Radiation Exposure From Cardiac Imaging: What are the Risks?

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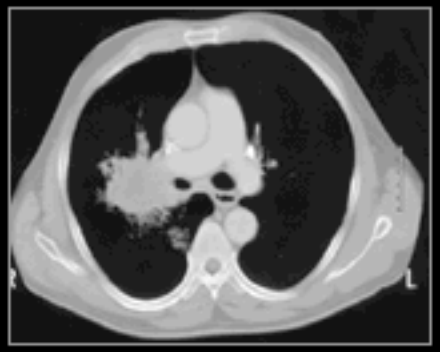
No Disclosures

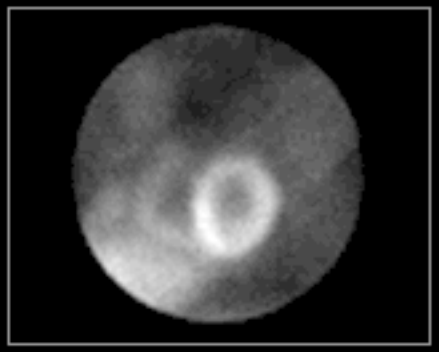
Cardiac Imaging:
Ionizing versus Non-ionizing Radiation

IONIZING RADIATION

Radiography



Computed Tomography



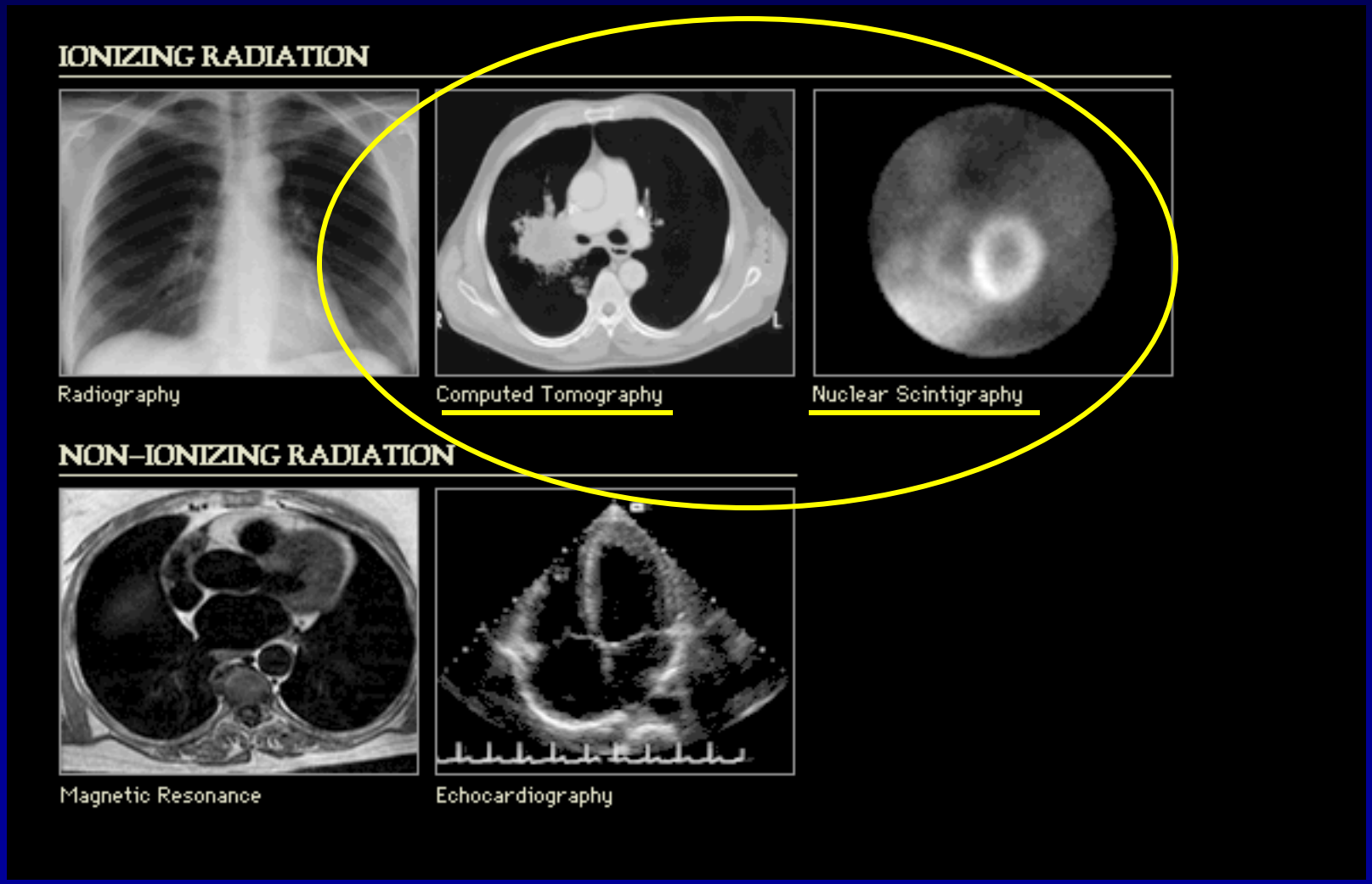
Nuclear Scintigraphy

NON–IONIZING RADIATION

Magnetic Resonance

Echocardiography

Cardiac Imaging:
Ionizing versus Non-ionizing Radiation



Radiation Exposure

Table 1 **Estimates of Effective Doses for Selected Cardiac Imaging Procedures (in mSv)**

Myocardial perfusion imaging study with ejection fraction	15.6
Diagnostic coronary angiography	7.0
Percutaneous coronary intervention	15.0
Cardiac blood pool imaging, gated equilibrium; planar, single study at rest or stress	7.8
Cardiac computed tomography (without contrast, for assessment of coronary calcium)	3.0
Cardiac computed tomography (with contrast, for assessment of coronary arteries, without assessment for coronary calcium)	16.0
Pacemaker insertion	1.5
Comprehensive electrophysiological evaluation	5.7

Estimating Cancer Risk

- Background cancer risk in general population
- Ubiquity of natural background radiation
  - 2.5 mSv annually
- Latency period of 10 to 40 years for most radiation-induced solid malignancies
- Difficult to verify the risk of malignancy of low levels of radiation in clinical prospective studies

Estimating Cancer Risk

- Uncertainty in converting radiation dose to lifetime cancer risk
- Based on a “linear, no-threshold hypothesis”
- Extrapolated cancer incidence from:
  - Atomic bomb survivors
  - Populations exposed to high doses and rates

- No data for diagnostic medical imaging doses
- Estimation of cancer incidence or deaths at low doses and rates is controversial

Estimating Cancer Risk

- 100 mSv would cause 1 additional cancer per 100 individuals over a lifetime
- CT coronary angiography lifetime attributable risks of cancer
  - 1in 284 for a 40-year-old woman
  - 1in 1,007 for a 40-year-old man

Estimating Cancer Risk

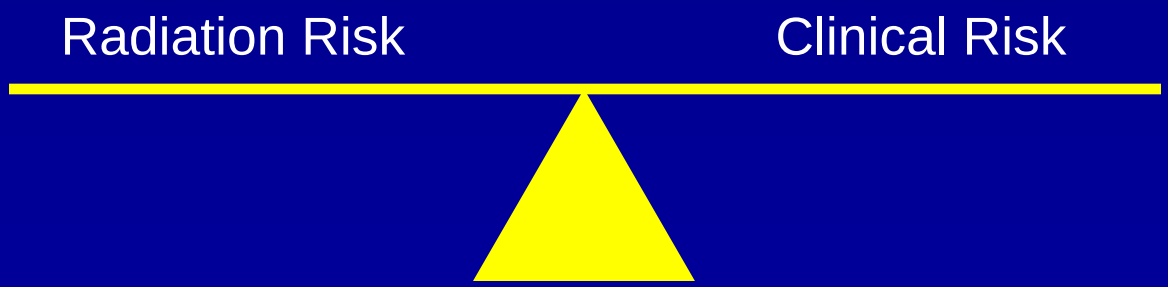
- All published estimates of potential cancer risk related to cardiovascular imaging are based on the “linear no-threshold” model.
- “Linear Quadratic Hypothesis”
  - No cancer risk with low dose radiation
  - Up-regulation of molecular cell repair mechanisms at lower radiation doses
- Cancer risk rises quadratically after an effective dose of 100 mSv.

Which Patients may be at Greatest Risk from Cardiovascular Imaging Studies?

- Women
  - Risk of breast cancer and lung cancer
- Younger patients
  - Radiosensitivity of many organs
  - Longer time after radiation exposure to develop malignancy

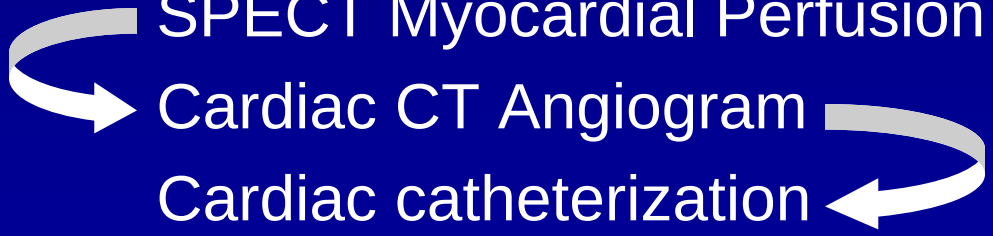
Balancing Risks and Benefits

- Age (Elderly less risk of cancer from testing)
- Gender (Women increased risk)
- Appropriate Use Criteria
  - Aceeptable indications for testing
  - Symptoms, risk factors, objective findings
- “Will results of test change management?”
- Consider all imaging modalities available



AHA 2009 Science Advisory: Cardiac Imaging Studies Employing Ionizing Radiation

- Individualized assessment of risks and benefits
- Risk of missing an important diagnosis if imaging not performed due to radiation exposure concerns.
- Routine studies in low risk, asymptomatic pts not performed
- Equivalent tests, choose least radiation exposure.
- Younger patients: imaging modalities without radiation
- Avoid “Layered testing”



Reducing Radiation Exposure

- ALARA (As Low As Reasonably Achievable)
  - Lowest dose of radiation that permit diagnostic quality images
- Use of modalities without ionizing radiation
  - Stress echocardiography
  - Cardiac MRI

Reducing Radiation Exposure

- Myocardial Perfusion Imaging
  - Stress-only imaging
  - If stress images normal, no rest imaging performed
  - Newer SPECT cameras/ image processing technology
    - Faster image acquisition: Lower isotope dose
    - Reduces radiation from 15-20 mSv to 5-6mSv.

- Cardiac CT-Angiography
  - Dose modulation and prospective ECG gating
  - 64-→256 slice scanners
  - Reduces radiation dosimetry from 15-~3-5 mSv.

Summary

- Health risks from medical imaging uncertain
- Assuming risk exists:
  - Appropriate patient selection
  - Proper test selection
- Balance of radiation and clinical risks
- Methods to reduce radiation exposure