Challenges and Opportunities for SPECT & PET in 2013: Implementing Latest Acquisition and Processing Protocols

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Conflict of Interest Disclosure

Dr. Bateman declares that the following relationships constitute a potential conflict of interest with respect to this presentation:

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Challenges and Opportunities for SPECT and PET in 2013

The challenges are the opportunities

- Necessity to reduce dosimetry
- Necessity to reduce costs
- Necessity to improve image quality/information
- Necessity to prove judicious utilization
- Necessity to show “patient centricity”
- Necessity to prove value (referral to cors/PCI/CABG)

Growing public concern in U.S.
- Ave. annual exposure 6.2 mSv* (3.2 mSv in 1980)
- 25% of annual exposure is from medical imaging
- ~22% of medical imaging exposure is from nuclear cardiology!
- Teaching Point: Need to consider dosimetry in imaging test selection

* NCRP 160
Recommendations for Reducing Radiation Exposure in Myocardial Perfusion Imaging

- Limit SPECT/PET to appropriate indications
- Eliminate TI-201 whenever possible (~30 mCi)
- Adopt new hardware/software to permit “micro” or at least “low” doses of Tc-99m tracers
- Perform stress-first/stress-only imaging for ~ 50% of referrals
- Use PET in favor of SPECT when rest/stress studies needed

Adapted from Cerqueira et al, ASNC Information Statement, J Nucl Cardiol 17: 709-718, 2010
Prevalence of LV Ischemia by Exercise Capacity

(974 SPECT pts achieving ≥ 85% MPHR)

19/473 (4%) = any ischemia
2/473 (0.4%) = sig ischemia

31% of pts: >85% MPHR, > 10 METS, non-ischemic ECG

Relationship of Ischemic ST-Segment Depression on the Exercise ECG and Workload Achieved to the Percentage of LV Ischemia
Reducing Radiation While Maintaining Quality Using Novel Technologies

Stress-Only Imaging for Lower-Likelihood Patients

- Value of attenuation correction
- Value of solid-state detectors

Low-Dose Stress-First Imaging

- Challenges and Strategies

Cardiac Mortality Following Normal Stress-Only vs Normal Rest/Stress SPECT

*Duvall et al, J Nucl Cardiol 2010: 17: 370 - 377*
Survival According to SPECT Protocol in Patients With Normal Attenuation-Corrected Scans (by either line-source or CT): Entire Pt Cohort

![Graph A](image1)

![Graph B](image2)

Chang et al. J Am Coll Cardiol 2010;55:221-230

Survival According to SPECT Protocol in Patients With Normal Attenuation-Corrected Scans (by either line-source or CT): Subgroup Analyses

![Graph A](image3)

![Graph B](image4)

Chang et al. J Am Coll Cardiol 2010;55:221-230
Lower Likelihood Patients Who Are Good Candidates For Stress-Only Imaging

Targeting Pts Who Most Likely Will Not need Rest Imaging

Selected Asymptomatic Patients

• High Framingham risk
• High CACS
• New onset atrial fibrillation
• Elevated troponin w/o other evidence for ACS
• More than 2 years after PCI

Selected Symptomatic Patients

• Anginal equivalents
• Normal/near normal ECG’s
• Arrhythmias, syncope/near-syncope
• Intermediate risk Duke Treadmill Score

Stress-Only Imaging For Appropriate Patients

Conclusions From the Published Literature

1. Most of the scans are normal
2. It seems that simple algorithms are useful for identifying a fairly low-risk group of patients for stress-only imaging
3. Most of the data is derived from attenuation-corrected SPECT
4. If normal, risk of MACE is extremely low

Could We Lower the Risk of Testing for this Select Group of Patients?
Reducing Radiation While Maintaining Quality Using Novel Technologies

Stress-Only Imaging for Lower-Likelihood Patients

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Low-Dose Stress-First Imaging

- Challenges and Strategies

Why consider a solid-state camera for SO imaging?

- High count sensitivity
- High spatial resolution
- High contrast resolution
- Permits use of much lower doses
- Much lower radiation exposure

- 4 mCi Tc-99m
- ~ 10 min acquisition
- $10^6$ myocardial cts
- Dosimetry ~ 1 mSv
- Reduced Tc-99m cost
## Results

<table>
<thead>
<tr>
<th>Event</th>
<th>Total n = 500</th>
<th>Anger n = 250</th>
<th>D-SPECT n = 250</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need for a Rest Image to Improve Diagnostic Certainty</td>
<td>19 (3.8%)</td>
<td>2 (0.8%)</td>
<td>17 (6.8%)</td>
<td>0.0005</td>
</tr>
<tr>
<td>Need for Additional Downstream Testing ≤ 30 Days</td>
<td>2 (0.4%)</td>
<td>0%</td>
<td>2 (0.8%)</td>
<td>0.157</td>
</tr>
<tr>
<td>Unnecessary Cor Angiography (UCA): No Stenosis ≥ 50%</td>
<td>3 (0.6%)</td>
<td>1 (0.4%)</td>
<td>2 (0.8%)</td>
<td>0.563</td>
</tr>
<tr>
<td>Unexpected Adverse Cardiac Event ≤ 90 days</td>
<td>3 (0.6%)</td>
<td>1 (0.4%)</td>
<td>2 (0.8%)</td>
<td>0.563</td>
</tr>
</tbody>
</table>

*Bateman et al, J Am Coll Cardiol 2012;59;E1316*

## Conclusions

Lower-likelihood patients who are candidates for stress-only SPECT MPI may ideally be imaged using new CZT systems vs current standard Anger cameras because:

1. The effective dosimetry is ~ 10% of the standard approach
2. These patients usually have normal scans
3. The 2 approaches provide comparably accurate information
4. Although ~7% (vs ~1%) require rest images, the inconvenience is minimal as this can be performed on same day

*Bateman et al, J Am Coll Cardiol 2012;59;E1316*
Current Clinical Paradigm for Solid-State Cameras

- Stress-first imaging at 4 mCi for all pts except:
  - BMI > 40
  - Prior MI
  - Known COM
- If normal, study is finished
- If rest image needed & > 4 hrs: 3X stress dose
- If rest image needed & < 4 hrs, 4X stress dose
- ~60% of pts do not have a rest study

Variation on Same Theme

- Small FOV Anger cameras with AC
- 9 mCi at stress
- If normal, finished
- If abnl, 4X stress dose if < 4 hrs, 3X if > 4 hrs
Implications

1. MUCH lower radiation exposure
2. Rapid through-put
3. Shorter days
4. Excellent image quality
5. Substantial overhead reduction
   - Staff reductions
   - Lower radionuclide costs
6. Volume growth
   - Better poised for competition with alternatives
   - Marketing

Reducing Radiation While Maintaining Quality Using Novel Technologies

Stress-Only Imaging for Lower-Likelihood Patients

- Value of attenuation correction
- Value of solid-state detectors

Low-Dose Stress-First Imaging

- Challenges and Strategies
Some Challenges:

1. Interpreter availability
2. Patient handling post-stress imaging (stay around; return)
3. Effective injected dose of Tc-99m (plastic syringes)
4. Low dose stress/high dose rest in large patients
5. Patient selection (who should be done with rest first)

Opportunity to Markedly Improve
SPECT Image Quality

• Solid-state detectors
• New processing algorithms
SPECT AC Images Acquired Into 128 X 128 Matrix

• Lexiscan stress
• Same-day Tc/Tc study
• 10 mCi rest; 28 mCi stress
• 40 secs/stop rest
• 30 secs/stop stress
• 261 lb man – BMI 35

Ischemia in Distribution of Obtuse Marginal Branch
Acquiring Rb-82 PET in 3D

• Advantages of 3D
  – Higher sensitivity (4-6 X higher than 2D)
    • Lower radiotracer dose
    • Lower radiation exposure
    • Potential cost savings

• Challenges with 3D
  – Higher scatter (30%-40% vs 10-15% for 2D)
    • Effective sensitivity is lower (randoms, scatter, camera dead time)
  – More processing time & disc space
  – Prompt-gamma problem

Importance of prompt-gamma compensation
• ~13% of Rb-82 nuclear decays are associated with a 776 keV emission in addition to the positron
• Because of their wider acceptance angle, images acquired on 3D systems (eg LSO) can be affected

Esteves et al, J Nucl Cardiol; 17: 247 – 53, 2010
**Stress-Only PET Imaging?**

- Not so much benefit (dosimetry; efficiency)
- Longer wait-time vs SPECT
- No validation studies
- Lose stress/rest MBF information

**Routine Flow Quantitation**

- Overcomes issues with spatial-relativity
- Knowledge of stress adequacy
- Complete depiction of myocardial blood flow
- A physiologic measure resembling invasive FFR
- Numerous commercially-available packages