Clinical Applications of Radiopharmaceuticals

Kara D. Weatherman, PharmD, BCNP, FAPhA
Purdue University
FIP Congress - Salvador Bahia, Brazil
August, 2006

Objectives

• Discuss various uses of common radiopharmaceuticals
• Compare nuclear medicine and other diagnostic imaging modalities
• Identify the role of radiopharmaceuticals in therapeutic applications

Nuclear Pharmacy

DIAGNOSTIC  THERAPEUTIC

Where Do We Start?

• X-rays discovered in 1895
• “Artificial” radioactivity discovered in 1934
• First clinical use of “radioactivity” - 1937
• Radioactive iodine used to successfully treat thyroid cancer - 1946
• Widespread use of nuclear medicine began in the early 1950’s
Brain Imaging

• Evaluate cerebral perfusion
• Evaluate cerebral function
• Products
  – Tc-99m labeled lipophilic agents
  – Ceretec, Neurolite
Brain Imaging

Thyroid Imaging

- Evaluate shape, size and location of thyroid gland
- Determine function (as % uptake of iodine)
Heart Imaging

- Assess myocardial perfusion
- Determine myocardial function
  - Wall motion
  - Ejection fraction
Gated Cardiac Blood Pool Images

Gastric Imaging

- Gastric Emptying / Reflux / Aspiration
  - Tc-99m SC
- GI Bleeds
  - Tc-99m SC, To-99m RBC
- Hepatobiliary
  - Tc-99m IDA compounds
- Liver / Spleen
  - Tc-99m SC
GI Bleed

Normal Liver Spleen Images

Liver uptake > Spleen uptake > Bone marrow uptake

Bone Imaging

- Assess trauma, bone pain, primary bone tumors, infection and prosthesis
- Detect and stage metastatic disease
  - Tc-99m phosphate compounds
Clinical Examples - Normal

Primary Cancer

Child Abuse / Trauma
Pulmonary Imaging

- Evaluation of pulmonary ventilation
  - Tc-99m DTPA, Xe-133 gas
- Evaluation of pulmonary perfusion
  - Tc-99m labeled MAA

82yowf with sudden onset SOB

Diagnosis: high probability for PE - multiple segmental defects

Renal Imaging

- Assessment of flow and function
  - Tc-99m labeled agents for filtration and secretion
- Evaluation of renal morphology
  - Tc-99m labeled morphology agents

PHASE 1 - Flow study

RESULTS: Normal uptake of the tracer by both kidneys. Kidneys appear normal in size, configuration and location
PHASE 2 - Static study

RESULTS: Normal uptake of the tracer by both kidneys. Kidneys appear normal in size, configuration and location. There is normal excretion of MAG-3 by both kidneys as evidenced by decreasing tracer concentration in the kidneys and increasing tracer concentration in the bladder.

RESULTS: Minimal left kidney function (~18% of total) with right renal function that shows no evidence of obstruction. Right renal function is calculated to be 82% of total.

RESULTS: Following slow accumulation of tracer in the kidney, there is decreased excretion of tracer through the ureter into the bladder which is well below normal. Findings could be consistent with Acute Tubular Necrosis (ATN), but due to the decrease in urine output, rejection can’t be excluded. Patient will be monitored over the next few days.
Infection Imaging

• Localize internal sources of infection
  – Tc-99m or In-111 labeled white blood cells
  – Ga-67

Labeled WBC: Crohn’s Disease

Tc-99m MDP / In-111 WBC

Ga-67: Sarcoidosis

Tc-99m MDP

In-111 WBC
Ga-67: PCP Pneumonia

Receptor Imaging

- Peptide based imaging designed to bind to receptors within the body
  - Somatostatin analog
  - DVT imaging

Carcinoid

Gastrinoma - Pancreas and Liver
Ilalllb Receptor Imaging

60 minutes 120 minutes

Tumor Imaging

- Evaluating location and spread of tumor
  - Ga-67
  - Monoclonal antibodies
- Evaluating metabolic activity of tumor cells
  - F-18 FDG

Ga-67: Lymphoma

Ga-67: non-Hodgkin's Lymphoma
Non-Hodgkin’s Lymphoma

remission  4 mo follow-up  8 mo follow-up

Nuclear Pharmacy

DIAGNOSTIC  THERAPEUTIC

Thyroid Therapy

- Treatment of hyperthyroidism
- Treatment of post-surgical tissue remnants
- Treatment of metastatic spread
  - I-131 sodium iodide
Bone Pain Palliation

- Palliative treatment for pain associated with metastatic disease to the bone
  - Sr-89
  - Sm-153

Non-Hodgkins Lymphoma

- Monoclonal antibodies specific for CD-20 marker on B-cells
  - Y-90 Zevalin
  - I-131 Bexxar
Normal In-111 Zevalin Distribution

Pharmacist’s Role - Current

• Preparation and dispensing
  – Dispensing primarily technician responsibility
• Consultant
  – Source of reference for nuclear medicine staff
  – Comfort level
• Educator

Where Are We Going?

• Therapeutic applications
  – Higher cost for medications
  – More technical labeling procedures
• Drug Utilization Review
  – Patient specific review
  – Common in community / hospital practice
  – How to implement?

Conclusions

• Advances in all imaging modalities changing the patterns of diagnostic imaging
• Nuclear medicine / nuclear pharmacy still plays an important role in patient care
• Nuclear pharmacists can and should play a bigger role in providing pharmaceutical care