

Lung CT screening: radiation risks vs benefits

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The National Lung Screening Trial

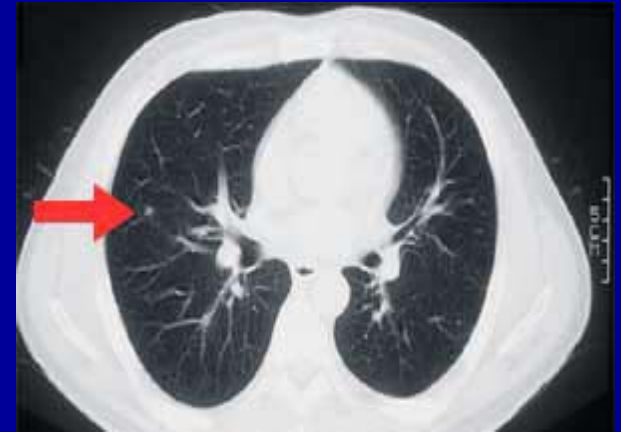
- Age 55-74
- 30+ pack-years smoking history
- Current smokers
- Former smokers (quit <15 yrs)

- 26,000 Low-dose lung CT
- 26,000 Chest X-ray
- 3 annual screening rounds



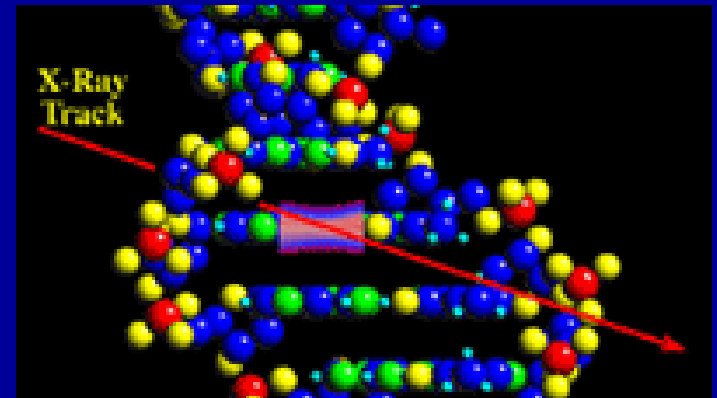
The National Lung Screening Trial - Results

- 5 years follow-up
- Lung cancer deaths
 - Lung CT n=354
 - Chest X-ray n=442
- 20% lung cancer mortality reduction



Radiation risks from Lung CT screening

- Radiation risks vs benefits?
- Before age 50 ?
- Never smokers?



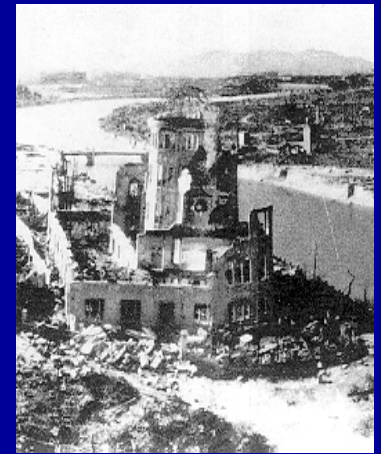
Estimation of radiation risks

- Not feasible to **quantify** the radiation risk for low doses directly in an observational study
 - Sample size
 - Follow-up time
- Extrapolate: linear no-threshold assumption
- Model for radiation-induced lung cancer risk
 - Japanese atomic bomb survivors

Life Span Study: key findings

- Most cancers can be caused by radiation
 - Risk varies according to cancer site
 - Risk greater at younger age at exposure
 - Risk greater for females
 - Solid cancer risk linear in dose

- Risk remains elevated 50+ years after exposure



NCI Radiation Risk Assessment Tool

RadRAT

Enter Input Information Manually:

Run Identifier [optional]

Run 1

Gender

Male

Birth Year

1950

Number of Dose Entries

1

Help

Dose Input Information

Enter Doses

Modify Advanced Settings

Adv Settings

Enter Input Information using a File:

Upload Page

Calculate Results:

Estimate Risk

About Calculator

View Model Details

Restart

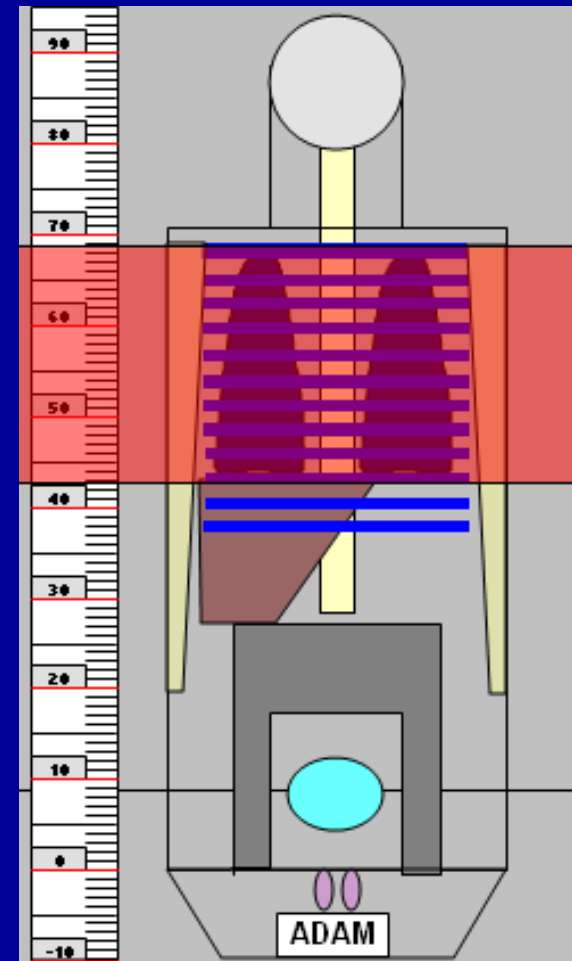
RadRAT for lung cancer in smokers



- **BEIR VII risk model for lung cancer (BEIR VII, 2006)**
 - Risk depends on age at exposure, sex and attained age
 - Weighted average of EAR (0.7) and ERR (0.3) model
- **Cumulative lifetime risk – adjusted for competing risks**
 - Smoking-specific all cause mortality rates (Doll et al, 2004)
- **‘Background’ lung cancer rates for US population**
 - Smokers – Bach model (2003)
 - Never-smokers – CPS II (Thun et al, 2006)

Radiation dose estimates per CT screen

- NLST protocol
- Effective dose ≈ 1 mSv
 - Lung dose ≈ 4 mGy
 - Breast dose ≈ 4 mGy
 - Thyroid dose ≈ 4 mGy
 - Red bone marrow ≈ 1 mGy
 - Liver dose ≈ 1 mGy
 - Stomach dose ≈ 1 mGy

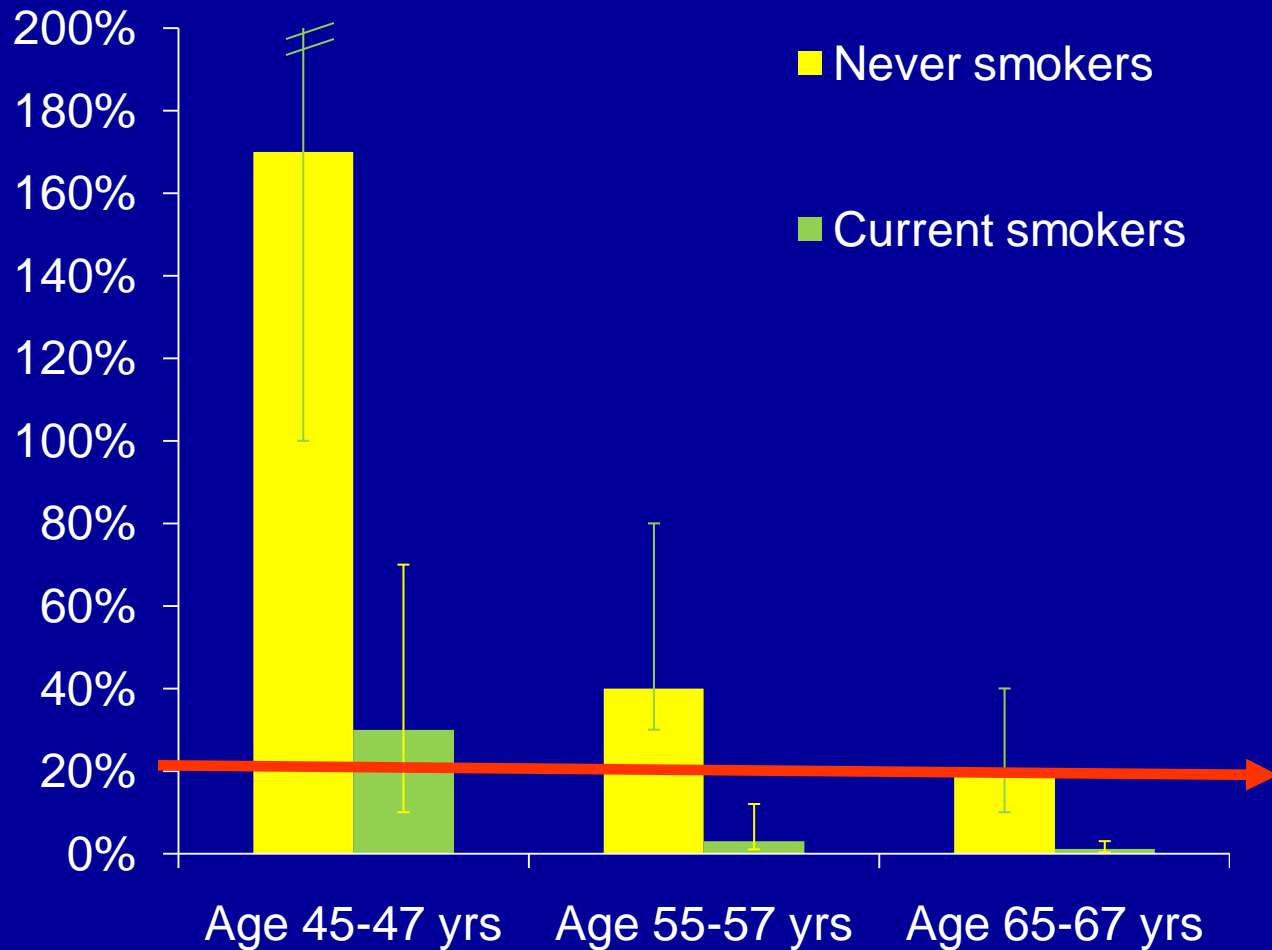


Lifetime risk of radiation-related lung cancer mortality

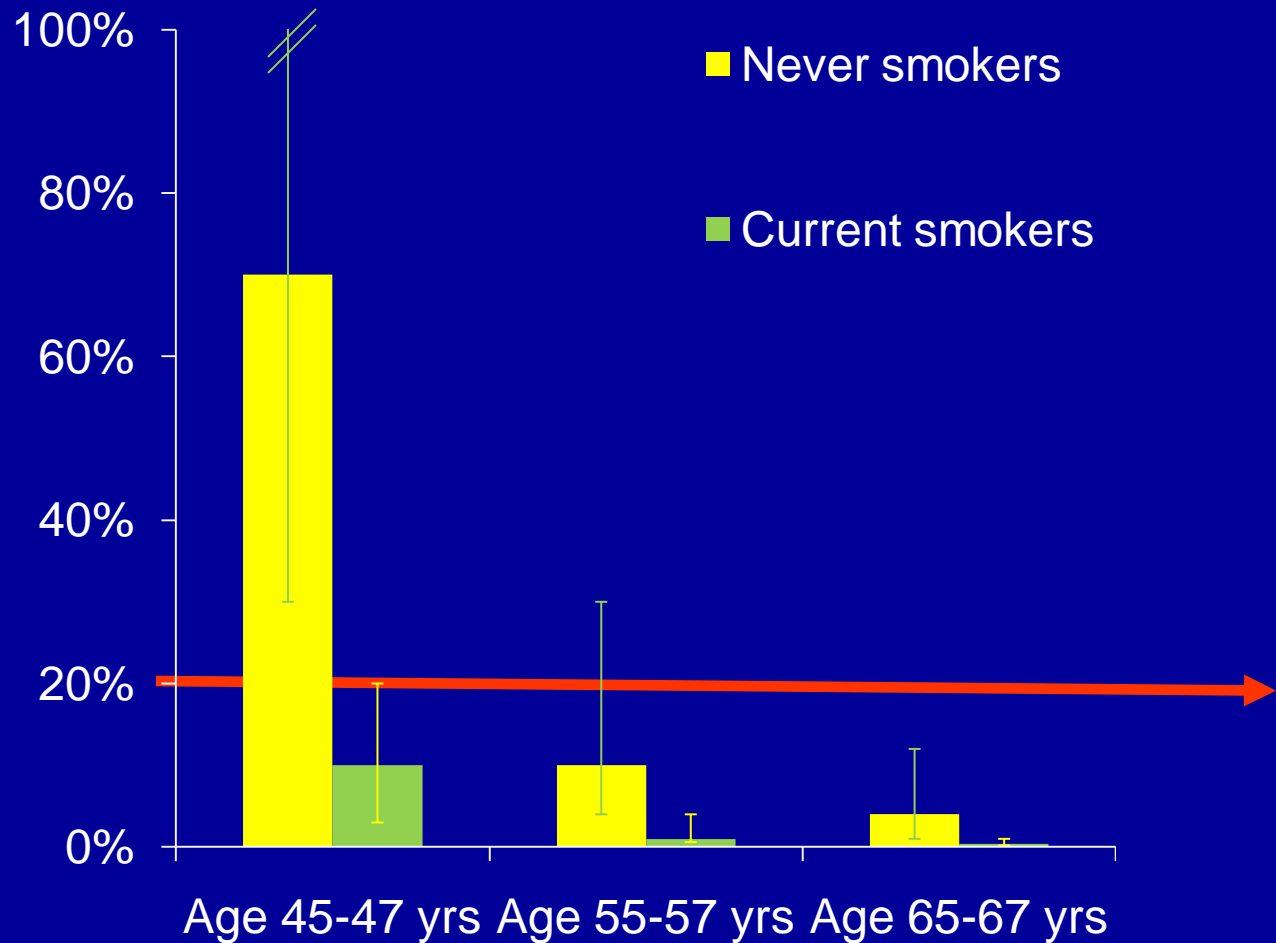
- 3 annual screens starting age 55

Sex	Smoking status	Lifetime risk (per 10,000)	(90% UI)
Females	Never	3	(2-6)
	Current (40/day)	5	(2-12)
Males	Never	1	(0.4-3)
	Current (40/day)	2	(1-4)

Percentage reduction in lung cancer mortality required to outweigh radiation risk - FEMALES



Percentage reduction in lung cancer mortality required to outweigh radiation risk - MALES



Summary

- 20% mortality reduction from annual lung CT
- Benefits outweigh radiation risks
 - Heavy smokers age 55+
- Never smokers (and other lower-risk groups)
 - Possibly for males age 65+

Additional questions - screening

- NLST % positive screens
 - Lung CT 24%
 - Chest X-ray 7%
- Additional cancer risks from follow-up scans?
- Risks from lung biopsies – pneumothorax (collapsed lung)?
- Anxiety, cost of false-positive findings

Additional questions - radiation

- Joint effect of radiation and smoking – lung cancer
 - Generalized multiplicative model
 - Furukawa et al Radiat Res 2010
- Male-female differences?
- Possible inverse age effect?
- Modify lung cancer risk projection model

Acknowledgements

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