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**SAVE THE DATES** - 2018 Winter Symposia
CARDIAC SPECT IMAGING

Arif Sheikh, M.D.
Associate Professor of Radiology
Interim Director, Nuclear Medicine Section
Columbia University Medical Center
New York Presbyterian Hospital
New York, NY
Cardiac SPECT Imaging

Cardiac SPECT imaging has undergone the most rapid transformation within the field of Nuclear Medicine. The purpose of this talk will be to briefly review the very basics, artifacts and pitfalls of stress perfusion imaging, and then move towards important newer developments, such as Stress Only Imaging, Newer Stress Techniques, and Novel Camera Technologies. Next, Cardiac Nuclear Medicine newer clinical frontiers will be briefly touched upon to expose the audience to the variety of techniques being used clinically in this field.

1) Review of the basics

2) Newer approaches
   a. Stress methods
   b. Newer technologies
   c. Broadening horizons

3) Cardiac SPECT beyond perfusion imaging

References:
CARDIAC PET IMAGING

Kevin L. Berger, M.D.
Director of PET/CT
Chesapeake Medical Imaging
Annapolis, MD

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Cardiac PET-CT

Kevin Berger, MD
Director of PET/CT

PET/CT and Nuclear Medicine in Clinical Practice

Objectives

- List approved indications for cardiovascular PET/CT
- Know the equipment needs necessary to perform cardiac PET/CT exams
- Propose a cardiac PET/CT imaging protocol
- Learn the advantages of PET/CT in the evaluation of patients with coronary artery disease

Approved PET Cardiac CPT Codes

- Implemented April 4 and retroactive to Jan 30, 2005, CMS discontinued G-codes and the following CPT codes are effective:
  - 78491 Myocardial imaging, PET, perfusion; single study at rest or stress
  - 78492 Myocardial imaging, PET, perfusion; multiple studies at rest and/or stress
  - 78459 Myocardial imaging, PET, metabolic evaluation (approved October 1, 2001)

Methods

- Equipment needs
- Patient preparation
- PET/CT acquisition protocols
- PET/CT data reconstruction

Additional Equipment Needs

- ECG gating system for PET/CT scanner
- Patient Arm Rest Devices
- Radiotranslucent grapsers and electrodes for ECG
- Remote ECG monitoring station
- Non-ionic, iso-osmolar contrast agent
- Contrast warmer
- Infusion pump for pharmacologic stress agent
- Pharmacologic stress agents: dipyridamole, adenosine, or dobutamine
- Automated blood pressure cuff
- Pulse oximeter
- Radiopharmaceutical dose shielding system
- Crash Cart and Defibrillator
Patient preparation

- No caffeine (12-24 hours prior to scan)
- No theophylline (48 hours prior to scan)
- NPO p MN or 6 hours prior to scan
- 20-22 gauge IV preferably in forearm site

PET Cardiac Perfusion Isotopes

<table>
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<tr>
<th>Agent</th>
<th>Half-Life</th>
<th>Positron</th>
<th>Production</th>
<th>Total Counts</th>
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<tr>
<td>N-13 Ammonia</td>
<td>9.8 min 0.7 mm Cyclotron More</td>
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<tr>
<td>Rb-82</td>
<td>75 sec 2.4 mm Generator Less</td>
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Pharmacologic stress

- 0.568 mg/kg dipyridamole over 4 minutes
- Alternatively, may use adenosine 140 ug/kg/min for 6 minutes
- Regadenoson 0.4mg over 10-15s
- 125 mg aminophylline
Pharmacologic stress

- If the patient is asthmatic, we prefer to use regadenoson. If unavailable, we use dobutamine as our stress pharmacologic agent.
- Do not gate the stress exam.
- To accommodate the short-half life radiotracer dosing schedule, we use an accelerated dobutamine administration protocol:
  - Infuse 10 ug/kg/min of dobutamine (250 mg/250cc D5W) for 1'
  - Infuse 40 ug/kg/min of dobutamine for next 7'
  - At 7' minutes into commencement of dobutamine infusion, we may give 0.5 mg of atropine i.v. rapid push.
  - Target 85% age predicted maximum heart rate or experience their typical anginal symptoms. If not target, we may give additional 0.5 mg of atropine and continue dobutamine infusion.
  - Ammonia is injected at peak target heart rate. Typically, this is at 6-12' post beginning the dobutamine infusion protocol.
  - Reverse patients with 3-10 mg of metoprolol.

PET Processing Parameters

- FBP Processing (OSEM also viable option)
  - Hanning Transaxial Filter (128 x 128 matrix Cutoff 6.5)
  - Butterworth Filter (Cutoff 0.55 Rolloff 10)
  - Diameter 41.9 cm
  - Center L 4.0 cm
  - Measured attenuation
  - Randoms correction by Singles
  - 3D PET Butterworth filtering

Radiation dose

- N-13 ammonia rest scan 20-25 mCi = 1.35-1.85 mSv
- N-13 ammonia stress scan 20-35 mCi = 1.35-2.59 mSv
- Total Effective Dose = 2.70-4.48 mSv
- Rb-62 rest or stress scan 60 mCi = 2.66 mSv
- Total Effective Dose = 5.24 mSv
- Tc-99m Sestambi rest scan 8 mCi = 2.4 mSv
- Tc-99m Sestambi stress scan 22 mCi = 6.6 mSv
- Total Effective Dose (Tc-99m) = 9.0 mSv
- Total Effective Dose (rest+stress) (TI-201) = 30.0 mSv

Background Contamination

- For same day Tc-99m sestamibi study, approximately 15-20% of total counts represent background contamination.
- For same day N-13 ammonia study, less than 15% of total counts represent background contamination.
PET v. SPECT

- Dr. Merhige argued that PET scanning as 1st line test could decrease use of angiograms by more than 50% secondary to improved accuracy.
  - His outcomes data show rate of heart attack and cardiac catheterization significantly lower after 1 year in patients managed by PET.
  - Decreased number of angiograms, balloon angioplasty with stenting and CABG lower in patients managed by PET.
  - The average cost to manage a patient with coronary artery disease was 25% lower in the PET group.

PET v. SPECT

- In 233 consecutive patients with non-diagnostic SPECT (usually breast/diaphragm attenuation), only 2% were indeterminate by PET.
  - PET Normal (170) had 100% three-year survival
  - PET Abnormal had less than 70% survival
  - PET achieved 41% cost savings

Bateman, SNM 2005
Bateman, Circ 108:IV-454, 2003

What is the added value of hybrid imaging?

- At the March, 2005 Academy of Molecular Imaging meeting, Dr. Daniel Berman posed the following benefits and limitations of CT imaging:
  - Strong quantitative relationship between coronary calcium score and atherosclerotic plaque burden, making it an accurate, sensitive test for early detection
  - Optimize attenuation correction
  - Hybrid scanners often delayed in latest CT technology
  - No data to show improved accuracy by simultaneous imaging rather than sequential stand-alone units

52 year-old woman with suspected coronary artery disease. PET/CT exam requested to assess for ischemia and progression of CAD. The study reveals normal perfusion and a minimal amount of calcification of the LAD.

Coronary artery and myocardial perfusion fused display

HeartFusion Quantification

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Myocardial Perfusion Quantitative Analysis

Absolute quantification method

Rest          Stress    Stress/rest      Stress-

The coronary angiogram revealed:
LAD   80%
M2, M3   96%, 90%
RCA  100%

Abnormal Sectors

PET Myocardial Perfusion

PET perfusion exam demonstrates lateral wall ischemia. The stress ECG was negative.

PET Myocardial Perfusion

81 year-old smoker with known history of CAD and is status post CABG. The patient complains of severe dyspnea on exertion. PET requested to assess for myocardial ischemia and CT coronary angiogram to assess graft patency.

Normal N-13 Ammonia Distribution

Normal N-13 Ammonia Distribution

A 51 year-old male with history of abnormal exercise stress test.

Normal N-13 Ammonia Distribution

• Septal wall shows more uptake than lateral wall
• Apex relative less perfusion (apical thinning)
• No gender differences

CT angiogram: Triple CABG on triple vessel disease
1) LIMA to LAD patent proximally
2) Sequential saphenous vein graft to circumflex and diagonal occluded
3) Saphenous vein graft to right coronary system patent

Coronary angiogram (1 month later):
1) LAD 50-60%
2) LIMA graft patent proximally
3) Diag 90%
4) Sequential SVG occluded proximally but arm to diagonal patent
5) Circumflex 80-90%
6) RCA 50-70%, 90%
7) SVG to RCA patent

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CT Chest with iodine (CT-angi) revealed a right upper lobe mass which was hypermetabolic on subsequent FDG-PET imaging.

**Treatment:**
1. For CAD:
   - Angioplasty and Rotablator on Cx
   - Stents placed of the ostial left circumflex artery and proximal 1st obtuse marginal branches
2. Lung Cancer:
   - Referred for biopsy prior to planned radiotherapy treatment of this lesion

Patients who are smokers have elevated risk of CAD and a higher risk of lung cancer, and this lesion would never have been detected by a conventional nuclear medicine imaging exam.

---

62 year-old woman with dyspnea and chest pain r/o myocardial ischemia

PET: Normal myocardial perfusion

CT: pericardial effusion and small bilateral pleural effusions

---

71 year-old man with dyspnea on exertion r/o myocardial ischemia

Short axis projections

Polar Maps

---

66 year-old man with diabetes mellitus and occasional chest pain

Myocardial perfusion PET shows large area of severe ischemia in the posterior wall. Coronary angiogram revealed near total occlusion of the proximal right coronary artery.

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50 year-old woman with precordial chest pain and report of septal ischemia on outside SPECT myocardial perfusion exam

Short axis PET shows hypoperfusion of the anterolateral wall

---

HeartFusion Correlates PET Perfusion Abnormality with Coronary Anatomy

**Treatment:**
1. For CAD:
   - Angioplasty and Rotablator on Cx
   - Stents placed of the ostial left circumflex artery and proximal 1st obtuse marginal branches
2. Lung Cancer:
   - Referred for biopsy prior to planned radiotherapy treatment of this lesion

Patients who are smokers have elevated risk of CAD and a higher risk of lung cancer, and this lesion would never have been detected by a conventional nuclear medicine imaging exam.
Gated PET/CT exam shows normal wall motion and ejection fraction.

PET/CT misregistration: The area of myocardium superimposed on the lung has an attenuation value lower than soft tissue (myocardium) thus the PET perfusion exam is under-corrected.

Correct PET/CT registration using repeat CT attenuation scan.

PET/CT Misregistration: Apparent hypoperfusion of the anterolateral wall.

Correct PET/CT registration: Normal perfusion.

PET/CT Misregistration
- In approximately 40% of cases, a false positive could result from misregistration
  - 76% occur in anterolateral wall
  - 16% occur in inferior wall
  - 8% in apex
- Recommend obtaining transmission scan at end normal expiration (consider using cine CT)
- Need for alignment programs

PET Myocardial Viability
- PET images obtained in “fed” state not fasting (shift heart from FFA to glucose)
- May use oral glucose 50g or i.v. dextrose 12.5-25g
- May use insulin clamp technique or sliding scale algorithm of glucose and/or insulin

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PET Myocardial Viability

• In areas with reduced perfusion, the FDG uptake is compared to the N-13 ammonia data. If they are concordant, it represents scar.
• If FDG uptake exceeds N-13 ammonia uptake by more than 15%, it is considered a mismatch and represents viable myocardial tissue.

PET Myocardial Viability

58 year-old man with known severe coronary artery disease and decreased perfusion in the inferior wall which is viable by FDG.

Rest NH3 FDG

PET Myocardial Viability

58 year-old man with recurrent chest pain s/p CABG with hypoperfusion of the anterolateral wall which is viable.

NH3 FDG

PET Myocardial Viability

• The degree of functional recovery of patients after revascularization can be predicted based on the extent of mismatch. There is an 80% likelihood of functional improvement in the presence of mismatch exceeding 18% of the left ventricle.
• In a meta-analysis, Allman et al found revascularization was associated with an 80% reduction in annual mortality compared to medical treatment in patients with evidence of viability.


Summary

• PET/CT offers many potential advantages over conventional SPECT myocardial perfusion protocols:
  – Accuracy
  – Cost-effective
  – Higher patient throughput
  – Radiation dosimetry/background contamination
  – Ability to combine with multislice CT Angiography
  – Unexpected CT findings
  – Potential for quantitative image assessment
• Disadvantages include:
  – Higher initial capital costs
  – Own unique potential diagnostic pitfalls
Radionuclide Evaluation and Management of Benign Thyroid Disease

Pradeep G. Bhambhvani, M.D.
Associate Professor, Tenure -Earning
Department of Radiology
Division of Molecular Imaging and Therapeutics
University of Alabama at Birmingham School of Medicine
Birmingham, AL
Hyperthyroidism

Introduction

Diagnosis

Treatment

Radioiodine Therapy

Mechanism

Indications

Patient preparation

Dosing strategies

Adverse effects

Radiation Safety

Pediatric Hyperthyroidism

Hyperthyroidism: Introduction

Syndrome associated with excessive production of thyroid hormones.

More common in women. Overall prevalence 1.3%.

(Hollowell JG et al. J Clin Endocrinol Metab. 2002;87(2):489)

Etiologies are based on the thyroid radiiodine uptake (RAIU).

Normal or Increased uptake:

- Graves’ disease
- Toxic adenoma & multinodular goiter
- Hashitoxicosis
- Trophoblastic tumors

Decreased uptake:

- Thyroiditis (subacute-viral, painless-postpartum, interferon, lithium etc.)
- Iodine induced: iodinated contrast or Amiodarone
- Exogenous thyroid replacement (Factitious, Struma ovarii)

Hyperthyroidism: Clinical Presentation

Mostly from excess thyroid hormones: increased sweating, appetite, palpitations, atrial fibrillation, SOB, weight loss, diarrhea, osteoporosis, anxiety, restlessness, tremors etc.

Some are minimally symptomatic with only a suppressed TSH & normal thyroid hormone levels (Subclinical Hyperthyroidism).

Goiter may cause compressive symptoms.

Ophthalmopathy (lid lag, periorbital swelling, proptosis) & infiltrative dermopathy (pretibial myxedema) are unique to Graves Disease.

Graves’ Disease (GD)

Most common cause of hyperthyroidism.

Autoimmune condition notable for the production of TSH receptor antibodies (TRAb) which continuously stimulate the thyroid.

Thyroid is often diffusely enlarged with increased 4 & 24 hour RAIU.

Up to 40% achieve remission with supportive therapy (mild disease, females, small goiters, low titer or normal TRAb etc.).
TOXIC MULTINODULAR GOITER (TMNG)

- Multiple thyroid nodules with or without hyperthyroidism. Thyroid can enlarge & cause compressive symptoms (dysphagia, stridor or dyspnea).
- Pathogenesis: Development of one or more autonomous nodules that secrete excessive thyroid hormones independent of normal negative feedback. Mutations of the TSH receptor gene have been implicated.
- Unlike GD which is diffuse, TMNG is mostly focal.
- More common in older women & iodine deficient areas.

TOXIC THYROID ADENOMA (TA)

- Autonomous often palpable nodule that on scintigraphy (“hot nodule”) suppresses uptake in the remaining thyroid.
- Pathogenesis: Similar to TMNG (gene mutation of the TSH receptor).

DIAGNOSIS

- Clinical + biochemical testing (free T3, free T4, TSH).
- Normal TSH mostly excludes hyperthyroidism.
- Thyroid may be variably enlarged (diffuse in GD & nodular in TA/TMNG) & painful & tender in subacute thyroiditis.

ROLE OF IMAGING

- Radiiodine uptake (RAIU) & thyroid scan are done with:
  - $^{123}$I or $^{131}$I (uptake) & $^{99m}$Tc pertechnetate (scan)
  - For accurate RAIU:
    - Methimazole & Propylthiouracil (PTU) should be discontinued 3-5 days prior &
    - Iodinated contrast avoided for at least 1 month
- RAIU is recorded with a thyroid probe at 4-6 & 24 hours
  - Normal: 4 hour = 6-18%, 24 hour = 10-35%
- Higher the RAIU the more active the thyroid

Kusic et al. J NucI Med 1990;31:393-399

$^{123}$I versus $^{99m}$Tc pertechnetate

- With $^{123}$I, both scan and RAIU possible, whereas only scan with $^{99m}$Tc pertechnetate.
- More convenient (given PO) but costs more ($$$$).
- $^{123}$I images are better when uptake is low.
- The slightly better overall quality of $^{123}$I scans does not in itself provide sufficient advantage to justify use of $^{123}$I over $^{99m}$Tc pertechnetate for routine thyroid imaging.
HYPERTHYROIDISM: THYROID SCAN

- Graves' Disease
- Toxic Multinodular Goiter
- Subacute Thyroiditis
- Toxic Adenoma

HYPERTHYROIDISM TREATMENT

- Normal or increased RAIU
  - Definitive: Thyroidectomy or Radiiodine (RAI)
  - Controller: Antithyroid drugs (ATDs) &/or beta blockers
- Goals
  - GD: Achieve hypothyroidism
  - TMNG/TA: Alleviate hyperthyroidism
- Decreased RAIU conditions like subacute thyroiditis, are not treated with RAI as it is usually self-limiting & RAIU is usually very low (<1%)

MEDICAL MANAGEMENT

- Symptom relief with β blockers and decreasing excessive thyroid hormone production with ATDs (PTU or Methimazole).
- Given to patients who are not tolerating symptoms or the elderly or those with underlying cardiovascular conditions. ATDs also help achieve euthyroidism prior to definitive treatment with RAI or surgery.
- Methimazole is preferred, except during the 1st trimester of pregnancy.
- Controversy regarding PTU use and an increased risk of subsequent RAI therapy failure.

Santos RB, Romanini JK, Nair LS. Thyroid. 2004;14(7):525
SURGICAL MANAGEMENT

- Near total thyroidectomy is the definitive surgical treatment in GD & TMNG, whereas lobectomy is often enough for TA.

- **Indications**: Cancer suspicion (suspicious biopsy), large cold nodule, obstructive symptoms, patient choice, associated hyperparathyroidism, low normal RAIU, moderate to severe GO.

- **Risks**: Anesthesia, hypoparathyroidism, recurrent laryngeal nerve injury, bleeding and infection.

RADIOIODINE (RAI) THERAPY: INTRODUCTION

- Most popular GD treatment in USA (60% of thyroid specialists chose RAI).

- Burch HB, Burman KD, Cooper DS. J Clin Endocrinol Metab. 2012;97(12):4549

- Used for >60 years for the treatment of hyperthyroidism & thyroid cancer.

- Safe, convenient (given as capsule/liquid PO as outpatient) & effective.

131I MECHANISM OF ACTION

- **Beta emissions** are responsible for the radiation "injury" & fibrosis which may take up to 3-4 months to attain full effect & control hyperthyroidism.

- The path length of the beta particle is only 0.4-0.8 mm, which minimizes damage to surrounding tissues.

- Gamma emissions enable imaging & the 8 days physical half life contributes to the overall radiation exposure.

RAI THERAPY: INDICATIONS

- All hyperthyroid conditions with normal or increased RAIU including:
  - GD
  - Toxic Multinodular Goiter (TMNG)
  - Toxic Adenoma (TA)

- Nontoxic goiter can be treated in those with compressive symptoms (dyspnea, stridor or dysphagia), high surgical & anesthesia risks or who refuse surgery. Up to 40-60% decrease in gland volume is possible.


RAI THERAPY: CONTRAINDICATIONS

- Absolute: Pregnancy and breastfeeding.

- Relative: Moderate to severe orbitopathy.

FACTORS FAVORING RAI THERAPY

- Patient and physician choice.

- Intolerance to ATDs.

- Comorbid illnesses which increase surgical risk.

- Previously operated or radiated necks.

- Lack of access to high volume thyroid surgeon.
RAI THERAPY: PREPARATION

- Optimize comorbid conditions.
- β blockers & ATDs for those at increased risk of complications due to worsening hyperthyroidism.
- RAIU to exclude low uptake states (i.e. thyroiditis) where RAI is not effective or indicated.
- Discontinue Methimazole/PTU 3-5 days prior.
- Serum HCG within 24 hours of RAI to exclude pregnancy.
- Avoid RAI within 1 month of iodinated contrast use and iodine containing vitamins for 1 week prior.
- Low iodine diet is usually not needed.

RAI THERAPY: DOSE DETERMINATION

- “Fixed” dosing
  - 10-15 mCi for medium or large thyroids in GD
  - 20-30 mCi for TMNG and TA
- “Calculated” dosing based on specific etiology, thyroid size, quantity of radiation deposited per gram of thyroid & 24 hour RAIU. Recommended doses are (several modifications exist):
  - GD: 150-200 microCi/gm.
  - TMNG & TA: 200 microCi/gm.
- No dose adjustments while on hemodialysis and treatment should be done only after maximal thyroid uptake (10 hours, typically the next day).

RAI THERAPY: DOSE CALCULATION

Example: GD with an enlarged 50 gram gland & 24 hour RAIU of 40%

Dose = \( \frac{\text{Gland weight (grams)} \times \text{Target dose/gram}}{\text{Fraction of RAIU}} \)

Dose = \( \frac{50 \times 160}{0.4} = 20 \text{ mCi} \)

Ultrasound can be used in calculating thyroid volume, based on gland length, width and height.

A mathematical model using thyroid scan has been reported to assess gland volume.

RAI THERAPY: ADVERSE EFFECTS

- Overall quite safe other than causing hypothyroidism.
- 5-10% fail initial treatment & need retreatment after 6 months.
- Occasional flare up of hyperthyroid symptoms (Thyroid storm is rare) from release of preformed hormones. ATDs pretreatment can prevent the same.
- Neck pain/compressive symptoms from thyroiditis are rare (1%) & respond to NSAID’s & steroids.
- Slight increase in all cause, cardiovascular, cerebrovascular & fracture deaths as well as hospitalization after RAI treatment, from untreated hyper or hypothyroidism.

RAI THERAPY & CANCER

- Cooperative Thyrotoxicosis Therapy Follow-up Study (>36K patients) found a small increase in thyroid cancer deaths notably in TMNG patients (18 excess deaths). No increase in overall cancer mortality.
- UK study (>7.4K patients) found an overall decrease in cancer incidence with slight increase in thyroid and small bowel cancers.
- Finnish study (>2.8K patients) found a slight increase in incidence of breast, stomach & renal cancers.

RAI THERAPY: PREGNANCY & LACTATION

- No significant effects on fertility.
- In men, conception should be delayed 3-4 months to allow turnover in sperm production.
- In women, delay conception by 4-6 months to assure euthyroidism.
- High incidence of fetal hypothyroidism & cretinism if RAI given after 10 weeks gestation.
- Offspring of treated patients show no increase in congenital anomalies compared to the population at large.
- RAI therapy should not be given for at least 6 weeks after stopping lactation to avoid RAI concentration in breasts.
20-25% of GD patients have clinical GO.

- Risk Factors: Genetics, smoking (should be discouraged), female sex, high T3 (>325 ng/dL; 5 nmol/L) & TRAb levels, age >60 years, stress.

- Most studies suggest RAI therapy is associated with the occurrence or the progression of GO. Bartalena L et al. Engl J Med. 1998;339(23):1549

- GO exacerbation is thought to be from increase in TRAb levels post RAI treatment.

- Present consensus is to recommend ATDs/Surgery for cases with moderate to severe eye disease or choose RAI with steroids.

- Prophylactic corticosteroids are helpful prior to RAI treatment in instances of moderate to advanced eye disease or in smokers with mild disease.

- Radiation safety: Hydration, Avoid: sharing personal items, public places, close contact with children, pregnant women, sexual activity, keep 2 meters distance from close family members & travel restrictions.

- Avoid pregnancy for at least 4-6 months.

- Expected hypothyroidism warrants follow up & appropriate LT4 replacement. If needed, ATDs can be resumed no sooner than 3 days after RAI treatment.

References:


Uptodate. Radioiodine in the treatment of hyperthyroidism.


Radiation safety: Hydration, Avoid: sharing personal items, public places, close contact with children, pregnant women, sexual activity, keep 2 meters distance from close family members & travel restrictions.

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Uptodate. Radioiodine in the treatment of hyperthyroidism.


APPROPRIATE USE CRITERIA

Kevin J. Donohoe, M.D.
Staff Radiologist, Nuclear Medicine
Beth Israel Deaconess Medical Center
Assistant Professor of Radiology
Harvard Medical School
Boston, MA
The Good, the Bad, and the Ugly of Appropriate Use Criteria, Decision Support Tools, and the Future of Advanced Imaging

Kevin Donohoe M.D.
Beth Israel Deaconess Medical Center
Harvard Medical School
kjd@bidmc.harvard.edu
Chair, SNMMI Guidance Oversight Committee
Chair, SNMMI Procedure Standards Committee

Conflicts of Interest

- I have no conflicts of interest

How It Happened

- 1997 - Sustainable Growth Rate (SGR) Bill to decrease Medicare spending.
  - "Doc Fix" bills have delayed implementation of SGR.
- 2014 - SGR cost reduction formula repealed.
  - Replaced with Medicare Provider Payment Modernization Act
  - Replaced SGR formula for Medicare physician fee reductions
  - Unpopular with Democrats
  - Would have resulted in 26% cut to Medicare payments in April 2014
- 2014 - Protecting Access to Medicare Act (PAMA) delays payment cuts until 2015
  - Payment for this delay in Medicare fee reduction through more targeted cuts - skilled nursing facilities, lab tests, overvalued physician services, etc.
  - Painted broad strokes about Clinical Decision Support (CDS) and Appropriate Use Criteria (AUC)
  - To be implemented by 2017

CMS Implementation of PAMA Details

- PAMA specifies AUCs, CDS but left Center for Medicare/Medicaid Services (CMS) to work out the details. Four main components are:
  1. Establishment of AUC by Nov. 15, 2015;
  2. Specification of clinical decision support (CDS) mechanisms for consultation with AUC by April 1, 2016;
  3. AUC consultation by ordering professionals and reporting on AUC consultation by furnishing professionals by Jan. 1, 2017;

CMS Delays Process

- CMS has said it will be 2018 or 2019 before implementation:
  - Appropriate Use Criteria (AUC)
  - Clinical Decision Support Tools (CDS)

Appropriate Use Criteria

- Documents written to describe the “Appropriate Use” of advanced imaging services
- Written by Provider Led Entities (PLE):
  - Providers apply to CMS for deemed status
  - Describe process to be used for AUC development
  - Should be written using rigorous standards
    - Institute of Medicine (IOM) Standards
    - Representation from all stakeholders
    - Systematic Literature Review
      - Very expensive
      - Conflicts of Interest
      - Documentation of the process
    - The physician providing the imaging service won’t be paid unless they document referring physician consulted AUC
Clinical Decision Support (CDS) Tools

- Will contain information in AUC
- Provide a "simplified" method for referring physicians to order "Advanced Imaging Studies"
- Replace prior approval problems
- Referring physician opens CDS software
  - Enters patient info
  - List of "Approved" imaging studies appears
  - MD selects study to do – automatically approved

Problems/Unknowns - AUCs

- AUCs
  - Is there a standard format for an AUC?
  - Conclusions need to be in tables?
  - Who should be on AUC workgroups?
    - Interested stakeholders
    - Experts?
  - Who will be able to write AUC?
    - Provider-led Entity
  - How will this be funded?
    - Industry?
    - Will smaller societies be penalized?
  - How often will AUC need to be updated?

Problems/Unknowns – CDS Tools

- Who will construct the CDS software?
  - CMS mandates a free version
  - ACR Select
  - Sage
- Who determines which AUC are in the CDS?
  - ACR?
  - CMS?
  - Guideline Clearing House?
- How will the AUC results appear in the CDS?
  - Appropriateness ranking?
  - Color coded?
  - What level of recommendation will be shown to the ordering physician?
- What if there are conflicting AUC in the CDS?

Stay Tuned

- More info on CDS in July CMS ruling

SNMMI Efforts

- AUC
  - Bone Scintigraphy
  - Pulmonary Ventilation/Perfusion Imaging in PE
  - Hepatobiliary Imaging
  - PET/CT in Re-Staging Neoplastic Disease
- Upcoming
  - Somatostatin
  - Prostate
  - I-131; I-123
  - Gastric Motility
  - Infection
  - Ra-223

Bone AUC Experience

- In-person meeting to develop indications
  - Clinical scenarios – e.g.:
    - Initial Clinical Staging for asymptomatic patients with normal alkaline phosphatase levels, PSA <10 and Gleason’s score<6
    - Initial Clinical Staging for asymptomatic patients with elevated alkaline phosphatase levels, PSA <10 and Gleason’s score<6
  - Discussion of indications with entire group and presentation of indications to OHSU.
  - Presentation of OHSU search results
  - In-person meeting to grade literature support of indications

Grade indication support by expert opinion
The Good News

- The benefits of this investment in time and money will go beyond production of AUC
- Systematic reviews will be available for other purposes.
- AUC will serve to educate referring and imaging physicians about the best use of nuclear imaging

Medical Practice Guidelines

- Practice guidelines had been produced since the 1940s or earlier
- No methodology for implementation

The Good

- Nuclear Medicine exams will be ordered more appropriately, based on evidence in the literature.
- Referring physicians will not have the same battle to get prior approval for advanced imaging studies as much as they do now.
- Literature gaps will be identified

The Bad

- Nuclear Medicine exams will be ordered more appropriately, based on evidence in the literature.
- Referring physicians will not have the same battle to get prior approval for advanced imaging studies as much as they do now.
- Literature gaps will be identified

The Ugly

- Substantial costs to be born by specialty societies, physicians, industry, hospitals, patients.
- Physician expertise is needed
  - Volunteers?
  - Paid consultants?
The Future

- How will the practice of nuclear medicine be affected?
Nuclear Medicine Practice: Where is it going?

Paul Shreve, M.D.
Advanced Radiology Services, P.C.
Michigan State University College of Human Medicine
Medical Director of PET-CT
Lemmen-Holton Cancer Pavilion
Spectrum Health
Grand Rapids, MI
Nuclear Medicine Practice: Where Is It Going?

Origins of Nuclear Medicine

- Atoms for Peace
- Harnessing nuclear science for healing
- Federal government isotope supply
- The American Board of Nuclear Medicine

Nuclear Medicine Practice: Where Is It Going?

Early Days of Nuclear Medicine Practice: Peace, Love and Nuclear Science
- Bone scans, liver/spleen scans, brain scans
- Lung scans
- Thyroid imaging and therapy
- Gallium scans
- Developing cardiac imaging (MUGA scans)
- Anatomic imaging was limited prior to development of ultrasound, CT, MRI
- Nuclear medicine could be practiced independently

Nuclear Medicine Practice: Where Is It Going?

Late 1970s: The Decline of Civilization
- Disco and cross sectional imaging emerged
- Funny hair, funny clothes
- Nuclear medicine was thriving none the less

Nuclear Medicine Practice: Where Is It Going?

1980s: The Ascendency of Cross Sectional Imaging
- Ultrasound and CT revolutionized medical imaging
- MRI emerged as the new imaging revolution
- Nuclear medicine imaging procedures were eclipsed by the rapidly improving cross sectional imaging modalities
- Nuclear medicine practice began to increasingly merge with radiology practice

Nuclear Medicine Practice: Where Is It Going?

1990s: The Cavalry Arrives
- Explosion of cardiac imaging, esp MPI, became a major component of nuclear medicine practice
- FDG PET was emerging as a clinical tool
- Molecular evangelicals began to preach – and they still do to this day

Nuclear Medicine Practice: Where Is It Going?

The 2000s
- Cardiology hoards invade and pillage
- FDG PET reimbursement and clinical growth
- Hybrid PET-CT and SPECT-CT emerges
- Efforts to preserve nuclear medicine as an independent specialty

Nuclear Medicine Practice: Where Is It Going?

Where we are now
- Line between anatomic imaging and physiologic imaging increasingly blurred with advent of hybrid scanners and expanding functional capability of ultrasound and MRI
- Molecular revolution still “just around the corner”
- Getting tougher to practice pure nuclear medicine in private setting
- Turf battles have not gone away
- Corporatization of medical practice underway
**Nuclear Medicine Practice: Where Is It Going?**

**What Is Hurting Nuclear Medicine Practice**

- Differential diagnosis approach is out, shotgun approach is in: CT first, ask questions later
- New radiopharmaceutical road remains long and expensive: regulatory burdens have not let up
- Money (RVUs) talk louder than publications

**PACs and Teleradiology**

- PACs makes multi-modality image interpretation explicit and routine
- Good old days: hot spot here, hot spot there, recommend radiologic correlation
- Now if you don’t look at the prior imaging studies and put all the information together, there is someone else who can and will provide integrated interpretations

**So, where are we headed?**

- The real disruptive technology is PACs and Teleradiology, not hybrid scanners
- Corporatization of medical practice
- Clinical imaging subspecialists vs the imaging physician specialty
Teleradiology means the film room is gone and we don’t own the images anymore.

Much easier for clinicians to interpret the imaging studies they order, even non-hospital based.

Sub-sub specialized imaging physicians now possible outside academic and large centers.

Dynamic emerging: Imaging physician vs clinical specialist imaging expert (ie: cardiac imaging).

**Nuclear Medicine Practice:**

**Where Is It Going?**

**PACs and Teleradiology**

- Teleradiology means the film room is gone and we don’t own the images anymore.
- Much easier for clinicians to interpret the imaging studies they order, even hospital based.
- Sub-sub specialized imaging physicians now possible outside academic and large centers.
- Dynamic emerging: Imaging physician vs clinical specialist imaging expert (ie: cardiac imaging).

**Corporatization of Medical Practice**

- Accountable Care Organizations favor formation of corporate medical groups.
- Specialties have less autonomy in medical groups.
- Quality can take back seat to “cost efficiency” in corporate medical group setting.
- Small specialty can get steam-rolled.

**Society of Nuclear Medicine convened a 2020 Nuclear Medicine Task Force**

- Conclusion 1: Nuclear medicine practice should become independent molecular imaging practice.
- Conclusion 2: Conclusion #1 not likely.
- Nuclear Medicine may become part of radiology or cannibalized into various clinical specialties (cardiac imaging by cardiologists, for example).

**Best Scenario**

- NM medicine remains a primary specialty evolving into a broader based discipline of molecular imaging, with partnerships and collaboration as necessary.
  - Increase in education (dual training).
  - Appropriate utilization of therapy.
Emerging Scenario

- Field is advanced by dual certified (ABNM/ABR or other) professionals who practice the broad-based discipline of molecular imaging
  - Appropriate utilization of therapy
  - Champion of quality regardless of who is doing it

Nuclear Medicine Practice: Where Is It Going?

Preaching To The Converted

- The Molecular Evangelicals' vision of a Molecular Imaging future may be true
- Molecular Imaging practice would involve combining medical imaging, internal medicine and laboratory medicine, as in the original conjoint Board of Nuclear Medicine
- The practical reality of molecular medicine may not come soon enough to birth a molecular imaging medical specialty

Academic vs Private Practice

- RVUs and meeting worklist turn around times is becoming the focus of both private and academic practice settings
- To deal with increasing compliance burdens and complexity many private practices are consolidating or becoming part of a large hospital system (accountable care organization)
- Large practice could allow for academic level sub-specialization

Our experience as a large private practice

- Sub-specialization is limited by need to “fill boxes”
- Covering multiple sites 24/7 requires a degree of general radiology capability on evenings/weekend
- Daytime weekday PET-CT and nuclear medicine can be covered by a subspecialist that still needs to “earn their keep” by reading other stuff
- Evening and weekend nuclear studies read by ER or body or pediatric radiologists
- Pediatric radiologists read on < 18 year old nuclear studies and SPECT-CT and PET-CT at our teaching hospital health system
- We have cardiac imaging sub-specialists to compete with cardiology imaging clinicians
- SIRT therapy done by interventional radiologists
- Brain SPECT and PET studies increasing read by certain neuroradiologists in the practice
- Same sort of cannibalization has been happening in ultrasound over the years
Nuclear Medicine Practice: Where Is It Going?

Where Are We Actually Going?

• The challenge of the day is imaging physician specialist vs medical subspecialty imaging specialist, and private practice vs corporate practice

• PACs and Teleradiology, as well as existing long term trends, are promoting organ/disease based imaging sub-specialization rather than modality

• Nuclear medicine will have to be practiced in an increasingly integrated fashion, both in terms of medicine and employment organization
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Vail, CO

Snowmass
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The Westin Snowmass Resort
Snowmass Village, CO

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