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## CHAPTER 69

### Conclusion: Making Sense of Three Sets of Irrefutable Correlations

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#### Part 1. Newly Uncovered: Three Remarkable Sets of Facts

#### Part 2. Basis for Correctly Identifying the Explanation

#### Part 3. Are High Fractional Causations Hard to Believe?

At the conclusion of a work like this, it can be helpful to review what is based on irrefutable observation and what is based on logic.

#### ● Part 1. Newly Uncovered: Three Remarkable Sets of Facts

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This final chapter focuses on the findings that death-rates at mid-century from Cancer and Ischemic Heart Disease each have a very strong positive correlation with physician-density (PhysPop), by Census Divisions, while death-rates from NonCancer NonIHD Causes have a significant inverse correlation.

These three sets of relationships are irrefutable facts, not interpretations. And they are remarkable. What EXPLAINS the extreme similarity in the relationship of Cancer and of Ischemic Heart Disease (IHD) with PhysPop, and the unambiguously different relationship of NonCancer NonIHD Causes of Death with PhysPop?

By investigating the major subsets of All-Cancers, we have confirmed that the positive correlation is not just the net result of some positive and some negative correlations. And by investigating the major subsets of All NonCancer NonIHD Causes, we have established that the negative correlation is overwhelmingly supported by the subsets. The mid-century results are easily compared with each other in Chapter 38's Box 1 (also reproduced in Chapter 1). The columns of that single page present a mountain of irrefutable facts, without any interpretation.

It is startling, indeed, to realize that the 1940 National All-Cancer Death-Rates are quite well predicted from PhysPop values 10 years earlier --- even 20 years earlier (Chapter 22, Box 4). And the 1950 National Death-Rates from Ischemic Heart Disease are also quite well predicted from the PhysPop values 20 years earlier.

#### ● Part 2. Basis for Correctly Identifying the Explanation

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While the correlations we uncovered are irrefutable observations, correlations alone can never PROVE causation. However, strong correlations are properly regarded as one of the "gold standards" when it comes to establishing causation, because they provide such strong circumstantial evidence.

And when strong correlations are supported by supplemental information and logic, the combination can establish causality beyond reasonable doubt. We are on extremely solid ground when we assert that the correlations we have uncovered are causal in nature. First, we consider the strong positive correlation uncovered between PhysPop and MortRates from Cancer, by Census Divisions.

#### The Cancer-Response to PhysPop

Chapter 3 shows, with evidence and logic, that PhysPop can be regarded as approximately proportional to the average per capita accumulated dose from medical radiation. This relationship constitutes information supplemental to the PhysPop-MortRate correlations. Additionally, Chapter 2 points to a large body of evidence that ionizing radiation (including the xray) is a well-established cause of Cancer. Such evidence is also a supplement to the PhysPop-MortRate correlations. Under these circumstances, it is highly reasonable to conclude that the strong positive correlations, between PhysPop and cancer MortRates, are causal --- a dose-response between medical radiation and cancer MortRates, by Census Divisions.

Even if there were NO pre-existing evidence that medical radiation is a cause of Cancer, the

strong positive correlation would be presumed to be causal --- in the absence (Chapter 68) of a better explanation.

### The IHD Response to PhysPop

Next, we consider the strong positive correlation uncovered between PhysPop and MortRates from Ischemic Heart Disease, by Census Divisions. This finding was an enormous surprise to us. But the correlation is an irrefutable fact, and it "demands" explanation. Within the same database, medical radiation is the cause of the cancer-response, so it would be irrational to assume (with no basis) a DIFFERENT cause of the IHD-response. Supplemental support is provided by pre-existing evidence on the role of acquired mutations in atherogenesis (Chapter 44, Parts 8+9) and on the structure of atherosclerotic plaques and the activity within them (Chapter 44, Part 7). Such evidence combines with logic (Chapter 45) to indicate that xray-induced mutations are the reasonable explanation for the observed positive dose-response between PhysPop and MortRates from Ischemic Heart Disease, by Census Divisions.

In research, Ockham's Razor is an important admonition: To explain a phenomenon, invoke only as many explanations as required. Avoid fabricating many explanations if one suffices. Of course, the explanation MUST be consistent with other well-established observations. Radiation-induction of Ischemic Heart Disease, via induction of mutations in the coronary arteries, is fully consistent with other well-established observations, and indeed, helps to explain some of them (Chapters 45, 46, and Appendix-N).

### The NonCancer NonIHD Response to PhysPop

Lastly, we consider the ABSENCE of a strong positive dose-response between PhysPop and NonCancer NonIHD Causes of Death, by Census Divisions. This finding is another irrefutable fact --- a fact which is consistent with the "general wisdom" that ionizing radiation is not a cause of such deaths (Chapter 23). Indeed, the significant negative correlation, produced by the evidence, is also in harmony with common sense: Physician-activity, including the use of medical radiation, helps to PREVENT such deaths.

The unambiguous difference, between the cancer-response to Phys-Pop and the NonCancer NonIHD response to PhysPop, constitutes very strong confirmation that PhysPop is reliable as a surrogate for medical radiation. And the observed behavior of PhysPop values, over the 1921-1990 period, supports their use as surrogates for average ACCUMULATED doses from medical radiation, by Census Divisions (Chapters 3 and 47).

### In short: Medical Radiation Explains the Irrefutable Facts

Thus, the foundation is solid for saying that MEDICAL RADIATION explains the irrefutable facts set forth in Part 1:

- 1) The very strong positive correlation which exists between PhysPop and Cancer MortRates, by Census Divisions.
- 2) The very strong positive correlation which exists between PhysPop and IHD MortRates, by Census Divisions.
- 3) The dramatically different relationship which exists between PhysPop and NonCancer NonIHD MortRates, by Census Divisions.

### ● Part 3. Are High Fractional Causations Hard to Believe?

The importance of medical radiation, in the etiology of both Cancer and Ischemic Heart Disease, has been evaluated in terms of Fractional Causation of their National Mortality Rates, decade by decade, from 1940-50 to 1988-93. For the reasons discussed above and additional reasons discussed in the text (especially Chapters 1, 2, 6, 48, 49, 67, 68) we have a high level of confidence that the observed correlations and the applied logic are sound.

The resulting estimates of Fractional Causation, by medical radiation, are summarized in Chapters 1 and 66. The high values are neither hard to believe nor inconsistent with well-established facts, if one remembers that:

- Xrays are a uniquely potent mutagen, able to induce virtually every kind of mutation in the cells of every organ. Moreover, the xray doubling-dose for structural chromosomal mutations is very low. Xrays are also an established cause of genomic instability.

- Although past and current exposure to medical radiation is extremely common in the USA, the magnitudes of accumulated doses are simply not known --- due to a persistent lack of routine measurements. One result is great uncertainty about the true risk per dose-unit. Nonetheless, our method is able to produce credible estimates of the consequences of such exposure, because PhysPop values are credible measures of the RELATIVE magnitude of accumulated doses in the Nine Census Divisions.

- A very high Fractional Causation --- such as 80% of a MortRate by medical radiation --- does not mean that medical radiation is the only cause of 80% of the MortRate. It means that medical radiation is a NECESSARY co-actor (with other causes) in 80% of the MortRate, and that approximately 80% of the MortRate would be absent, in the absence of medical radiation.

But nothing in this book argues against the use of medical radiation, which can have undeniable benefits. The findings in this book do argue, strongly, that we will safely prevent much of the future mortality from Cancer and Ischemic Heart Disease, if we eliminate uselessly high doses of medical radiation. Techniques (already proven) exist for obtaining every benefit of medical radiation at much lower doses, without eliminating a single radiation procedure (Chapter 1, Parts 3, 9, and 10).

The findings in this book also argue, strongly, that epidemiologists may obtain seriously flawed results in studies of non-xray causes of Cancer and Ischemic Heart Disease, if their studies have cohorts which are poorly matched for accumulated exposure to medical radiation.

The irrefutable observations presented by this work are at variance with some comfortable assumptions. The benefits for human health, of discarding comfortable, but erroneous assumptions, will be very large. Whether the field is biomedicine or astro-physics or engineering, some words from a successful pioneer may have merit. Orville Wright, one of the two brothers who had to discard some prevailing wisdom in order to develop the first operable airplane, wrote: "If we all worked on the assumption, that what is accepted as true really is true, there would be little hope of advance."

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