On "Phantom Risks" Associated with Diagnostic Ionizing Radiation: Evidence in Support of Revising Radiography Standards and Regulations in Chiropractic

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Radiography has been part of chiropractic diagnostics since shortly after its discovery in 1895, the same year D.D. Palmer discovered chiropractic. In fact, it was B.J. Palmer who brought x-ray to chiropractic in 1910.[1] This is what led to a very interesting and rich chiropractic history of technique innovators with their varied radiographic biomechanical analysis systems. Many different x-ray analysis systems are used today in clinical practice and research as well as taught in the chiropractic colleges around the world. In fact, use of radiography for structural data is an integral component to the practice of chiropractic.[2,3]

With the recent concerns about the profession's future (i.e. to remain a separate entity or be incorporated into mainstream medicine),[4] there has been pressure to restrict the use of radiography in clinical practice.[5–10] In fact, recent proposed guidelines suggest that except for ruling out "red flags" (i.e. serious medical conditions such as cancer, infection etc…) no radiographic imaging should be taken for treatment management of patients presenting with uncomplicated low back pain.[11–15] To no surprise, the current practice trend is much higher than this.[15–18]

This commentary is written to present to the profession, and specifically to the advocates of continued restrictive use of radiography in clinical practice and research (i.e. DACBRs), that at low doses of ionizing radiation there is a significant lack of scientific evidence for health risks presumably associated with routine use of radiography. Risks in the diagnostic range cannot be measured very reliably. Just as important, we review some of the data from investigators that supports the notion that there is not only essentially *no risk*, but perhaps *health benefits* to such practices.

Discussion

Radiation hormesis is the stimulatory or beneficial effect of low doses of ionizing radiation. While an actual benefit from radiation exposure may seem outrageous, there is much supportive evidence for this phenomenon. This topic is in direct conflict with the "Linear No-Threshold Hypothesis" (LNT), which has been assumed to be true for more than 50 years. This LNT model comes from estimating the risks at lower doses of radiation, in the *absence of data*, by extrapolating in a linear model from large doses of radiation from atomic bombs dropped on Japan in the 1940s. The Linear No-Threshold (LNT) model is used for any known carcinogen for any exposure level assuming any exposure, regardless of how small, can induce cancer.[19]

This LNT model has been used to set limits of radiation exposure by all official and governmental associations.[20] The use of the LNT model includes the recent 2005 report by the USA National Research Council.[21] This report stated, "there will be some risk, even at low doses (100 mSv or less), although the risk is small" and "there is no direct evidence of increased risk of non-cancer diseases at low doses."[21] This 2005 report ignored and contradicted an earlier 2003 review by Kant et al., who stated, "Through various studies, it is established that whole body exposure to low-level ionizing radiation (LLIR) decreases overall cancer incidence (the most important long-term somatic effect of radiation exposure)." After performing a comprehensive analysis of available

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historical and scientific data relating to LLIR, Kant et al. state "(the) substantially acceptable conclusion (is) that whole body exposure to LLIR reduces cancer mortality rates when compared with control populations in both experimental animals and humans."[22]

Due to the increasing evidence supporting either no harmful effects or beneficial effects of low-dose radiation exposures, the LNT model has been "increasingly challenged."[23] Feinendengen states "The LNT hypothesis should be abandoned and be replaced by a hypothesis that is scientifically justified and causes less unreasonable fear and unnecessary expenditure."[24] Cohen concludes "the linear no-threshold theory fails badly in the low-dose region because it grossly overestimates the risk from low-level radiation…cancer risk from diagnostic radiography is much lower than is given by usual estimates, and may well be zero."[25]

We now provide a selected overview of some of the current evidence on the effects of low-level radiation exposure to human health.

100-year study of British radiologists

The 100-year study of British radiologists is the most important study of the effects on health from moderate dose rate radiation ever published.[26] This study[27] compared the death rates resulting from cancer, non-cancer, and overall causes of British radiologists to a control group of all male medical doctors (non-radiologists), as well as all social class I males, and all the men of England and Wales. Cohorts of radiologists were analyzed by the date they joined a radiological society; these are: 1897–1920, 1921–1935, 1936–1954, and 1955–1979.

The study[27] determined that British radiologists never demonstrated a statistically significant increase in cancer mortality compared to controls when joining a radiology society after 1920. In fact, radiologists joining a society after 1920 had lower cancer mortality than the average for the whole population of England and Wales. Further, for the group of radiologists joining a society after 1954, as compared to their most relevant peer group (male medical practitioners), the radiologists had 29% *lower* standardized mortality rate (SMR) from cancer, 32% *lower* SMR from all causes, and 36% *lower* SMR from non-cancer causes. On the basis of this extensive data, "this contradicts the present dogma of a linear increase of cancer with dose."[28]

Background radiation and cancer mortality across the US

Natural background radiation is ubiquitous and ranges from about 1mSv–20mSv. In 1973, the US Atomic Energy Commission[29] determined that there exists a 15% lower cancer mortality rate for the six States with the *greatest* radiation background as compared to the average of all 48 States! Jagger confirmed these findings in 1998.[30] He determined that the Rocky Mountain States (Colorado, Idaho, New Mexico) had background radiation levels 3.2 times greater (0.72cGy/yr[31] = 33 cervical series/yr; 6 lumbar series/yr), but the Gulf States (Alabama, Louisiana, Mississippi) had an average cancer death rate 1.26 times greater.

Nuclear shipyard workers study (NSWS)

The "Nuclear Shipyard Workers Study" is considered the world's best epidemiological study on radiation workers ever performed[32] as it is the only study on radiation workers that has had an age-matched *and* job-matched control group.[28] It was performed by the School of Public Health at John Hopkins University under contract of the US Department of Energy (DOE). Taking place from 1980–1988, the study cost 10 million and the final report was completed in 1991.[32]

The study compared three groups: 27,872 "exposed" workers (> .5rem), 10,348 "minimally exposed" workers (< .5rem), and 32,510 "unexposed" controls (0rem). The data from the study revealed that the "exposed" workers death rate from cancer was four standard deviations lower than the controls. Further, the death rate of the "exposed" workers from all causes was 24% lower ($p < 10^{-16}$) than the controls (this equates to 16 SDs lower!). It must be realized that "the probability of such a very low death rate from all causes being accidental is less than one in 10 million billion."[28] Although group radiation exposures were not given in dose rates, an estimate can be made from Table 3.1.C1 in the final report. The health benefits as seen in the "exposed" workers were equivalent to about the background radiation levels received by those living in the Rocky Mountain States!

Japanese radon spas

Perhaps surprising to some, millions of people have sought out health spas throughout the centuries having high levels of radiation.[33] Spa treatments typically entail the inadvertent inhalation or even drinking radium-containing water.[34] These spas are common in some parts of Japan. Urban residents in Misasa, Japan, for example, are exposed to much greater levels of radiation than rural residents due to the presence of many radon spas. Kondo[35] and Pollycove[36] present data comparing cancer mortality rates of residents from the urban vs. rural areas in Misasa. The data is clear, the urban population (with spas) have significantly *lower* cancer-induced mortality ratios than those living in the suburbs.

Russian post-thermal explosion study

In 1957, a thermal explosion occurred in a radioactive waste storage facility in the former Soviet Union (Siberia) exposing many thousands of nearby residents to varying amounts of radiation.[37] An exposed population of 7852 villagers from the Eastern Ural mountains were divided up per estimated dose ranges (49.6cGy, 12cGy, 4cGy). The cancer mortality rates were compared to those living in nearby villages that were not exposed. It was determined that all three of the exposed population groups had a *lower* tumor-related mortality than the nearby controls! Specifically, the exposure groups of 49.6cGy, 12cGy, and 4cGy corresponded to 28%, 39%, and 27% *lower* cancer mortality rates.[37] The two highest exposure groups were statistically significant corresponding to equivalent radiological exposures in the range of 546–2255 cervical series or 92–382 lumbar series.

Cohen's radon study

In 1995, Cohen[38] investigated the effects of radon exposure to incidence of lung cancer for 90% of the US population. The results were clear; that is, homes with greater radon levels had less of the residents dying from radon-induced lung cancer. What makes this study robust is the fact that Cohen attempted to eliminate the potential confounding factors including 54 socioeconomic, 7 altitude and weather, numerous geographical variables, as well as smoking. Further, the data has now been rigorously evaluated to eliminate more than 500 potential confounding factors,[39,40] and despite these analyses, the results from extremely high-power statistical analysis remained unchanged, counties with the higher levels of radon have 40% less lung cancer mortalities. These results also suggest that *radiation eliminates cancers initiated by smoking!*[41]

Canadian breast cancer flouroscopy study

Treatment for tuberculosis (TB) prior to the antibiotic era consisted of x-ray doses to the chest. Therefore, there was great concern about the possibility that examination and treatment may induce breast cancer in those with TB. The Canadian fluoroscopy study[42] consisted of 31,710 females treated between the years 1930–1952, where study follow-up was up to 50 years.

The data demonstrated a hormetic pattern.[43] Those females exposed to cumulative doses of 10–19cGy (455–867 cervical series; 77–146 lumbar series) had a relative risk of breast cancer of 0.66. Females with a cumulative exposure of 20–29cGy (909–1318 cervical series; 154–223 lumbar series) had a relative risk of breast cancer of 0.85. Thus, the TB patients exposed to cumulative exposures ranging from 10–29cGy had lower rates of breast cancer; this dose range correlates to about 500 to over 1,000 cervical series or just less than 100 to over 200 lumbar series.

Does diagnostic radiation induce cancer?

The radiation dose received by patients getting diagnostic radiographs needs to be put into perspective. The fact that the death rate from cancer was higher in the radiologist pioneers (1897–1920) than to all other comparison groups surprises no one. However, the non-cancer deaths were less and overall longevity was not different than the other comparison groups. After 1920, radiologists had less cancer deaths than the rest of the population! After 1954, radiologists had superior health to that of other male practitioners! This data combined with the NSWS provides evidence that "humans need a level of radiation *above* natural background in most areas of the world"[44] (emphasis ours).

Considering that exposure rates from diagnostic radiographs are less than that of background, Cameron has stated: "It is a mystery to me why some radiologists and other healthcare workers involved with radiation still believe that diagnostic x-ray doses much lower than annual background radiation carry a risk of inducing cancer."[26] It would be more prudent to set radiography guidelines by geographical region if it were determined that the higher levels found for the Rocky Mountain States (≈20mSv) were associated with health risks. However, they are not. In fact, according to the Health Physics Society 1996, risks of health effects below 0.1Sv (455

Cervical series; 77 Lumbar series), health risks are nonexistent (too small to observe).[45]

The fact remains there is no existing, reliable data proving cancer can be induced by diagnostic x-rays.[46,47] Diagnostic radiography provides about 1–2mSv.[23] The data used to extrapolate to the zero dose assuming the LNT model, is primarily the Japanese data at exposure rates of more than 250mSv.[23]

Radiation phobia[48] and unfounded regulations

Taylor, a co-founder of the ICRP stated in 1980 that: "No one has been identifiably injured by radiation while working within the first numerical standards set first by the NCRP and then the IRCP in 1934. ... The theories about people being injured have still not led to the demonstration of injury and, if considered as facts by some, must only be looked upon as figments of the imagination."[49] Further, Cameron[44] argues that the current dose limit for radiation workers (20mSv/yr) should be questioned because it is so low that the health benefits seen in the British radiologists after 1935 will not be experienced. The 1934 standard (500mSv/yr) would allow the health benefits of low-level radiation to be enjoyed by all.

In 1996, the Health Physics Society released their position statement on low dose radiation: "the Health Physics Society recommends against quantitative estimation of health risks below an individual dose of 0.05Sv (5rem) in one year (above background)…Risk estimation in this dose range should be strictly qualitative accentuating a range of hypothetical health outcomes with an emphasis on the likely possibility of zero adverse health effects." The equivalent of 5rem/yr is that of 39 lumbar series/yr or 227 cervical series/yr. As can be seen and expressed by others even if the LNT is valid (which it is not at low levels), the public's (including chiropractic patients and DACBRs) fear of low-level radiation is "grossly exaggerated."[50] Please note, for comparison purposes, a standard lumbar series equates to 130mrem and a standard cervical series equates to 22mrem.[51]

For radiation exposure to reach the optimal hormetic zone, Luckey suggests limits of safety would have to increase 200 times (from 5mGy/yr to 1Gy/yr).[31] Therefore, according to Luckey, exposure rates of diagnostic radiation could increase significantly; in fact, many-fold from current practice rates and still be within safe limits. With this being said, it is very prudent to suggest that pressures for limiting use of radiography in current clinical practice and research should at least be reconsidered or even ceased. As stated by Renner "at the very least, it might be reasonable to stop worrying about exceedingly low exposures."[52] This is because there is solid evidence that health benefits may be attained by levels of radiation exposures above the current recommended safe doses.[52] In fact, "Patients should not be dissuaded from screening with x-rays, PET scans, or radioisotopes unless the doses are excessive, or the diagnostic benefits nonexistent."[43]

Summary

In light of the discussions presented above, it is our view that a modern and realistic view of the current health risk of routine use of diagnostic radiography in chiropractic practice and research is that there is essentially no scientifically demonstrable risk to the given patient. Further, follow-up radiographs to monitor response to treatment as required by some technique protocols, also provide negligible risk. Chiropractic radiologists and those pressing for more restrictive guidelines to dictate restraint in clinical x-ray use should know these efforts are not supported by scientific evidence and are anti-progressive[26] and costly.[53,54] Efforts to limit the use of x-ray in chiropractic clinical practice by influencing the education of the student at chiropractic college or by devising more restrictive practice guidelines to restrict the chiropractor in practice should be ceased. It is now time for radiologists to reconsider or even reverse their opinions on the risks of x-ray usage in practice.

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