Optimize your MPI Lab: Strategies for Success

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Outline

• Hardware and Software
• Protocols and Process
• Personnel and Culture
• Interpretation and Reporting
• Quality and Appropriateness
• Safety and Customer Service
• Billing and Bottom Line
1. Hardware and Software

- Dual head camera vs Cardiac specific camera
- Emory Cardiac toolbox vs QGS/ QPS
- Camera age (7-10), Accreditation, Q/C
- New vs refurbished, Maintenance contract
- SPECT/CT options - soft tissue atten.
Cardiac SPECT with CZT Detectors

Improved: Count rate, Contrast/Noise ratio, Energy resolution, and Spatial resolution; leading to decreased dose (Radiation Exposure), and decreased Imaging Time (Throughput)
Cardiac SPECT with CZT Detectors

GE: Discovery NM/CT 670 CZT

Spectrum Dynamics: D-SPECT
Myocardial perfusion and left ventricular quantitative parameters obtained using gated myocardial SPECT: Comparison of three software packages.


Author Information

Abstract

BACKGROUND: The aim of the present study was to compare Emory Cardiac Toolbox, Myovation, and Quantitative Gated SPECT software regarding the automatic measurements of perfusion and functional left ventricular (LV) quantitative parameters, summed stress score (SSS), perfusion defect score, LV ejection fraction (LVEF), end-diastolic volume, and end-systolic volume (ESV).

METHODS AND RESULTS: 99mTc-tetrofosmin gated SPECT studies were performed in 634 consecutive patients based on the one-day stress/rest protocol. Participants were divided into subgroups according to heart size (ESV cut-off value: 25 mL), perfusion (SSS >3), and other patient/protocol-related factors. LVEF was categorized as normal (≥50%), mildly moderately impaired (35-49%), and severely abnormal (<35%). The concordance between the packages was good to excellent, in overall population, ESV ≤25 mL, ESV >25 mL, and SSS >3 subgroups (intraclass correlation coefficients, ICCs 0.73-0.93). In SSS ≤3 subgroup, the correlation was excellent for LV functional parameters, but suboptimal for perfusion variables (ICCs 0.30-0.83). LVEF categorization revealed similar variability (discordance 18.1 and 11.1% for stress/rest LVEF values, respectively). Pair comparisons demonstrated considerable differences concerning all parameters for all patient subgroups. The statistical significance of our findings by ESV and SSS classifications was evaluated.

CONCLUSIONS: Despite the significant concordance between software packages, considerable differences in mean values of myocardial perfusion and LV functional parameters were demonstrated.
Camera / Facility Accreditation


ICANL and ACR nuclear medicine accreditation: a comparison.
Wackers FT.
SPECT Camera Q/C

- **DAILY Q/C**: Energy peaking, System Uniformity (5-15 million cts) (extrinsic – with the collimators on, using flood phantom)
- **WEEKLY Q/C**: Intrinsic Uniformity (without collimators) (30-120 million cts), Spatial Resolution (semi quantitative assessment with 4 quadrant bar phantom) and COR Alignment
- **QUARTERLY Q/C**: Tomographic Uniformity (30-120 million cts), Efficiency, Head tilt and Pixel size check, and Overall System Performance (Jaszczak phantom)
- **Acceptance Testing and Annual Testing**: Medical Physicist
Flood Non Uniformities

- Normal
- PMT malfunction
- Mixing Artifact
- Cracked crystal
- Poor gain alignment (tuning) of PMTs
- Collimator defect
Soft Tissue Attenuation = Chest wall thickness

The stunning rise of obesity in America

SOURCE: CDC
Soft Tissue Attenuation = Chest wall thickness

The average restaurant meal today is more than four times larger than in the 1950s

1950
- French fries: 2.4 oz
- Burger: 3.9 oz
- Soda: 7 oz

NOW
- French fries: 6.7 oz
- Burger: 12 oz
- Soda: 42 oz

America leads the world in soft drinks
Per capita volume sales of sweetened, carbonated drinks in 2015.

SOURCE: CDC
Audience Poll Question

How many of you use a CZT detector camera for MPI?
2. Protocols and Process

- **Patient variables**: age, sex, weight / height (BMI), chest wall/breast thickness, NPO, caffeine, insulin, other medications, ability to stay supine, arrhythmias, body jewelry

- **Protocol variables**: 1 day vs 2 day, exercise vs pharmacologic stress, radio-pharmaceutical, dose, imaging time, SPECT/ CT

- **Process mapping**: waiting and registration, interview and injection, imaging, stress lab and injection, imaging, follow up

- Assembly Line vs Personalized Imaging
Patient Preparation

PRACTICAL POINTS FOR NUCLEAR CARDIOLOGY

Best patient preparation before and during radionuclide myocardial perfusion imaging studies

Lisa A. Boger, RN,^a^ Lyndy L. Volker, MS,^b^ Ginger K. Hertenstein, CNMT, RT(N),^a^ and Timothy M. Bateman, MD^abc^
Patient Preparation - Recommendations

- Use EMR to obtain relevant demographics and history at the time of scheduling. Prior verbal and written instructions.
- When patient arrives: Review history, IV access (20G antecubital), IV hydration, ECG, questionnaire (prior history, risk factors, current symptoms, medications) Sample letters/forms, weight based dose chart, medication list
- Weight (BMI): >250 lbs (32/35) - Tc99m agent with AC, >350 lbs – 2 day study
- Exercise stress is preferred. Pharma stress (40%): elderly, cannot exercise due to co morbidities, morbidly obese, LBBB, pacemaker/defibrillator
- Meds: withhold beta blockers for 24-48 hrs, Ca++ for 24 hrs, 4 hrs for nitrates
- Stress only: no h/o CAD, able to exercise, normal ECG
- Caffeine (adenosine antagonist): hold for 24 hrs, Fasting: 4-6 hrs
ASNC imaging guidelines for SPECT nuclear cardiology procedures: Stress, protocols, and tracers.
Henzlova MJ¹, Duvall WL², Einstein AJ³, Travin MI⁴, Verberne HJ⁵.

Approaches to reducing radiation dose from radionuclide myocardial perfusion imaging.
Dorbala S¹, Blankstein R², Skali H², Park MA², Fantony J², Mauceri C², Semer J², Moore SC², Di Carli MF².
Process Mapping – a tool to improve efficiency

- Planning and management tool that visually describes the flow of work.
- Shows an entire process from the beginning to the end, with detailed connections and sequences, using symbols.
- Better understanding, Improved communication, Project design, Identify problems and possible solutions.
- Steps: Identify the problem, brainstorm activities involved, figure out boundaries, determine and sequence the steps, draw basic flowchart symbols, finalize the process flowchart.
Stress First MPI


**Stress-only SPECT myocardial perfusion imaging: a review.**

Gowd BM¹, Heller GV, Parker MW.


**Myocardial perfusion scintigraphy dosimetry: optimal use of SPECT and SPECT/CT technologies in stress-first imaging protocol.**

Lecchi M¹, Malaspina S², Scabbi C³, Gauderi V⁴, Del Sole A⁵.


**Stress-first Myocardial Perfusion Imaging.**

Hussain N¹, Parker MW¹, Henzlova M², Duvall WL³.

**Abstract**

Stress-first approaches to myocardial perfusion imaging provide diagnostically and prognostically accurate perfusion data equivalent to a full rest-stress study, save time in the imaging laboratory, and reduce the radiation exposure to patients and laboratory staff. Converting a nuclear cardiology laboratory from a conventional rest-stress strategy to a stress-first approach involves challenges such as the need for attenuation correction, triage of patients to an appropriate protocol, real-time review of stress images, and consideration of differential reimbursement.
Audience Poll Question

How many of you use Stress only imaging for MPI?
3. Personnel and Culture

- Front desk, NM Tech (CT), Nurse / PA, MD
- Work culture, responsibilities, expectations
- Leadership: “Discipline without punishment”
- Commitment / Compliance / Conflict
- Hard vs Soft tactics, Strategy vs Culture
We need to move from looking at errors as individual failures to realizing they are caused by system failures.

We must move from a punitive environment to a just culture.

We must move from secrecy to transparency.

Care must change from being provider-centered (doctor-centered) to being patient-centered.

We must move our models of care from reliance on independent, individual performance excellence to interdependent, collaborative, inter-professional teamwork.

Accountability must be universal and reciprocal, not top-down.

“Values-supportive Model of Shared Accountability”

Developing a Just Culture
Barbara A. Brunt, for HealthLeaders Media, May 18, 2010
Five Components of Mindfulness

- A constant concern about the possibility of failure even in the most successful endeavors
- Deference to expertise regardless of rank or status
- An ability to adapt when the unexpected occurs (commitment to resilience)
- An ability to concentrate on a specific task while having a sense of the bigger picture (sensitivity to operations)
- An ability to alter and flatten hierarchy as best fits the situation
Audience Poll Question

How many of you have heard of this phrase: "Culture Eats Strategy for Lunch"?
4. Interpretation and Reporting

- Recognizable patterns on MPI
- ASNC and SNMMI Guidelines
- Training, Certification, and Experience
- Reporting and follow up
- Common Artifacts on MPI
American Society of Nuclear Cardiology consensus statement: Reporting of radionuclide myocardial perfusion imaging studies.
Hendel RC, Wackers FJ, Berman DS, Ficaro E, DePuey EG, Klein L, Cerqueira M; American Society of Nuclear Cardiology.
Acquisition and Processing

- Dual head gamma camera with High Res Collimators
- 20% window set around 140 keV
- Circular orbit (vs elliptical/ body contouring)
- 180 degree SPECT: LPO to RAO
- Step and shoot (20-30 sec); Frame mode (vs List)
- Resting SPECT and post stress Gated SPECT (16 fr)
- Filtering (lower cut off = more filtering / smoothening)
- Processing (FBP vs OSEM)
- Interventions: Prone, Water, SPECT/ CT, Motion Corr.
MPI SPECT – Normal Study

• No significant non cardiac activity
• No patient motion or soft tissue attenuation
• Uniform uptake at rest and stress
• No fixed or reversible myocardial perfusion defects
• Normal myocardial wall motion and thickening
• Normal LVEF (>50%), EDV (<110), ESV (<50)
• Normal polar plots and scores (SRS, SSS, SDS)
Case 1
# Perfusion Metabolism Patterns

<table>
<thead>
<tr>
<th></th>
<th>Rest</th>
<th>Stress</th>
<th>Gated</th>
<th>FDG</th>
<th>Mechanism</th>
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<tbody>
<tr>
<td>Normal</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>++</td>
<td>Normal</td>
</tr>
<tr>
<td>Ischemia</td>
<td>++</td>
<td>- -</td>
<td>++</td>
<td>++</td>
<td>Stress Induced</td>
</tr>
<tr>
<td>Scar</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>- -</td>
<td>Prior MI</td>
</tr>
<tr>
<td>Hibernating</td>
<td>-</td>
<td>-</td>
<td>+/-</td>
<td>++</td>
<td>Per-Met Mismatch</td>
</tr>
<tr>
<td>Stunned</td>
<td>+</td>
<td>+</td>
<td>+/-</td>
<td>++</td>
<td>Recent Ischemia</td>
</tr>
<tr>
<td>Attenuation</td>
<td>- -</td>
<td>-</td>
<td>+ +</td>
<td>+ +</td>
<td>Breast and Diaphragm</td>
</tr>
<tr>
<td>Artifact</td>
<td>- -</td>
<td>-</td>
<td>+ +</td>
<td>+ +</td>
<td></td>
</tr>
</tbody>
</table>
Case 2
Case 2
MPI SPECT Artifacts

Artifacts and pitfalls in myocardial perfusion imaging.
Burrell S, MacDonald A.

Optimal SPECT processing and display: making bad studies look good to get the right answer.
Ibrahim DY, DiFilippo FP, Steed JE, Cerqueira MD.
MPI SPECT Artifacts

- Soft Tissue Attenuation
- Patient Motion
- Non Cardiac Activity
- Non Coronary Disease
- Image Normalization
- Prep. / Injection / Stress test
- Processing Related
- Flood Field Non Uniformity
- COR Misalignment
- Camera Head Misalignment
Soft Tissue Attenuation

- Causes: diaphragm, breasts, obese body habitus
- Imaging Characteristics: decreased counts, fixed defects, worse at rest, normal wall motion, ischemia
- Recognition: review raw data, inferior wall in males, anterior/lateral/apical in women, worse with Thallium
- Solution: reimage, prone imaging, breast / arm positioning, attenuation correction (CT)
Case 3
Case 4

ED Perfusion (%)  ES Perfusion (%)

Motion (0-15mm)  Thickening (%)

Volume (mL)

Volume (mL) and Filling (mL/s)

Diagrams showing perfusion and motion patterns in different regions of the heart. Parameters include:
- Name: Hidden 01
- Pat ID: Hidden 01
- Sex: MALE
- Limits:
- TID: 0.93
- LHR: 0.27
- SMS: 0
- SRS: 0
- Type: QGS Stress
- Proc ID: INTRACELLULAR PERMEABILITY WALL MOTION
- How ID: PROC-65-STR
- Date: 2008-05-11 12:12:12
- Volume: 75mL [4]
- EDV: 16.2mL [8]
- ESV: 75mL [4]
- EF: 54%
- Max Ext %: 0, Max Ext cm [4]
- Min Ext %: 0, Min Ext cm [4]
- Max Ext 64.164 x 27.2 x 20.1
- Min Ext 6.49 x 6.49 x 6.49
- Max Vol: 808.646 x 808.646 x 808.646
- Min Vol: 0.000 x 0.000 x 0.000
- Slices:
  - PER: 2.64 EDV/s [1.6], PFR 1.57 EDV/s [0.2]
  - PFR 2.6 EDV/s [1.5], BPM [assume 66]
  - MIT: 0.72 EDV/s, TTPF 300ms
Case 5
Case 6
Patient Motion

- Causes: vertical (or horizontal) motion ($\geq 2$ pixels)
- Imaging Characteristics: opposed defects and streaks from edges, anterior / inferior (hurricane sign) vs septal / lateral, cardiac creep - exercise and thallium
- Recognition: review raw data in cine mode
- Solution: reimaging, preparation and positioning, motion correction software
Non Cardiac Activity

• Causes: liver, stomach, bowel or tumor uptake

• Imaging Characteristics: scattering Ê increased counts, ramp filter artifact Ê decreased counts

• Recognition: review raw data in cine mode

• Solution: drink water / milk, walk / low level exercise, and reimage, optimize injection to imaging time
Case 8
Case 11
Non Coronary Disease

- Causes: LBBB, hypertrophic cardiomyopathy, short septum, apical thinning, balanced ischemia, dextrocardia
- Imaging Characteristics / Recognition: perfusion defect at increased heart rate (pharmacologic stress test), septum > lateral wall, septal defect, apical defect, false-ve / stunning, right sided heart / processing
- Solution: review patient history, EKG, Echo, prior studies
Case 12
Case 13
Case 14

STRESS_IRNC(G)  REST_IRNC
EF(R0) N/A
EDV: N/A
ESV: N/A
Case 16
Case 16
Normalization Artifacts

- Causes: images normalized to the hottest pixel (cardiac or non cardiac)
- Imaging Characteristics: focal hot spot (papillary muscle), decreased counts in myocardium
- Solution: reprocess / reimagining, increase intensity
Case 17
How many of you use CT based attenuation correction for MPI?
5. Quality and Appropriateness

- Quality / Cost of Healthcare in US
- Cost and Utilization of Imaging
- Precertification / Preauthorization
- Challenges and Opportunities
- Quality Control vs Assurance
The Business Model of Healthcare

- **Product** – Healthcare Services
- **Vendor** – Healthcare Provider
- **Consumer** – Patients (not a direct customer)
- **Customer** – Payors (not a direct consumer)
- **Quality** – Customer vs Consumer
- **Cost** – Customer vs Consumer
# Quality of Healthcare in US

<table>
<thead>
<tr>
<th>COUNTRY RANKINGS</th>
<th>AUS</th>
<th>CAN</th>
<th>FRA</th>
<th>GER</th>
<th>NETH</th>
<th>NZ</th>
<th>NGR</th>
<th>SWE</th>
<th>SWI</th>
<th>UK</th>
<th>US</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>OVERALL RANKING (2013)</strong></td>
<td>4</td>
<td>10</td>
<td>9</td>
<td>5</td>
<td>5</td>
<td>7</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>11</td>
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<tr>
<td>Quality Care</td>
<td>2</td>
<td>9</td>
<td>8</td>
<td>7</td>
<td>5</td>
<td>4</td>
<td>11</td>
<td>10</td>
<td>3</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Effective Care</td>
<td>4</td>
<td>7</td>
<td>9</td>
<td>6</td>
<td>5</td>
<td>2</td>
<td>11</td>
<td>10</td>
<td>8</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Safe Care</td>
<td>3</td>
<td>10</td>
<td>2</td>
<td>6</td>
<td>7</td>
<td>9</td>
<td>11</td>
<td>5</td>
<td>4</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Coordinated Care</td>
<td>4</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>5</td>
<td>2</td>
<td>7</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Patient-Centered Care</td>
<td>5</td>
<td>8</td>
<td>10</td>
<td>7</td>
<td>3</td>
<td>6</td>
<td>11</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Access</td>
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<td>9</td>
<td>11</td>
<td>2</td>
<td>4</td>
<td>7</td>
<td>6</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>9</td>
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<tr>
<td>Cost-Related Problem</td>
<td>9</td>
<td>5</td>
<td>10</td>
<td>4</td>
<td>8</td>
<td>6</td>
<td>3</td>
<td>1</td>
<td>7</td>
<td>1</td>
<td>11</td>
</tr>
<tr>
<td>Timeliness of Care</td>
<td>6</td>
<td>11</td>
<td>10</td>
<td>4</td>
<td>2</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>1</td>
<td>3</td>
<td>5</td>
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<tr>
<td>Efficiency</td>
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<td>9</td>
<td>7</td>
<td>3</td>
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<td>2</td>
<td>6</td>
<td>1</td>
<td>11</td>
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<td>Equity</td>
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<td>10</td>
<td>6</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>11</td>
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<tr>
<td>Healthy Lives</td>
<td>4</td>
<td>8</td>
<td>1</td>
<td>7</td>
<td>5</td>
<td>9</td>
<td>6</td>
<td>2</td>
<td>3</td>
<td>10</td>
<td>11</td>
</tr>
<tr>
<td>Health Expenditures/Per Capita, 2011*</td>
<td><strong>$3,600</strong></td>
<td><strong>$4,522</strong></td>
<td><strong>$4,113</strong></td>
<td><strong>$4,406</strong></td>
<td><strong>$5,099</strong></td>
<td><strong>$3,182</strong></td>
<td><strong>$5,669</strong></td>
<td><strong>$3,925</strong></td>
<td><strong>$5,643</strong></td>
<td><strong>$3,465</strong></td>
<td><strong>$8,508</strong></td>
</tr>
</tbody>
</table>

Notes: *Includes Tax. **Expenditures shown in $US PPP (purchasing power parity). Australian $ data are from 2010.

Cost of Healthcare in US
Growth in Imaging Utilization

MedPAC Evaluation of Growth in Physician Services From 1999 to 2000
The average growth of physician services during this period was 22%. Adapted from MedPAC Analysis of Medicare Claims Data, March 17, 2005, Executive Director, Medicare Payment Advisory Commission, Mark Miller.
Global MPI Utilization

Studies/100,000 population/annum
“In this imaginary world no one cares enough to create and enforce imaging use policies to help patients, physicians, and society in general. Why? Because in this bizarre world, doctors feel entitled to function as isolated, noncommunicating, disconnected cottage-industry prima donnas, are used to being above question, are unreasonably sure of their competence in areas where they have none, are accountable to nobody, and experience no downside for bad (ie, irrationally expensive) behavior."
Precertification / Preauthorization

- Radiology Benefits Management Program
- Out Patient / High Cost - Advanced Imaging
- Evidence Based Criteria / Published Online
- NCQA / URAC/ State Approved
- Telephone / Web Algorithms – CPOE / DS
- Favorable vs Adverse Determination
- Challenge / Appeal Process
The appropriateness of medical imaging is under intense scrutiny, partly because of an unsustainable national health care spending trajectory, as well as remote disproportionate growth in the utilization of radiologic services. Although unit cost reduction mechanisms have traditionally been used to contain costs, UM approaches are becoming increasingly prevalent. Radiology benefits managers and DS systems have both demonstrated success in curtailing imaging growth, but both currently have intrinsic limitations.
An unsustainable national health care spending trajectory has focused considerable scrutiny on medical imaging as a potential cost driver. Radiology benefits managers and DS systems have both been successful in slowing imaging volume growth, but their promulgation, in the absence of active radiologist involvement in UM, risks further commoditization of radiologists’ services. Evolving trends suggest the potential for increased convergence of these historically competing approaches to control imaging volume. The ultimate role of practicing radiologists in this evolution is uncertain and will likely hinge less on technological developments than the ability of radiologists to adapt to ongoing cultural and structural changes in health care payment systems.
These best practice guidelines for RBMPs were developed through a joint effort of the ACR Managed Care Committee and the RBMA Payor Relations Committee and are intended to provide guidance to payors, RBMs, and radiology providers on best practices to consider when implementing an RBMP.” (2012)
“The most common reason for insurance denial of a Nuclear Cardiac Stress test with MPI, is for evaluation of a low risk patient who has not had a treadmill stress test.”
Evaluation of suspected coronary artery disease symptoms [One of the following]

A. Evaluation of documented ventricular tachycardia
B. Evaluation of chest pain equivalent [One of the following]
   1. Pre-test probability assessment – high risk
   2. Pre-test probability assessment – low or intermediate risk
      a. Requirement for pharmacologic test due to inability to perform an exercise stress test
      b. Electrocardiogram demonstrates Wolff-Parkinson-White syndrome, complete left bundle branch block, ventricular paced rhythm, or one mm or more ST-J depression with horizontal or downsloping ST segments for 80 msec after the J point
      c. Currently taking digoxin/Lanoxin®
      d. Routine exercise stress test documents [One of the following]
         i. One mm or more ST-J depression with horizontal or downsloping ST segments for 80 msec after the J point
         ii. Ventricular tachycardia, multifocal premature ventricular contractions or triplets
         iii. Heart block
         iv. Drop in systolic blood pressure of 10 mmHg or more
         v. Inability to attain 85 percent of the maximum predicted heart rate
         vi. Chest pain
   C. Evaluation of syncope [Both of the below are required]
      1. Diabetes
      2. ATP® risk calculation 10 percent or more and no imaging stress test has been performed in the last two years
APPROPRIATE USE CRITERIA

ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM 2009

Appropriate Use Criteria for Cardiac Radionuclide Imaging

A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, the American Society of Nuclear Cardiology, the American College of Radiology, the American Heart Association, the American Society of Echocardiography, the Society of Cardiovascular Computed Tomography, the Society for Cardiovascular Magnetic Resonance, and the Society of Nuclear Medicine

Endorsed by the American College of Emergency Physicians
### Table A. Pretest Probability of CAD by Age, Gender, and Symptoms*

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
<th>Asymptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40–49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>50–59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
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<td>Low</td>
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<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>&gt;60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
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<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
</tbody>
</table>

*High: Greater than 90% pretest probability. Intermediate: Between 10% and 90% pretest probability. Low: Between 5% and 10% pretest probability. Very low: Less than 5% pretest probability. *Modified from the ACC/AHA Exercise Testing Guidelines to reflect all age ranges (14).

### Table 1. Detection of CAD: Symptomatic

<table>
<thead>
<tr>
<th>Indication</th>
<th>Appropriate Use Score (1–9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Low pretest probability of CAD</td>
<td>I (3)</td>
</tr>
<tr>
<td>ECG interpretable AND able to exercise</td>
<td></td>
</tr>
</tbody>
</table>
### Clinical Classification of Chest Pain

<table>
<thead>
<tr>
<th>Classification</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical angina</td>
<td>1) Substernal chest discomfort with a characteristic quality and duration that is 2) provoked by exertion or emotional stress and 3) relieved by rest or nitroglycerin</td>
</tr>
<tr>
<td>(definite)</td>
<td></td>
</tr>
<tr>
<td>Atypical angina</td>
<td>Meets 2 of the above characteristics</td>
</tr>
<tr>
<td>(probable)</td>
<td></td>
</tr>
<tr>
<td>Noncardiac chest pain</td>
<td>Meets 1 or none of the typical anginal characteristics</td>
</tr>
</tbody>
</table>

**Anginal Equivalents**: Dyspnea, Nausea, Fatigue, usually in elderly and diabetic patients
Audience Poll Question

How many of you have had their patient’s MPI denied?
6. Safety and Customer Service

- Safety of Cardiac Stress testing
- Risks in Myocardial Perfusion SPECT
- Customer Service Strategies
- Radiation Safety Officer (RSO)
- Quality and Safety Officer
Regadenosone Safety


Regadenoson: a focused update.

Ghimire G¹, Hage FG, Heo J, Iskandrian AE.

Author information

Abstract
Since its approval by the Food and Drug Administration in 2008, regadenoson has become the most commonly used vasodilator in the United States. Previous reviews have summarized the pre-clinical and clinical data on the use of regadenoson for myocardial perfusion imaging (MPI). Since then, data have emerged on the safety of this agent in special groups of patients such as those with chronic kidney disease, airway disease (asthma and chronic obstructive pulmonary disease), and liver disease. There has also been recent interest in the use of regadenoson in hybrid protocols with exercise as a way to improve patient tolerance and image quality. Finally, although regadenoson was approved for clinical use based on the agreement rate of regadenoson MPI and adenosine MPI with regards to perfusion abnormalities, data are now available on the prognostic data derived from regadenoson MPI. We will briefly summarize these recent reports here in a focused update on the use of regadenoson for MPI.
Radiation Exposure

NCRP Report No. 160, Ionizing Radiation
Exposure of the Population of the United States

<table>
<thead>
<tr>
<th></th>
<th>Early 1980s</th>
<th>2006</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collective effective dose (person-Sv)</td>
<td>655,000</td>
<td>1,870,000</td>
</tr>
<tr>
<td>Effective dose per individual in the U.S. population (mSv)</td>
<td>3.6</td>
<td>6.2</td>
</tr>
</tbody>
</table>
Background exposure in the US per year = 300 mR / 3 mSv
Approaches to reducing radiation dose from radionuclide myocardial perfusion imaging.

Dorbala S1, Blankstein R2, Skali H2, Park MA2, Fantony J2, Mauceri C2, Semer J2, Moore SC2, Di Carli MF2.
Radiation Exposure

### Annual Radiation Dose Limit (millisievert)

<table>
<thead>
<tr>
<th>Population at Risk</th>
<th>Total Body</th>
<th>Lens of the Eye</th>
<th>Extremities or Single Organs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adult Occupation Workers</td>
<td>50</td>
<td>150</td>
<td>500</td>
</tr>
<tr>
<td>Declared Pregnant Employees</td>
<td>5 mSv to the embryo/fetus During the Period of Gestation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minor Occupational Workers</td>
<td>5</td>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>Members of the Public</td>
<td>1 mSv</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Approximate Effective Radiation

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Approximate Effective Radiation</th>
<th>Comparable to Natural Background Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Abdominal Region</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computed Tomography (CT) — Abdomen and Pelvis</td>
<td>10 mSv</td>
<td>3 years</td>
</tr>
<tr>
<td>Computed Tomography (CT) — Abdomen and Pelvis, repeated with and without contrast material</td>
<td>20 mSv</td>
<td>7 years</td>
</tr>
<tr>
<td>Intravenous Pyelogram (IVP)</td>
<td>3 mSv</td>
<td>1 year</td>
</tr>
<tr>
<td>Radiography (X-ray) — Lower GI Tract</td>
<td>8 mSv</td>
<td>2 years</td>
</tr>
<tr>
<td>Radiography (X-ray) — Upper GI Tract</td>
<td>6 mSv</td>
<td>3 years</td>
</tr>
<tr>
<td><strong>Bone</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Radiography (X-ray) — Spine</td>
<td>1.5 mSv</td>
<td>6 months</td>
</tr>
<tr>
<td>Radiography (X-ray) — Extremity</td>
<td>0.001 mSv</td>
<td>3 hours</td>
</tr>
<tr>
<td><strong>Central Nervous System</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computed Tomography (CT) — Head</td>
<td>2 mSv</td>
<td>8 months</td>
</tr>
<tr>
<td>Computed Tomography (CT) — Head, repeated with and without contrast material</td>
<td>4 mSv</td>
<td>16 months</td>
</tr>
<tr>
<td>Computed Tomography (CT) — Spine</td>
<td>6 mSv</td>
<td>2 years</td>
</tr>
<tr>
<td><strong>Chest</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Computed Tomography (CT) — Chest</td>
<td>7 mSv</td>
<td>2 years</td>
</tr>
<tr>
<td><strong>Dental</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introral X-ray</td>
<td>0.0025 mSv</td>
<td>1 day</td>
</tr>
<tr>
<td><strong>Heart</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Coronary Computed Tomography Angiography (CTA)</td>
<td>12 mSv</td>
<td>4 years</td>
</tr>
<tr>
<td>Cardiac CT for Calcium Scoring</td>
<td>3 mSv</td>
<td>1 year</td>
</tr>
<tr>
<td><strong>Men's Imaging</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone Densitometry (DEXA)</td>
<td>0.001 mSv</td>
<td>3 hours</td>
</tr>
<tr>
<td><strong>Nuclear Medicine</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Positron Emission Tomography — Computed Tomography (PET/CT)</td>
<td>25 mSv</td>
<td>8 years</td>
</tr>
<tr>
<td><strong>Women's Imaging</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bone Densitometry (DEXA)</td>
<td>0.0005 mSv</td>
<td>3 weeks</td>
</tr>
<tr>
<td>Mammography</td>
<td>0.4 mSv</td>
<td>7 weeks</td>
</tr>
</tbody>
</table>
## Radiation Safety Officer

<table>
<thead>
<tr>
<th>Responsibility</th>
<th>Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Training program</td>
<td>Provide job-specific training to authorized user, physicians under the supervision of authorized user, and supervised individuals (technologists, nursing personnel, physicists, and other ancillary individuals)</td>
</tr>
<tr>
<td>Personnel monitoring program</td>
<td>Monitor occupational radiation exposure to ensure compliance with Nuclear Regulatory Commission regulations</td>
</tr>
<tr>
<td>Facilities and equipment</td>
<td>Participate in early planning stages of the design of new or remodeling of existing facilities in regard to radiation safety</td>
</tr>
<tr>
<td>Incident response</td>
<td>Investigate overexposure from accidents, spills, losses, or theft of radioactive materials; investigate deviation from approved radiation safety practice</td>
</tr>
<tr>
<td>Security of licensed materials</td>
<td>Ensure that materials are safe from theft or loss; take ultimate responsibility for security of licensed materials</td>
</tr>
<tr>
<td>Radiation surveys</td>
<td>Conduct required radiation surveys or ensure that they are conducted in accordance with license commitments and regulatory requirements</td>
</tr>
<tr>
<td>Radioactive material inventory</td>
<td>Establish and maintain an inventory system for ordering, receiving, and properly disposing of radioactive materials</td>
</tr>
<tr>
<td>Radioactive waste management</td>
<td>Supervise and coordinate the radioactive waste disposal program</td>
</tr>
<tr>
<td>Records and reports</td>
<td>Maintain records and reports to document certain activities of the radiation safety program</td>
</tr>
</tbody>
</table>

Note—Information from the U.S. Nuclear Regulatory Commission [5].

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All You Need to Know as an Authorized User.

Baldwin JA¹, Bag AK¹, White SL¹, Palot-Manzil FF¹, O'Malley JP¹.
10 Strategies to Provide Patients With Superior Customer Service

December 20, 2010 | Print | Email

1. **Start seeing patients as customers.** Taking care of patients is what healthcare is all about. It may be hard for some people to think of patients as customers, but they definitely are. Their choices bring thousands and even millions of dollars into a hospital’s coffers. In most cases, they don’t necessarily need to use your hospital, even though you have Dr. Brightstar on staff. They may end up at the institution down the street that treats patients better.

2. **Be courteous and respectful.** Always, always, make sure patients are treated with courtesy and respect. I know executives who pretended to be patients inside their own institutions and were shocked by the lack of focus and concern they received. Treating patients has become simply a job for many healthcare professionals. They manifest boredom with their jobs by treating patients indifferently. That’s not professional and it’s bad business!

3. **Never show indifference to patients.** Watch the way patients are treated when entering the ED. It can be quite disappointing at some urban hospitals and even at some suburban settings. If the illness is not life-threatening, patients are virtually given a number and told to sit down and wait. Many otherwise competent and even brilliant healthcare professionals give patients the feeling they are an inconvenience and a bother. Patients should not be made to feel inferior and misinformed.

4. **Don’t contradict, argue or match wits.** Telling patients they are wrong about anything is just plain rude. Even when they have incorrect information, they still should be accorded respect. If you disagree with them, politely explain why their point of view isn’t necessarily correct. Your goal should be to explain and communicate, and then to continue to explain and communicate. Help patients understand what is going on as treatment is being given. Patients should feel they are just important, in the scheme of things, as you are.
5. **Tell patients you appreciate their business.** Everybody likes to be thanked when purchasing an item in a retail store, but in all too many healthcare venues, saying "thank you" is seen as inappropriate. You know as well as I do that saying "thank you" has magic vibes for any kind of relationship. Go ahead and try it! It's a great way to receive your customers' repeat business.

6. **Use plain terms and simple explanations.** It may be fun to throw around complicated jargon, but it results in misunderstandings and sometimes errors. Nobody wants errors in today's healthcare environment. Always make sure your explanations are not clouded with excessive and complicated verbiage. Be brief and to the point. True professionals go out of their way to explain things in simple, declarative sentences.

7. **Good manners will get you everywhere.** Good manners are part and parcel of confidence and competence. Don't hide the truth even if it creates problems for you. Treat patients the way you'd want to be treated. Saying the appropriate words can show respect. Establishing eye contact is also part of good manners. Go way out of your way to show respect to others! It's what being civilized is all about, isn't it?

8. **Keep seeing healthcare as a calling.** Too many professionals begin to see healthcare as a job rather than a calling. There's a big difference between the two. When healthcare becomes a job, mistakes are not far behind. Today there are so many complicated variables in healthcare that it is easy to get off track. Remember who you are and what your core business is. It might help to recall what brought you into the healthcare field. Was it to take care of people or was it to make a lot of money?

9. **Stay in touch with patients.** Many healthcare professionals don't think they have the time to stay in touch with patients after care is rendered. They tend to think it's unnecessary and creates too much stress. That rationale should never be tolerated. Staying in touch with patients, even if it's an e-mail or a phone call, will pay off.

10. **Keep your promises.** Many promises made to patients are never kept. Things like, "You'll get the best care here" and "We treat each individual who comes to us with dignity and respect" and also, "You'll be just fine in a week or so." The difference between empty talk and promises is that promises must be kept. And if it turns out you overpromised, own up to it. Being honest will pay off later. Any quality business must keep its promises.
Malpractice Risk

Malpractice Risk According to Physician Specialty

Anupam B. Jena, M.D., Ph.D., Seth Seabury, Ph.D., Darius Lakdawalla, Ph.D., and Amitabh Chandra, Ph.D.

Audience Poll Question

How many of you have had a serious adverse event with MPI?
7. Billing and Bottom Line

- Profitability of Healthcare services
- Reimbursements in MPI SPECT
- Lessons from the past
- Future Trends – CZT Camera, Stress first, PET
- Challenges and Opportunities
Comparison of recent utilization trends in radionuclide myocardial perfusion imaging among radiologists and cardiologists.

Levin DG, Itenzo CM, Rino VM, Frangos AJ, Parker L, Sunshine JH.

Abstract

PURPOSE: To study recent practice patterns in radionuclide myocardial perfusion imaging (MPI) and related procedures among radiologists, cardiologists, and other physicians.

METHODS AND MATERIALS: The nationwide Medicare administrative Part B claims summary databases from 1998 and 2002 were used to assess utilization rate changes in the 4 primary procedure codes for MPI, the seven codes for diagnostic cardiac catheterization with coronary angiography, and the single code for stress echocardiography. Rate changes among radiologists, cardiologists, and other physicians were determined for the total Medicare population, as well as for the 3 primary places of service at which imaging is formed: hospital inpatient facilities, hospital outpatient facilities, and private offices. Ratios of the use of the 2 supplementary codes for left ventricular (LV) wall motion and ejection fraction to that of the primary MPI codes were calculated for 2002.

RESULTS: The utilization rate per 1000 Medicare beneficiaries of MPI rose among radiologists from 19.8 in 1998 to 20.1 in 2002, a 2% increase. The rate among cardiologists rose from 22.9 in 1998 to 40.7 in 2002, a 78% increase. Most of this growth occurred in cardiologists' offices, where the utilization rate increased 101% over the 4 years. In 2002, the ratios of the use of the supplementary LV wall motion and ejection fraction code to that of the primary MPI codes were 1.73 for cardiologists and 1.46 among radiologists. Between 1998 and 2002, the utilization of diagnostic cardiac catheterization among cardiologists increased by 19%, and their utilization of stress echocardiography increased by 21%.

CONCLUSION: In recent years within the Medicare population, the rate of utilization of MPI among radiologists has remained relatively stable, whereas it has risen sharply among cardiologists. The greatest growth was seen in cardiologists' private offices. This raises concerns about possible inappropriate utilization of MPI and also about the potential effect self-referral has on this utilization trend. The increased use of MPI by cardiologists did not result in reduction in their use of either cardiac catheterization with coronary angiography or stress echocardiography.
Recent payment and utilization trends in radionuclide myocardial perfusion imaging: comparison between self-referral and referral to radiologists.

Levin DC¹, Rao VM, Parker L, Frances AJ, Intenzo CM.

Abstract

PURPOSE: The aim of this study was to examine the effects of self-referral by comparing recent trends in payments and utilization rates for radionuclide myocardial perfusion imaging (MPI) among radiologists and cardiologists between 1998 and 2006.

MATERIALS AND METHODS: Nationwide Medicare Part B claims databases for 1998 through 2006 were used. The 4 primary MPI codes were selected. Using Medicare’s physician specialty codes, physician providers were identified as radiologists, cardiologists, or other physicians. Payments for MPI to the 3 groups were tracked over the study period. Trends in utilization rates in both hospital and private office settings were also compared among the 3 groups. In addition, utilization trends were studied for related procedures, such as stress echocardiography (SE) and invasive diagnostic coronary angiography (CA).

RESULTS: Between 1998 and 2006, Medicare Part B payments to radiologists for MPI increased from $72.6 million to $84.0 million (+16%), while among cardiologists, payments increased from $242.6 million to $972.0 million (+301%). Private office utilization rates per 1,000 Medicare beneficiaries increased by 215% among cardiologists, compared with 32% among radiologists. In hospital settings, the rate changes were much more modest. Hospital utilization rates were consistently higher among radiologists than cardiologists; in hospital settings in 2006, the rate was 15.3 per 1,000 among cardiologists, compared with 11.8 per 1,000 among cardiologists. Between 1998 and 2006, the utilization rate for SE among cardiologists increased by 20%, and the rate for diagnostic CA among cardiologists also increased by 20%.

CONCLUSION: In recent years, there have been very sharp increases in the costs and utilization of MPI among cardiologists compared with radiologists. Most of the growth occurred in cardiologists’ private offices. In hospital settings, radiologists still do more MPI examinations than cardiologists. Because MPI is a highly reimbursed procedure and there is no evidence that coronary disease is increasing in frequency in the Medicare population, this trend raises a concern about inappropriate self-referral. This is particularly true in view of the facts that the utilization of a competing procedure such as SE also continues to increase among cardiologists and that MPI is not substituting for an invasive procedure such as diagnostic CA.
Recent reimbursement changes and their effect on hospital and private office use of myocardial perfusion imaging.

Levin DC, Parker L, Intenzo CM, Rao VM.

Abstract

PURPOSE: The aims of this study were to examine recent trends in the utilization of radionuclide myocardial perfusion imaging (MPI) and to reflect on their causes and their implications for radiologists.

METHODS: Nationwide Medicare Part B databases for 2000 through 2010 were used. Codes for primary MPI studies (including PET) were selected. Medicare specialty codes were used to identify MPI examinations done by radiologists, cardiologists, and other physicians. Place-of-service codes were used to identify examinations performed in offices versus hospital settings. Utilization rates per 1,000 fee-for-service beneficiaries were calculated. Trends were assessed by place of service and specialty.

RESULTS: The overall MPI utilization rate rose from 2000 through 2004, followed by a period of stabilization from 2005 to 2008. A peak of 88.0 per 1,000 was reached in 2006. In 2009 and 2010, a decline occurred, with the rate dropping by 13% to 76.9. In private offices, cardiologists' utilization grew rapidly from 2000 through 2008, but growth stopped thereafter. Their rate peaked in 2008 at 50.6 but dropped to 44.4 by 2010 (-12%). Radiologists' role in office MPI was minimal. In hospital settings, radiologists predominated in 2000. Their rate remained stable through 2004 but thereafter began to decline steadily, dropping by 35% by 2010. Cardiologists' hospital-based utilization rate rose gradually, then flattened, but began to rise in 2009 and 2010. By 2010, cardiologists performed more hospital MPI examinations than radiologists.

CONCLUSIONS: Radiologists' initially predominant role in hospital-based MPI has eroded recently, while that of cardiologists has strengthened. This seems related to a shift among cardiologists away from office practice and into hospital affiliations.
Outcomes after inappropriate nuclear myocardial perfusion imaging: A meta-analysis.

Elenov IV, Mahmoud A², Stuteser J³, Doukly R⁴, Winchester DE⁵.

Abstract

BACKGROUND: The relationship between inappropriate MPI and cardiovascular outcomes is poorly understood. We sought to systematically review the literature on appropriate use criteria (AUC) for MPI, including temporal trend of inappropriate testing and resulting cardiovascular outcomes.

METHODS: We searched the MEDLINE database for studies related to AUC and MPI. The co-primary outcomes were abnormal test results and the presence of cardiac ischemia. Random effects odds ratios (OR) were constructed using DerSimonian-Laird method.

RESULTS: A total of 22 studies with 23,443 patients were included. The prevalence of inappropriate testing was 14.8% (95% confidence interval (CI) 11.6%-18.7%). Inappropriate MPI studies were less likely to be abnormal (OR 0.41 95% CI 0.36-0.49, P < .0001) and to demonstrate ischemia (OR 0.40, 95% CI 0.24-0.67, P < .0001) compared to appropriate testing. No difference in the rate of inappropriate tests was detected based on the midpoint of the enrollment year (P = .54). The pattern of ordering inappropriate studies was not different between cardiology and non-cardiology providers (OR 0.74, 95% CI 0.51-1.06, P = .10).

CONCLUSION: Inappropriate MPI studies are less likely to yield abnormal results or demonstrate myocardial ischemia. The rate of inappropriate MPI has not decreased over time.

Turf wars in radiology: should it be radiologists or cardiologists who do cardiac imaging?

Levin DC¹, Rao VM.

Abstract

In recent years, the cardiac capabilities of computed tomography, magnetic resonance imaging, and to a lesser extent positron emission tomography have rapidly advanced. This has led to contention between radiologists and cardiologists over who should perform and interpret these studies. The authors present the arguments favoring both sides and discuss strategies radiologists should pursue. Although the arguments favoring radiologists are more compelling, this may be an instance in which both sides should work together.
How many of you do PET MPI?
Summary

- Hardware and Software: keep it state-of-the-art
- Protocols and Process: do not over-complicate this
- Personnel and Culture: “culture eats strategy for lunch”
- Interpretation and Reporting: follow current guidelines
- Quality and Appropriateness: do not compromise on this
- Safety and Customer Service: keep them safe & happy
- Billing and Bottom Line: prosperity is our shared destiny
Acknowledgements

• SWCSNMMI, Ms. Melissa Andrews

• LSURAD, Shreveport, LA

• VA Medical Center, Houston, TX

• St. Luke’s Roosevelt Hospital, New York, NY

• University of Pennsylvania, Philadelphia,

• Randy Glasbergen (2/20/1957 – 8/11/15)
Thank you!!

“My doctor says I need to take a stress test. I thought sitting in his waiting room surrounded by coughing children for two hours WAS the stress test!”