Risks

RADIATION DOSES IN CARDIOLOGY AND MEDICINE 2011
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Disclosures

- Fuji Medical Systems
- Philips
- GE Medical
- Lantheus
- Quinton
OUTLINE

- THE CURRENT PROBLEM OF RADIATION TODAY IN MEDICINE TODAY
- RISKS OF RADIATION AND EFFECTS
- SOLUTION USING RADIATION AND NON IONIZING MODALITIES FOR TESTING
- THE FUTURE OF IMAGING
- ALLEVIATE THE FEAR FACTOR
Hospital Radiation Overexposure
Issues: Radiation exposure
First Physical

Obama's physical draws medical journal comment on two tests

By Susan Perry | Published Tue, Mar 9 2010 8:27 am

As Paul Scott pointed out in this space last week, President Obama’s recent annual physical checkup stirred up some long-brewing controversy about the value of two medical screening tests: the computed tomographic (CT) scan for coronary calcium and the CT colonography (often referred to as a “virtual” colonoscopy).

President Obama underwent both tests.

On Monday, the controversy became a bit more heated with the online publication of an editorial in the Archives of Internal Medicine. In it, the editor of the journal, Rita F. Redberg, MD, expresses being “troubled” that the president’s physical exam included these tests, especially the CT scan for coronary calcium. (This test looks for the presence of calcium in the arteries and is thought to help identify people with...
Over 10 years

RADIATION EXPOSURE FRONT AND CENTER ACC 2011

TOTAL MSEV = 560

67 stents, 28 coronary angiograms, and a crippled healthcare system

Download a mobile-friendly version

Posted Nov 01, 2010 at 02:20 PM, EDT by Eric Topol
Doctors 'Shocked' by Radiation Overexposure at Cedars-Sinai
Medical Scans Continue Increasing Our Exposure to Radiation, Experts Say

BY RADHA CHITALE
ABC NEWS MEDICAL UNIT
Oct. 13, 2009

Doctors have expressed outrage and concern for the unsuspecting patients who received eight times the normal dose of radiation during a specific type of brain scan at Cedars-Sinai Medical Center in Los Angeles.

The overdose was discovered when a patient reported lost patches of hair following a CT scan.

The error, which Cedars-Sinai attributed to a "misunderstanding" about an incorrectly programmed CT machine, in a statement released Oct. 12, remained unchecked for 18 months, involved 206 people, and exacerbated existing concerns that patients nationwide are being exposed to excess radiation during medical testing.

"To me, even as a professional, this is a fairly shocking story. These patients...
Cedars-Sinai offers to pay patients’ further medical costs for overexposure to radiation

Patient Safety Monitor Alert, November 11, 2009

After admitting last month it delivered radiation via CT scans to patients at eight times the normal dose, Cedars-Sinai Medical Center in Los Angeles, CA, has said it will pay the medical expenses for any of those patients suffering from specific ailments related to the scans, reports HealthLeaders Media. Since the error was announced, some patients have found that they have developed cataracts. Twenty percent of the 260 patients who received the abnormal amount of radiation had exposure directly to their eyes. The hospital sent letters to the patients who received the radiation, apologizing and explaining their potential risk for developing cataracts earlier than they would have normally.

The hospital discovered the error after a patient who had undergone a CT scan to evaluate a suspected stroke reported losing his hair and noticing his skin was red. The hospital then found that the settings on one of its CT scanners had been altered.
Safety Investigation of CT Brain Perfusion Scans: Initial Notification

This is an archived document. Updated information about FDA’s safety investigation of CT brain perfusion scans can be found at: http://www.fda.gov/MedicalDevices/Safety/AlertsandNotices/ucm185898.htm

Date Issued: October 8, 2009

Audience: CT facilities, Emergency Medicine Physicians, Radiologists, Neurologists, Neurosurgeons, Radiologic Technologists, Medical Physicists, Radiation Safety Officers

Medical Specialties: Emergency Medicine, Radiology

Device: Multi-slice CT machines.

Summary of Problem and Scope:

FDA has become aware of radiation overexposures during perfusion CT imaging to aid in the diagnosis and treatment of stroke.

Over an 18-month period, 206 patients at a particular facility received radiation doses that were approximately eight times the expected level. Instead of receiving the expected dose of 0.5 Gy (maximum) to the head, these patients received 3-4 Gy. In some cases, this excessive dose resulted in hair loss and erythema. The facility has notified all patients who received the overexposure and provided resources for additional information.

While this event involved a single kind of diagnostic test at one facility, the magnitude of these overexposures and their impact on the affected patients were significant. This situation may reflect more widespread problems with CT quality assurance programs and may not be isolated to this facility.
Study of Children Raises Concerns Over Radiation

The first large study on the use of medical radiation in children says that the average child will get more than seven radiation scans by age 18. Most of them involve X-rays. But there is growing concern about CT scans, which entail far more radiation and can raise the risk of cancer. More than 3 percent of children got two or more CT scans. "That's particularly concerning," said Dr. Adam Dorfman of University of Michigan Medical School, the lead author of the study, which appeared Monday in The Archives of Pediatrics and Adolescent Medicine.
THE FACTS TO CONSIDER
Japanese Atomic Bomb Survivors

- The best risk estimate for exposure to low-dose radiation rely on results of the Life Span Study, the study of the 120,000 survivors of the atomic bombings in Hiroshima and Nagasaki Japan
- The median dose of survivors was 40 mSv
- Organ specific radiation doses are closely linked with the risk of organ specific cancer and cancer mortality, high exposures increased the risk of nearly every cancer
- Even at low doses (10 mSv) survivors were at a significantly increased risk of developing cancer
Trends in testing and treatment of CAD, 1993-2001

- Stress Test (non-imaging)
- Stress Test (imaging)
- Cardiac Cath
- Revascularization
- AMI

Lucas et al. Circulation 2006;113:374-9
Trends in age- and gender-adjusted incidence rate per 100,000 person-years for overall CHD mortality, nonsudden CHD death, and SCD from 1950-1969 to 1990-1999

Cumulative Survival in Patients With Moderate (>50%) Plaque by CCTA

Even in the Setting of Integrated Health Plans, Imaging has Soared

Results based on 2.5 million enrollees per year, including 30 million imaging examinations of all types and over 3 million CTs.
<table>
<thead>
<tr>
<th>Procedure</th>
<th>Radiation Exposure (msv)</th>
<th>Equivalent Chest X-rays</th>
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</thead>
<tbody>
<tr>
<td>Spect MIBI</td>
<td>6-10 msv</td>
<td>500-1000</td>
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<tr>
<td>Cath</td>
<td>5 msv</td>
<td>500</td>
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<td>CT Angio</td>
<td>8-16 msv</td>
<td>800 - 1500</td>
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<tr>
<td>Calcium score</td>
<td>3-5 msv</td>
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<tr>
<td>PCI</td>
<td>8-20 msv</td>
<td>800-2000</td>
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</tbody>
</table>
Radiation Exposure from Different Sources / Year
US Exposure in 2006
3.1 mSv/yr ubiquitous; 3.0 mSv medical Imaging

<table>
<thead>
<tr>
<th>Source</th>
<th>mSv</th>
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<tbody>
<tr>
<td>Cosmic</td>
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<tr>
<td>Living in Denver</td>
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<td>Food</td>
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<tr>
<td>Dental Xrays (series)</td>
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<tr>
<td>Jet Travel (6 hrs)</td>
<td>.03</td>
</tr>
<tr>
<td>Airport Screening / Screen</td>
<td>.00002</td>
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<tr>
<td>Chest Xray (PA &amp; Lat)</td>
<td>.06</td>
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<tr>
<td>CT Chest</td>
<td>8.0</td>
</tr>
<tr>
<td>CT Head, Chest, Abdomen, Pelvis</td>
<td>35 → &gt;100</td>
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# Radiation Risks Levels

<table>
<thead>
<tr>
<th>Level</th>
<th>Radiation Level (msv)</th>
<th>Procedure/Description</th>
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</thead>
<tbody>
<tr>
<td>Level 1</td>
<td>&lt; 5</td>
<td>X-ray calcium score</td>
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<tr>
<td>Level 2</td>
<td>5-10</td>
<td>Diagnostic cath</td>
</tr>
<tr>
<td>Level 3</td>
<td>10-20</td>
<td>CTA, MPI, PCI, LAB WORKER</td>
</tr>
<tr>
<td>Level 4</td>
<td>20-50</td>
<td>Multiple procedures</td>
</tr>
<tr>
<td>Level 5</td>
<td>&gt; 50</td>
<td>Lab worker</td>
</tr>
</tbody>
</table>
Berrington de Gonzalez, Archives of Int Med 2009, Estimated 1.5-2% of Cancers from CT imaging

**Figure 2.** Projected number of future cancers (mean and 95% uncertainty limits) that could be related to computed tomographic scan use in the United States in 2007, according to age at exposure.
Cumulative Incidence of Cancer in Women

- Sestamibi 40 mCi (Annually from age 40-80 yrs)
- Background Radiation (3 mSv/yr)
- Natural Cancer Incidence (SEER)

Risks of CT scans

- Radiation risk
  - Based on CT scans done in 2007 alone
    - 30,000 excess cancers
    - 15,000 excess deaths
- Incidental findings
  - Additional CT scans
  - Biopsy
  - Surgery
- Anxiety due to increased abnormalities

Berrington de Gonzalez A. Archives of Internal Medicine 2009
RESULTS OF DUKE STUDY

- total of 90,121 (9.5%) individuals in the five studied markets underwent at least one cardiac imaging procedure using radiation during the study period
- their cumulative effective dose over three years was 16.4 msv, ranging from 1.5 to 189.5 msv
- 3.3 people per 1000 received a cumulative dose over 20 msv/year from cardiac imaging
- annual effective doses increased with age and were generally higher among men
- 10% of this population gets some kind of cardiac imaging, and of those, some get a fairly substantial dose."
More Results

- There were 35 myocardial perfusion imaging (MPI) procedures per 1000 study enrollees annually.

- MPI accounted for 74.2% of the cumulative effective dose in this study.

- There were nearly 22 diagnostic cardiac catheterization and PCI procedures per 1000 people per year contributed 21.4% of the total radiation dose for the population.
Chen et al estimate that cardiac computed tomography for the assessment of the coronaries without assessment of coronary calcium has an effective dose of 16 msv.

Noncontrast CT for assessment of coronary calcium has an effective dose of 3 msv.

**Opposite Opinion**

- **Drs Matthew Budoff** and **Mohit Gupta** (Harbor UCLA Medical Center, Torrance, CA) write that population rates of high radiation exposure from cardiac imaging "must give us pause."

- But stress that the reason anyone is concerned about radiation exposure is that the radiation increases the risk of cancer, and yet "the entire premise that radiation doses from medical testing cause cancers remains hypothetical."
Lifetime absolute risk from radiation (LAR)

- Model delivered organ dose ranged from 42 to 91 msv for the lungs and 50 to 80 msv for the female breast.
- The highest calculated LAR was 1 in 143 for a 20-year-old woman.
- 1 in 3,261 for an 80-year-old man.
- For a 60-year-old woman or male, estimated LAR was 1 in 715 and 1 in 1,911, respectively.
- The highest LAR was for lung cancer but in younger women it is breast cancer.
- Electrocardiographic tube current modulation for CTCA decreased the risks by 35%.
- ALARA important in every day practice.
More Facts

- There is no record of the patient’s radiation history in the patient’s chart
- No one currently pays attention to the radiation history of the patient
- Lifetime radiation exposure takes a long time to develop and this is often forgotten
- One in 270 women who have a CT angio at age 40 will develop cancer
- One in 600 men who have a CT angio at age 40 will develop cancer
- The incidences double in patients aged 20 years
- It is 50% lower in patients above the age of 60
Coronary Calcium Scan

- Benefit?
  - No effect on outcomes – short or long term
  - Not actionable

- Risk
  - A single CAC score by MDCT is estimated to result in a lifetime excess cancer risk of 9 (3-42) additional cancers per 100,000 men*
  - High rate of incidental findings which lead to additional testing and procedures
  - Associated with increased anxiety

* Einstein AJ et al. Archives of Internal Medicine 2009
Medically Irradiated Populations
Repeated X-rays

- Studies have assessed groups who received repeated x-rays
  - Women with scoliosis (frequent x-rays late childhood)
  - Patients with Anklosing Spondylitis
  - Patients with tuberculosis (repeated chest fluoroscopy)
  - Children who underwent cardiac catheterizations

- All significantly more likely to develop cancer
- Some patients may have a particularly increased sensitivity to developing radiation induced cancer due to genetic variation; BRCA1/2 mutation carriers /ataxia telangiectasis
Why Are Doses so High and Variable

- There are no clear dose targets set for CT in the US
  - Diagnostic reference levels are set in Europe
- There is no professional organization or governmental organization responsible for collecting and reporting dose data – and few clear quality standards
  - Radiologists in US are largely unaware of doses
- The improvement in the technical aspects of CT, have ironically let to increasing high doses
February 27, 2010

At Hearing on Radiation, Calls for Better Oversight

by WALT ROSEBACH

WASHINGTON — A dozen witnesses, including representatives of virtually all of the leading professional groups in medical radiation, told a House subcommittee during a hearing Friday that more needed to be done to make sure that radiation continues to help, not harm, patients.

The call for a more standardized, comprehensive method of overseeing medical radiation, both diagnostic and therapeutic, came from radiation oncologists, radiologists, therapists, researchers, medical physicists and equipment manufacturers.

Saying that recent news reports about radiation accidents had "raised huge concerns for me," Frank Pallone Jr., the New Jersey Democrat who is the chairman of the Energy and Commerce subcommittee on health, said he was shocked that the people who operate radiologic devices need not be licensed in many states and that "the requirements to report errors and the penalties for making errors are basically nonexistent or not enforced."

But it was the panel's first witness, James Parks, who, in describing the death of his son Scott Jerome-Parks, 43, from a radiation overdose at a New York City hospital, provided the hearing's emotional wallop.

His son's minimally invasive radiation treatments for tongue cancer, Mr. Parks said, quickly turned into a nightmare. "He rapidly became..."
Radiation Over Exposure Investigation Efforts Continue—Patients With Strokes Over Exposed

Finding the solution still continues and more patient stories are coming out with the effects of what happened to them when over exposed, with hair falling out, rashes, etc. One man was even judged by his co-workers as they thought he had some contagious disease based on the rash that was covering his body and loss of hair. The link below somewhat amazed me as our members of Congress have limited intelligence in some of these areas and the word "surprise" I guess fits as they are pretty much non-participants in basic consumer IT knowledge and use.
SO WHERE ARE WE GOING?
Facts and Questions

• In 2010 Duke University study showed that acute MI patients receive over 17 msv of ionizing radiation per hospital admission from imaging.
• This is the first study to document the radiation exposure from cardiac procedures at the population level.
• Chen et al estimated the three-year cumulative effective doses of radiation in msv from these procedures.

The Questions are:

• How often cardiac imaging exposes people to an effective dose greater than 3 msv/year the background level of radiation from natural sources.
• How many cardiac imaging patients are getting more than 20 msv/year the standard upper annual limit for occupational exposure averaged over five years.
Japanese Atomic Bomb Survivors

- The best risk estimate for exposure to low-dose, radiation rely on results of the Life Span Study, the study of the 120,000 survivors of the atomic bombings in Hiroshima and Nagasaki Japan.
- The median dose of survivors was 40 mSv.
- Organ specific radiation doses are closely linked with the risk of organ specific cancer and cancer mortality, high exposures increased the risk of nearly every cancer.
- Even at low doses (10 mSv) survivors were at a significantly increased risk of developing cancer.
RADIATION RISK IN PERSPECTIVE

Don’t perform quantitative risk estimation below 5 rem in one year or 10 rem lifetime

Radiogenic health effects have not been consistently demonstrated below 10 rem

Collective dose often used inappropriately, i.e., large dose to small number of people ≠ small dose to a larger number of people

In accordance with current knowledge of radiation health risks, the Health Physics Society recommends against quantitative estimation of health risks below an individual dose of 5 rem in one year or a lifetime dose of 10 rem above that received from natural sources. Doses from natural background radiation in the United States average about 0.2 rem per year. A dose of 5 rem in one year would be equivalent to 0.15 rem per day, which is slightly above the annual limit for occupational exposure.

There is substantial and convincing scientific evidence for health risks following high-dose exposures. However, below 5–10 rem (which includes occupational and environmental exposures), risks of health effects are either too small to be observed or are nonexistent.
Radiation Workers

- Large scale studies of 400,000 radiation workers in the nuclear industry have been reported.
- Average doses of 20 mSv were reported and these are clearly in the range of a single CT scan.
- There was a significant association between low dose exposures (5 - 150 mSv) and cancer mortality.
- Several large studies of radiology technologists, physicians who use radiation ongoing, suggestion of an increase risk of breast and probably other cancers.
Imaging - Conclusions

- Cardiac imaging growing rapidly
- Outcomes data is needed
- Real costs
- Known risks
- Patient benefit must be clear
- How does imaging change treatment?
Conclusion: What Needs to Be Done

- Medical Imaging is an integral component of medical care
- However, there are remarkably few evidenced based guidelines about when to image: and the default is to over-image
- Research is desperately needed to outline when and how to image, and to do so using lowest possible doses
- More widespread efforts are needed to
  - Standardize and reduce the doses per study: standards
  - Reduce the number of studies: shared responsibility
  - Educate patients and providers about risks /benefits of imaging
  - Directly assess the risks /benefits of medical imaging to inform practice
2. Use of Multislice Computed Tomography (MSCT) versus Conventional Coronary Angiography (CCA)

The effective dose from the use of MSCT is about 14 mSv (1.4 rem) (Coles et al. 2006). Using the LNT model, this would suggest an excess radiogenic cancer death risk of 0.07 percent. The effective dose from CCA by comparison is about 6 mSv (0.6 rem) (Coles et al. 2006), suggesting an excess radiogenic cancer death risk of 0.03 percent. The nonradiogenic, noncontrast mortality risk from CCA is 0.11 percent, according to Noto et al. (1991). The U.S. population of individuals aged 50 to 55 years (2006) is 18.8 million. The number of excess cancer deaths due to the use of MSCT screening for CAD (coronary artery disease), if such screening were done, can be estimated as 13,160 for a single exam. The number of excess cancer deaths would be 39,480 or 2,627 per year when an exam is given every five years to age 70.

The potential gross benefit of MSCT CAD screening is estimated at 33,500 per year. The number of lives saved is 10 percent of ~335,000 sudden cardiac deaths per year (American Heart Association 2005). For an individual having a first myocardial infarction at age 68 (American Heart Association 2005) more than 90 percent had greater than 75 percent stenosis in more than one vessel (Libethson et al. 1974), which is detectable by MSCT. Conservatively, therefore, the net benefit of MSCT is seen to be 30,873 lives saved per year.
Benefits of Medical Radiation Exposures

Pat Zanzonico, PhD, and Michael G. Stabin, PhD, CHP

Background

We frequently receive questions on the Ask the Experts (ATE) feature of the Health Physics Society Web site from people who have received one or more diagnostic medical exams. These people express concern about the risks of the radiation exposure(s) from these exams.

We always encourage people to become well informed about the risks and benefits of all uses of radiation, and in the case of medical exposures, it is good to be an active participant in the process. This includes an understanding of the procedures involved and the possible risks associated with them.

We routinely answer this kind of ATE question with as much information taken from various standard published data sources as we can provide about typical radiation doses for the procedure. However, only the physician, physicist, and other professionals from the institution where the procedure is performed can provide specific radiation dose information for the particular exams and techniques employed.
Patient Perception

- Internet-savvy patients
- Risk numbers = glazed eyes, blank stares
- Confusing terms, i.e., ‘low’ risk
- Stress benefit of exam over radiation risk
- Stress oversight and maintenance program related to imaging equipment
- Stress continued review of protocols to ensure the lowest possible dose
- If applicable, stress participation in national accreditation programs
Study: Too many heart patients get angiograms

NEW YORK (AP) — A troublingly high number of U.S. patients who are given angiograms to check for heart disease turn out not to have a significant problem, according to the latest study to suggest Americans get an excess of medical tests.

The researchers said the findings suggest doctors must do better in determining which patients should be subjected to the cost and risks of an angiogram. The test carries a small but real risk — less than 1% — of causing a stroke or heart attack, and also entails radiation exposure.

DIAGNOSTIC TOOLS: Radiation from CT scans linked to cancers
HEART HEALTH: Happiness may help
INTERACTIVE: Compare nearby hospitals on heart attack death rates
Mammography and Lives Saved

- Randomized prospective trial:
  - 77,080 women invited for screening (7 years)
  - 55,985 not invited
  - 20 year f/u
- Outcomes:
  - Number of women screened for 7 years, to save one life over 20 years is 465 (95% CI=324-819)
  - Number of mammograms to save one life is 1499 (95% CI=1046-2642)

CT Scans Cut Lung Cancer Deaths, Study Finds

By GARDNER HARRIS
Published: November 4, 2010

WASHINGTON — Annual CT scans of current and former heavy smokers reduced their risk of death from lung cancer by 20 percent, a huge government-financed study has found. Even more surprising, the scans seem to reduce the risks of death from other causes as well, suggesting that the scans could be catching other illnesses.

The findings represent an enormous advance in cancer detection that could potentially save thousands of lives annually, although at considerable expense. Lung cancer will claim about 157,000 lives this year, more than the deaths from colorectal, breast, pancreatic and prostate cancers combined. Most patients discover their disease too late.
Trends in age- and gender-adjusted incidence rate per 100,000 person-years for overall CHD mortality, nonsudden CHD death, and SCD from 1950-1969 to 1990-1999

RECOMMENDATIONS FOR THE FUTURE
ETT, SPECT, Echo
Diagnostic Accuracy

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<th>ETT</th>
<th>SPECT</th>
<th>Echo</th>
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<td>Specificity</td>
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ACC/AHA/Exercise Testing Guideline, 2002
ACC/AHA/ASE Echo Guideline, 2003
ACC/AHA/ASNC Radionuclide Imaging Guideline, 2003
## Appropriateness Criteria
Evaluation of Chest Pain Syndrome

<table>
<thead>
<tr>
<th>Indication</th>
<th>SPECT MPI</th>
<th>Stress Echo</th>
<th>Stress CMR</th>
<th>CT Angio</th>
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<td>Low pre-test prob, ECG interp and able to exercise</td>
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<td>I</td>
<td>I</td>
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<tr>
<td>Low pre-test prob, ECG uninterp or unable to exercise</td>
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<td>?</td>
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<td>Intermed pre-test prob</td>
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ACCF Criteria, JACC
# Appropriateness Criteria

**Evaluation of Chest Pain Syndrome**

<table>
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<tr>
<th>Indication</th>
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<td>CABG</td>
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<td>A*</td>
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<td>Stent</td>
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<td>U^</td>
</tr>
</tbody>
</table>

* To establish graft patency

^Inappropriate if stent diameter <3 mm

ACCF Criteria, JACC
European and North American Guidelines

Stress Echo vs. Competing Techniques

Key point: Stress echocardiography should be preferred due to its lower cost, wider availability and—most importantly—for the radiation-free nature. Stress scintigraphy offers similar information to stress echocardiography, but with a radiation burden between 600 and 1300 chest X-rays for every single stress scintigraphy. This poses a significant biological risk both for the individual and for the society, since small individual risks multiplied by millions of stress tests per year become a significant population burden.

“When similar information is obtained with ionizing and non-ionizing techniques, the latter should be employed”

www.escardio.org/EAE
Role of three-dimensional echocardiography in breast cancer: comparison with two-dimensional echocardiography, multiple-gated acquisition scans, and cardiac magnetic resonance imaging.

**J Clin Oncol. 2010 Jul 20;28(21):3407-10 – Canadian Study July 2010**

PURPOSE: In patients with breast cancer, the administration of doxorubicin and trastuzumab is associated with an increased risk of cardiotoxicity. Although multiple-gated acquisition (MUGA) scans and two-dimensional transthoracic echocardiography (TTE) are conventional methods for baseline and serial assessment of left ventricular ejection fraction (LVEF) in these patients, little is known about the use of real-time three-dimensional TTE (RT3D TTE) in this clinical setting. The aim of this study was to assess the accuracy of MUGA, 2D TTE, and RT3D TTE for determining LVEF in comparison to cardiac magnetic resonance imaging (CMR).

METHODS: Between 2007 and 2009 inclusive, 50 female patients with human epidermal growth factor receptor 2-positive breast cancer received adjuvant trastuzumab after doxorubicin. Serial MUGA, 2D TTE, RT3D TTE, and CMR were performed at baseline, 6, and 12 months after the initiation of trastuzumab.

RESULTS: A comparison of left ventricular end diastolic volume (LVEDV) demonstrated a modest correlation between 2D TTE and CMR ($r = 0.64$ at baseline; $r = 0.69$ at 12 months, respectively). A comparison of LVEDV between RT3D TTE and CMR demonstrated a stronger correlation ($r = 0.87$ at baseline; $r = 0.95$ at 12 months, respectively). Although 2D TTE demonstrated a weak correlation with CMR for LVEF assessment ($r = 0.31$ at baseline, $r = 0.42$ at 12 months, respectively), both RT3D TTE and MUGA showed a strong correlation when compared with CMR ($r = 0.91$ at baseline; $r = 0.90$ at 12 months, respectively).

CONCLUSION: As compared with conventional MUGA, RT3D TTE is a feasible, accurate, and reproducible alternate imaging modality for the serial monitoring of LVEF in patients with breast cancer.
What Are the (potential) Risks of Radiation in Cardiology?

- **Deterministic**
  - From CT (hypothetical)
  - From fluoroscopy (angiogram/intervention)

- **Stochastic (cancer)**
  - From examination (CT, SPECT, invasive angio)
  - From downstream utilization of radiation

- **Disease**
  - False negative and adverse outcome
  - False positive with downstream utilization and procedural risk
Possible Benefits of Cardiac Imaging
Gerber TC and Gibbons RJ. Table 1. J Am Coll Cardiol Img, 2010; 3:528-535.

• Symptomatic patients
  – Correct diagnosis
    Choice of disease-specific therapy
    Improved quality of life by relief of symptoms
  – Prognostication
  – Improved outcomes (survival)—selected subjects

• Asymptomatic patients
  – Improved survival—unproven
Issues with Measuring Outcomes (especially in Cardiology)

• A diagnostic procedure is almost always associated with a therapeutic action (+ or -)
  – The decisions may not be tightly coupled
    Variability in decision-making
  – They may be too tightly coupled
    The diagnostic study may be required for the therapy (e.g. diagnostic angiogram and PCI/CABG)

• Comparative effectiveness would almost always be required (ethical considerations)
  – Study duration long with changing technology, Rx

• Proving increased risk (cancer) “impossible”
ACTION ITEMS

- Take a Radiation history and record it
- Know the radiation numbers for the tests
- Be familiar with old standards plus the new standards
- Stress only MIBI in selective patients
- Better cameras
- More protection for all
- Pretest likelihood of disease
- Use Appropriateness guidelines for testing
- Use alternative technologies – Echo, MRI
BE AWARE WHEN ORDERING TESTS

- The cumulative effect of the radiation is the problem that we all experience.
- The annual accepted exposure is 20-50 msv which is equivalent to 2000-5000 chest x-rays.
- 15-100 msv in 5 years is the limit for workers.
- 50% of the exposure in radiation medicine today is from CT.
- 44% are examinations that involved the chest.
- 26% of the radiation exposure is from nuclear procedures.
- 14% for fluoroscopy.
- 11% other procedures.
- Screening in asymptomatic patients is risky with regards to radiation exposure.
- PACS AND INFORMATION SHARING A MUST.
Radiation Dose from Coronary CT Angiography

Dose (mSv)

Year

2005 2006 2007 2008 2009 2010

Raff GL. JCCT 2010:4;365-74
IS THIS STILL TRUE POST STICH?
ROLE OF VIABILITY STUDIES NOW in ?

Log hazard ratio for revascularization (Revasc) vs medical therapy (Medical Rx) as a function of % myocardium ischemic based on final Cox proportional hazards model.

*p<0.001

% Total Myocardium Ischemic


Circulation
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American Heart Association
Learn and Live
The Potential Relationship Between the Benefit of Cardiac Imaging and Harm Associated With Medical Imaging Radiation in Younger and Older Patients

Older Patients

Benefit

Risk

Younger Patients

Benefit

Risk

President Obama RX correct?

Conclusion on First Physical

- 2 cutting edge expensive screening tests
  - Coronary artery calcium scan
  - CT colonography
- No known benefits
- Known risks
- Even for the President
  - More care is NOT necessarily better care
The World is Changing

- Slides on our website rvcardiology.com
- 3D echo with and without contrast at all of our locations has been part of our daily practice for last 4 years.
- Why? To reduce the radiation exposure to the cancer and non-cancer patients in our community and to improve our assessment of patients for CRT
- Muga 8-10 msv and echo with contrast can image 99% patients
- Radiation dose going down