Professional Engineers Ontario
York Chapter
Yummy Grill, Vaughan, February 28, 2017

Low dose rates of radiation increase lifespans in dogs

Jerry M. Cuttler, DSc, PEng, Cuttler & Associates, Vaughan, ON, Canada
Ludwig E. Feinendegen, MD, Heinrich-Heine University, Düsseldorf, Germany
Yehoshua Socol, Falcon Analytics, Karney Shomron, Israel

Original Article

Dose-Response:
An International Journal
2017:1-6

DOI: 10.1177/1559325817692903
journals.sagepub.com/home/dos
SAGE

Evidence That Lifelong Low Dose Rates of Ionizing Radiation Increase Lifespan in Long- and Short-Lived Dogs

Jerry M. Cuttler[1], Ludwig E. Feinendegen[2], and Yehoshua Socol[3]

Abstract

After the 1956 radiation scare to stop weapons testing, studies focused on cancer induction by low-level radiation. Concern has shifted to protecting "radiation-sensitive individuals." Since longevity is a measure of health impact, this analysis reexamined data to compare the effect of dose rate on the lifespans of short-lived (5% and 10% mortality) dogs and on the lifespans of dogs at 50% mortality. The data came from 2 large-scale studies. One exposed 10 groups to different γ dose rates; the other exposed 8 groups to different lung burdens of plutonium. Reexamination indicated that normalized lifespans increased more for short-lived dogs than for average dogs, when radiation was moderately above background. This was apparent by interpolating between the lifespans of nonirradiated dogs and exposed dogs. The optimum lifespan increase appeared at 50 mGy/y. The threshold for harm (decreased lifespan) was 700 mGy/y for 50% mortality dogs and 1100 mGy/y for short-lived dogs. For inhaled α-emitting particulates, longevity was remarkably increased for short-lived dogs below the threshold for harm. Short-lived dogs seem more radiosensitive than average dogs and they benefit more from low radiation. If dogs model humans, this evidence would support a change to radiation protection policy. Maintaining exposures "as low as reasonably achievable" appears questionable.

Keywords

ionizing radiation, beagle dogs, individual sensitivity, longevity benefit, harmful thresholds, adaptive protection

Introduction

- X-rays were discovered in 1895, and radioactivity in 1896
- Since then (> 120 years), many studies have been carried out on ionizing radiations and their effects on organisms
- Overall effects are well known at high doses
- Detailed cell response mechanisms at high and low doses are complicated; involve all levels of biological organization
- 75% of human body is water; **radiation creates reactive oxygen species (ROS)**, which are beneficial or harmful
- Depending on its concentration, ROS *signals* or *damages*

Low level radiation up-regulates protection

- Abundant ROS produced constantly by oxygen metabolism
- Most studies were on harmful effects because of the scare introduced in 1956 to stop nuclear weapons testing
- National regulators accepted US NAS recommendation to assess *risk* radiation-induced mutations and cancer using *linear no-threshold* model, which was not validated
- Studies have shown that *low* doses of radiation *up-regulate* many biological *protective* mechanisms, which also operate against non-radiogenic toxins and produce *beneficial* health effects, including a lower risk of cancer

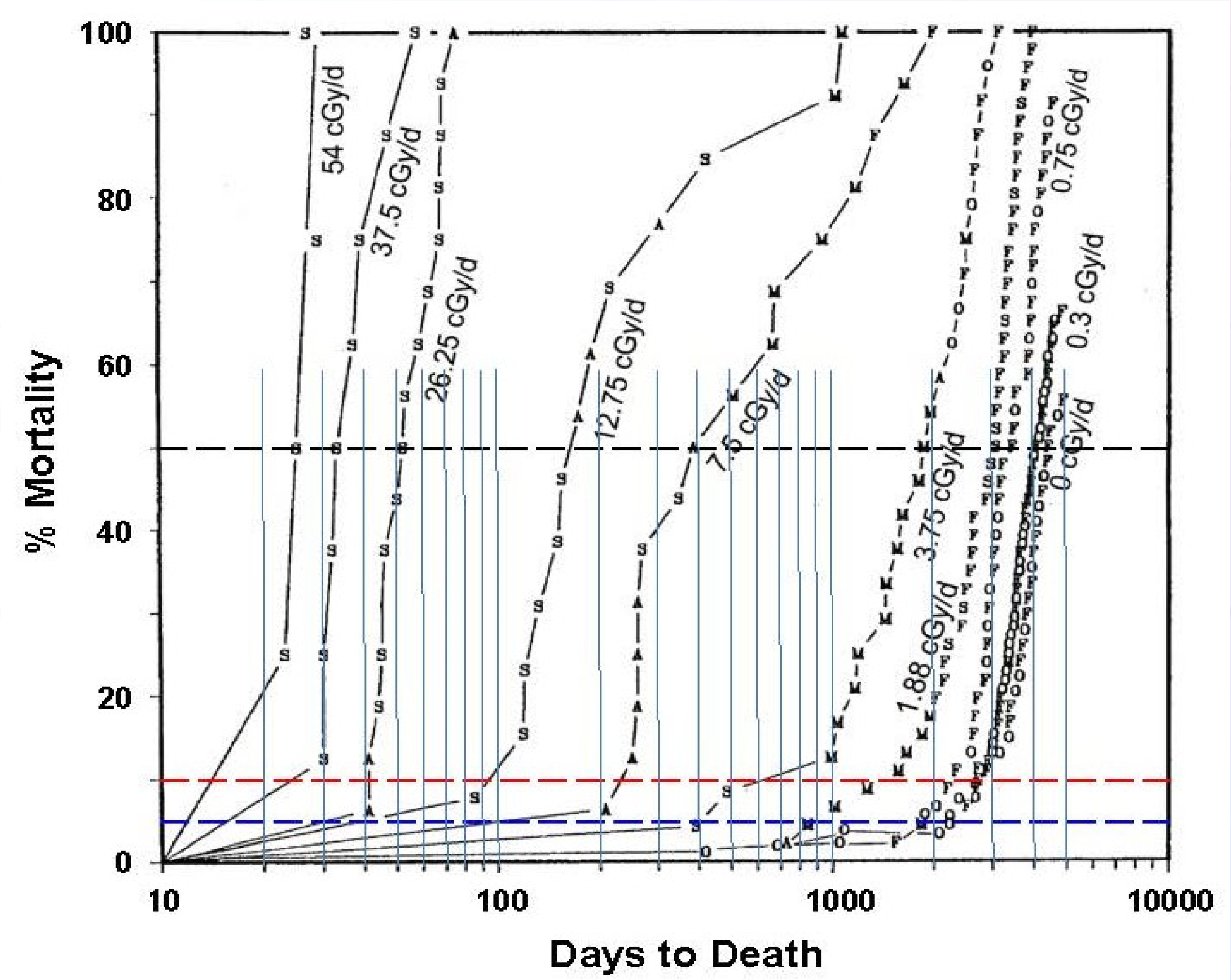
Do radiation-sensitive people need protection?

- After considering all adverse effects of 2011 precautionary Fukushima evacuations (1600 deaths), clearly society is paying a very high price for public fear of low-dose radiation
- Rad protection knows policy contradicts biological evidence, but a broad consensus rejects low-dose beneficial effects
- Since epidemiology is being questioned; ICRP wants to protect “radiation-sensitive individuals” from “health effects”
- This paper analyzes effect of radiation on dog longevity and shows that short-lived dogs: 1) are more radiation-sensitive than average dogs, and 2) *benefit* more than average dogs from low-level radiation

Mortality data of two dog studies analyzed

- Beagle dogs preferred – assumed to model humans well
- 1st study exposed dogs to whole-body cobalt-60 gamma radiation for their entire lives
- 10 groups, each group received a different dose-rate
- 2nd study evaluated dogs whose lungs were exposed to alpha-particle radiation from inhaled plutonium particles
- 7 groups, each group had different initial Pu lung burden
- Extracted lifespans of dogs at 5%, 10% and 50% mortality in the “control group” and compared to lifespans of dogs at 5%, 10% and 50% mortality in the each exposed group

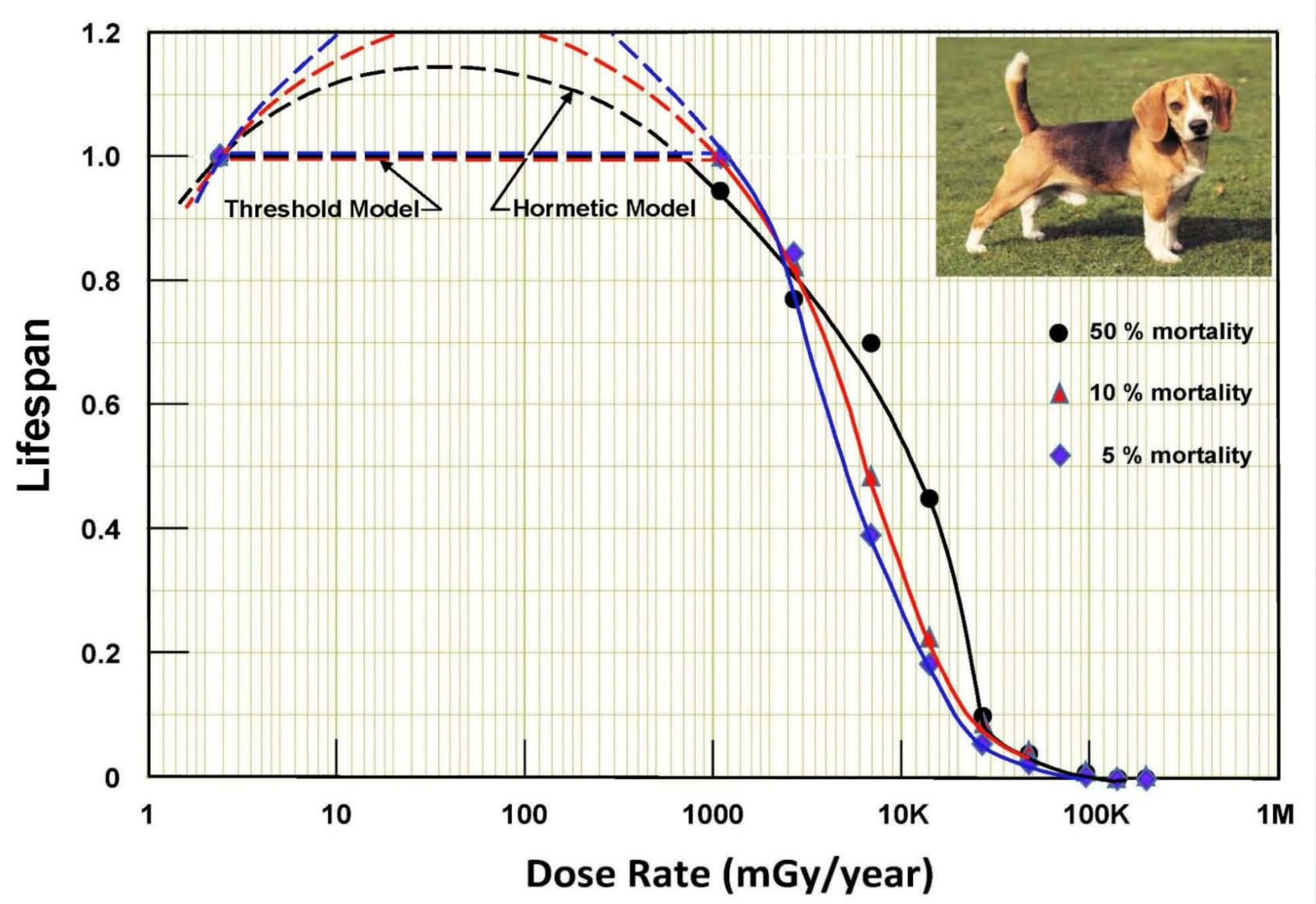
Mortality curves for different Co-60 dose rates



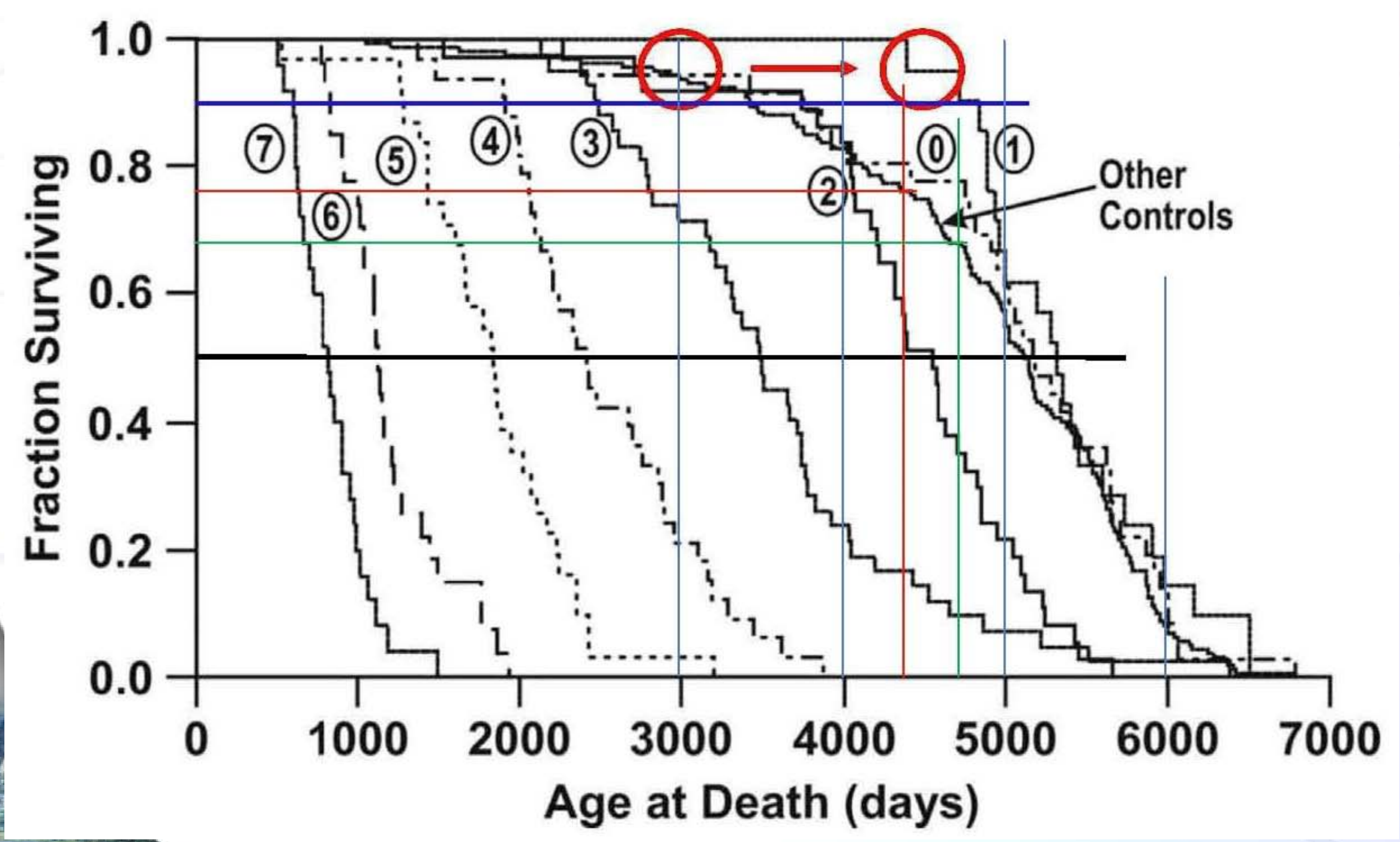
Lifespan vs. cobalt-60 dose rate

Dose Rate (cGy/day)	Dose Rate (mGy/year)	Lifespan (days)			Lifespan (normalized)		
		50% mortality	10% mortality	5% mortality	50% mortality	10% mortality	5% mortality
background	2.4×10^{0}	4300	2700	2150	1.00	1.00	1.00
0.3	1.1×10^{3}	4050	2700	2150	0.94	1.00	1.00
0.75	2.7×10^{3}	3300	2200	1800	0.77	0.82	0.84
1.88	6.9×10^{3}	3000	1300	850	0.70	0.48	0.386
3.75	1.4×10^{4}	1900	600	400	0.44	0.222	0.182
7.5	2.7×10^{4}	400	220	95	0.093	0.081	0.043
12.75	4.7×10^{4}	150	91	40	0.035	0.034	0.0182
26.25	9.6×10^{4}	51	40	30	0.012	0.0148	0.0136
37.5	1.4×10^{5}	32	23	15	0.0074	0.0085	0.0068
54	2.0×10^{5}	24	13	11	0.0056	0.0048	0.0050

Lifespan vs. cobalt-60 dose rate



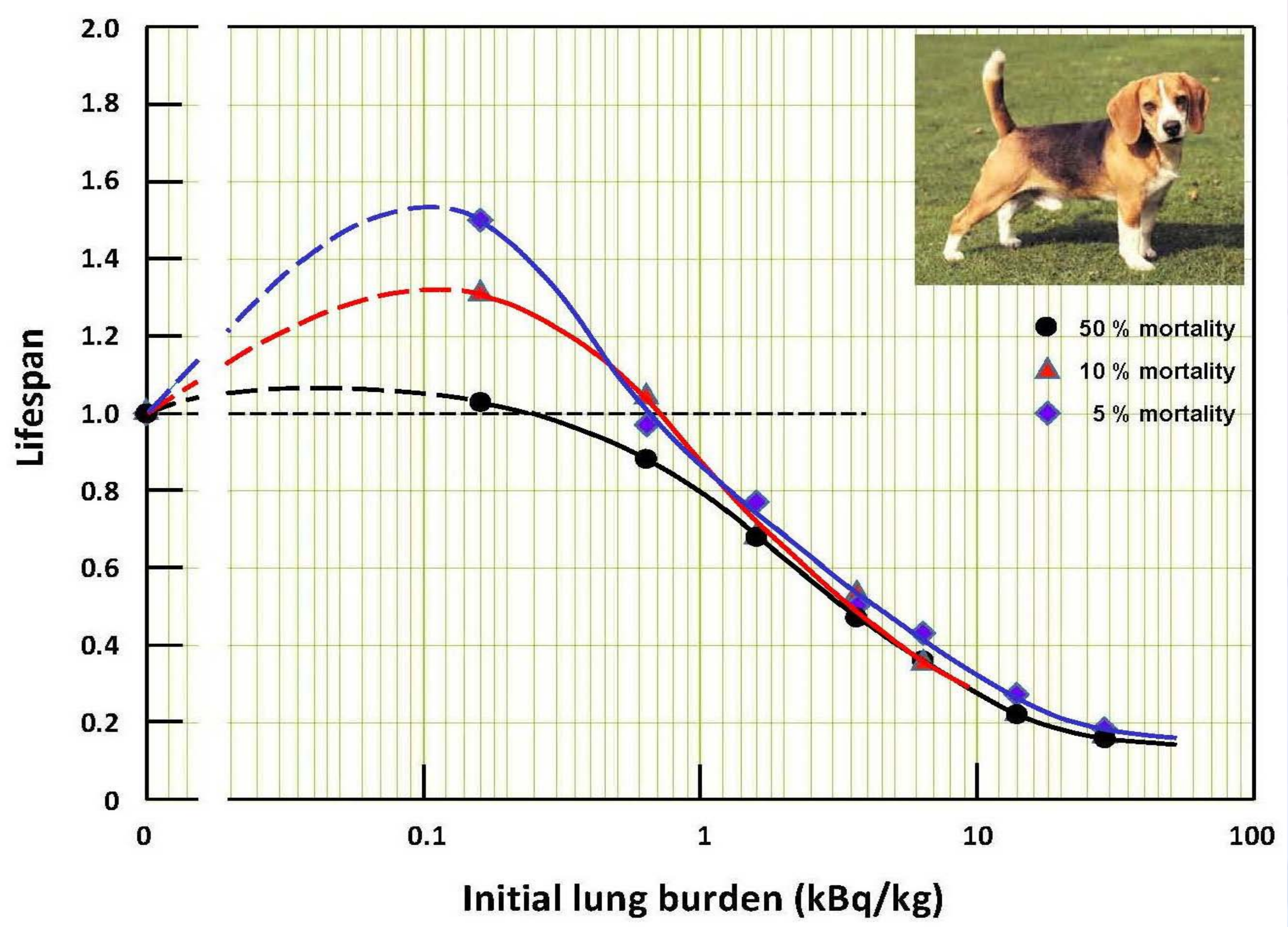
Fraction surviving different Pu lung burdens



Lifespan vs. initial plutonium lung burden

Group	Initial Lung Burden (kBq/kg)	Lifespan (days)			Lifespan (normalized)		
		50% mortality	10% mortality	5% mortality	50% mortality	10% mortality	5% mortality
Control	0	5150	3610	3000	1.00	1.00	1.00
1	0.16	5316	4760	4500	1.03	1.32	1.50
2	0.63	4526	3780	2910	0.88	1.05	0.97
3	1.6	3482	2500	2310	0.68	0.69	0.77
4	3.7	2421	1940	1500	0.47	0.54	0.50
5	6.4	1842	1280	1280	0.36	0.35	0.43
6	14	1122	840	810	0.22	0.23	0.27
7	29	807	625	530	0.16	0.17	0.18

Lifespans vs. initial plutonium lung burden



Discussion

- Expected short-lived dogs to be more sensitive, *adversely*
- But have dose-rate *thresholds* for harm that are *higher* than for 50% mortality dogs, 1100 vs. 700 mGy/y for Co^{60} and 0.65 vs. 0.25 kBq/kg for inhaled plutonium particles
- For gamma irradiations, interpolations suggest the lifespan *increases* by 15 to 30% when dose rate is below threshold for harm; optimum dose rate for longevity is ~ 50 mGy/y
- For inhaled plutonium, data suggest lifespan *increases* by 30% for dogs at 10% mortality and 50% at 5% mortality; optimum lung burden for longevity is about 0.1 kBq/kg

Conclusions

- There are dose-rate thresholds for onset of life reduction
- Short-lived dogs, 5 and 10% mortality, are more sensitive to radiation than the median (50% mortality) dogs
- Short-lived exposed dogs benefit, not suffer, from low-level radiation; they live longer than the short-lived control dogs
- Short-lived dogs benefit more from low-level radiation than do the median dogs; their % lifespans are increased more
- They benefit more from radiation-induced up-regulation (or stimulation) of their protection systems than median dogs do

Recommendations

- If dogs model humans, then we should expect radiation-sensitive individuals to benefit more from exposures to low-level radiation than average humans do. So it would *not* be appropriate to protect them from low-dose gamma or alpha radiation. Protection would deprive them of the health benefit of a longer life.
- Radiation protection should focus on avoiding exposures above the thresholds for harmful effects. Beneficial effects are likely below these thresholds, so harmless exposures should not be regulated.
  - Study signaling mechanism of alpha radiation in lungs