

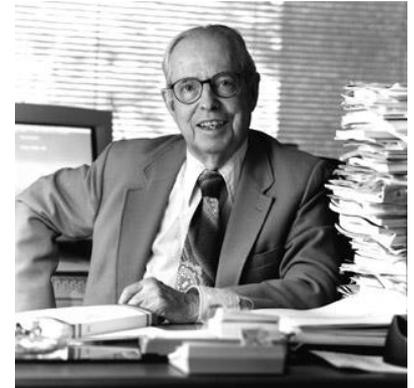
Cardiovascular Health Effects

Gilbert W Beebe Symposium on 30 Years after the Chernobyl Accident

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Cardiovascular disease

- **Heart and blood vessels disease** ... includes numerous problems, many of which are related to **atherosclerosis** ... that can cause a **heart attack or stroke**. - *American Heart Association*
- Cardiovascular disease generally refers to a condition that involves narrowed or blocked blood vessels that can lead to a heart attack, angina or stroke. Other forms of heart disease ... involve **heart's muscles, valves or rhythm**. - *Mayo Clinic*

Radiation effects on cardiovascular disease

- Radiation-induced heart disease from high therapeutic doses has long been known
 - Patients irradiated for Hodgkin's lymphoma, breast cancer, etc.
 - Involves a wider spectrum of cardiac pathologies, including coronary artery disease (or ischemic heart disease)
- Radiation exposure at low dose, e.g., < 5 Gy
 - Late 1990s - Evidence of dose response for cardiovascular disease mortality in atomic-bomb survivors (Life Span Study - LSS)
 - Growing body of epidemiological data from populations with low and low-dose rate exposures – occupational, environmental and medical

Why cardiovascular disease risk is important

- Excess relative risk related to radiation exposure is small (about 10% per Gy) compared to cancer (about 40% per Gy)
- But excess absolute risk is large because of high baseline cardiovascular disease rates in many populations
 - Cardiovascular disease = 30-50 % of all deaths
 - Cancer causes = 15-30 % of all deaths
- Absolute risk is important for radiation protection standards

UNSCEAR 2008 Chernobyl Report

Cardiovascular data review

- Ecological data: mortality/incidence by residence, occupation, etc.
 - Ukraine
 - Belarus
- Cohort data
 - Russian recovery workers (60,000)
 - Estonian emergency workers (4,700)

Russian recovery worker study

- Follow-up from 1986 thru 2000
- Significant dose response for
 - Ischemic heart disease, essential hypertension and cerebrovascular disease
 - Excess relative risk ~ 30-40% per Gy
 - But not adjusted for smoking and other possible confounders

(Ivanov et al, 2006)

“Further study is needed before concluding whether radiation exposure from the Chernobyl accident has increased the risk”

Epidemiological data on cardiovascular disease risk

- Since 2008 UNSCEAR Report

- Chernobyl studies
- Atomic-bomb studies
- Occupational exposures
- Environmental exposures
- Medical exposures
- Pooled analyses – high-dose therapeutic to low dose

Russian Recovery Worker data update

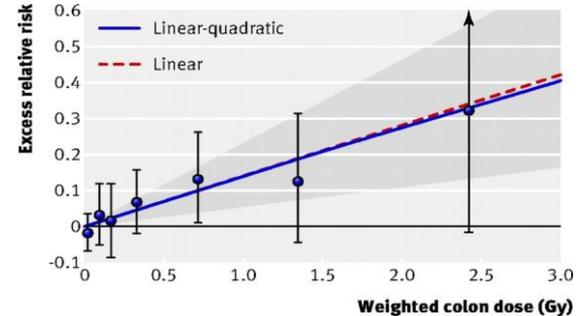
	Previous study Ivanov et al, 2006	Updated study Kashcheev et al, 2016
Follow-up	1986-2000	1986-2012
Cohort size	29,003	53,772
Excess relative risk per Gy		
Cerebro-vascular disease	0.45 (0.11-0.80)	0.45 (0.28-0.62)
Ischemic heart disease	0.41 (0.05-0.78)	Not reported

- Dose estimates
 - Dosimeter records (“official doses”)
 - Estimates based on dose rates and worker locations
- Risk adjusted for concomitant diseases
 - Diabetes, atherosclerosis, hypertension, ischemic heart disease
- But not for other risk factors
 - Smoking, alcohol consumption, excessive weight, socioeconomic status

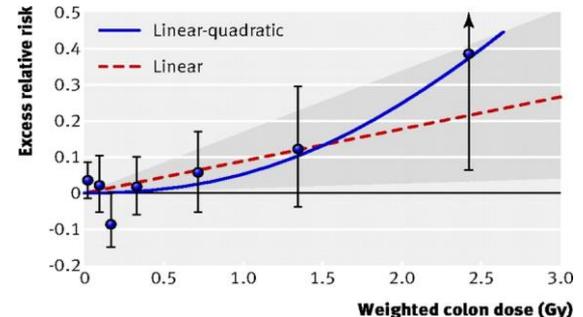
Cardiovascular disease in atomic-bomb survivors

- Significant dose response
 - Excess relative risk
 - 14% per Gy - heart disease
 - 9% per Gy - stroke
- Dose response not accounted for smoking, alcohol intake, education, occupation, obesity and diabetes
- Uncertainty in risk at low dose
 - Non-significant dose response in the 0-0.5 Gy dose range
 - Suggestion of upward curvature for stroke

Heart disease



Stroke



(Shimizu et al, 2010)

Cohort		Excess relative risk per Gy		
		Heart disease	Stroke	
LSS atomic-bomb survivors	Shimizu et al, 2010	0.14	0.09	Adjusted for confounders*
Russian Mayak nuclear workers	Azizova et al, 2014 & 2015	0.14	0.46	Incidence Adjusted for confounders**
UK National Registry for Radiation Workers	Muirhead et al, 2009	0.251 (NS)		
Russian Techa River cohort	Krestinina et al, 2013	0.18 (NS)		
Peptic ulcer patients	Little et al, 2012	0.102		Localized high-dose exposure
Pooled analysis	Little, 2016	0.092	0.238	Medical, occupational and environmental exposures

* Smoking, alcohol intake, education, occupation, obesity and diabetes

** Smoking, alcohol consumption and residence status

Current status of knowledge

- Growing body of epidemiological data suggesting the persistence of a cardiovascular disease effect after radiation exposure in various settings
- Unresolved questions
 - Shape of the dose response, especially at low dose
 - Target organs and endpoints
 - Modifying effects of age and other factors
 - Underlying biological mechanisms
- Chernobyl populations can offer unique opportunity – large populations, fractionated exposure, infrastructure for epidemiological studies

Chernobyl studies: Where improvements are needed

- Understand the nature and uncertainty of doses for different exposure groups – recovery workers
 - Large heterogeneity in quality of dose data among different groups of recovery workers - military workers, professional nuclear workers, Chernobyl nuclear plant employees/workers, etc.
 - “Official dose records” available from Chernobyl State Registries are likely biased
- Understand the association between dose and non-radiation risk factors
- Coordinated efforts are needed to address the issues and questions
 - E.g., sampled surveys, quality control



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