National Cancer Institute

National Cancer Advisory Board

Cancer Risks from Medical Radiation Exposure

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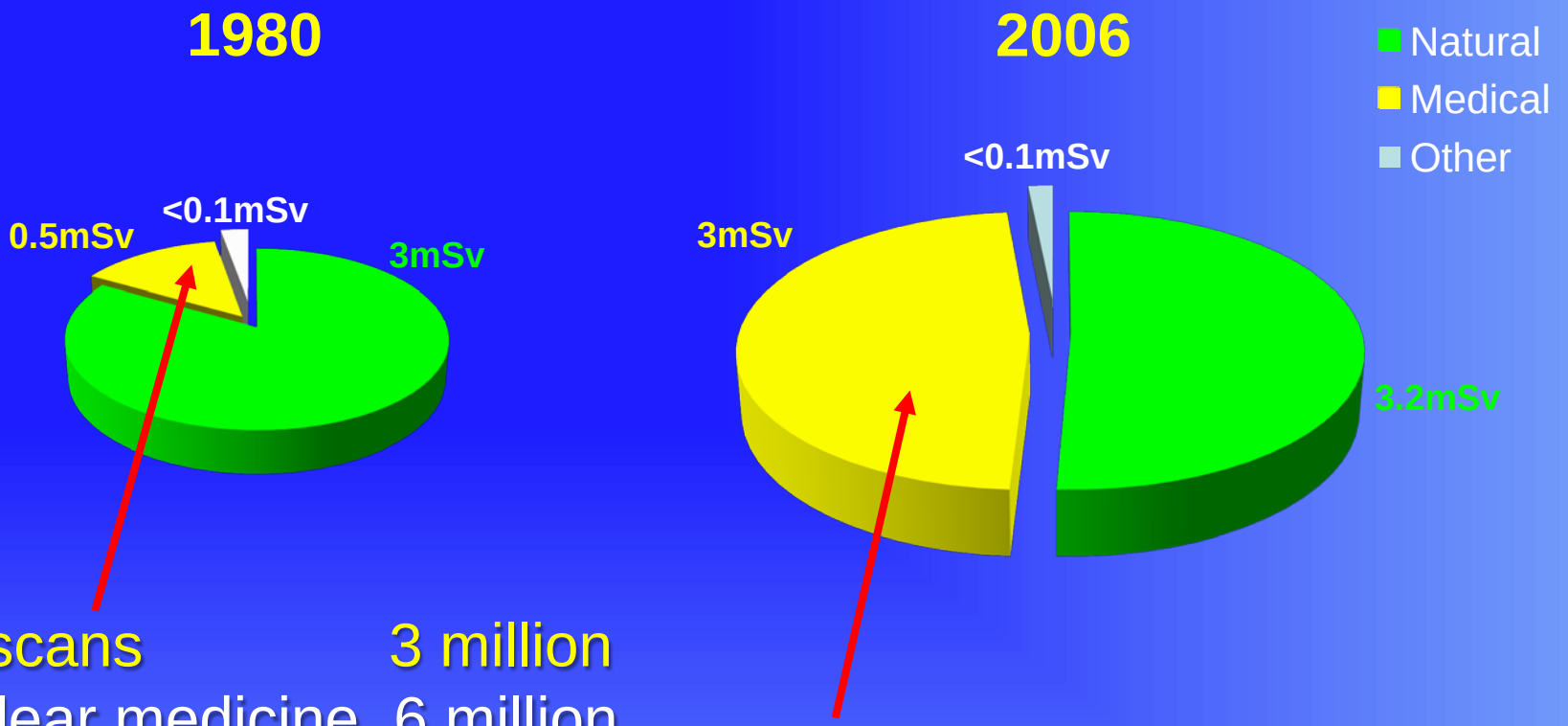
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
National Institutes of Health

Diagnostic Radiation Exposure

Radiation Exposure in the U.S.



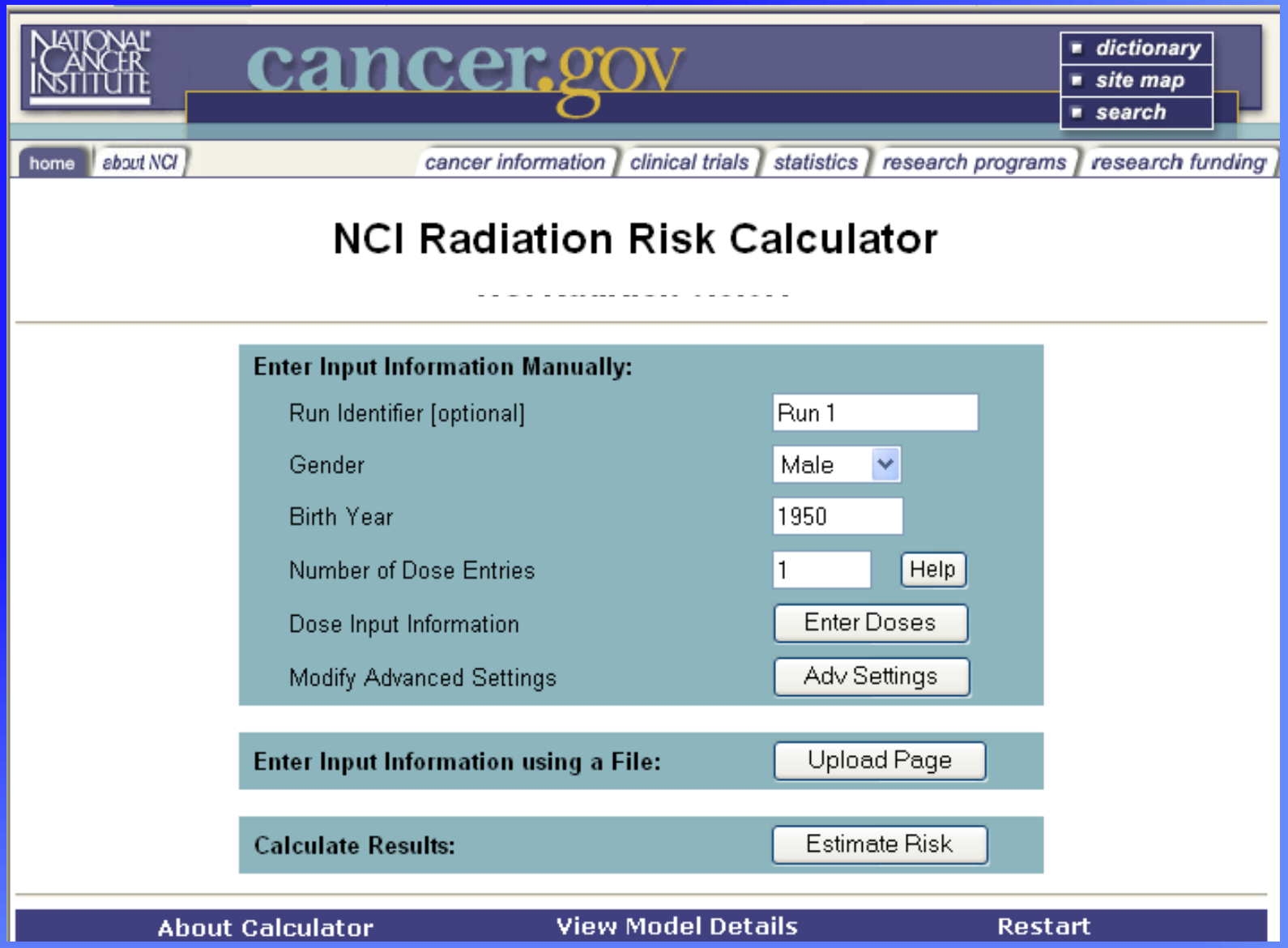
CT scans	3 million	CT scans	70 million
Nuclear medicine	6 million	Nuclear medicine	18 million

NCRP report 160 (2009)

Diagnostic Radiation Exposure in the U.S.

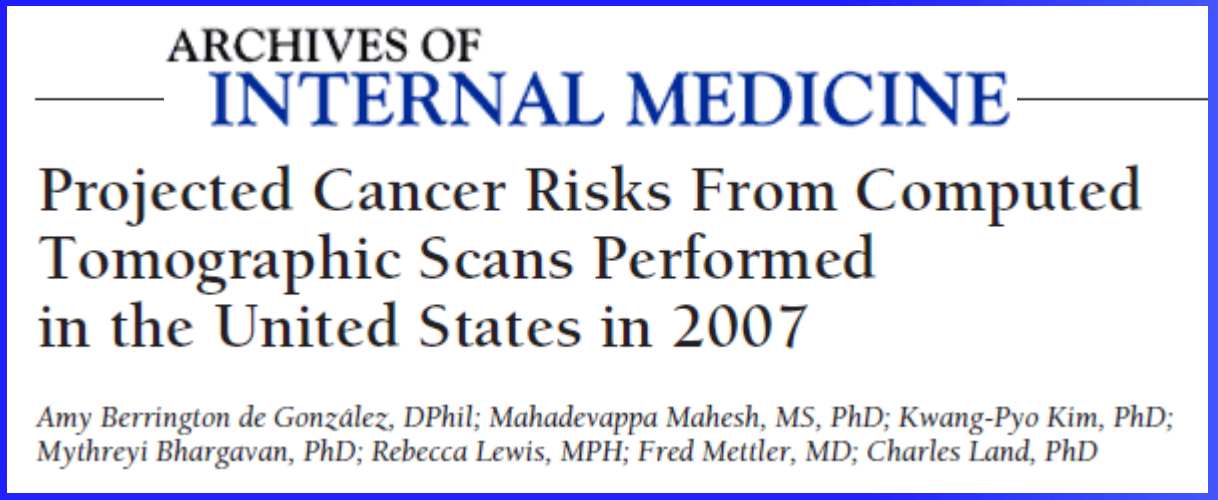
- Great medical benefits but rapid increase public health concern
- 1991-95 Attributable Risk ≈ 1% of US cancers
  - Impact of increase on attributable risk?
- Observational studies often not feasible
- Projection models provide timely estimates of potential risks

Berrington de Gonzalez & Darby (Lancet 2004)



Berrington de Gonzalez et al (in preparation)

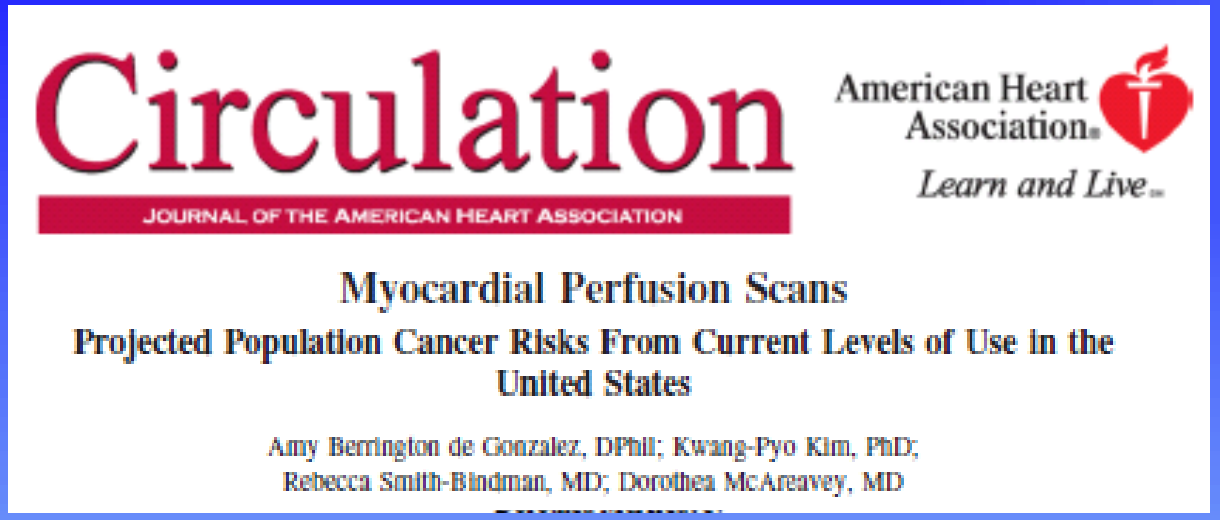
Radiation Risk Projection Research



ARCHIVES OF
INTERNAL MEDICINE

Projected Cancer Risks From Computed Tomographic Scans Performed in the United States in 2007

Amy Berrington de González, DPhil; Mahadevappa Mahesh, MS, PhD; Kwang-Pyo Kim, PhD; Mythreyi Bhargavan, PhD; Rebecca Lewis, MPH; Fred Mettler, MD; Charles Land, PhD



Circulation

JOURNAL OF THE AMERICAN HEART ASSOCIATION

American Heart Association.

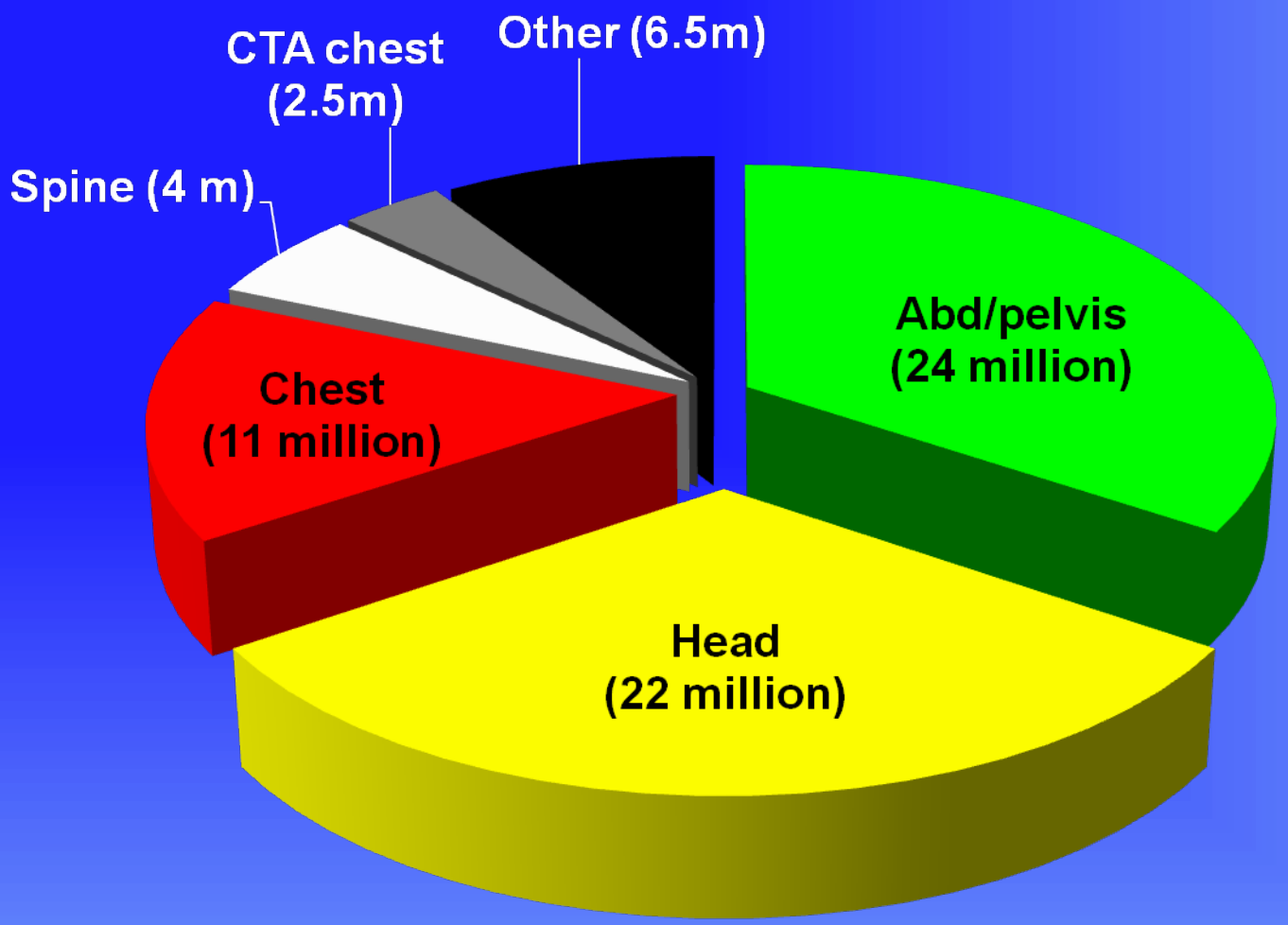
Learn and Live.

Myocardial Perfusion Scans

Projected Population Cancer Risks From Current Levels of Use in the United States

Amy Berrington de Gonzalez, DPhil; Kwang-Pyo Kim, PhD; Rebecca Smith-Bindman, MD; Dorothea McAreavey, MD

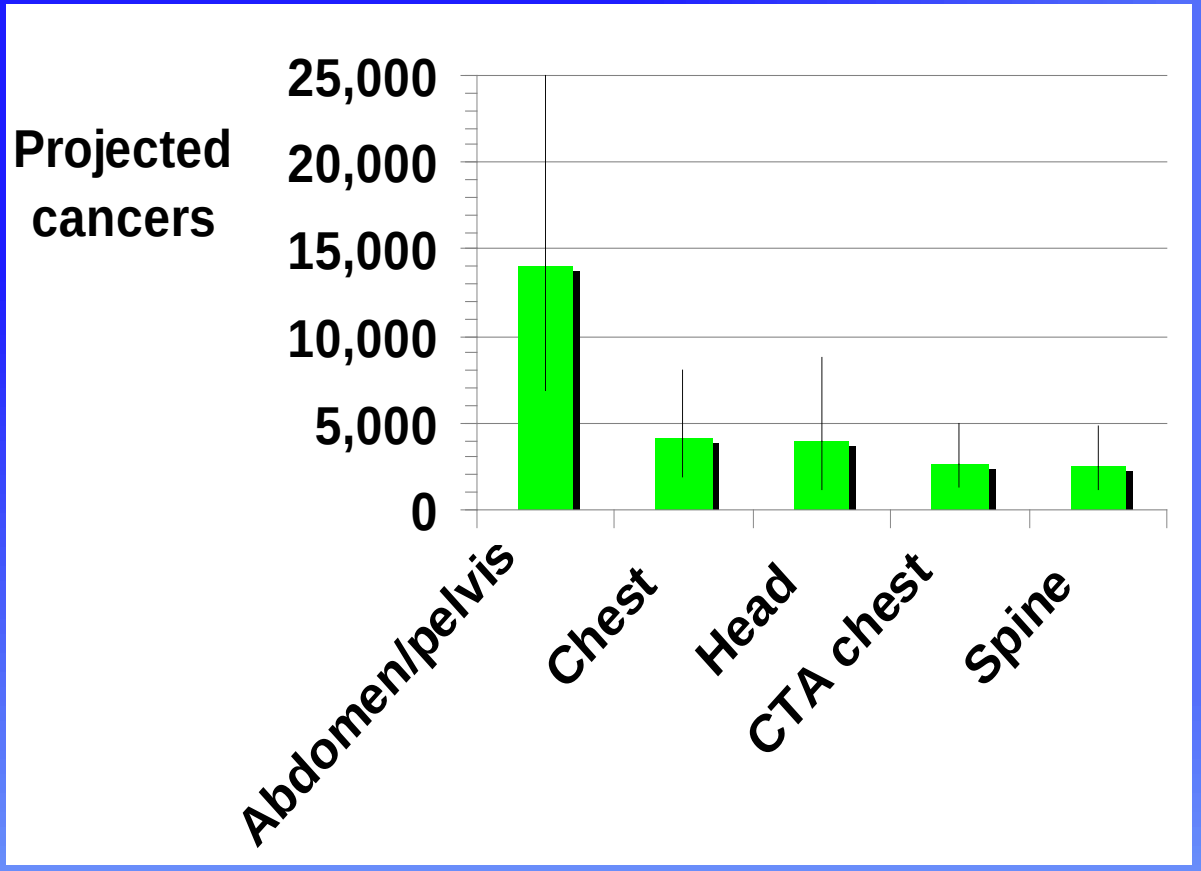
70 Million CT Scans U.S. 2007



Mettler et al (Radiology 2008); IMV 2008

Projected Cancers from CT Scans (U.S. 2007)

29,000 cancers (95% Uncertainty limits: 15,000 – 45,000)



Berrington de González et al (Arch Int Med 2009)

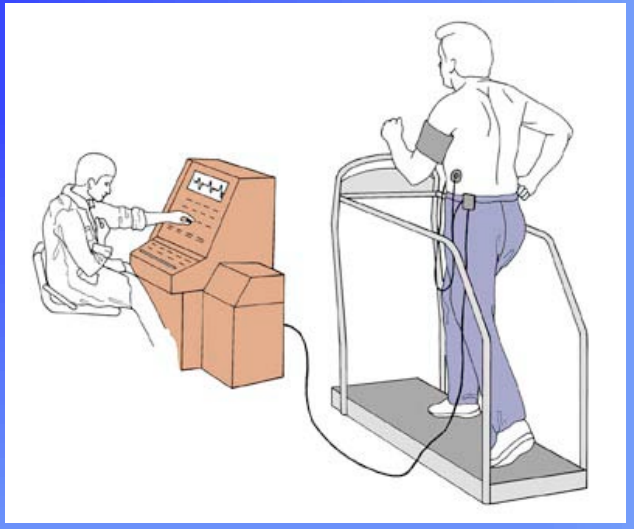
Cardiac Stress Tests

- 9 million tests annually in US - 1 million 1982
- 85% collective dose from nuclear medicine tests
- Average doses higher than CT

7 mSv Chest CT

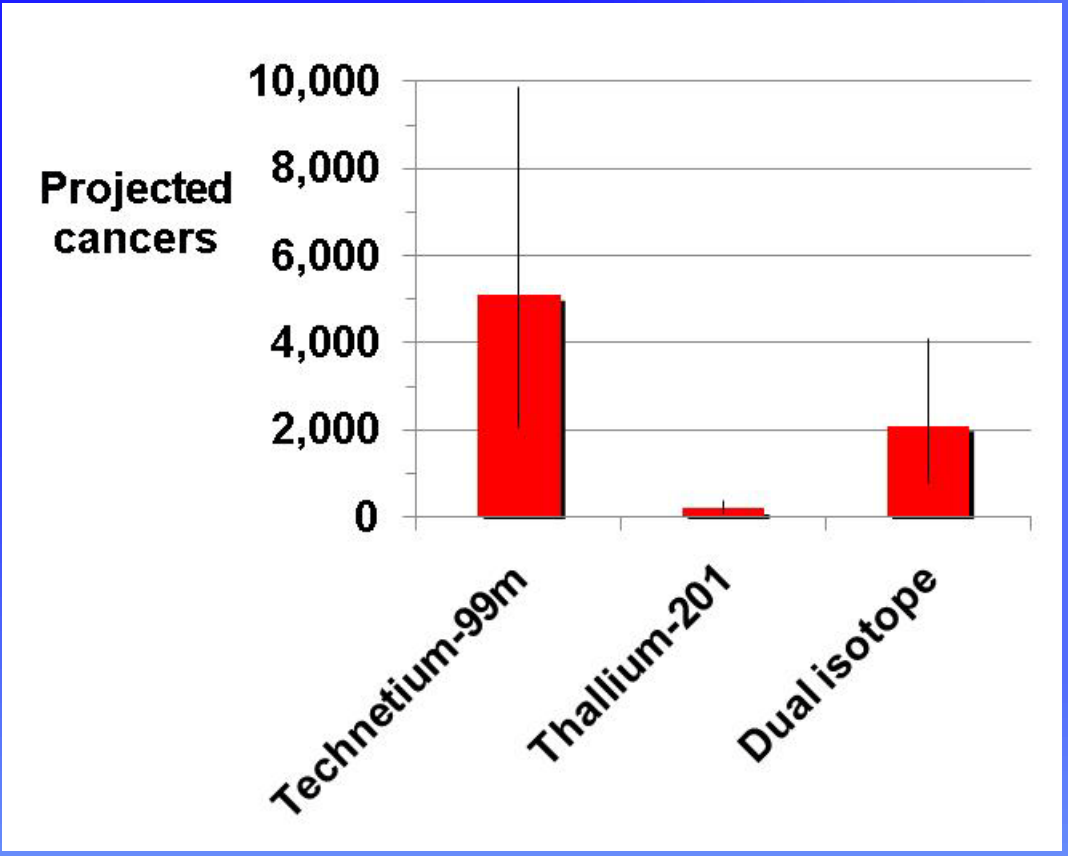
15 mSv Technetium-99m

35 mSv Dual Isotope



Projected Cancers from Cardiac Stress Tests (U.S. 2008)

7,400 cancers (95% Uncertainty limits: 3,300 – 13,700)



Berrington de González et al (Circulation 2010)

Implications for Future Attributable Risk

- **Levels of Use 1991-95 Attributable Risk ~ 1%**
  - **Radiography 0.5%**
  - **CT scans 0.5%**
  - **Nuclear medicine <0.1%**

- **Levels of Use 2007-8 Attributable Risk ~ 3.0%**
  - **CT scans 2.0%**
  - **Nuclear medicine 0.5%**
  - **Radiography 0.5%**

Berrington de González & Darby (Lancet 2004); Berrington de González et al (Arch Int Med, 2009) ; Berrington de González et al (Circulation, 2010)

Recent Campaigns to Mitigate Risks

- **NIH Clinical Center Radiation Dose Tracking**
- **FDA white paper "Initiative to reduce unnecessary radiation exposure"**
  http://www.fda.gov/Radiation-EmittingProducts/RadiationSafety/RadiationDoseReduction/default.htm
- **Image Gently & Image Wisely Campaigns**

Summary of Recommendations

If test clinically justifiable then benefits > risks

Reduce use

- **Use Appropriateness criteria**
  - **American College of Radiology CT scans**
- **Seek Alternatives**
  - **eg MRI, ultrasound**

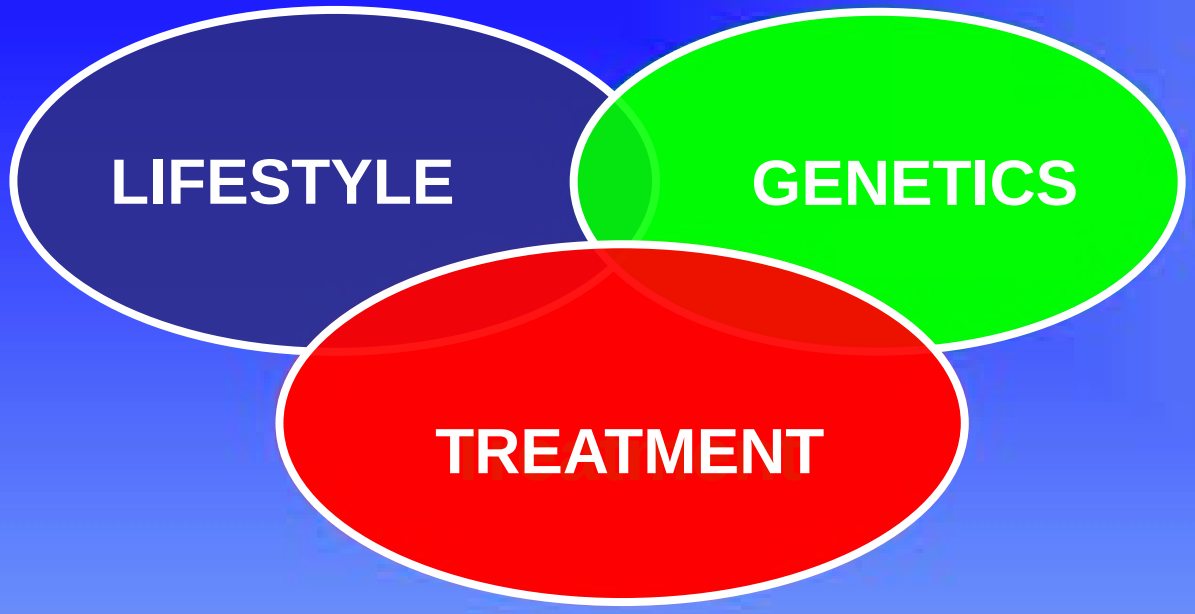
Reduce doses

- **Standardize protocols**
- **Monitor doses**

Therapeutic Radiation Exposure

Subsequent Malignancies in Cancer Survivors

- 12 million cancer survivors living in US
- 14% higher risk of subsequent malignancy than general population



SEER prevalence database 2010; Curtis et al (SEER monograph 2006)

SEER Study of Adult Cancer Survivors

- **What proportion of second cancers are related to radiotherapy?**
- **SEER cancer registries (1973-2007)**
- **15 cancers routinely treated with radiotherapy**
- **N ≈ 1.3 million**
- **Poisson regression analysis**

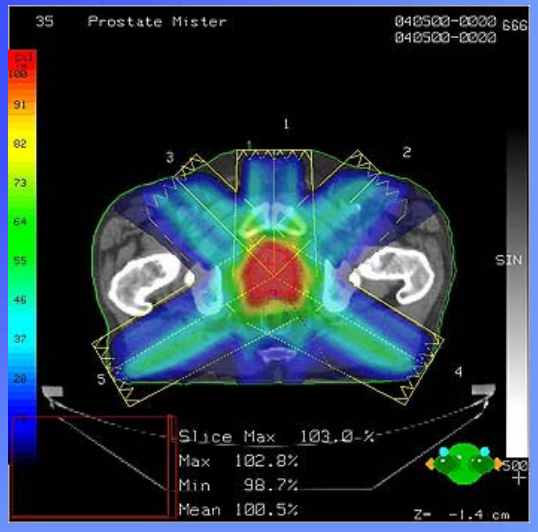
Excess Cancers Related to Radiotherapy

- 42,000 (9%) RT patients developed 2nd cancer
- 3300 excess cancers (95% CI 2900-3700)
  - 8% of second cancers (95% CI 7%-9%)
  - 1 excess cancer for every 150 treated
- Risks higher for younger age & pelvic radiation
- Benefits should generally outweigh risks

Berrington de Gonzalez et al (in preparation)

Newer Radiotherapy Modalities

- Intensity modulated radiotherapy (IMRT) & proton therapy
- Aim to reduce high-dose exposures
  - Acute toxicities (eg bladder damage)
- Second cancer risks?



Radiation Epidemiology Branch Strategic Plan - Medical Radiation Exposure

- **Monitor use of existing and emerging medical technologies**
  - **Conduct studies of questions of public health & clinical concern**

- **Assess the radiation dose-response relationship**
  - **Low & high-dose range**
  - **Fractionated vs acute exposures**
  - **Identify radiosensitive sub-groups**

Acknowledgements

Cardiac stress tests

Kwang Pyo Kim (NCI)

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CT scans

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