted attenuation correction
b. Cardiology case study
- Inferior wall attenuation correction
- Anterior wall attenuation correction

13.Oncology
a. Low dose localization
b. Neuroblastoma
c. MAA mapping for radioembolization
d. Carcinoma of the penis
e. Post Lu-177 DOTA-TATE therapy
f. Incidental pulmonary nodule
g. Benign reactive lymph node
h. Right breast mass
i. Metastatic neuroblastoma
j. Lymphoscintigraphy of the penis
k. Sarcoma in pubic symphysis
l. Pheochromocytoma in adrenal nodule
m. Calcification of tibial-fibular ligament
n. Thyroid cancer
o. Neuroendocrine tumor of ilium
p. Melanoma at the right ear
q. Pheochromocytoma

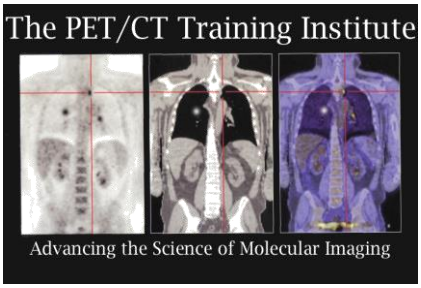
r. Bilateral breast cancer
s. Left adrenal mass
t. Hemangioendothelioma
u. Sclerotic bony metastases
v. Multiple degenerative mutations of spine
w. Lung cancer evaluation for bone mets

14.Orthopedics
a. Multiple fractures in Down's Syndrome patient
b. Early pars stress fracture
c. Scaphoid fracture
d. Right foot pain
e. Torus palatini
f. Biceps enthesopathy
g. Osteonecrosis
h. Calcaneal fracture
i. Cervical spine pain
j. Sacroiliitis
k. Guide facet block or medial branch block
l. Stress fracture of tibia
m. Pseudoarthrosis
n. Atypical insufficiency fractures

15.Infection
a. Pelvic graft infection
b. Foot and shin ulcers
c. Apophysitis verses Brodie's abscess
d. Osteomyelitis with sequester
e. Occult fracture

16.Other localization
a. Pulmonary embolism
b. Biliary leak
c. Lung perfusion with unusual anatomy
d. Venogram
e. Hyperparathyroidism

V. Conclusion
VI. Post Test
VII. Course Evaluation



50 HR "CT REGISTRY REVIEW COURSE"
Course Control Document
Timothy K. Marshel, MBA, R.T. (R), (N)(CT)(MR)(NCT)(PET)(CNMT)
The PET/CT Training Institute, Inc.

Course Overview:

This *50 hour* online self- study "***CT Registry Review Course"*** is designed to provide entry level and experienced Technologist with a comprehensive knowledge of elementary principles and practices related to ***CT and SPECT/CT imaging***. This course can also be used to prepare technologists to take the NMTCB or ARRT CT Registry exam, or to provide technologist with ARRT, ASRT, NMTCB, ICANL, ACR, and State DOH, Society of Nuclear Medicine and Molecular Imaging- Technologist Section approved category A Voice credits.

Course Objectives:

These courses are intended for Technologist who needs an effective way to prepare for, and pass, the NMTCB/ARRT CT Certification Examination. This course curriculum will provide broad fundamental knowledge of CT and SPECT/CT principles and concepts as outlined in the published Content Specifications of the NMTCB and ARRT. This course provides sample questions and different test strategies to help prepare the student to be successful with the CT certification examination. In addition, the course will consist of an overview of CT Physics, Instrumentation, Radiation Safety and Protection, CT Quality Control, Contrast Medias, Artifacts, Special Procedures, Pediatric and Adult Methodology, Acquisition Protocols, and Cross Sectional Anatomy with and without contrast agents.

Title: ***Syllabus Review (Course Control Document)***
Title: ***Disclaimer***
Title: ***PRE-TEST***

Title: MIWIQI Lecture I: Introduction to CT: The Fundamentals *(60 minutes)*

Keywords: *CT Definitions, Tomographic Principles, Planes, CT Roots, CT components*

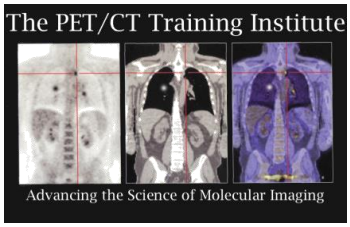
Objectives:

- *Describe the discovery of computed tomography.*
- *Explain the basic designs of earlier CT scanner generations.*
- *Identify the function of CT components.*
- *List the uses of CT in medical diagnostics.*
- *Discuss basic image processing.*

Contents

1. *Basic CT Definitions and terminology*
2. *Tomographic principles*
3. *Tomographic Planes*
4. *CT history*
5. *Founder Godfrey Hounsfield*
6. *Earlier CT generations*
7. *Dual Source CT*
8. *Beam Geometry*
9. *Pencil Beam*
10. *Fan Beam*
11. *Cone Beam*
12. *Multidetector CT*
13. *Digital Imaging*
14. *Sequential Scanning*
15. *Spiral Imaging*
16. *Helical Imaging*
17. *Tissue Differentiations*
18. *Basic Components of CT System*
19. *Console*
20. *Gantry*
21. *Table*
22. *CT Tube*
23. *Generators*
24. *Slip rings*
25. *Filters*
26. *Collimators*
27. *Detectors*
28. *Arrays*
29. *Data Acquisition Systems*
30. *Array Processors*
31. *Monitors*
32. *Archival devices*

MIWIEI: Exam I: "Introduction to CT: The Fundamentals" *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIWIIQI Lecture 2: Basic CT Instrumentation *(60 minutes)*

Keywords*: CT scanner components, Axes, Helical Scanners, Conventional Axial Scanning, Volumetric acquisitions, Operators console*

Objectives

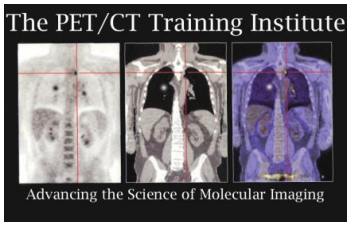
- *Explain the CT Scanner Computer System*
- *Trace the electrical current from the CT Tube to the image display components*
- *Discuss how to adjust the operator controls that effect the image quality*
- *Discuss the key elements of a digital CT image.*

Contents

1. *CT Scanner components*
2. *Patient Imaging table*
3. *X,Y, Z axes*
4. *Gantry*
5. *CT Tube*
6. *Generator*
7. *Detectors*
8. *Collimators*
9. *Scanner configurations*
10. *Helical Scanners*
11. *Axial Scanning*
12. *MDCT*
13. *Volumetric Acquisitions*
14. *Slip rings*
15. *Operators console*
16. *Pitch*
17. *Scan Field of View*
18. *Display Field of View*
19. *Annotations*
20. *Scout localizers*
21. *Regions of Interest*
22. *CT/Hounsfield Numbers*
23. *Window Width*
24. *Window Level*
25. *Computer systems*

26. *Digital images*
27. *Pixel*
28. *Matrix*
29. *Voxel*
30. *Sampling*
31. *Aliasing*
32. *Spatial Resolution*
33. *Contrast Resolution*
34. *Temporal Resolution*
35. *Noise*
36. *Partial Volume Averaging*

MIWIIEII: Exam 2: "Basic CT Instrumentation"*: You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIWIIIQI: Lecture 3: "CT Data Acquisition" *(90 minutes)*

Keywords*: Axial Scanning, Spiral Technology, Helical Scanning, Cine, Data Acquisition Systems, ADC, DAC, Amplifiers, Binary Encoding, Fourier Transforms, Aliasing Artifacts*

Objectives

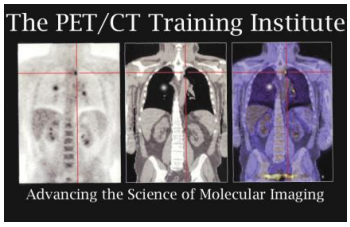
- *Discuss the methods for acquiring CT images.*
- *Explain the Data Acquisition System.*
- *Discuss the process of acquiring the CT data.*
- *Identify the key factors that can influence the raw data.*
- *Review the selectable scanning parameters used to acquire the CT data.*

Contents

1. *Axial Scanning*
2. *Helical Technology*
3. *Spiral Scanning*
4. *Cine mode*
5. *Data Acquisition processes*
6. *Lambert-Beer Law*
7. *CT Hounsfield Numbers*
8. *Data Acquisition System*
9. *Analog to Digital Converters*

10. *Digital to Analog Converters*
11. *Amplifiers*
12. *Transmitted Beam Measurements*
13. *Binary Data Encoding*
14. *Binary System*
15. *Fourier Transformations*
16. *Data Transmissions*
17. *Aliasing Artifacts*
18. *Ring Artifacts*
19. *Convolutions*
20. *Back Projections*
21. *Iterative Algorithm's*
22. *Analytic Reconstructions*
23. *Kernels*
24. *Interpolations*
25. *Digital Acquisition System performances*
26. *CT Tube*
27. *Detectors*
28. *Gas Ionization Detectors*
29. *Scintillation Detectors*
30. *Detector Properties*
31. *Data Acquisition*
32. *Filters*
33. *Collimators*
34. *Pre patient Collimators*
35. *Post Patient Collimators*
36. *Selectable Scan Factors*
37. *Scan Field of View*
38. *Display Field of View*
39. *Matrix*
40. *Slice Thickness*
41. *Spacing*
42. *Reconstruction Intervals*
43. *mAs*
44. *kVp*
45. *Kernels*
46. *Bypass Filters*
47. *Scan Time*
48. *Rotational Arcs*
49. *Rotation Times*
50. *Regions of Interest*
51. *Magnifications*
52. *Focal Spot Size*
53. *Tube Geometry*
54. *Dose Modulation*
55. *Pitch*

MIWIIIEIII: Exam3: "CT Data Acquisition"*: You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIWIVQI: Lecture 4: "CT Image Processing and Reconstruction" *(90 minutes)*

Keywords: Linear Interpolation, Filtered Back Projections, Z-Axis Filtering, Interlaced Sampling, Smoothing, Windowing, Rendering, 3-D Reconstructions

Objectives

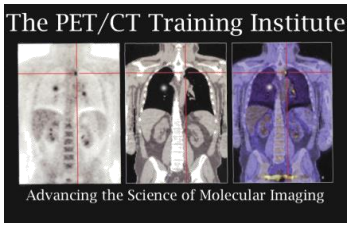
- *Describe the CT reconstruction steps.*
- *Discuss Image Enhancement, and post processing techniques.*
- *Discuss the tools used to view a CT Scan.*
- *Discuss various workstation applications used with specialized CT studies.*
- *Discuss recording and archival of CT data.*

Content

1. *CT Image processing*
2. *Reconstruction*
3. *Mini and Microprocessors*
4. *Array Processors*
5. *Simple Back Projections*
6. *Linear Interpolation*
7. *Z-Axis Filtering*
8. *Interlaced Sampling*
9. *Retrospective Reconstruction*
10. *Reformatting*
11. *Maximum Intensity Pixels*
12. *Image Smoothing*
13. *Edge Enhancements*
14. *Gray Scale Manipulation*
15. *Window Width*
16. *Window Level*
17. *WW/WL Equation*
18. *Shaded Surface Rendering*
19. *Multiplanar Reconstructions*
20. *Curved Multiplanar Reconstructions*
21. *Volume Rendering*

22. *3-D Reconstruction*
23. *Image Display*
24. *Cathode X-Ray Tubes*
25. *Liquid Crystal Display*
26. *Pan*
27. *Zoom*
28. *Scroll*
29. *Swivel*
30. *Roll*
31. *Rotate*
32. Measurement
33. Magnify
34. Viewing
35. 2-D vs 3-D
36. Slab
37. Planar
38. Cine
39. Workstation
40. Patient Directory
41. Print
42. Delete
43. Archival
44. Query
45. Network
46. Copy
47. Applications
48. Ejection Fraction
49. Calcium Scoring
50. Stereotaxic
51. Radiation Oncology Treatment Planning
52. Fusion
53. Neurology
54. Vessel Analysis
55. Vessel Tracking
56. Recording
57. Archiving
58. Laser Cameras
59. PACS

MIWIVEIV: Exam 4: "CT Image Processing and Reconstruction": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIIWIQI: Lecture 5: "CT Radiation Safety and Protection" (60 minutes)

Keywords: Measuring Patient Doses, CT Dose Indices, mA Modulation, Pitch, Occupational Exposures, CT Order, Contrast Contraindications, Power Injectors, Venipuncture, Extravasation

Objectives

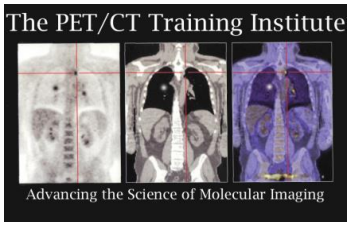
- Describe the methods used to measure a patients CT dose.
- Discuss the role of the CT Technologist in reducing the radiation exposures.
- Explain the occupational exposures in the CT department.
- Discuss the pediatric patient special considerations.
- Describe ethical considerations, including the overuse of CT, appropriate imaging of pediatric patients and how protocols can affect scanning.
- Discuss basic patient care and safety principles.
- Discuss Venipuncture techniques in the CT lab.
- Discuss the use of CT contrast and Informed Consent.
- Explain PRE and Post procedures Instructions.
- Discuss Emergency procedures.

Content

1. Patient Safety
2. Measuring Patient Dose
3. CT Dose Indices
4. Reducing Radiation Dose
5. Patient Education
6. Physicians Education
7. Positioning
8. Shielding
9. Technical Factors
10. kVp and mAs
11. mA Modulation
12. Pitch
13. Collimation
14. Gating
15. Detector Configuration
16. Occupational Exposure
17. CT Order
18. Contrast
19. Contrast Contraindications
20. Power Injectors

21. Venipuncture
22. Venipuncture procedures
23. Extravasation
24. Central Access Devices
25. PICC Lines
26. Port a Cath
27. Perm a Cath
28. Prescan Procedures
29. Metformin
30. Patient Consent
31. IV Lines
32. Post Scan Instructions
33. Ethics
34. Restraints
35. Pediatrics
36. Pregnant Patients
37. Emergency Equipment
38. Emergency Situations

MIIWIEV: Exam 5: "CT Safety and Protection": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIIWIIQI: Lecture 6: "CT Radiation Dose Calculations" *(60 minutes)*

Keywords*: Volume CTDI, Patient Dose, mGy, Size Specific Dose Estimates, Dose Length Product, Scan Modes, Table Feed/Increments, Automatic Exposure Controls*

Objectives

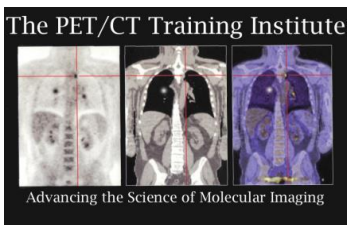
- *Discuss radiation dose output.*
- *Describe how volume CTDI is related to patient dose.*
- *Discuss Dose Modulation and reduction methods.*
- *Describe dose display.*

Content

1. *CTDI Volume*
2. *Patient Dose*
3. *Size Specific Dose Estimate*

4. *ACR Dose Index Registry*
5. *Dose Length Product*
6. *mGy*
7. *Axial*
8. *Helical*
9. *Spiral*
10. *Dynamic*
11. *Table Feed/Increment*
12. *Detector Configuration*
13. *Beam Collimation*
14. *Pitch*
15. *Exposure Time vs Rotation*
16. *Tube Current*
17. *Tube Potential*
18. *Tube Current Time Product*
19. *Effective Tube Current Time Product*
20. *Field of Measurement*
21. *Beam Shaping Filter*
22. *Dose Modulation and Reduction*
23. *Automatic Exposure Control*
24. *Image Quality Reference Parameter*
25. *Angular Tube Current Modulation*
26. *Longitudinal Tube Current Modulation*
27. *ECG Based Tube Current Modulation*
28. *Retrospective Gating*
29. *Organ Based Tube Current Modulation*
30. *Automatic Tube Potential Selection*
31. *Iterative Reconstruction*
32. *Noise Reduction Techniques*
33. *Dose Display*
34. *Post Study Data Page*
35. *Summing dose Report Values*
36. *Dose Notification Levels*
37. *Dose Alert Levels*
38. *Radiation Dose Structured Reports*

MIIWIIEVI: Exam 6: "CT Radiation Dose Calculations"*: You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



***Title: MIIWIIIQI: Lecture 7**: "**Measuring a Patients Dose from a CT scanner"** (90 minutes)*

***Keywords:** Matrix, Voxel, CT Numbers, Grey Scale, Parallel Beam, Fan Beam, Spiral Beam, Tube trajectory, Hounsfield Units, Ionization Chamber, Absorbed Dose*

Objectives

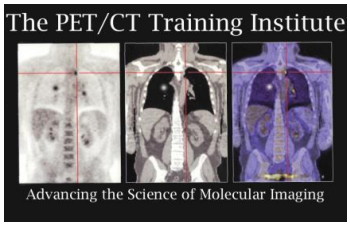
- *Discuss the basic principles of CT*
- *Describe the geometry of a CT scanner.*
- *Examine the measurements of a patient dose.*
- *Discuss the dosimetry quantities in CT.*
- *Describe the principals of thermo luminescent dosimeters.*
- *Examine the CTDI dosimetry of an acrylic phantom.*
- *Explore multi scan average dose.*
- *Discuss dose length products.*
- *Discuss methods for reducing patient doses.*

Content

1. *Tomography*
2. *Background*
3. *X-Radiation*
4. *Tube Principles*
5. *Conventional X-Rays*
6. *Attenuation*
7. *Absorption*
8. *Scatter*
9. *Intensity*
10. *Image Densities*
11. *Prototype CT Scanners*
12. *Present CT Scanners*
13. *2-D Array*
14. *Slice/Cut*
15. *Matrix*
16. *Pixel*
17. *Voxel*
18. *Digital image*
19. *CT Numbers*
20. *Grey Scale*
21. *Phases of CT*
22. *Parallel Beam*
23. *Fan Beam*
24. *Spiral Beam*
25. *Gantry*
26. *X-Ray Tube*
27. *X-Ray Detectors*
28. *Beam Geometry*

29. *Tube Trajectory*
30. *Hounsfield Units*
31. *CT Number Conversions*
32. *Volume Acquisitions*
33. *Serial Acquisitions*
34. *FOV*
35. *Image Manipulation*
36. *Windowing*
37. *Ionization Chamber*
38. *Absorbed Dose*
39. *Single Slice Radiation Dose*
40. *Weighted CTDI*
41. *Volume CTDI*
42. *Dose Length Product*
43. *Effective Dose*
44. *Radiation Units*
45. *Radiation Dosimetry*
46. *CTDI 100*
47. *CTDI (w)*
48. *CTDI (Volume)*
49. *Pencil Ionization Chamber*
50. *CT Phantom*
51. *Z-Axis Dose Profile*
52. *Thyroid Shield*
53. *Gonadal Shield*

***MIIWIIIEVII: Exam 7**: "**Measuring a Patients Dose from a CT scanner"**: You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



***Title: MIIIWIQI: Lecture 8**: "**CT Image Quality"** (90 minutes)*

***Keywords:** Image Quality, Contrast Resolution, Linearity, Uniformity, Spatial Resolution, Temporal Resolution, Focal Spot Size, Image Receptor, Subject Contrast, Selectable Factors, Preset Options, Artifacts*

Objectives

- *Discuss factors that affect image quality in CT.*
- *Explain the methodology used to define image quality.*
- *Identify CT image artifacts.*

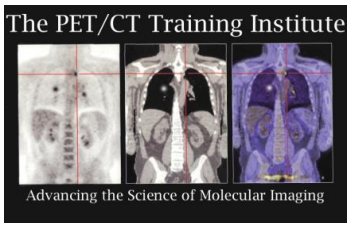
- *List factors that influence artifacts.*
- *Identify the tests associated with a QC program.*

Content

1. *Image quality*
2. *Contrast Resolution*
3. *Linearity*
4. *Noise*
5. *Uniformity*
6. *Spatial Resolution*
7. *Temporal Resolution*
8. *Factors Influencing Image Quality*
9. *Focal Spot Size*
10. *Beam Geometry*
11. *Image Receptor*
12. *Subject Contrast*
13. *Viewing Conditions*
14. *Selectable Factors*
15. *mA*
16. *Scan Time*
17. *SFOV*
18. *DFOV*
19. *Slice Thickness and Spacing*
20. *Filters*
21. *kVp*
22. *Preset Options*
23. *Artifacts*
24. *Beam Hardening Artifacts*
25. *Partial Volume Averaging Artifacts*
26. *Motion Artifacts*
27. *Metal Artifacts*
28. *Equipment Artifacts*
29. *Ring Artifacts*
30. *Cone Beam Artifacts*
31. *Edge Gradient Artifacts*
32. *Out of Field Artifacts*
33. *Quality Control Program*
34. *Principles of QC Testing*
35. *Phantom set up*
36. *CT Number Calibration Tests*
37. *Standard Deviation of the CT Number in Water*
38. *High Contrast Resolution*
39. *Low Contrast Resolution*
40. *Distance Measuring Device Accuracy*
41. *Video Monitor Distortion*
42. *CT Number Flatness*
43. *Hard Copy Output*

44. *Localization Device Accuracy*
45. *CT Couch Indexing*
46. *CT Couch Backlash*
47. *Light Field Accuracy*
48. *Slice Width*
49. *Radiation Leakage and Scatter*
50. *Measurements by Physicist*

***MIIIWIEVIII: Exam 8**: "**CT Image Quality**": You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MIIIWIIQI: Lecture 9: "CT Quality Control Procedures" (90 minutes)

Keywords: Quality Assurance, Quality Control, Record Keeping, QC Tests, Average CT Numbers, Standard Deviation, High Contrast Resolution, Low Contrast Resolution, Accuracy, Noise Properties

Objectives

- Discuss what Quality Control is.
- Discuss why we need Quality Control.
- Explain the principles of Quality Control
- Discuss the Quality Control procedures performed on a CT Scanner.
- Discuss Image Quality.

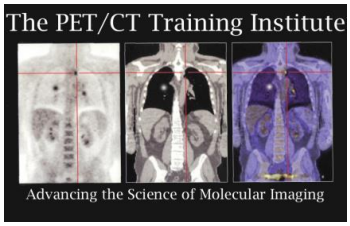
Content

1. Quality Assurance Program
2. Quality Control
3. Periodic QC procedures
4. Record Keeping
5. Average CT Number in Water
6. Standard Deviation of CT
7. High Contrast Resolution
8. Low Contrast Resolution
9. Accuracy of Distance Measuring Devices
10. Accuracy of Image Measuring Devices
11. Resolution
12. Noise Properties
13. Linearity

14. Common Artifacts
15. Image Quality Parameters
16. Factors Influencing Quality
17. Spatial Resolution
18. Resolvable Object Size
19. Limiting Resolution
20. Geometric Factors affecting Spatial Resolution
21. Geometric Unsharpness
22. Non Geometric Factors affecting Spatial Resolution
23. Reconstruction Algorithms
24. CT Contrast Resolution
25. Noise Level
26. Noise Measurement in CT
27. Photon Flux to Detectors
28. Slice Thickness
29. CT Image Quality Equation
30. Point Spread Function
31. Qualifying Blurring
32. Full Width at Half Maximum
33. Line Spread Function
34. Contrast Response Function
35. CT Phantom
36. Modulation Transfer Function
37. Component Modulation Transfer Function
38. CT Number Calculations
39. Linearity
40. CatPhan
41. Cross field Uniformity
42. CT Artifacts-Distortion
43. CT Artifacts: Causes
44. Motion Artifacts
45. Abrupt High Contrast Changes
46. Beam Hardening Artifacts
47. Partial Volume Effects
48. Ring Artifacts
49. Slice Sensitivity
50. Multiple Scan Average Dose
51. CT Dosimetry
52. Single Dose Descriptor
53. Patient Dose
54. Linear Attenuation Coefficients
55. Attenuation
56. Atomic Number
57. Density of Electrons
58. Thickness
59. Photon Energy
60. kVp
61. Slice Thickness

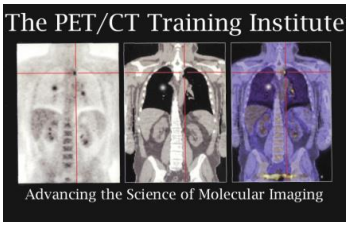
62. Single Row Detectors Scanners
63. Multi Row Detectors Scanners
64. Table Increments
65. Pitch
66. Pitch Affects
67. Reconstruction Intervals
68. Field of View
69. Scan Field of View
70. Reconstruction Field of View
71. Matrix
72. Magnification
73. Widow Width and Window Level

MIIIWIIEIX: Exam 9: "CT Quality Control Procedures": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MIIIWIIIQI: Lecture 10: "Artifacts in CT"

MIIIWIIIEX: Exam 10: "Artifacts in Computed Tomography": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIVWIQI: Lecture 11: "CT Image Processing and Reconstruction" (90 minutes)

Keywords: Image Processing and Reconstruction, Array Processors, Backprojection, Linear Interpolation

Objectives

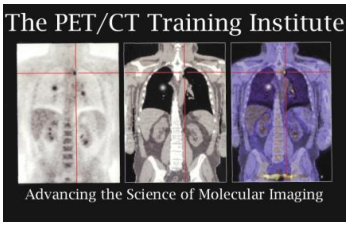
- Describe the required steps for CT image reconstruction.
- List the post processing techniques need for image enhancement.
- Define the tools needed used to view a CT image.
- List the workstation applications used for specialized CT Scanning.
- Describe the methods of recording and archiving CT data.

Content

1. Image Processing
2. Image Reconstruction
3. Minicomputer
4. Microprocessor
5. Array Processor
6. Back projection
7. Linear Interpolation
8. Filtered Back projection
9. Longitudinal Interpolation
10. Interlaced Sampling
11. Reconstruction
12. Reformatting
13. Specific Post processing Techniques
14. Maximum Intensity Pixels
15. Minimum Intensity Pixels
16. Image Smoothing
17. Edge Enhancement
18. Gray-Scale Manipulation
19. Window Width
20. Window Level
21. Shaded Surface Rendering
22. Multi planar Reconstruction
23. Curved Multi planar Reconstruction
24. Volume Rendering
25. 3 D Reconstruction
26. Virtual Reality
27. Image Display
28. Image Manipulation
29. Image Recording
30. Image Archiving
31. Cathode Ray Tube
32. Liquid Crystal Display
33. Pan
34. Zoom
35. Image Scrolling
36. Swivel
37. Roll
38. Rotate
39. Measurement
40. Magnify
41. Viewing Modes
42. 2 D vs. 3 D
43. Slab
44. Planar
45. Cine
46. Technologist Workstation
47. Directory

48. Patient List
49. Film
50. Print
51. Delete
52. Archive Button
53. Query
54. Send
55. Network
56. Copy
57. Applications
58. Ejection Fraction
59. Calcium Scoring
60. Stereotaxic
61. Radiation Oncology Treatment Planning
62. Fusion
63. Neurology
64. Vessel Analysis
65. Vessel Tracking
66. Laser Camera
67. PACS

MIVWIEXI: Exam 11: "CT Image Processing and Reconstruction": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MIVWIIQI: Lecture 12: "CT Physics and Instrumentation" (90 minutes)

Keywords: Bremsstrahlung Radiation, Characteristic X-Rays, Voltage Variation, CT scanner Design, Rotation Speed, Kernels, Shaded Surface Displays, Scout, Scan Geometry, Mosaic Detectors

Objectives

- Describe the physics processes involved in the production of X-Rays.
- Describe the role of each component in the X-Ray Tube.
- Discuss the role of proper adjustments of X-Ray Tube voltage and current in CT.
- Name the principle parts of a CT scanner.
- Discuss the function of each CT scanner component.
- Discuss how CT image data is acquired and processed.
- Describe the calculation process of the Hounsfield Unit.
- Describe CT number values assigned to various tissues and how each of these values are assigned into meaningful display windowing.
- Discuss CT image quality issues.
- List the origin of CT image artifacts and describe their prevention.

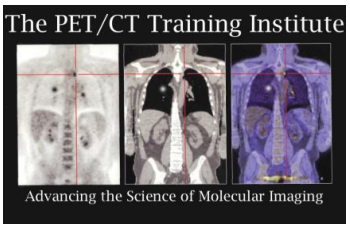
- Discuss appropriate parameters for the acquisition of low-dose CT for PET attenuation correction.
- Describe the parameters and image characteristics required for a diagnostic CT scan.
- Discuss the importance of CT quality Control.
- Review a CT scanner's system configuration.

Content

1. X-Ray Physics
2. Bremsstrahlung Radiation
3. Characteristic X-Rays
4. X-Ray Tube Design
5. Voltage Variation
6. Beam Hardening
7. Advantages and Disadvantages of high kVp
8. Current Variation
9. Advantages and Disadvantages of current variations
10. X-Ray Filters
11. CT scanner design
12. Gantry Composition
13. X-Ray Detectors
14. Collimation
15. Rotation Speed
16. Pitch
17. Increments
18. Image Data Acquisition
19. CT Reconstruction
20. Hounsfield Units
21. Tissue Hounsfield Unit values
22. CT Reconstruction Algorithm's
23. Post Processing Filtering
24. CT Display
25. Limitations of CT Display
26. Volumetric Image Data
27. MIP
28. Shaded Surface Displays
29. Image Noise
30. CT Artifacts
31. Streaks
32. Rings
33. Bands
34. Shading
35. Quality Control
36. Hardware components
37. Scan Geometry
38. Mosaic Detector
39. Detector Configurations
40. Axial Signal Collection
41. Axial Interfacing
42. Axial Intervals
43. Axial Interval with Skip

44. Tilt Correction
45. Helical Pitch
46. Helical Configurations
47. Helical Interface
48. Retrospective
49. Prospective
50. Slice Profiles

Proceed to Lecture 13



Title: MIVWIIQII: Lecture 13: "**CT Instrumentation and Operations"** (60 minutes)

Keywords: Coordinate System, Gantry, Detectors, ADC, High Voltage Generator, Gantry Control, DAC, Scan Controller, Host Computer, Console, Array Processors

Objectives

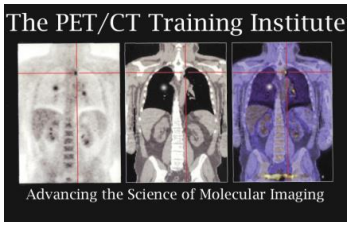
- Discuss the key components of a basic CT scanner.
- Discuss the components found within the housing unit of the Gantry.
- Discuss the coordinate system of a CT scanner.
- Discuss the scannable ranges of a CT system.
- Discuss the patient couch weight limits.
- Discuss the different focal spot sizes.
- Discuss how the tube voltage would have an impact on the CT image.
- Discuss various CT Detector scintillation crystals.

Content

1. Imaging system
2. Computer system
3. Data display
4. Recording systems
5. Gantry
6. Detectors
7. Analog to Digital Converters
8. Array Processors
9. Storage
10. X-Ray Tube
11. High Voltage Generators
12. Host Computer

13. Gantry Control
14. DAC
15. Scan Controller
16. Console
17. Couch
18. Collimator
19. Aperture
20. Tilt Range
21. Coordinate System
22. Isocenter
23. Tilt Range
24. Maximum Scannable Range
25. Filter
26. Detector Electronics
27. Thermionic Emission
28. Focal Spot Sizes
29. Anode
30. Tungsten
31. Tube Current
32. kVp
33. Time of Exposure
34. Heat Units
35. Technique Compensation
36. CT Generator
37. Collimation
38. Filtration materials
39. Detector Types
40. Scintillation Crystals
41. Photocathodes
42. Sodium Iodide
43. Calcium Fluoride
44. Bismuth Germanate
45. Calcium Tungstate
46. Gas Ionization
47. Computer System
48. Minicomputers
49. Sequential Processing
50. Unix
51. Windows
52. Amplifiers
53. Sample Hold Units
54. Image Display
55. Laser Printers
56. Hard Copy
57. CT Layout

MIVWIIEXII: Exam 12: "CT Physics and Instrumentation": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MVWIQI: Lecture 14: "**Cross Sectional Anatomy of the Head and Neck"** (90 minutes)

Keywords: Body Planes, Directional Terminology, Skull, Frontal Bones, Parietal Bones, Temporal Bones, Auditory Ossicles, Vestibules, Ethmoid, Sphenoid Sinus, Occipital Bone, Facial Bones, Nasal Septum

Objectives

- Describe the anatomical planes of the body.
- Define directional terminology related to the body.
- Describe human embryo development
- Name the major structures of the head and neck.
- Describe the function of each anatomical structure.
- Locate specific organs or structures on a schematic image.
- Identify the anatomical planes in which cross sectional images were either acquired or reformatted.
- Recall the structures of the human vascular system.
- Name the 12 cranial nerves, their distribution and function.
- Identify selected muscular structures.

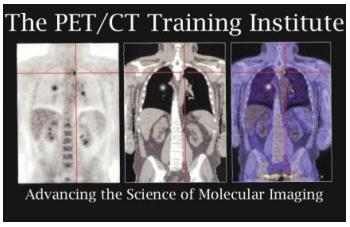
Content

1. Body Planes
2. Directional Terminology
3. Axial Plane
4. Coronal Plane
5. Sagittal Plane
6. Oblique Planes
7. Anterior
8. Posterior
9. Caudal
10. Cranial
11. Proximal
12. Distal
13. Dorsal
14. Ventral
15. Superior

16. Inferior
17. Lateral
18. Medial
19. Prone
20. Supine
21. Skull
22. Frontal Bones
23. Parietal Bones
24. Temporal Bones
25. Petrous Bones
26. Auditory Ossicles
27. Vestibule
28. Ethmoid
29. Sphenoid
30. Sphenoid Sinus
31. Occipital Bone
32. Facial Bones
33. Maxillae
34. Maxillary Sinus
35. Palatine Bones
36. Zygomatic Bones
37. Inferior Nasal Conchae
38. Nasal Conchae
39. Nasal Septum
40. Mandible
41. Brain Tissue
42. Sulci Gyri
43. Gray and White Matter
44. Meninges
45. Dura Mater
46. Falx Cerebri
47. Tentorium Cerebelli
48. Arachnoid Layer
49. Pia Mater
50. Subarachnoid Cistern
51. Cerebellomedullary Cistern
52. Pontine Cistern
53. Cistern of the Lateral Sulcus
54. Interpeduncular Cistern
55. Chiasmatic Cistern
56. Cisterna Ambien's
57. Pineal Gland
58. Cerebrospinal Fluid
59. Choroid Plexus
60. Ventricles
61. Cerebrum
62. Corpus Callosum
63. Longitudinal Fissure

64. Lobes of the Cerebrum
65. Fissures and Sulci
66. Central Sulcus
67. Cerebral Cortex
68. Diencephalon
69. Thalamus
70. Pituitary Gland
71. Brain Stem
72. Cerebral Peduncles
73. Pons
74. Medulla Oblongata
75. Cerebellum
76. Cranial Nerves
77. Arteries of the Brain
78. Cerebral Arteries
79. Vertebral Arteries
80. Basilar Arteries
81. Circle of Willis
82. Venous System
83. Dural Sinuses
84. Superior Sagittal Sinus
85. Inferior Sagittal Sinus
86. Sigmoid Sinus
87. Cavernous Sinus
88. Orbits
89. Organs of Site
90. Bulbus Oculi
91. Eye Muscles
92. Salivary Gland
93. Parotid Gland
94. Sublingual Glands
95. Pharynx
96. Cervical Vertebrae
97. Atlas
98. Axis
99. Dens
100. Transverse Foramina
101. Spinous Process
102. Vertebral Prominence
103. Neck Muscles
104. Carotid Sheath
105. Posterior Triangle
106. Larynx
107. Thyroid Cartilage
108. Thyroid Gland
109. Jugular Veins

MVWIEXIII: Exam 13: "**Cross Sectional Anatomy of the Head and Neck":** *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MVWIIQI: Lecture 15: **Cross Sectional Anatomy: Chest, Abdomen and Pelvis** (90 minutes)

Keywords: Thorax, Diaphragm, Lungs, Mediastinum, Aortic Arch, Heart, LCA, RCA, IVC, Esophagus, Thymus, Rhomboid, Abdomen, Psoas, Celiac Artery, Renal Arteries, Portal Veins, Stomach, Liver

Objectives

- Define anatomical terms of the Chest, Abdomen, and Pelvis.
- Name the major structures of the Chest, Abdomen and Pelvis.
- Describe the function of each anatomical structure found in the Chest, Abdomen, and Pelvis.
- Identify the abdominal quadrants.
- Locate specific organs or structures on a schematic.

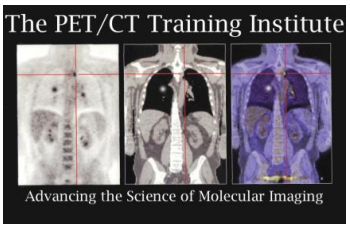
Content

1. Thorax
2. Thoracic Inlet
3. Costal Cartilages
4. Muscles of the Thorax
5. Diaphragm
6. Pleural Cavities
7. Lungs
8. Hilum
9. Mediastinum
10. Great Vessels
11. Ascending Aorta
12. Branches of the Aorta
13. Descending Aorta
14. Heart
15. Chambers of the Heart
16. Blood Supply to the Heart
17. Right Coronary Artery
18. Pulmonary Circulation
19. Vena Cava

20. Inferior Vena Cava
21. Esophagus
22. Trachea
23. Bronchi
24. Azygos
25. Hemiazygos
26. Thymus
27. Pectoral Muscles
28. Subclavius Muscle
29. Serratus Anterior Muscle
30. Rhomboid
31. Deltoid Muscles
32. Infraspinatus and Supraspinatus Muscles
33. Teres Major
34. Abdomen
35. Diaphragm
36. Diaphragm Opening
37. Artic Hiatus
38. Abdominal Walls
39. Lateral Abdominal Walls
40. Posterior Abdominal Walls
41. Psoas Major
42. Illiopsoas Muscles
43. Quadratus Lumborum Muscles
44. Vasculature
45. Celiac Artery
46. Superior Mesenteric Artery
47. Suprarenal Artery
48. Renal Arteries
49. Gonadal Arteries
50. Lumbar Arteries
51. Median Sacral Artery
52. Common Illiac Artery
53. Inferior Vena Cava
54. Hepatic Portal System
55. Portal Vein
56. Esophagus
57. Stomach
58. Liver
59. Liver Lobes
60. Caudate Lobe
61. Quadrate Lobe
62. Gallbladder
63. Spleen
64. Pancreas
65. Tail of the Pancreas
66. Body of the Pancreas
67. Neck of the Pancreas

68. Kidneys
69. Ureters
70. Adrenal Glands
71. Small Intestines
72. Duodenum
73. Ileum
74. Large Intestines
75. Colon
76. Rectum
77. Urinary Bladder
78. Seminal Vesicles
79. Prostate Gland
80. Corpus Cavernosum

MVWIIEXIV: Exam 14: "**Cross Sectional Anatomy: Chest, Abdomen, and Pelvis":** *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MVWIIIQI: Lecture 16: "**Gross Cross Sectional Anatomy : Structures of the Heart and Great Vessels in CT"** (60 minutes)

Keywords: Rt. Brachiocephalic Vein, Trachea, Esophagus, Brachiocephalic Truck, Lt. Common Carotid Artery, Lt. Subclavian Artery, Superior Vena Cava, Aortic Arch, Teres Minor, Pectoralis major

Objectives:

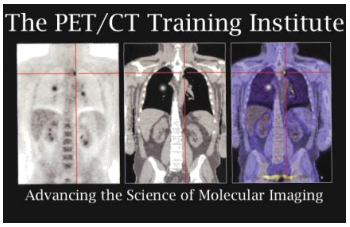
- Discuss the axial cross sectional location of the anatomy of the heart and great vessels.
- Identify pertinent axial anatomic structures of the heart and great vessels with the use of IV contrast agents.

Content

1. Right Brachiocephalic Vein
2. Brachiocephalic Truck
3. Left Common Carotid Artery
4. Left Subclavian Artery
5. Esophagus
6. Trachea
7. Superior Vena Cava
8. Aortic Arch
9. Pectoralis Major

10. Teres Minor
11. Scapula
12. Spinal Cord
13. Serratus Anterior
14. Arch of Azygous Vein
15. Thoracic Aorta
16. Ascending Aorta
17. Azygous Vein
18. Left Pulmonary Artery
19. Left Main Bronchus
20. Right Main Bronchus
21. Pulmonary Trunk
22. Sternum
23. Left Superior Pulmonary Vein
24. Right Coronary Artery
25. Right Atrium
26. Left Atrium
27. Left Coronary Artery
28. Right Ventricle
29. Left Ventricle
30. Left Inferior Pulmonary Vein
31. Right Inferior Pulmonary Vein
32. Latissimus Dorsi
33. Interventricular Septum
34. Xiphoid Process
35. Inferior Vena Cava
36. Coronary Sinus
37. Hemiazygous Vein
38. Apex
39. Diaphragm
40. Posterior Intercostal Artery
41. Lingula of Left Lung
42. Linea Alba
43. Right Lobe of the Liver
44. Intercostal Muscles
45. Costodiaphragmatic Recess
46. Left Lobe of the Liver
47. Fundus of the Stomach
48. Internal Thoracic Artery
49. Spleen
50. Caudate lobe of the Liver

Proceed to the next lecture.



Title: MVWIIIQII: Lecture 17: "Gross Cross Sectional Anatomy: CT of the Thorax viewed with Lung Windows" (60 minutes)

Keywords: Infraspinatus, Subscapularis, Left Subclavian Artery, Brachiocephalic Trunk, Trachea, Teres major, Left Common Carotid Artery, Aortic Arch, Pectoris Major, Superior Vena Cava, Superior Mediastinum

Objectives

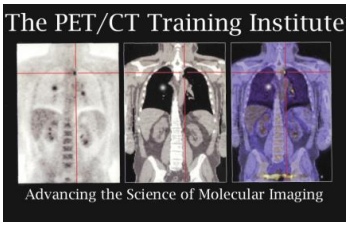
- Review axial views of the thorax with emphasis on viewing through the lung windows algorithm as seen by Computed Tomography.
- Review axial images of the thorax with IV contrast agents as viewed through the lung windows algorithm in CT.

Content

1. Left Brachiocephalic Vein
2. Left Common Carotid Artery
3. Left Subclavian Artery
4. Scapula
5. Esophagus
6. Subscapularis
7. Infraspinatus
8. Teres Major
9. Trachea
10. Right Brachiocephalic Vein
11. Sternoclavicular Joint
12. Arch of Aorta
13. Superior Vena Cava
14. Superior Mediastinum
15. Ascending Aorta
16. Anterior Mediastinum
17. Thoracic Aorta
18. Trachea Bifurcation
19. Trapezius
20. Transversospinalis
21. Longissmus
22. Iliocostallis Thoracis
23. Trasversospinalis
24. Carina
25. Left Main Bronchus

26. Internal Thoracic Artery
27. Arch of Azygous Vein
28. Azygous Vein
29. Right Main Bronchus
30. Eparterial Bronchus
31. Right Pulmonary Artery
32. Left Pulmonary Artery
33. Sternum
34. Right Intermedius Bronchus
35. Left Superior Lobar Bronchus
36. Right Atrium
37. Left Atrium
38. Superior Pulmonary Vein
39. Left Coronary Artery
40. Right Coronary Artery
41. Aortic Semilunar Valves
42. Aortic Vestibule
43. Left Ventricle
44. Right Ventricle
45. Serratus Anterior
46. Latissimus Dorsi
47. Bronchi
48. Papillary Muscle
49. Atrioventricular Sulcus
50. Coronary Sinus
51. Interventricular Septum
52. Costomediastinal Sulcus
53. Vertebral Canal
54. Inferior Vena Cava
55. Thoracic Duct
56. Diaphragm

MVWIIIEXV: Exam 15: "**Gross Cross Sectional Anatomy of the Chest"** *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MVWIIIQIII: Lecture 18: "**Gross Cross Sectional Anatomy: CT of the Abdomen and Pelvis without Contrast Agents" Part I** (60 Minutes)

Keywords: Axial Orientation, Liver, Hepatic Vein, Inferior Vena Cava, Hemiazygous Vein, Stomach, Spleen, Right Renal Gland, Left Renal Gland, Left Crus of Diaphragm, Left Kidney, Right Kidney

Objectives:

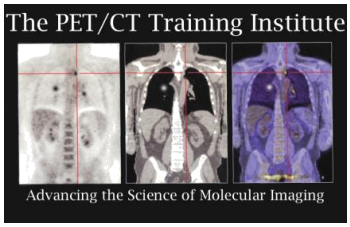
- Identify the axial anatomy of the Abdomen with and without Contrast Agents.
- Identify the axial anatomy of the Pelvis with and without Contrast Agents.

Content:

1. Hepatic Flexure of the colon
2. Splenic Flexure of the colon
3. Acetabulum
4. Pubic Symphysis
5. Sternum
6. Right Ventricle
7. Interventricular Septum
8. Left Ventricle
9. Esophagus
10. Aorta
11. Azygous Vein
12. Vertebral Canal
13. Latissimus Dorsi
14. Intercostal Muscles
15. Hemiazygous Vein
16. Liver
17. Stomach
18. Spleen
19. Inferior Vena cava
20. Stomach with air and barium
21. Rugae of Stomach
22. Right Renal Gland
23. Left Renal Gland
24. Left Crus of Diaphragm
25. Portal Vein
26. Celiac Artery
27. Left Kidney
28. Right Kidney
29. Gall Bladder
30. Superior Mesenteric Vein
31. Descending Duodenum
32. Left Renal Vein
33. Right Renal Vein
34. Left Psoas Major
35. Right Psoas Major
36. Transverse Colon

37. Inferior Mesenteric Artery
38. External Oblique Muscle
39. Internal Oblique Muscle
40. Left Common Iliac Artery
41. Right Common Iliac Artery
42. Small Intestine
43. Jejunum
44. Ascending colon
45. Cecum
46. Ileocecal Junction
47. Sacroiliac Joints
48. Left Common Iliac Vein
49. Right Common Iliac Vein
50. Left External Iliac Artery
51. Right External Iliac Artery
52. Sigmoid Colon
53. Ileum
54. Anterior Sacral Foramina
55. Pyriformis Muscles
56. Gluteus Maximus Muscles
57. Rectus Abdominis Muscles
58. Rectum
59. Hiatus Sacralis
60. Urinary Bladder
61. Pectineus
62. Coccyx
63. Acetabulum
64. Left Femoral Artery
65. Left Femoral Vein
66. Right Femoral Artery
67. Right Femoral Vein
68. Head of the Femur
69. Greater Trochanter of Femur
70. Lessor Trochanter of Femur
71. Obturator Internus Muscle
72. Ischiorectal Fossa
73. Great Sephanous Vein
74. Rectus Femoris
75. Vastus Lateralis Muscle
76. Spermatic Cord
77. Prostate
78. Pubic Symphysis
79. Penis
80. Ischial Tuberosities

Proceed to Part II:



Title: MVWIIIQIII: Lecture 19: "**Gross Cross Sectional Anatomy: CT of the Abdomen and Pelvis with Contrast Agents" Part II** (60 minutes)

Keywords: Axial Orientation, Liver, Hepatic Vein, Inferior Vena Cava, Hemiazygous Vein, Stomach, Spleen, Right Renal Gland, Left Renal Gland, Left Crus of Diaphragm, Left Kidney, Right Kidney

Objectives:

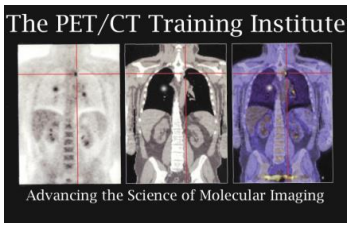
- Identify the axial anatomy of the Abdomen with Contrast Agents.
- Identify the axial anatomy of the Pelvis with Contrast Agents.

Content:

1. Hepatic Flexure of the colon
2. Splenic Flexure of the colon
3. Acetabulum
4. Pubic Symphysis
5. Sternum
6. Right Ventricle
7. Interventricular Septum
8. Left Ventricle
9. Esophagus
10. Aorta
11. Azygous Vein
12. Vertebral Canal
13. Latissimus Dorsi
14. Intercostal Muscles
15. Hemiazygous Vein
16. Liver
17. Stomach
18. Spleen
19. Inferior Vena Cava
20. Stomach with air and barium
21. Rugae of Stomach
22. Right Renal Gland
23. Left Renal Gland
24. Left Crus of Diaphragm
25. Portal Vein
26. Celiac Artery
27. Left Kidney
28. Right Kidney
29. Gall Bladder

30. Superior Mesenteric Vein
31. Descending Duodenum
32. Left Renal Vein
33. Right Renal Vein
34. Left Psoas Major
35. Right Psoas Major
36. Transverse Colon
37. Inferior Mesenteric Artery
38. External Oblique Muscle
39. Internal Oblique Muscle
40. Left Common Iliac Artery
41. Right Common Iliac Artery
42. Small Intestine
43. Jejunum
44. Ascending colon
45. Cecum
46. Ileocecal Junction
47. Sacroiliac Joints
48. Left Common Iliac Vein
49. Right Common Iliac Vein
50. Left External Iliac Artery
51. Right External Iliac Artery
52. Sigmoid Colon
53. Ileum
54. Anterior Sacral Foramina
55. Pyriformis Muscles
56. Gluteus Maximus Muscles
57. Rectus Abdominis Muscles
58. Rectum
59. Hiatus Sacralis
60. Urinary Bladder
61. Pectineus
62. Coccyx
63. Acetabulum
64. Left Femoral Artery
65. Left Femoral Vein
66. Right Femoral Artery
67. Right Femoral Vein
68. Head of the Femur
69. Greater Trochanter of Femur
70. Lessor Trochanter of Femur
71. Obturator Internus Muscle
72. Ischiorectal Fossa
73. Great Sephanous Vein
74. Rectus Femoris
75. Vastus Lateralis Muscle
76. Spermatic Cord
77. Prostate

78. Pubic Symphysis
79. Penis
80. Ischial Tuberosities



Title: MVWIIIQIV: Lecture 20: "Gross Cross Sectional Anatomy: CT of the Head" (60 Minutes)

Keywords: CT History, Protocolling, Variables, Patient History, Terminology, Artifacts, Contrast, Safety

Objectives:

*Discuss the first CT scanner used for head examinations.
*Discuss the parameters used for acquiring a CT of the Head on a 64 slice scanner.
*Discuss the procedures when a CT of the head is requested.
*Discuss various head protocols.
*Discuss CT variables in the acquisition menu.
*Discuss CT Terminology
*Discuss the use of CT Contrast in head procedures.
*Review the risks of using iodinated contrast agents.
*Discuss who is at risk for anaphylactic reactions from the contrast agents. *Discuss the risk factors for contrast induced acute renal failure.
*Discuss CT Radiation Safety.
*Discuss the Hounsfield Units.
*Review the CT Plains of the body.
*Review normal CT Anatomy of the Head.

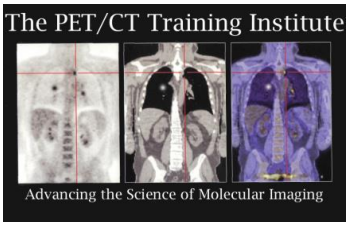
Content:

1. Nasal septum
2. Maxillary Sinus
3. Lateral Pterigoid Plate
4. Medial Pterigoid Plate
5. Spinal Cord
6. Styloid Process

7. Mastoid Process
8. Ramus of the Mandible
9. Coronoid process
10. Foramen Magnum
11. Vertebral Artery
12. Medulla Oblangata
13. External Auditory Meatus
14. Temporal Mandibular Joint
15. Eye Globe
16. Lacrimal Gland
17. Cerebellar Hemisphere
18. Lens
19. Auditory Tubes
20. Internal Occipital Protuberance
21. Sigmoid Sinus
22. Petrous bone
23. Basilar Artery
24. Optic Nerve
25. Crista Galli
26. Pons
27. Sphenoidal Sinus
28. Dorsum Sellae
29. Sella Tursica
30. Tentorium Cerebelli
31. Aged Brain
32. Abnormal CT Scans of the Head
33. Subdural Hematomas
34. Acute Ischemic Lt. MCA Stroke
35. Head Trauma
36. Brain Death
37. Seizures
38. Heterotopia
39. Transverse Sinus Thrombosis
40. Acute Hemorrhage
41. Acute, Subacute, Chronic bleeds
42. Subarachnoid Hemorrhage
43. Increased Intracranial Pressure
44. Cerebral Artery Stroke
45. Abnormal Ventricles
46. Bone Pathologies
47. Neuroemergencies
48. Subacute Infarcts
49. Territories
50. Venous Occlusions
51. Venous Hemorrhagic Infarcts
52. Skull Fractures
53. Linear Skull Fractures
54. Depressed Comminuted Skull Fractures

55. Basilar Skull Fractures
56. Tentorial Hemorrhage
57. Infections
58. Congenital
59. Meningitis
60. Pyogenic Parenchymal Infections
61. Encephalitis
62. Tuberculous and Fungal
63. Parasitic Infections
64. Herpes Simplex
65. Neurocystecercosis
66. Aneurysms
67. Ateriovenous Malformations
68. Normal MR anatomy

MVWIIIEXVI: Exam 16: "CT Cross Sectional Anatomy of the Head" *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits*



Title: MVIWIQI: Lecture 21: "CT Special Procedures" (90 Minutes)

Keywords: Multi detector CT, Trauma CT, Musculoskeletal CT, Arthrograms, Interventional CT, Biopsy, Aspirations, Radiofrequency Ablation, Cryoablation, Urography, Cystography, Angiography

Objectives:

- Describe current trends and applications of CT in the Radiology suite.
- Explain basic techniques for additional uses of CT applications.
- Identify uses of CT for trauma and identifying pathological conditions.
- Recognize the uses of Virtual CT.
- Explain how CT is used in Radiation Treatment Planning.
- Explain the Uses of CT in Nuclear Medicine.

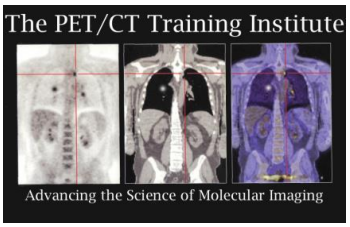
Content:

1. Multi detector CT
2. Trauma
3. Pathological Modifications

4. Trauma Acquisitions
5. Trauma of the Chest/Abdomen/Pelvis
6. Angiographic CT of Trauma
7. Benefits of CT in the ER
8. Non-Emergency CT
9. Musculoskeletal system CT
10. CT Arthrograms
11. Interventional CT
12. CT Biopsy
13. CT Fluid Aspirations and Drainage
14. Percutaneous Cryoablation
15. Radiofrequency Ablation
16. Fusion Volume Navigation
17. Urographic CT Procedures
18. Urographic Contrast Agents
19. CT Cystography
20. Renal Stone Quantification
21. Renal Transplants
22. CTA
23. Neurological Digital Subtraction Angiography techniques
24. CTA: Circle of Willis
25. CTA: Carotid Arteries
26. CTA: Body
27. CTA: Thoracic or Abdominal Aorta Pre-endovascular Artery Repair
28. ECG-Gated CTA: Thoracic Aorta
29. CTA: Thoracic or Abdominal Aortic Dissection
30. CTA: Subclavian Artery
31. Preoperative Planning Coarctation
32. CTA: Deep Inferior Epigastric Perforator Flap Planning
33. Preoperative Planning for Breast Reconstruction
34. CTA: Mesenteric Ischemia
35. CTA: Renal Arteries
36. CTA Runoff: Lower Extremity
37. CTA: Upper Extremity
38. CTA: Living Liver Donor
39. Neurological Venography
40. Body Venography
41. CT Perfusion
42. Virtual CT Endography
43. Virtual Bronchoscopy
44. Virtual Autopsy
45. Virtual Colonoscopy
46. CT Enterography
47. Dual-source/Dual Energy CT
48. Mass Differentiation- Cyst vs. Tumor
49. Stone Characterization
50. Gout Study
51. Perfusion Blood Volume

52. Bone Removal
53. Plaque Removal
54. Bariatric
55. Cardiac CT
56. ECG Gating
57. Patient Preparation
58. PET/CT
59. Radiopharmaceuticals
60. FDG Imaging Procedures
61. SPECT/CT
62. CT Radiation Treatment Planning
63. CT Simulations
64. Cone Beam CT
65. 4-D CT
66. CT Myelograms
67. Dynamic CT Myelograms
68. Portable CT

MVIWIEXVII: Exam 17: "Introduction to CT Special Procedures": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIWIQII: Lecture 22: "The CT Protocols Manual": (120 Minutes)

Keywords: CT Scan parameters, Scan Acquisition, User interface Basics, Dose Modulation, Reduction Tools, SFOV, DFOV, SP, SL/Thickness, Algorythm, kVp, mA/sec., Retros, Target, Contrast

Objectives:

- Identify the relevant terms from established standard CT lexicons.
- Recognize the acquisition parameters for various CT Protocols.
- Understand the key components of the CT Protocols Manual
- Review the indications for the basic CT protocol.
- Understand the correct Field of View size for various CT protocols.
- Understand how to adjust these technical parameters to perform the CT study.
- Understand the following key technical parameters of CT protocols.
  1. SFOV: (Small Field of View)
  2. DFOV: (Display Field of View)
  3. SP/Th: (Slice Thickness)
  4. Alg: (Algorythm)

5. kV: (Kilovoltage)
6. mA/Sec: (Miliamperage/second)
7. Retros: (Retrospective Reconstruction)

Content:

1. CT Scan Acquisition terms for:
   a. GE
   b. Philips
   c. Siemens
   d. Toshiba
   e. Hitachi
   f. Neusoft
   g. Neurologica
2. Dose Modulation tools
3. Dose Reduction tools
4. Automatic Exposure Controls
5. Angular Tube Modulation
6. Longitudinal Tube Current Modulation
7. ECG-Based Tube Current Modulation
8. Image Quality Reference Parameters for AEC
9. Multi-Slice Detector Geometry of various CT manufacturers
   a. Detector Array Design
   b. Detector configuration
10. Image Reconstruction and Display
    a. Window width
    b. Window Center
    c. Reconstruction FOV
    d. Prescribing
11. Contrast Media Tools
    a. Bolus Tracking
    b. Test Bolus
    c. Time-Attenuation Curves
    d. Monitoring Delays
    e. Scan Delays
12. Multi-Planar Formatting
13. Service Tools
14. Applications Tools
15. Workflow
16. CT Protocol Manual applications;
    a. Cavernous Sinus
    b. Temporal Bone
        1. CFS Otrorrhea
        2. Cochlear Implants
        3. 8^{th} Cranial Nerve
        4. Inflammatory Disease
        5. Trauma
        6. Middle Ear Mass

7. Pulsatile Tinnitus
8. Petrous Apex Mass
9. Jugular Fossa Mass
10. Malignant Tumors

c. Orbits
1. Trauma
2. Varix
3. Retinoblastoma
4. Ocular Masses
5. Inflammatory Diseases
6. Optic Nerve Pathways
7. Graves' Disease

d. Sinuses/Naval Cavity
1. CFS Rhinorrhea
2. Congenital Lesions
3. Choanal Atresia
4. Simple Inflammatory Disease
5. Complicated Inflammatory Disease
6. Benign/Malignant Tumors

e. Facial Bones
1. Congenital Growth Related Acquired Deformities
2. Benign/ Malignant Tumors
3. Trauma

f. Mandible
1. Trauma
2. Inflammatory Benign Diseases
3. Malignant Tumors
4. Dental Implants
5. Temporal Mandibular Joint

g. Nasopharynx
1. Benign Masses
2. Malignant Tumors
3. Inflammatory Disease
4. Clivus Lesions

h. Parapharyngeal
1. Inflammatory Disease
2. Benign/Malignant Tumors

i. Parotid Gland
1. Inflammatory Disease
2. Benign Masses
3. Malignant Tumors
4. Masses of Unknown Etiology

j. Oropharynx
1. Soft Palate Malignant Tumors
2. Tonsil/Glossotonsillar Sulcus Malignant Tumors
3. Tongue Base Malignant Tumors
4. Posterior Pharyngeal Wall Malignant Tumors

k. Oral Cavity

1. Inflammatory Disease
2. Benign Masses
3. Hard Palate Malignant Tumors
4. Retromolar Trigone/Upper GBS Malignant Tumors
5. OT/FOM/Lower GBS Malignant Tumors without Bone Involvement
6. OT/TOM/Lower GBS Malignant Tumors with Bone Involvement

l. Larynx/Hypopharynx
1. Trauma
2. Inflammatory Disease
3. Benign Masses
4. Malignant Tumors
5. Subglottic Tracheal Stenosis

m. Submandibular Gland
1. Inflammatory Disease Benign Masses
2. Malignant Tumors

n. Neck/ Thoracic Inlet
1. Congenital Lesions
2. Vascular Lesions
3. Skin Cancer/Melanoma of the Neck
4. Skin Cancer/Melanoma of the Face
5. Skin Cancer/Melanoma of the Scalp
6. Mass of Unknown Etiology
7. Brachial Plexus
8. Lymph Node Survey/ Lymphoma

o. Thyroid/Parathyroid
1. Inflammatory Disease
2. Benign Masses
3. Thyroglossal Duct Cyst
4. Malignant Thyroid Tumors
5. Parathyroid Adenomas

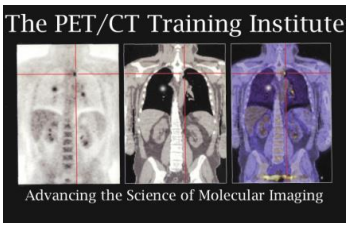
p. Syndromes
1. Unknown Primary
2. Serous Otitis Media
3. Trigeminal Neuralgia
4. Atypical Facial Pain
5. Facial Nerve Weakness/Paralysis
6. Hemifacial Spasms
7. Tongue Weakness/ Atrophy
8. Horner Syndrome
9. Otalgia
10. Vocal Cord Paralysis
11. Dysphagia/ Odynophagia

q. Fractures
1. Acetabular
2. Calcaneal
3. Cervical Spine
4. Chest
5. Femoral Neck

6. Humeral Head
7. Lumbar spine Disc Disease
8. Piriformis
9. Wrist
10. Scaphoid
11. Carpal
12. Lisfrac
13. Tarsal Navicular
14. Shoulder Arthrogram
15. Thoracic
16. Lumbar
17. Tibial Plateau

r. Body Protocols

1. Abdomen Survey
2. Pelvic Survey
3. Cervical/Uterine/Prostate/Bladder Cancer
4. Chest/Abdomen Survey
5. Chest/Abdomen/Pelvis Survey
6. Chest Survey
7. Pelvic Survey
8. Chest/Abdomen/Pelvis Trauma



Title: MVIWIIQI: Lecture 23: "CT Procedures Manual" Part I: (60 Minutes)

Keywords: Technical Protocols, Area of Concern, Clinical History, Positional Landmarks, Topogram Direction, Respiratory Phase, Scan Type, Rotation time, kVp, Pitch, Detector width, Detector Rows

Objectives:

- Discuss how to take a patient CT history.
- Identify the proper landmarks for positioning the patient for the study.
- Identify the topogram direction for the study.
- Understand the correct respiratory phase when acquiring the study.
- Understand the proper kVp, mA, Rotation Time, Pitch, Detector Width and Rows.
- Understand the average Tube output radiation exposure.

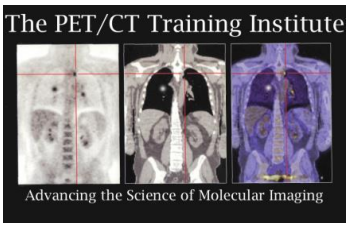
- Identify the optimal Slice Thickness/ Spacing, Algorithm and Reconstruction destination for the data set.
- Understand the Scan Start and End Locations
- Discuss the IV Contrast Volume, Type, and Rate of administration.
- Understand the Scan Delays for the acquisition.
- Choose the proper 2D or 3D acquisition modes.
- Discuss Pediatric CT Protocols

Content:

1. GE Light speed 16 CT Scanner
2. GE VCT Protocols
3. CT and MRI Patient Clinical History Sheet
4. Chest/Abdomen/Pelvis with Thoracic and Lumbar Spine Protocol
   a. Position/Landmark
   b. Topogram Direction
   c. Respiratory Phase
   d. Scan Type
   e. kVp
   f. mA/ Rotation time
   g. Pitch
   h. Speed (mm/rotation)
   i. Noise Index
   j. AEC (Dose Reduction)
   k. Detector Width x Rows (Beam Collimation)
   l. Average Tube Output
   m. Helical Set
   n. Scan Start/ End Location
   o. Display Field of View
   p. IV Contrast Volume/Type/Rate
   q. Scan Delay
   r. 2D/3D Technique used
   s. PACS
5. Neck CTA, Chest Abdomen Pelvis Run Off Protocols
6. Neck CTA, Chest Abdomen Pelvis and Cervical, Thoracic, and Lumbar Spines Trauma Protocols
7. Prospective Gated Coronary CTA
   a. Bypass Graft Patency
   b. Stent Patency
   c. Cardiomyopathy
   d. Anomalous Arteries
   e. CAD
   f. Thoracic Aorta aneurysm
   g. Pulmonary Emboli
8. Prospective Gated Aorta and Cardiac valves
   a. Ascending Aorta Aneurysm
   b. Dissections
   c. Aortic Valve disease

9. Gated Aorta and Carotid CTA
10. Gated Aorta and Abdominal CTA (TAVI)
11. Calcium Scoring

MVIWIIEXVIII: Exam 18: "CT Procedures": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIWIIQII: Lecture 24: "CT Procedures Manual" Part II: (60 Minutes)

Keywords: Cholesteatoma, Hearing Loss, Fractures, Pediatric Spine, Pediatric Pelvis, Pediatric Pectus Excavatum, Pediatric Neck CTA, Chest, Abdomen, Pelvis, Pediatric Mastoiditis

Objectives:

- Identify the proper landmarks for positioning the patient for the study.
- Identify the topogram direction for the study.
- Understand the correct respiratory phase when acquiring the study.
- Understand the proper kVp, mA, Rotation Time, Pitch, Detector Width and Rows.
- Understand the average Tube output radiation exposure.
- Identify the optimal Slice Thickness/ Spacing, Algorithm and Reconstruction destination for the data set.
- Understand the Scan Start and End Locations
- Discuss the IV Contrast Volume, Type, and Rate of administration.
- Understand the Scan Delays for the acquisition.
- Choose the proper 2D or 3D acquisition modes.
- Identify various Pediatric CT Protocols

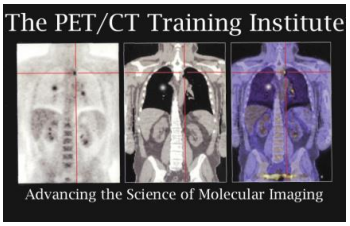
Content:

1. GE Light speed 16 CT Scanner Protocols
2. GE VCT Protocols
   a. Position/Landmark
   b. Topogram Direction
   c. Respiratory Phase
   d. Scan Type
   e. kVp

f. mA/ Rotation time
g. Pitch
h. Speed (mm/rotation)
i. Noise Index
j. AEC (Dose Reduction)
k. Detector Width x Rows (Beam Collimation)
l. Average Tube Output
m. Helical Set
n. Scan Start/ End Location
o. Display Field of View
p. IV Contrast Volume/Type/Rate
q. Scan Delay
r. 2D/3D Technique used
s. PACS

3. Pediatric Temporal Bones
   a. Cholesteatoma
   b. Hearing Loss
   c. Fractures
4. Pediatric Spine
5. Pediatric Pelvis for RLQ Pain
6. Pediatric Pelvis
7. Pediatric Pectus Excavatum
8. Pediatric CTA Neck, Chest, Abdomen, Pelvis
9. Pediatric Neck
10. Pediatric Mastoiditis
11. Pediatric Hips, Acetabulum
12. Pediatric Low Dose Helical Head

MVIWIIEXIX: Exam 19: "CT Procedures Manual" Part II: *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIWIIQIII: Lecture 25: "CT Procedures Manual" Part III: (60 Minutes)

Keywords: Pediatric Face, Orbits, Sinus, Pediatric Extremity, Pediatric Choanal Atresia, Pediatric Chest, Pediatric Face Trauma, Pediatric Brain CTA, Pediatric Head, Axial Brain, 3D Head, Abdomen, Pelvis

Objectives:

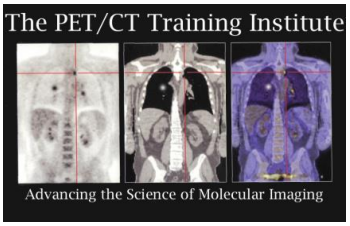
- Identify the proper landmarks for positioning the patient for the study.
- Identify the topogram direction for the study.
- Understand the correct respiratory phase when acquiring the study.
- Understand the proper kVp, mA, Rotation Time, Pitch, Detector Width and Rows.
- Understand the average Tube output radiation exposure.
- Identify the optimal Slice Thickness/ Spacing, Algorithm and Reconstruction destination for the data set.
- Understand the Scan Start and End Locations
- Discuss the IV Contrast Volume, Type, and Rate of administration.
- Understand the Scan Delays for the acquisition.
- Choose the proper 2D or 3D acquisition modes.
- Identify various Pediatric CT Protocols

Content:

1. GE Light speed 16 CT Scanner Protocols
2. GE VCT Protocols
    a. Position/Landmark
    b. Topogram Direction
    c. Respiratory Phase
    d. Scan Type
    e. kVp
    f. mA/ Rotation time
    g. Pitch
    h. Speed (mm/rotation)
    i. Noise Index
    j. AEC (Dose Reduction)
    k. Detector Width x Rows (Beam Collimation)
    l. Average Tube Output
    m. Helical Set
    n. Scan Start/ End Location
    o. Display Field of View
    p. IV Contrast Volume/Type/Rate
    q. Scan Delay
    r. 2D/3D Technique used
    s. PACS
3. Pediatric Face/ Orbits/Sinus
4. Pediatric Extremity
5. Pediatric Choanal Atresia
6. Pediatric Chest
7. Pediatric Brain Trauma/Face
8. Pediatric Brain CTA
9. Pediatric Helical Head
10. Pediatric Axial Brain

11. Pediatric 3D Head
12. Pediatric Abdomen/Pelvis
13. Lumbar Sacral Spine
    a. Fracture
    b. Trauma
    c. Mets
    d. Disc Rupture
    e. Disc Herniation
    f. Stenosis
    g. Post Myelogram
14. Thoracic Spine
    a. Trauma
    b. Fracture
    c. Facet Dislocation
    d. Abscess

MVIWIIEXX: Exam 20: "CT Procedures Manual" Part III: *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIWIIQIV: Lecture 26: "CT Procedures Manual" Part IV: (60 Minutes)

Keywords: Cervical Spine, Hand and Wrist CT, Patella Tracking, Lower Extremity Runoffs, Knee, Elbow, Ankle, Foot, Pelvic Floor Fractures, Acetabular Fractures, Routine Pelvis,

Objectives:

- Identify the proper landmarks for positioning the patient for the study.
- Identify the topogram direction for the study.
- Understand the correct respiratory phase when acquiring the study.
- Understand the proper kVp, mA, Rotation Time, Pitch, Detector Width and Rows.
- Understand the average Tube output radiation exposure.
- Identify the optimal Slice Thickness/ Spacing, Algorithm and Reconstruction destination for the data set.
- Understand the Scan Start and End Locations
- Discuss the IV Contrast Volume, Type, and Rate of administration.
- Understand the Scan Delays for the acquisition.
- Choose the proper 2D or 3D acquisition modes.

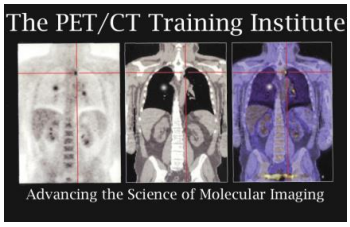
Content:

1. Cervical Spine CT
    a. Fractures
    b. Trauma
    c. Mets
    d. Disc Rupture
    e. Disc Herniation
    f. Stenosis
    g. Post Myelogram
2. Wrist/Hand CT
    a. Fracture
    b. Dislocation
    c. Osteomyelitis
    d. Bone Injury
    e. Bone Tumor
3. Shoulder CT
    a. Fracture
    b. Dislocation
    c. Osteomyelitis
    d. Bone Injury
    e. Bone Tumor
4. Patella Tracking/Femoral Anteversion
    a. Knee Pain
    b. Evaluate Patella location
    c. Femoral Anteversion
5. Lower Extremity Runoff CTA
    a. Peripheral Artery Disease
    b. Claudication
6. Knee CT
    a. Fracture
    b. Dislocation
    c. Osteomyelitis
    d. Bone Injury
    e. Bone Tumor
7. Elbow CT
    a. Fracture
    b. Dislocation
    c. Osteomyelitis
    d. Bone Injury
    e. Bone Tumor
8. Ankle/ Foot CT
    a. Fracture
    b. Dislocation
    c. Osteomyelitis
    d. Bone Injury
    e. Bone Tumor
9. Pelvis for Fracture/Acetabulum

a. Trauma
b. Fracture
c. Dislocation

10. Routine Pelvis
    a. Mass
    b. Mets
    c. Lymphoma
    d. Fractures
    e. Post CT Cystograms

MVIWIIEXXI: Exam 21: "CT Procedures Manual" Part IV: *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIWIIQV: Lecture 27: "CT Procedures Manual" Part V: (60 Minutes)

Keywords: Three Phase Kidney, Renal Mass, Renal Donor CTA, Pancreatic Mass, Nissan Fundoplication, Para-Esophageal, Hematuria, Enterography, Three Phase Liver, Pelvis CT

Objectives:

- Identify the proper landmarks for positioning the patient for the study.
- Identify the topogram direction for the study.
- Understand the correct respiratory phase when acquiring the study.
- Understand the proper kVp, mA, Rotation Time, Pitch, Detector Width and Rows.
- Understand the average Tube output radiation exposure.
- Identify the optimal Slice Thickness/ Spacing, Algorithm and Reconstruction destination for the data set.
- Understand the Scan Start and End Locations
- Discuss the IV Contrast Volume, Type, and Rate of administration.
- Understand the Scan Delays for the acquisition.
- Choose the proper 2D or 3D acquisition modes.

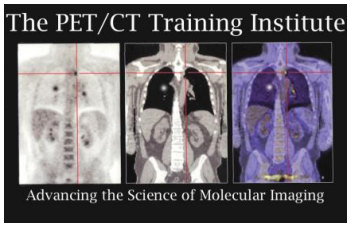
Content:

1. Renal RF Three Phase Kidney
    a. Evaluate/Characterize a known Renal Mass before and after tumor ablation
2. Renal Mass
    a. Evaluate/Characterize a potential Renal Mass
3. Renal Donor CTA

a. Evaluation of Renal Arteries of potential renal transplant donor
b. Evaluation of Renal Arteries Stenosis
c. Aneurysm

4. Pancreatic Mass
   a. Known or Suspected Pancreatic Mass
5. Nissan Fundoplication/Para-Esophageal CT
   a. Evaluation of patient who has undergone a surgical procedure of tucking or folding the fundus of the stomach around the esophagus to prevent reflux.
   b. Evaluate the repair of a hiatal hernia.
6. Hematuria
   a. Non Contras and dual medullary and delayed phase study for patients with hematuria.
7. IV Contrast CT Enterography
   a. Evaluation of diseases affecting the mucosa and bowel wall.

MVIWIIEXXII: Exam 22: "CT Procedures Manual" Part V: *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIIWIQI: Lecture 31: "CT Methodology I": (90 Minutes)

Keywords: Head Procedures, Positioning, Parameters, Neck Procedures, Scan Mode, Cervical Spine Procedures, Pitch, Chest CTA, Timing Bolus, Abdomen Procedures, Pelvic CTA, Thoracic/Lumbar Spine Procedures, Extremities, 3 D Reconstruction

Objectives:

- Properly position a patient and select appropriate parameters for the CT Examination.
- Explain why different window widths and levels are selected.
- List the required imaging planes for each procedure.
- List the information that should be noted on each scout and scan image.
- Discuss how to review images for quality and accuracy.

Content:

1. Routine Head Procedure
   a. Positioning
   b. Scout Image
   c. Scan Mode
   d. Scan Field of View
   e. Scan Parameters
   f. Pitch
   g. Algorithms

h. Image Annotation
i. Image Archiving
j. Contrast
k. Image Review

2. Routine Neck Procedure
   a. Positioning
   b. Scout Image
   c. Scan Mode
   d. Scan Field of View
   e. Scan Parameters
   f. Pitch
   g. Algorithms
   h. Image Annotation
   i. Image Archiving
   j. Contrast
   k. Image Review
3. Routine Cervical Spine Procedure
   a. Positioning
   b. Scout Image
   c. Scan Mode
   d. Scan Field of View
   e. Scan Parameters
   f. Pitch

h. Algorithms Image Annotation
i. Image Archiving
j. Contrast
k. Image Review

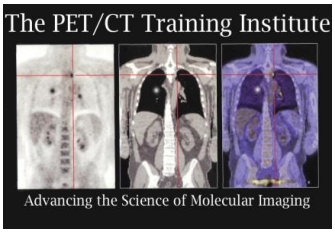
4. Routine Cervical Spine Procedure
   a. Positioning
   b. Scout Image
   c. Scan Mode
   d. Scan Field of View
   e. Scan Parameters
   f. Pitch
   g. Algorithms
   h. Image Annotation
   i. Image Archiving
   j. Contrast
   k. Image Review
5. Routine CT Chest Angiogram Procedure
   a. Positioning
   b. Scout Image
   l. Scan Mode
   m. Scan Field of View
   n. Scan Parameters
   o. Pitch
   p. Algorithms
   q. Image Annotation
   r. Image Archiving
   s. Contrast
   t. Labels

u. Post Processing
v. Timing
w. Image Review

6. Chest CTA: PE Study
7. Chest CTA: Thoracic Aorta
8. Routine Abdomen/Pelvis Procedure
   a. Positioning
   b. Scout Image
   d. Scan Mode
   e. Scan Field of View
   f. Scan Parameters
   g. Pitch
   h. Algorithms
   i. Image Reconstruction
   j. Post Processing
   k. Timing
   l. Image Annotation
   m. Image Archiving
   n. Contrast
   o. Image Review

9. Abdomen/Pelvis CTA
10. Abdomen/Pelvis Contrast
11. Routine Thoracic and Lumbar Spine Procedures
    a. Positioning
    b. Scout Image
    d. Scan Mode
    e. Scan Field of View
    f. Scan Parameters
    g. Pitch
    h. Algorithms
    i. Image Annotation
    j. Image Archiving
    k. Contrast
    l. Image Review
12. Routine Extremity Procedures
    a. Positioning
    b. Scout Image
    b. Scan Mode
    c. Scan Field of View
    d. Scan Parameters
    e. Pitch
    f. Algorithms
    g. Image Annotation
    h. Image Archiving
    i. Contrast
    j. Image Review

MVIWIIEXXIV: Exam 24: "CT Methodology I": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIIWIQII: Lecture 32: "CT Methodology II": (60 Minutes)

Keywords: Risks, Patient Orientation, CT Brain, Indications, Positioning, Arm Position, Parameters, Unit Controls, Gantry Tilt, Lateral View, Slice Thickness, Soft Tissue, Bone Window, Omnipaque 300, Bolus

Objectives:

- Discuss the patient preparation for a CT Brain.
- Discuss setting up the patient on the Gantry Table for CT Brain.
- Discuss the respiratory cycle for acquiring a CT Brain.
- Discuss tilting the CT Gantry parallel to the Orbital-Meatal Line.
- Discuss start slice at Tentorial Rim to Vertex of Skull.
- Discuss Tumor or Mets Brain Protocol with and without contrast.
- Discuss the filming of Bone fractures.
- Discuss the scout films for the Sella Turcica.
- Discuss patient set up for CT Pituitary Fossa.
- Discuss the Pre and Post Contrast Images for CT Pituitary Fossa.
- Discuss the Patient Preparation for CT of the Neck.
- Discuss the use of contrast material with a bolus injection for spiral CT.
- Discuss the Position for CT of the Neck.
- Discuss the start and end slices for CT Neck.
- Discuss CT scan of the Chest Patient Preparation.
- Discuss the positioning of the patient in the Gantry for CT of the Chest.
- Discuss the Start and End slices for Chest CT.
- Discuss the Unit Controls of the CT scanner when setting up the acquisition for CT Chest.
- Discuss the factors that could interfere with the accuracy of the CT of the Abdomen.
- Discuss the Patient preparation procedures for CT of the Abdomen.
- Discuss the use of Oral and IV Contrast for CT of the Abdomen.
- Discuss the Start and End slices for CT of the Abdomen.
- Discuss the patient preparation for CT of the Lumbar Spine.
- Discuss the start and End slices for acquiring a CT of the Lumbar Spine.
- Discuss the Unit Controls for the acquisition of a CT of the Lumbar Spine.

Content:

1. Risks
   a. Nausea
   b. Breathing Difficulty
2. Patient education

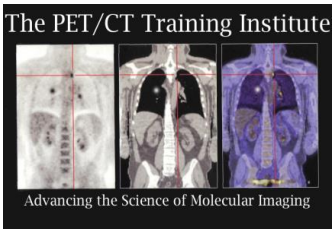
3. Patient History
4. Prior to showing up to center
5. CT Brain
    a. Tumors
    b. Blood clots
    c. Hemorrhages
    d. Acute Cranial Facial Trauma
    e. Strokes
    f. Intracranial Hemorrhage
    g. Headaches
    h. Positioning
        i. Supine
        j. Arm location
        k. Head immobilizing
        l. Parameters
        m. Respiratory Cycle
        o. Unit Controls
        p. Pathological Findings
        q. Pre Contrast baseline
        r. IV Contrast
        s. Post Contrast Examination
        t. Filming
6. Pituitary Fossa CT
    a. 2 mm Cuts for High Resolution
    b. Zooming
    c. Dynamic CT
7. Neck CT
    a. Patient Preparations
    b. Contrast
    c. Positioning
    d. Supine
    e. Arm position
    f. Head immobilized
    g. Start and End Slice
    h. Respiratory Cycle
    i. Unit Controls
8. Chest CT
    a. Patient Preparation
    b. Positioning
    c. Supine
    d. Arm position
    e. Start and End Slice
    f. Respiratory Cycle
    g. Unit Controls
9. Abdominal CT
    a. Factors that can interfere with accuracy of CT Abdomen
        1. Metallic Objects
        2. Barium in the intestines from recent study
        3. Stool
        4. Bowel Gas
    b. Patient Preparation

1. Fasting
2. May need Ultrasound for Radiologist
3. Oral laxative
4. Sedatives
5. Remove foreign objects
6. Put patient in gown

c. Oral Contrast
d. IV Contrast

10. Lumbar Spine CT
    a. Patient Preparation
    b. Contrast
    c. Positioning
        1. Supine
        2. Feet First
        3. Arms above head
        4. Knees flexed
    d. Starting and Ending slices
    e. Respiratory Cycle
    f. Unit Controls
    g. Filming

MVIWIIEXXV: Exam 25: "CT Methodology II": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIIWIQIII: Lecture 33: "Principles of Patient Care in CT" (120 minutes)

Keywords: Maslow's Hierarchy of Needs, Grieving Process, Vital Signs, Cyanosis, Infusions, Collecting Containers, Patient Transfers, Sliding Boards, Consent, BUN, Creatine levels, Hyperventilating, Responsibilities, Side Effects, Non-Ionic Contrasts, Ionic Contrasts, Needles

Objectives:

- List Maslow's Hierarchy of Needs for the Patient
- Discuss the Grieving Process
- List the normal ranges for Vital Signs.
- Discuss the types of collecting containers used in CT.
- Discuss the CT Procedures requiring Consent.
- Discuss the requirements before using Contrast agents.

- Identify the High Risk patients to contrast material.
- Discuss the effects of Ionic vs. Nonionic Contrast Medias.
- Discuss the types of angiocatheter needles.
- List possible veins for venipuncture.
- List the gauge of needle suitable for a CTA procedure.
- Discuss the key parameters of a Power Injector.
- Discuss the purpose of a Contrast Warmer.
- Discuss the first aid steps for an extravasation.
- List the Mild reactions to contrast material symptoms.
- List the Moderate reactions to contrast material symptoms.
- Discuss the technologist responsibilities during a Moderate Contrast Reaction.
- List the Severe reactions to contrast material symptoms.
- Discuss the types of shock patients can experience in CT.
- List the types of Oral Contrast agents.
- Discuss the Biopsy procedures.
- Discuss the various Blood clotting time lab tests.
- List the factors that influence drug administration.
- Discuss various drug administration routes.
- Discuss parenteral drug administration methods.
- List drugs that act on the nervous system used in CT.
- List drugs used to treat cardiovascular disease.
- List the drugs used in treating allergic responses.
- Discuss the legal aspect working with patients in CT.
- Discuss the security of health information.

Content:

1. Maslow's Hierarchy of Needs
    a. Physiological needs
    b. Safety and security
    c. Love and belongingness
    d. Self Esteem
    e. Self-Actualization
2. Grieving Process
    a. Denial
    b. Anger
    c. Bargaining
    d. Depression
    e. Acceptance
3. Patient Assessments
    a. Vital Signs
        1. Temperature
        2. Pulse
        3. Respiration
        4. Blood Pressure

4 Infusion and Collecting Containers

5 Consent
    a. Arthrography
    b. Biopsy

c. CTA
d. Myelography

6 Types of Consents
a. Informed
b. Implied

7 IV Contrast requirements
a. BUN
b. Creatine
c. Patient Preparation
d. Steroid Therapy

8 Mild hyperventilation before breath hold

9 Side Effects vs. Reactions
a. Non-Ionic (water soluble)
b. Ionic (Iodine based)

10 Technologists responsibilities
a. Patient History
b. Clinical complaints
c. Food or Drug Allergies
d. Previous Contrast reactions
e. Asthma
f. Hay fever
g. Hives

11 High Risk patients to reactions
a. Hypersensitivity towards iodinated contrast agents
b. Diabetes Mellitus
c. Asthma or other respiratory conditions
d. Multiple myeloma
e. Severe Dehydration
f. Chronic or acute renal or hepatic failure

12 Effects of Ionic vs. Non Ionic Contrast Agents

13 Angiocatheter needles
a. Butterfly
b. Over the needle catheter
c. Straight through the needle

14 Veins for venipuncture
a. Superficial Dorsal Veins
b. Basilic Vein
c. Dorsal Venous Arch
d. Cephalic Vein
e. Median Cubital Vein
f. Radial Vein
g. Median Vein of Forearm

15 Gauge suitable for CTA
a. 18 gauge
b. 20 gauge

16 Power Injector

17 Power Injector parameters
a. Volume of contrast
b. Rate in ml/sec
c. Time of Injection
d. Scan Delay time

18 Contrast Warmer
19 Extravasation Steps
20 Drugs to hold prior to or after CT Scan
21 Mild Reactions (Self Limiting)
   a. Nausea and Vomiting
   b. Hives (Urticaria)
   c. Itching
   d. Sneezing
   e. Extrtavasation
   f. Vasovagal Response
21 Moderate Reactions
   a. Excessive Urticaria
   b. Tachycardia
   c. Giant hives
   d. Excessive Vomiting
22 Technologist responsibilities during Moderate Reactions
23 Severe Reactions
   a. Very Low Blood Pressure
   b. Cardiac or Respiratory arrest
   c. Convulsions
   d. Laryngeal edema
   e. Cyanosis
   f. Difficulty in breathing
   g. Profound shock
24 Common shocks in CT
25 Shock symptoms
   a. Hypotension
   b. Weak Pulse
   c. Rapid Pulse
   d. Rapid Breathing
26 Other shock types
   a. Hypovolemic
   b. Septic
   c. Cardiogenic
   d. Neurogenic
   e. Anaphylactic
27 Oral Contrast Procedures
28 Types of Oral Contrast
   a. Barium Sulfate
   b. Water soluble (Gastrographin)
   c. Air
   d. Carbon Dioxide (Effervescent Agents)
29 Barium Sulfate Contraindications
30 Oral Contrast patient preparations
31 Biopsy restrictions
32 Blood clotting level components
   a. PT
   b. PTT
   c. Platelets Count
33 Pharmacology

34 Drug Excretion Routes
a. Perspiration
b. Tears
c. Feces
d. Breast milk
e. Saliva

35 Factors that influence drug administration
a. Age
b. Gender
c. Hormonal Differences
d. Emotional or Psychological State
e. Time of Day
f. Channel or Route of Administration

36 Drug Administration Routes
a. Oral
b. Topical
c. Parenteral
d. Sublingual
e. Intrathecal
f. Rectal
g. Transdermal
h. Inhalation

37 Parenteral Drug Administration
a. Subcutaneous
b. Intradermal
c. Intramuscular
d. Intravenous
e. Intrathecal

38 Drug Names
a. Trade name
b. Chemical name
c. Generic name
d. Official name

39 Drugs with effect on Nervous System
a. Chloral Hydrate
b. Morphine Sulfate
c. Lidocaine

40 Other drugs in CT
a. Analgesics
b. Antipyretics
c. Anti-Inflammatory
d. Lasix
e. Heparin
f. Nitroglycerin

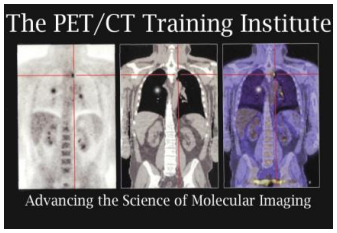
41 Drugs to treat allergic responses
a. Epinephrine
b. Benadryl

42 Legal Aspects of CT Imaging
a. Ordinary Negligence
b. Gross Negligence

c. Assault
d. Battery
e. False Imprisonment
f. Defamation of Character

g. Libel
h. Slander
i. Fraud
j. Invasion of Privacy
k. Patient Confidentiality
l. Security of Information from Health Informatics 43 Legal Doctrines in CT
a. Respondeat Superior

MVIIWIIEXXVI: Exam 26: "Principles of Patient Care in CT": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIIIWIQI: Lecture 34: "CT Pathology I" (30 Minutes)

Keywords: Pathology, Hounsfeld Unit, CT Number, Hernias, Lymphoma, Ovarian Cysts, Pancreatic Cancers, Pleural Effusions, Renal Cysts, Sarcomas, Ewings Sarcoma, Sinus Mass, Toxoplasmosis, Traumatic Injury

Objectives:

- Identify selected pathology found on CT Images.
- Name the causes of some of the pathology found in this lecture.
- Provide statistical data on the prevalence of certain pathological conditions.
- List symptoms associated with the presence of selected pathology.
- Distinguish between the CT appearance or normal organs and tissues from those involved with pathology.
- Define the pathological processes.

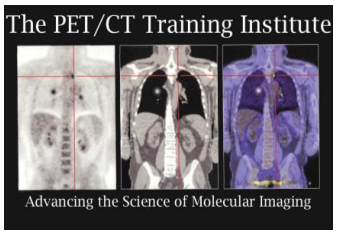
Content:

1. Image Display
2. Hounsfield Units/ CT Numbers
3. CT Numbers and Pathology
4. Appendicitis
5. Hernia
   a. Incisional Hernia

b. Bochdalek
c. Diaphragmatic

6. Pancreatitis
7. Hydrocephalus
8. Lymphoma
   a. Hodgkins
   b. Non-Hodgkins
   c. Lymphoadenopathy
9. PET/CT
10. Meningiomas
11. Ovarian Cysts
12. Pancreatic Cancers
13. Pleural Effusion
14. Renal Cysts
15. Sarcomas
    a. Ewings Sarcoma
16. Sinus Mass
17. Toxoplasmosis
18. Traumatic Injury

MVIIIWIIEXXVII: Exam 27: "CT Pathology Part I": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MVIIIWIQII: Lecture 35: "CT Pathology II" (30 Minutes)

Keywords: Adrenal Glands, Aneurysms, Appendicitis, Bezoar, Cerebral Arteriovenous Malformation, CVA, Ischemic Stroke, Cholecystitis, Colon Cancer, Polysplenia, Coronary Artery Calcification, Calcium Scoring, Hemangioma, Pancolitis, Lung Cancer

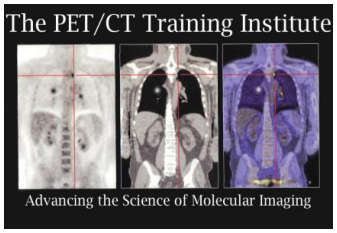
Objectives:

- Identify pathology on selected CT Images.
- Name the pathology presented on some of the images.
- Provide statistics on the prevalence of certain pathology.
- List symptoms associated with the presence of selected pathology.
- Distinguish between the CT appearance of normal organs and tissues from those involved in pathology.
- Define the pathological processes found in this lecture.

Content:

1. Adrenal Glands
2. Adrenal Masses
    a. Adenomas
    b. Cysts
    c. Lipomas
    d. Mets
    e. Pheochromocytomas
3. Aneurysms
4. Classification of Aneurysms
    a. True
        1. Saccular
        2. Fusiform
    b. False
        1. Pseudoaneurysms
    c. Abdominal
    d. Bilateral Iliac Artery
    e. Carotid Artery
    f. Splenic Artery
    g. Diverticular
5. Appendicitis
    a. Bezoar
6. Cerebral Arteriovenous Malformation
7. Cerebrovascular Accidents
8. Ischemic Stroke
9. Cholecystitis
10. Colon Cancer
11. Congenital Abnormalities
12. Polysplenia
13. Vascular abnormalities associated with Polysplenia
14. Coronary Artery Calcifications
15. Calcium Scoring
16. Hemangioma
17. Pancolitis
18. Lung Carcinoma

MVIIIWIIEXXVIII: Exam 28: "CT Pathology Part II": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIXWIQI: Lecture 36: CT Contrast Agents Part I: (150 Minutes)

Keywords: Contrast Medium, Radiation Quality, Film Contrast, Small Bowel Obstruction, Iodine Contrast, Hypaque, Isopaque, Hexabrix, Isovue, Omnipaque, Oxilan, Isopromide, Visipaque

Objectives:

- Discuss the purpose of Contrast Agents.
- Understand the physical and physiological principles of Contrast medias.
- Discuss why contrast agents are necessary.
- Discuss the ways contrast agents can enter the body.
- Discuss the uses of contrast with GI Imaging.
- List contrast agents used today in the CT department.
- List the injection rates of contrast materials in CT.
- Discuss the differences between contrast agents.
- Discuss the history of contrast agents in medicine.
- Compare the chemical structures of ionic and non -ionic contrast agents.
- Discuss the adverse reactions contrast agents can cause.
- Discuss the patient preparation for a procedure with contrast agents.
- Outline the categories of reactions to contrast agents.
- Discuss the administration of contrast Medias to the breastfeeding mothers.
- Discuss those certain patients that are at increased risk for extravasation.
- Discuss the use of contrast agents with children.
- Discuss adverse reactions to Gadolinium-based contrast agents.
- Discuss the risk factors associated with IV Contrast agents.
- Discuss premedicating patients with a known contrast reaction.
- Discuss how to handle patients with various levels of contrast reactions.
- Discuss the use of a power injector.
- Discuss key parts of the power injector.
- Discuss future directions of contrast enhanced CT procedures.
- Discuss the advancements of the modern power injector.
- Discuss current applications of the pressure injector.
- Discuss venipuncture techniques.
- Discuss key acquisition parameter used for a routine CTA procedure.
- Discuss CT of the abdomen with contrast agents.
- Discuss factors that affect the CT image quality.
- Discuss methods for reducing patient artifacts in Cardiac CT.
- Distinguish between Prospective and Retrospective ECG scanning.
- Discuss Contrast Media guidelines for use.

Content:

1. Purpose
2. Names
3. Necessity
4. Routes of administration

5. Negative Agents
    a. Air
    b. Carbon Dioxide
    c. Gases
6. Influences
7. Atomic Number
8. Quality
9. Types
10. Positive Agents
11. Barium Sulfate
12. Gastrografin
13. Iodine Contrast
    a. Hypaque
    b. Isopaque
    c. Hexabrix
    d. Isovue
    e. Omnipaque
    f. Oxilan
    g. Iopromide
    h. Visipaque
14. Ionic
15. Non Ionic
16. Indications
17. Blood Vessels
18. Injection Rates
    a. CTA Chest w/Contrast
    b. CT Chest w/Contrast
    c. CT Radiation Therapy
    d. CT Abdomen/Pelvis w/Contrast
    e. CT Head w/wo Contrast
    f. Vascular CTA Chest (Adult)
19. Digestive Tract
20. Forms
    a. Liquid
    b. Paste
    c. Tablet
21. Molecular Properties
    a. Viscosity
    b. Osmolality
    c. Chemotoxicity
    d. Hydrophilicity
    e. Histamine-Releasing potentials
22. Dosing
23. Uroselectan
24. Structural Comparison
25. Adverse reactions
26. Hypersensitivities
    a. Urticaria

b. Cardiovascular reactions
c. Bronchospasm
d. Laryngospasm
e. Antigen-antibody interactions

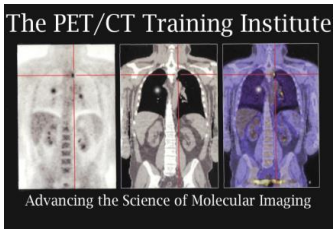
27. Categories of reactions
    a. Minor
    b. Moderate
    c. Severe
28. Patient preparation
29. Side Effects Barium Sulfate
    a. Stomach cramps
    b. Diarrhea
    c. Nausea
    d. Vomiting
    e. Constipation
30. Severity
    a. Dose
    b. Route
    c. Rate of delivery
31. Types of reactions
    a. Anaphylactoid
    b. Nonanaphylactoid
    c. Chemotoxic
    d. Vasovagal
    e. Iopathic
    f. Combined
32. True Incidence
    a. Medication
    b. Local anesthetics
    c. Needles
    d. Catheters
    e. Anxiety
33. Fatal Outcomes
    a. Underlying conditions
    b. Coronary Artery Disease
    c. GI Distress
    d. Skin Rash
    e. Ulcers
    f. Headaches
    g. Fatigue
    h. Asthma
34. Patient Selection
    a. History
    b. Hemodynamic
    c. Neurological
    d. Nutritional
    e. Allergies
    f. Asthmatic

    g. Anxiety level
35. Breast Feeding Mothers
36. Methods of delivery
37. Risk of Extravasation
    a. Non communicable
    b. Elderly
    c. Infants
    d. Children
    e. Altered Consciousness
    f. Severely Ill
    g. Debilitated
    h. Abnormal Circulation
38. Site of extravasation
    a. Tender
    b. Local edema
    c. Erythema
    d. Surgical Consultation
    e. Altered tissue perfusion
    f. Sensational changes
    g. Skin ulcerations
    h. Blistering
39. Adverse reactions to Gadolinium
40. Treatment
41. Risk Factors
42. Policy
43. Procedures
44. Premedicating patients
45. Other Effects
    a. Hives
    b. Itching
    c. Red skin
    d. Swelling of the throat
    e. Hoarseness
    f. Agitation
    g. Confusion
    h. Fast Heart beat
    i. Bluish skin color
46. Cystic Fibrosis patients
47. Asthmatic patients
48. Dehydrated patients
49. Pregnant patients
50. Treatment
51. Medication
52. Power injector
53. Equipment
54. Hose System
55. Pump Hose
56. Patient Hose

57. Touch terminal
58. Insert Hose System
59. Uses
60. Bolus
61. Timing
62. Consistency
63. Costs
64. Future uses
65. Injection rates
66. Concentration vs. Enhancement
67. Concentration vs. Flow rate
68. Effects of Iodine Concentration
69. Advances
70. Current applications
71. CTA requirements
72. Patient preparation
73. Venipuncture veins
74. Needles
75. Gauges
76. Parameters
77. Slice thickness
78. Spatial resolution
    a. Cerebral CTA
    b. Abdominal CTA
    c. Thoracic CTA
79. Spiral Pitch
80. kVp, mA, Time
81. Reconstruction Intervals
82. Subsecond scanning
83. Volume of Contrast
84. Rate
85. Time of Injection
86. Scan Delay
87. Contrast warmer
88. Automated Systems
    a. Smart prep
    b. Care
    c. Surestart
89. Scanning Methods
    a. Bolus Tracking
    b. Bolus Timing
    c. Manual Preset Time
90. Other diagnostic applications
91. Biopsy
92. Abscess Drainages
93. CT Abdomen
94. Image Quality
95. Image Resolution

96. Applications
    a. Circle of Willis
    b. Renal Arteries
    c. Abdominal Runoffs
    d. Femoral Runoffs
    e. Cardiac CT
97. Motion reduction techniques
    a. Prospective Gating
    b. Retrospective Gating
98. Contrast Guidelines

MIXWIEXXIX: Exam 29: "CT Contrast Agents I": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Topic: MIXIQII: Lecture 37: "CT Contrast Agents II" (120 Minutes)

Keywords: Characteristics of Reactions, Risk Factors, Diagnosing a reaction, Treatment, Prevention, Incidence, Onset, Anaphylactoid, Chemotactic, Mechanisms, Cutaneous, Seafood, Atopic patients

Objectives:

- Discuss the types and characteristics of a reaction.
- List the risk factors for a reaction.
- Discuss how to diagnose a reaction.
- Discuss the treatment plan for a reaction.
- Discuss the prevention of a reaction.
- Discuss the incidence of a reaction.
- Discuss the immediate onset of a reaction.
- Compare anaphylactoid vs. chemotactic reactions.
- Discuss the mechanism of an anaphylactoid contrast reaction.
- Discuss the risk factors for an anaphylactoid reaction.
- Discuss the non-immediate response to contrast reactions.
- Discuss the risk factors for non-anaphylactoid reactions.
- Discuss the risk of seafood allergies with contrast agents.
- List the facts on shellfish allergies and contrast reactions.
- Discuss symptoms of an anaphylactoid reaction.
- List the common symptoms of anaphylactoid reactions.

- List the clinical criteria for anaphylaxis reactions.
- Discuss contrast reaction delays.
- Discuss the typical delayed reaction patient.
- Discuss the delayed reaction post biopsy.
- Discuss the infrequent delay reaction patients.
- Discuss test to find the delayed reaction patient.
- Discuss the treatment plan for adverse reactions.
- Discuss the therapy plan for adverse reactions.
- Discuss methods for enhancing pediatric safety during a contrast reaction.
- Discuss anaphylaxis treatment plan.
- Discuss CPR procedures.
- Discuss the medications used during a reaction.
- Discuss how to handle the reaction emergency.
- Discuss the delayed emergency reaction treatment.
- Discuss methods to prevent contrast reactions.
- Discuss Tramer's Systematic Review of Severity Grades to reactions.
- Discuss the benefits to using H1 Antihistamines for preventing reactions.
- Discuss the use of Corticosteroids in the prevention of contrast reactions.
- Discuss methods for preventing contrast reactions.
- Discuss the emergent procedures for preventing reactions.
- Discuss the history of contrast use in CT.
- Discuss the cofounding variables for use of contrast agents on patients.
- Discuss the ACR recommendation for preventing contrast reactions.
- Discuss contrast induced nephropathy.
- Discuss when to check the creatinine levels of a patient.
- Discuss what does not work in dealing with contrast reactions.
- Discuss ways to prevent contrast induced nephropathy.
- Discuss the patients on Metformin.
- Discuss Metformin contraindications.

Content:

1. Types
2. Risk factors
3. Diagnosis
4. Treatment
5. Prevention
6. Incidence
7. Immediate reactions
8. Anaphylactoid (Non-Immunological)
9. Chemotoxic (Cardiac, neurological, or Nephrotoxic)
10. Mechanisms
11. Severe anaphylactoid reactions
12. Possible risks factors
13. Risk factors for non anaphylactoid reactions
14. Seafood Allergies

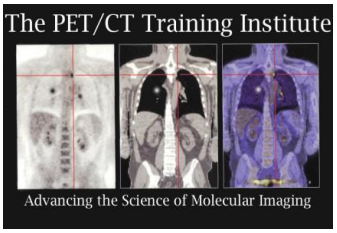
15. Atopic patients
16. Facts on shellfish allergies
17. Myths
18. Symptoms of anaphylactoid reactions
19. Common symptoms
    a. Flushing
    b. Pruritus
    c. Urticaria
    d. Angioedema
    e. Bronchospasm
    f. Wheezing
    g. Laryngospasm
    h. Stridor
    i. Hypotension
    j. Shock
    k. Loss of consciousness
20. Grade I: Mild Reactions
    a. Limited nausea
    b. Limited Vomiting
    c. Pruritus
    d. Diaphoresis
21. Grade II: Moderate Reactions
    a. Faintness
    b. Severe Vomiting
    c. Profound Urticaria
    d. Facial edema
    e. Laryngeal edema
    f. Mild bronchospasm
22. Grade III: Severe Reactions
    a. Hypotensive shock
    b. Pulmonary edema
    c. Respiratory arrest
    d. Cardiac arrest
    e. Convulsions
23. Clinical criteria for anaphylaxis
    a. Acute onset (hours to minutes)
    b. Skin and mucosal symptoms
    c. Airway compromised
    d. Decreased blood pressure
    e. Exposure to known allergen
    f. History of severe reaction
    g. GI Symptoms with food allergy
24. Delayed reactions
25. Risk Factors
26. Biopsy findings
27. Infrequent reactions
28. Diagnostic testing for propensity for reactions
    a. Blood tests

    b. Skin testing
29. Treatment for anaphylaxis
30. Treatment Plan
31. Enhancing Pediatric Safety during an reaction
32. Broselow Luten Pediatric Emergency Tape
33. Information sheet
34. Anaphylaxis treatment plan
    a. Epinephrine
    b. Supine position
    c. Oxygen
    d. H1 and H2 Antihistamines
    e. IV Fluids
    f. Steroids
35. Assessing signs and symptoms
36. CPR
    a. Adult
    b. Child
37. Drugs used for Anaphylaxis
    a. Epinephrine
    b. Sodium Chloride
    c. Anti-histamines
    d. Diphenhydramine
    e. Cetirizine
    f. Ranitidine
38. Bronchodilators
    a. Nebulizer
    b. Albuterol
    c. Levalbuterol
    d. Atrovent
    e. Glucagon
39. Vasopressors
40. Corticosteroids
41. Patterns of reactions
    a. Uniphasic
    b. Biphasic
    c. Protracted
42. Prolonged Observation periods
43. Beta Blockers
44. Ace Inhibitors
45. Receptor blockers
46. Medications for special considerations
    a. MAO Inhibitors
    b. Tricyclic Anti-depressants
47. Vagal reactions
48. Prevention of first reaction
49. Patient history of prior reactions
50. Evidence of pretreatment of reactions
51. Tramer Systematic Review of Premedication

52. Tramer Severity Grade
53. Benefits of using H1 Antihistamines for prevention of reactions
54. Benefits of using H1 and H2 Antihistamines for preventing reactions
55. Benefits of corticosteroids systematic review
56. Pre-Medication- Unclear benefits
57. Current recommendations for patients with prior history of reactions
58. Categories
59. Emergent procedures for prevention of reactions
60. Delayed reaction prevention
61. History of Contrast
62. Importance of contrast agents
63. Oral contrasts
64. Adverse reaction occurrence
65. Iodine allergy
66. Seafood allergy
67. ACR recommendations for patient has history of reactions
68. Does prevention work
69. Asthmatics and IV contrast
70. Contrast induced nephropathy
71. Checking creatinine levels
    a. Age greater than 70 years old
    b. CHF
    c. Cirrhosis
    d. Diabetes
    e. Multiple Myeloma
    f. Anemia
    g. Sepsis
    h. Hypotension
    i. Hypertension
    j. Nephrotoxic drugs
72. What does not work
    a. Diuresis
    b. Mannitol
    c. Furosemide
    d. Vasodilators
    e. Dopamine
    f. Fenoldopam
    g. Atrial Natriuretic peptides
    h. Calcium Channel Blockers
    i. Ace Inhibitors
    j. Endothelin Receptor antagonists
    k. Aminophylline
    l. Theoophylliine
73. Preventing Contrast Induced Nephropathy
74. Patients taking metformin
75. Metformin and IV Contrast agents
76. Metformin Contraindications
    a. Hypersensitivity

b. DKA
c. Diabetic Coma
d. Chronic Liver Disease
e. CHF
f. Vitamin B-12 Deficiency
g. Recent MI
h. Shock
i. Severe Systemic Disease
j. Pulmonary Insufficiency

MIXWIEXXX: Exam 30: "CT Contrast Agents II": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MIXWIQIII: Lecture 38: "Basic Patient Skills for the CT Technologist: (90 Minutes)

Keywords: Vital Signs, Body temperature, Pulse, Respiration, Blood Pressure, Guidelines, Height and Weight, Intake and Output, Edema, Dehydration, Trauma CT, Indications, Epidural Hematoma

Objectives:

- Discuss taking the vital signs of the patient.
- Discuss the purpose of vital signs to monitor the patients' health.
- Discuss the factors affecting the temperature reading of a patient.
- Discuss the equipment used to detect the patient's temperature.
- Discuss the sites to take a patient's temperature.
- Discuss the safety precautions when taking a patients temperature.
- Discuss the measurement of a patients pulse.
- Discuss the sites for taking a patient's pulse.
- Discuss the factors that affect a patient's pulse.
- Discuss the measurement of a patient's respiration.
- Discuss the factors that can affect a patient's respiration rate.
- Discuss the measurement of a patient's blood pressure.
- Discuss the factors influencing blood pressure changes.
- Discuss the equipment used to acquire the blood pressure values.
- Discuss the guidelines for blood pressure measurements.
- Discuss how to read the blood pressure gauge.
- Discuss the measurement of the patient's height and weight.
- Discuss the measuring of a patient's Intake and Output of fluids.

- Discuss the causes of edema.
- Discuss the symptoms of edema.
- Discuss the causes of dehydration for a patient.
- Discuss the symptoms of dehydration of a patient.
- Discuss the process of measuring and recording the Intake and Output of patient's fluids.
- Discuss the Trauma CT patient.
- Discuss the indications of CT of the Head.
- Discuss the rules for dealing with the trauma patient.
- Discuss the normal range for the BUN.
- Discuss the normal range for the Creatinine.

Content:

1. Vital signs
2. Temperature
3. Pulse
4. Respiration
5. Blood Pressure
6. Purpose
7. Heat production
    a. Muscles
    b. Glands
    c. Oxidation of food
8. Heat Loss
    a. Respiration
    b. Perspiration
    c. Excretion
9. Factors affecting temperature
    a. Exercise
    b. Illness
    c. Age
    d. Time of Day
    e. Medications
    f. Infections
    g. Emotions
    h. Hydration
    i. Clothing
    j. Environmental temperature
    k. Air movement
10. Equipment
    a. Oral
    b. Rectal
11. Types of thermometers
12. Normal temperature range for adults
    a. Oral
    b. Rectal
    c. Axillary

13. Reading a glass thermometer
14. Sites to take temperature
    a. Oral
    b. Rectal
    c. Axillary
    d. Tympanic
15. Safety precautions
16. Measuring the pulse
17. Sites for taking pulse
    a. Radial
    b. Temporal
    c. Carotid
    d. Brachial
    e. Femoral
    f. Popliteal
    g. Dorsalis pedis
    h. Apical
18. Factors affecting pulse
    a. Age
    b. Sex
    c. Position
    d. Drugs
    e. Illness
    f. Emotions
    g. Activity level
    h. Temperature
    i. Physical training
19. Normal pulse ranges
20. Measuring respiration
21. Factors affecting respiration rates
    a. Age
    b. Activity level
    c. Position
    d. Drugs
    e. Sex
    f. Illness
    g. Emotions
    h. Temperature
22. Qualities of normal respiration
23. Documenting respiratory rates
24. Measuring blood pressure
25. Factors influencing blood pressure
    a. Weight
    b. Sleep
    c. Age
    d. Emotions
    e. Sex
    f. Heredity

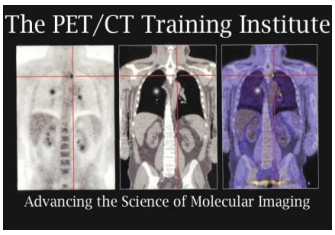
g. Viscosity of blood
h. Illness
i. Disease

26. Equipment for taking the blood pressure
27. Normal blood pressure ranges
28. Guidelines for taking the blood pressure
29. Blood pressure gauge readings
30. Measuring Height and weight of patient
31. Guidelines for measuring a patients weight and height
32. Measuring Intake and Output of fluids of a patient
33. Edema
34. Symptoms of Edema
    a. Weight gain
    b. Swelling of feet
    c. Swelling of ankles
    d. Swelling of hands
    e. Swelling of fingers
    f. Swelling of face
    g. Decreased urine output
    h. Shortness of breath
    i. Collection of fluids in the abdomen
35. Dehydration
36. Symptoms of dehydration
    a. Thirst
    b. Decreased urine output
    c. Parched or cracked lips
    d. Dry, cracked skin
    e. Fever
    f. Weight Loss
    g. Concentrated Urine
    h. Tongue coated and thick
37. Causes of dehydration
    a. Poor fluid intake
    b. Diarrhea
    c. Bleeding
    d. Vomiting
    e. Excessive perspiration
38. Measuring and Recording Intake and Output
39. Intake
    a. Mouth
    b. Food items
    c. Tube feedings
    d. IV fluids
40. Output
    a. Urine
    b. Stool
    c. Emesis
    d. Drainage

e. Suctioned secretions
f. Excessive perspiration

41. Traumatic CT patients
42. Indication for CT Head
43. Epidural Hematomas
44. Mass effect of the brain
45. Basilar skull fractures
46. Depressed skull fractures
47. Rich's Rules for Trauma patients
48. BUN
49. Creatinine
50. Sternal fractures
51. Dissecting aneurysms
52. Pulmonary emboli
53. Lacerated spleen
54. Kidney stones
55. Fractured calcaneus

MIXWIEXXXI: Exam 31: "Basic Patient Care skills for the CT Technologist": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MXWIQI: Lecture 39: "Basic Instrumentation of SPECT/CT" (120 Minutes)

Keywords: Physics, X-Ray, Tube, Voltages, Current, Components, Helical scanners, Hounsfield Units, CT numbers, Windowing, Artifacts, Low Dose CT, Occupational exposure, CT Quality Control

Objectives:

- Describe the physics processes involved in the production of Xrays.
- Describe the role of each component in the Xray tube.
- Discuss the role of proper adjustment of the Xray tube voltage and current in CT.
- Name the principle parts of the CT scanner.
- Discuss the function of the CT scanner components.
- Describe the function of a helical CT scanner and its components.
- Describe CT data acquisition and processing.
- Describe Hounsfield units.
- Describe the CT number values assigned to various tissues and how these values are assigned meaningful display windowing.
- List the parameters set by the technologist and the effects of these parameters on the image.

- Discuss CT image quality.
- List the origin of CT artifacts and their prevention.
- Discuss appropriate parameters for the acquisition of low dose CT.
- Describe the parameters and image characteristics required for a diagnostic quality CT scan.
- Describe the integration of the CT scan into the combined PET/CT or SPECT/CT exam.
- Discuss occupational radiation exposure from operating a CT scanner.
- Describe the CT Quality Control program.
- Discuss CT Quality Assurance.
- Discuss SPECT/CT Technology.
- Describe SPECT/CT architecture.
- Discuss the technical skills to operate a SPECT/CT Scanner.
- Discuss the effects of CT based attenuation correction in SPECT/CT.
- Discuss radiopharmaceuticals used in SPECT/CT.
- Compare todays SPECT/CT Systems.

Content:

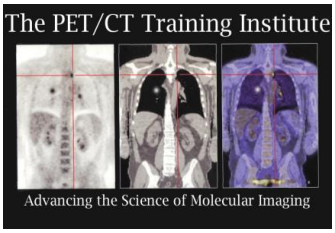
1. CT Physics
2. Bremsstrahlung Radiation
3. Characteristic X-Rays
4. X-Ray Tube
5. Production of X-Rays
6. kVp
7. mA
8. Time
9. Slice Thickness
10. Slice increments
11. Voltage variations
12. Noise
13. Focal spots
14. Filaments
15. X-Ray filters
16. Filtration material
17. Principles of CT
18. CT scanner design
19. CT system components
20. Gantry
21. Detectors
22. X-Ray tube heat capacity
23. Heat Unit calculation
24. Anode
25. Cathode
26. CT Generator
27. Collimation
28. Advantages of Thinner Collimation
29. Compromises of Thinner Collimation

30. Rotation speed
31. Pitch
32. Increment
33. Helical scanners
34. Image data acquisition
35. Reconstruction
36. Display
37. Control console
38. Matrix
39. Coordinate system
40. Aperture
41. Isocenter
42. Patient Orientation
43. Tilting
44. Patient Couch
45. Scannable range
46. Scan Field of View
47. Display Field of View
48. Surview
49. Scanogram
50. Topogram
51. Volumetric CT
52. AP Scout
53. Lateral Scout
54. Fundamentals of Multislice CT
55. Axial Scan
56. Spiral scan
57. Conventional CT
58. Spiral/Helical CT
59. Advantages
60. Digital Projections
61. Table speed
62. Advantages of Volume CT
63. Multislice fundamentals
64. Multislice effectiveness
65. Dual slice detectors
66. Quad Detector Technology
67. Sixth Generation Scanners
68. Seventh Generation Scanners
69. Slip Ring Technology
70. Single Slice vs. Multislice CT
71. Single Row detectors
72. Multi Row detectors
73. Slice Thickness
74. Spiral CT pathway
75. Display of Volumetric data
76. Image quality
77. High Contrast

78. Low Contrast
79. Image noise
80. Low Dose CT for attenuation correction
81. Attenuation
82. Integrated SPECT/CT Protocols
83. CT Protocols
84. Diagnostic CT
85. Abdominal CT
86. Chest CT
87. Neck CT
88. Contrast Media
89. Contrast Agents
90. Administration
91. Iodine
92. Barium Sulfate
93. Gastrografin
94. Rectal Contrast
95. CT Advantages
96. Limitation of CT
97. Goals of CT
98. Density Information
99. Window Settings
100. Image Quality
101. Isotropic Imaging
102. Post Processing Options
103. Attenuation coefficients
104. Pixel size
105. Reconstruction
106. Pixel vs. Voxel
107. Image display
108. Grey Scale
109. CT Numbers
110. CT Number vs. Brightness level
111. CT Number of Cyst
112. CT Number of Lipoma
113. Filtered Back projection
114. Hounsfield Scale
115. Windowing
116. Narrow Contrast
117. Wide Contrast
118. Host Computer
119. CT Operating System
120. Array Processors
121. DAS
122. Amplifier
123. ADC
124. Sample/Hold Unit
125. Image recording and storage devices

126. Laser Printers
127. Hard copy
128. Image storage media
129. Communications
130. Radiopharmaceuticals
131. CT Quality control
132. General QC Tests
133. Alignment laser Accuracy
134. Table Incrimination accuracy and collimation
135. Helical Pitch accuracy
136. kVp accuracy
137. Half Value Layer
138. Exposure Reproducibility and Linearity
139. Radiation Profile width
140. Slice Sensitivity Profile
141. Image quality measures
142. Phantoms and test tools
143. Noise and field Uniformity axial scan
144. Field Uniformity and Volume Scan
145. CT Number linearity
146. Low Contrast detectability
147. Spatial resolution
148. Modulation Transfer function
149. Reconstruction time
150. Scout views
151. Display and hard copy image quality
152. Dosimetry Measurements CTDI
153. CT Equipment Quality Assurance Program
154. Acceptance testing
155. AAPM Acceptance testing recommendations
156. Annual ACR Requirements
157. Monthly Tests
158. Continuous Quality control
159. Daily Tests
160. AutoQA Lite Overview
161. CT Radiation Safety
162. Basic SPECT/CT
163. Overview of SPECT/CT architecture
164. SPECT/CT Protocols
165. Basic Technologist Skills to operate a scanner
166. Advantages of SPECT/CT
167. Effects of CT Based Attenuation Correction in SPECT/CT
168. Diagnostic Quality CT Studies
169. CT Internal Radiation Dose Dosimetry
170. Estimated Radiation Dose from a SPECT/CT Procedure
171. SPECT/CT radiopharmaceuticals
172. Comparing todays SPECT/CT Systems

MXWIEXXXIII: Exam 33: "Basic Instrumentation of SPECT/CT": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MXWIQII: Lecture 40: "The Electronics of a SPECT Detector" (60 Minutes)

Keywords: Hal Anger, Design, Photomultiplier Tubes, High Voltage Power Supply, Preamplifier, Gain Control, Pulse Height Analyzer, Spectrometers, Collimators, Uniformity, Spatial Linearity

Objectives:

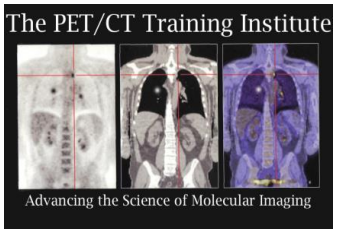
- Discuss the key electrical components of a gamma camera system.
- Discuss the positional circuitry of an analogue camera system.
- Discuss the positional circuitry of a hybrid camera system.
- Discuss the positional circuitry of a digital camera system.
- Discuss the choices of collimators used in imaging.
- Discuss the principles of uniformity.
- Discuss the principles of spatial linearity.
- Discuss the principles of system efficiency.
- Discuss the principles of energy resolution.

Content:

1. Anger Scintillation Camera
2. Design
3. Photomultiplier tubes
4. High voltage power supply
5. Preamplifiers
6. Gain Control
7. Pulse Height Analyzers
8. Spectrometers
9. Analog Camera
10. Hybrid Camera
11. Digital Camera
12. Collimators
13. Parallel Hole Collimators
14. Pinhole Collimators
15. Converging Collimators
16. Diverging Collimators
17. Image Formation

18. Spatial Resolution
19. Uniformity
20. Spatial Linearity
21. Multi energy Spatial Resolution
22. System efficiency
23. Collimator efficiency
24. Energy resolution
25. Count rate performance

MXWIEXXXIV: Exam 34: "The Electronics of a SPECT Detector": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*



Title: MXWIQIII: Lecture 41: "Clinical Applications of SPECT/CT" (60 Minutes)

Keywords: SPECT, CT, Hybrid Imaging, Advantages, Bone Imaging, Infection Imaging, Oncological Imaging, Sentinel Node Localization, I-131 Body Imaging, General Imaging, Low Dose CT

Objectives:

- Discuss the purpose of Hybrid Imaging techniques.
- Discuss implementation considerations when designing a SPECT/CT suite.
- Discuss the advantages of SPECT/CT.
- Discuss the general indications for SPECT guided low dose procedures.
- Discuss the general indications for SPECT guided diagnostic CT when anatomic information is needed.
- Discuss Sentinel Node localization with SPECT/CT.
- Discuss the use of SPECT/CT in Skeletal Disease.
- Discuss the use of SPECT/CT in Parathyroid Tumors.
- Discuss the use of SPECT/CT for tumors of the Sympathetic Nervous System and Adrenal Cortex tumors.
- Discuss the diagnosis of pheochromocytoma with Tc99m MIBG SPECT/CT.
- Discuss the use of SPECT/CT in cardiac imaging.
- Discuss the use of cardiac gating in SPECT/CT.
- Discuss the principles of cardiac gating.
- Compare the differences between regular SPECT and Gated SPECT.
- Discuss the requirements for a Gated SPECT study.
- Discuss the use of SPECT/CT in differentiating thyroid cancers.
- Discuss the use of SPECT/CT in Bone Imaging.

- Discuss the use of SPECT/CT for suspected bone infections.
- Discuss the role of SPECT/CT in oncological applications.
- Discuss the role of SPECT/CT with I-131 Whole body imaging.
- Discuss the role of SPECT/CT with General Nuclear Medicine procedures.

Content:

1. SPECT
2. CT
3. Hybrid Imaging
4. CT Coregistration
5. Background
6. Implementation considerations
7. Advantages
8. Clinical applications
9. Low Dose CT
10. Indications
11. Diagnostic CT
12. Sentinel Node Localization
13. Skeletal Diseases
14. Malignant skeletal diseases
15. Parathyroid tumors
16. Sympathetic Nervous System
17. Adrenal cortical tumors
18. Pheochromocytoma
19. Tc99m MIBG
20. Cardiac Imaging
21. Cardiac Gating
22. Utility of gating
23. Methodology
24. Comparison between SPECT vs. Gated SPECT
25. Hardware requirements
26. Differentiating Thyroid Cancers
27. Bone Imaging
28. Bone Infections
29. Oncology Imaging
30. I-131 Whole Body Imaging
31. Thyroid Cancers
32. Lung Cancers
33. General Nuclear Medicine Imaging
34. Additional considerations
35. Other applications of SPECT/CT

MXWIEXXXV: Exam 35: "Clinical Applications of SPECT/CT": *You must score an 80% or greater in order to receive SNMMI-TS Voice Credits.*

Title: POST TEST
Title: Course Evaluation