Linkage— Multiple Sclerosis and Ionizing Radiation

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INTRODUCTION

For many years the medical and health science communities have been frustrated over our inability to identify the nature of what it is in the etiological environment that triggers the adverse immune reaction of multiple sclerosis. We know that the immune system plays havoc with the myelin nerve sheath but still have only intuitive evidence as to what it is that provokes the immune system to deal so sordidly with myelin. The main thrust has been in finding a virus as the culprit. Difficulty in locating the potentials of a susceptibility gene (or genes) on the DNA is the other factor under continuing research. But neither factor has been 'solidly characterized for all of the several hundred millions of research dollars that have been expended.

This paper will present some epidemiological background and touch on several studies in regard to a different approach for finding the long sought environmental “trigger” for MS whose prevalence in the U. S. is estimated at 400,000 cases.[1]

PRIOR MS INVESTIGATIONS

Charcot, in France in 1868, has been credited as the first medical practitioner to describe MS as a distinct disease with a variety of symptoms that included a triad of nystagmus, slurred speech and impaired coordination.[2] But as clinical experience with the MS afflicted has grown, other neurological symptoms have been added including blindness, paresis, clonus, spasticity, fatigue, numbness and dementia.[3,4]

Over many years a disparate group of environmental conditions have been investigated as possible etiological triggers for MS to include among other factors: latitude, hours of daylight, carbon monoxide, ultraviolet light, temperature, a virus, ionizing radiation, pets and toxic chemicals.[5,6] But the preponderance of ongoing research has been in virology in attempts to find an offending virus and how it operates to thwart the immune

system.[5(pp.29-33),7] The other area of upcoming etiological research prominence is in Ionizing radiation as a potential environmental trigger; the investigational emphasis of the authors.[8] In the past few years, European health scientists, especially in Sweden and Norway, have been actively investigating ionizing radiation as a potential environmental trigger for MS,[9,10] but there is a growing emphasis in the U.S.[11-13] that Ionizing radiation is also being more highly implicated in other diseases.[14] In another twist, Swedish health scientists in referring to Latarjet's studies in the U. S., consider that there may be reasons for a two-step pathogenic development in the etiology of MS: “since both ultraviolet and ionizing radiation can induce viral synthesis in lysogenic bacteria, one could speculate that radiation might cause primary damage... (i.e., if there is a viral or immunologic etiology as well).” [15]

All life is subject to ionizing radiation exposure from many sources; natural from radon, cosmic radiation, rocks and soils; and man-created radiation from medical and dental X-ray diagnosis and therapy, radiological medical procedures, nuclear medicine, radionuclide fall-out and consumer products. But of these, radon is the greatest single source of average background radiation as it forms some 55 percent of the average exposure to man.[16,17] (See Figure 1.) As an exception, geographically spotty but extremely heavy radionuclide fallout from nuclear bomb tests can cause a far greater exposure.[18]

Genetically, research continues unabated as to which gene or genes may be the culprit(s) associated with MS.[19] Since there is a bias for younger people to contract the disease, especially women in the ages of 16-34, some health scientists believe that there may be causality factors from birth whether these be from genes or a latent virus or hormonal changes or other factors.[20]

Geography also appears to play an important part in the causality of MS as the disease is more predominate in the higher latitudes of both the northern and southern hemispheres, especially in northern Europe, the United States and southern Australia; the latter two areas most likely from European emigrants of Caucasian descent.[5(pp.11-13)] As a general rule, the geographical gradient of MS prevalence is found to increase as distance from the equator increases, the exception being inhabitants native to subarctic regions. For example, in 1994 average MS prevalence in cases/100,000 population (cases/100k) in the U. S. ranged from 57 in southern states to 150 in northern states.[21] (See Figure 2.) MS is little known among African, Asiatic, Hispanic and Eskimo populations.[5(pp.16-18)] Also, some health physicists believe that the northern and southern magnetic geographical poles are a factor in the etiology of MS due to increased intensity of cosmic radiation in higher latitudes.[22]

STUDY GENESIS

In learning that ionizing radiation is considered the probable cause of Down's syndrome,[23.24] and when in 1983 there was a considered epidemic of MS in Spokane County, Washington, Prater

speculated that there might also be a connection between high MS prevalence and the contamination of eastern Washington from a very heavy 40 year downwind radiological fall-out from nearby U.S. Hanford Nuclear Reservation nuclear weapon production. In addition this area was in the path of radionuclide fall-out from Russian and U.S. nuclear bomb tests. Prater outlined these thoughts at a seminar conducted by several Spokane medical doctors who were concerned about the number of MS cases in Spokane County. Prater's contributions were taken into consideration but with little apparent further action.

RADON— A POWERFUL SOURCE OF IONIZING RADIATION

In 1983 radon effects were not highly publicized. But today radon-222, a progeny of uranium-238, is a background radiation known to cause harmful health conditions. Importantly, radon-222 is the only progeny of uranium in gaseous form that is created in most soils from tiny amounts of ubiquitously distributed uranium-238 that over billions of years changes its chemical composition several times from uranium-238 to radon-222 and into lead-206, a final and stable form.[25] (See Figure 3.) To investigate the extent of the problem, Congress passed the U. S. Radon Abatement Act of 1988 that directed the U.S. Environmental Protection Agency to identify and measure indoor radon levels for each of the 3,141 counties in the U.S.[26] From these data, indoor radon measurements are shown to be particularly high in the northern U. S.

Radon Concentrations and MS Prevalence

In September, 1993, the Environmental Protection Agency published radon measurements for Iowa that reported average elevated indoor radon concentrations in 92 of Iowa's 99 counties as 4 to 5.8 times the upper EPA health limit standard of 4 picoCuries/liter of air (pCi/I). In 81 counties, individual home indoor radon measurements were (are) dangerously high ranging from 10 to 25 times the EPA health limit[26(pp.IV-15)] Now living in Iowa, Prater again wondered if there was an MS connection.

From 1993 membership roll data provided by the National Multiple Sclerosis Society - Iowa Chapter, a large number of MS cases/100,000 population (cases/100k) were found in Iowa counties that also coincided with high Environmental Protection Agency indoor radon levels. As in Washington state, long lived radionuclides from nuclear bomb test fall-out had also been heavy across lowa.[27] From these observations, it was speculated again that high radon emissions and nuclear fall-out were the radiological sources that could be responsible for the high MS prevalence rates /100k population in these counties.

Since preliminary Iowa findings indicated a potential linkage between MS and ionizing radiation, further investigation was warranted. To study possibilities, an independent team of Walter B. Eidbo, M.D., a Des Moines, Iowa physician experienced in clinical MS, and Merle P. Prater, Ph.D., an Ames, Iowa environmental scientist and educator, was formed. After analyzing the data, a preliminary report of our findings was informally

presented to health scientists at the 1994 National Multiple Sclerosis Society Annual Conference in San Francisco.[28] The report received mixed reactions as most MS etiological research efforts in the U.S. were being directed, and still are, toward finding an offending virus and how it acts as the long sought etiological trigger for MS.

From further National Multiple Sclerosis Society data furnished by state chapters, Washington, Idaho and Minnesota also have high prevalences of MS cases/1 00k that prompted a further study by the authors to help corroborate a possible link between MS and ionizing radiation. In eastern Washington and northern Idaho with also large uranium deposits, indoor radon emissions were very high.[29,30] For study purposes Environmental Protection Agency indoor radon data, by county, and National Multiple Sclerosis Society state chapter MS membership roll data, by county, were used. Extremely high MS prevalence/100k were found in Washington and Idaho counties in the same counties that also had high indoor radon concentrations. Conversely, in Washington counties upwind to the west and northwest of Hanford with much lower indoor radon readings, much smaller MS cases /100k were found.

More specifically, the five counties surrounding the Hanford Nuclear Reservation with but moderate EPA radon exposure, have a high prevalence of 200 MS cases/100k.[11] Within the highest indoor radon zones of eastern Washington, Northern Idaho and in northern Minnesota, we found “hot spots” with extremely high MS prevalence/100k. In Spokane County there was a very high prevalence of 255 MS cases/100k; and in nearby Shoshone County, Idaho, there was an even higher prevalence of 253 MS cases/100k. Spokane County also had the highest indoor radon exposure of any Washington county where 60 of every 100 homes exceeds the safe radon emission standard of 4 pCi/l.[29(p.99)] In contrast to downwind eastern Washington, the upwind King County [Seattle] had a low prevalence of 121 MS cases/100k and also is in the lowest radon exposure zone.[14] Our highest prevalence of MS cases/100k found was in Cook County in far northeast Minnesota with an extreme 289 MS cases/100k.

Radon and Disease

Radon-222 has a half-life of 3.8 days but continuously decays to radioactive heavy metal radionuclide progeny particles, among which are bismuth-2l0, polonium-2l0 and lead-210 with half-lives of 5.01 days, 138.4 days and 19.4 years, respectively. Since both radon gas and its progenies are breathable and ingestible, the radioactive particles can reside in the lungs and/or the gastrointestinal tract. Radon, being a gas, enters the blood stream to be carried to other parts of the body that can remain in body organs for the life of the decay particles. Lung tissue damage and cancer is one result.

From Alzheimer and Parkinson disease research, Glenn I. Lykken, Ph.D. and colleagues with the Department of Physics, University of North Dakota, have found high energy alpha and beta radiation from radon progeny particles embedded within Alzheimer

disease brain protein and Parkinson disease brain lipids. The team has reported a "ten fold increase" of radioactivity in the diseased brains versus the control brains from those who had no previous clinical evidence of neurological disease.[3l,32] In conjunction with the Eidbo-Prater MS and radon studies, Lykken et al are adding to their Alzheimer and Parkinson research to determine if high energy alpha and beta radiation from brain embedded radon progeny may also be instrumental in creating MS myelin nerve sheath lesions.

Kurtzke has done seminal epidemiological work in conducting over 200 surveys worldwide for which he has established MS prevalence rates. The highest rate found was 250 MS cases/100k in the Orkney and Shetland Islands north of Scotland and in the Faroe Islands of the North Atlantic. From the surveys, no strong evidence regarding MS etiology was uncovered.[5(pp.11-19)]

To further a radon connection, MS cases were reported as being "rampant" in the late 1980's among National Park Service personnel at the Mammoth Hot Springs, Yellowstone National Park headquarters. Radon ground readings there reach 1000 pCi/l or 250 times the Environmental Protection Agency health standard.[33]

U.S. Immune-Autoimmune Disease Studies at Nuclear Weapon Sites

To open another front on MS and ionizing radiation, the U.S. Department of Energy and the U.S. Health and Human Services are collaborating to investigate immune, autoimmune and other disease clusters found in populations within, and external to, 20 Department of Energy nuclear weapon facilities and eight U.S. Navy nuclear submarine bases.[34] The U.S. Center for Disease Control and Prevention and its Agency for Toxic Substances and Disease Registry are conducting the studies. One study is to be centered on the Department of Energy Carson County, Texas, Pantex nuclear warhead assembly plant near Amarillo where it is reported that: "the number of people with muscular dystrophy, multiple sclerosis, amyotrophic lateral sclerosis and lupus erythematosus in the area indicated a higher than expected number of deaths, from all but the lupus."[34(p.85)] Knowledge of the reported U.S. Department of Energy and the U. S. Department of Human and Health Services Pantex plant health problems prompted the authors to investigate a wider Pantex-Amarillo, Texas area with respect to radon and MS.

The average Environmental Protection Agency indoor radon exposure concentrations for the 33 counties surrounding the Carson County Pantex plant are found to be moderately high. The radon measurements were not as high as in eastern Washington but the highest in Texas except for a few other counties.[35] From recent National Multiple Sclerosis Society-Texas Panhandle Division membership roll data, a workup shows that the four adjacent counties to Carson County have a relatively high average of 147 MS cases/100k. The entire 33 county region surrounding and away from the plant has a lower average of 121 MS cases/100k, ranging from a high of 157 in adjacent Potter County (Amarillo) to a low of 100 in Roberts County (the latter data

deemed non-reliable as the county has but one reported NMSS MS case in a population of 1000). The Agency for Toxic Substance Disease Registry formal radon-disease studies are scheduled for years 2003-2005.[34(p.117)]

Norwegian MS and Radon Studies

Perhaps the most convincing scientific studies linking MS with ionizing radiation have been done in Norway through the geomedical work of a Norwegian Geological Survey project: Radon a possible factor in multiple sclerosis.[20(pp.87-94)] In the study, statistically significant differences were found between high MS prevalence rates in the drier south-central Norway east of the coastal mountains with significantly lower rates along the wetter western coast. The findings and rationale of the Geological Survey scientists were that moist ocean air along the Norwegian coast precipitated large amounts of magnesium2+ into the soil that through chemical exchange decreases the soil's radium content, the precursor of radon. As an additional factor, the high western coast soil moisture was considered to block radon gas from escaping.

Using "spatially moving bivariate correlation analysis,"[36] the Norwegian Geological Survey found that in the drier areas "the [correlation] coefficients are positive ($p<0.01$) for MS versus Rn [radon]..." and in the wetter coastal region, "negative for MS versus precipitation and magnesium (Mg) ($p<0.01$)."[20(p.32)] Although a strong potential for causality was concluded, the Survey scientists warned against their findings as being proof.

Furthering the accuracy of the Geological Survey study results, the small country of Norway with 5 million population, maintains an MS medical registry; whereas in the United States the best available data are those from National Multiple Sclerosis Society state chapters' county-by-state membership rolls. In most cases, however, these data are estimated to be only perhaps 65-80 percent of the actual total. In this regard, the Eidbo-Prater survey results must be taken as extremely conservative.

Discussion

Obviously more sophisticated and comprehensive research is needed in dealing with the many clinical and environmental factors that lead to further discoveries for causes of multiple sclerosis. Clinical and multiple regression statistical analysis studies must investigate the many variables associated with potential MS causality. These studies must not only consider etiological areas as genetic susceptibility, viruses, toxic substance exposure and the effect on immune systems from high energy alpha, beta, gamma and X-ray radiological exposure, but also epidemiological factors that include demographic details as to age, race, geographical location, climate, migratory history, familial clustering, socioeconomic conditions urban-rural differences; and the way both etiological and epidemiological variables change over time.

If our work over these years in studying potential linkages between ionizing radiation and multiple sclerosis has in any way assisted the process of finding credible answers to this debilitating disease, we will be well rewarded.

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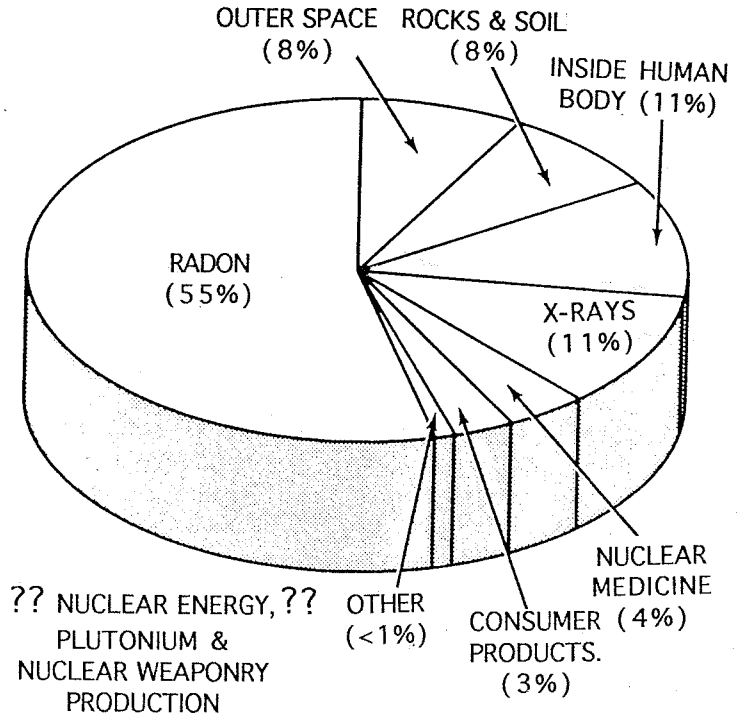
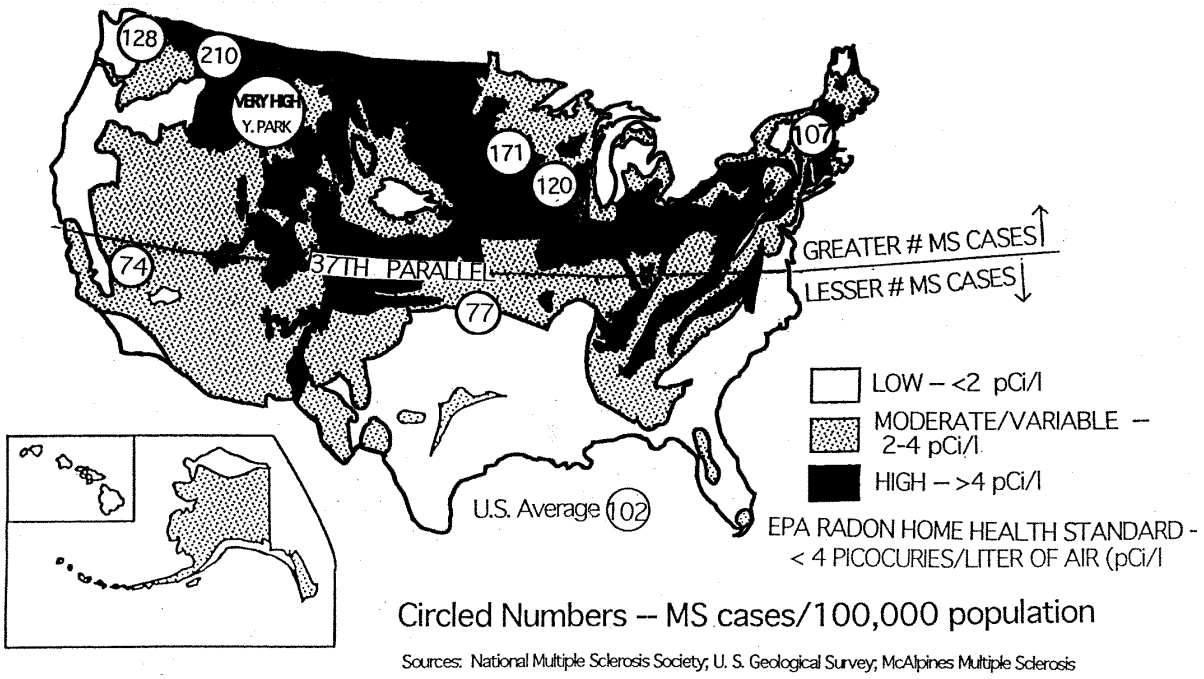


Source: Mayo Clinic Family Health Book, 1990, p. 334.
(From the National Council on Radiation Protection and Measurements)

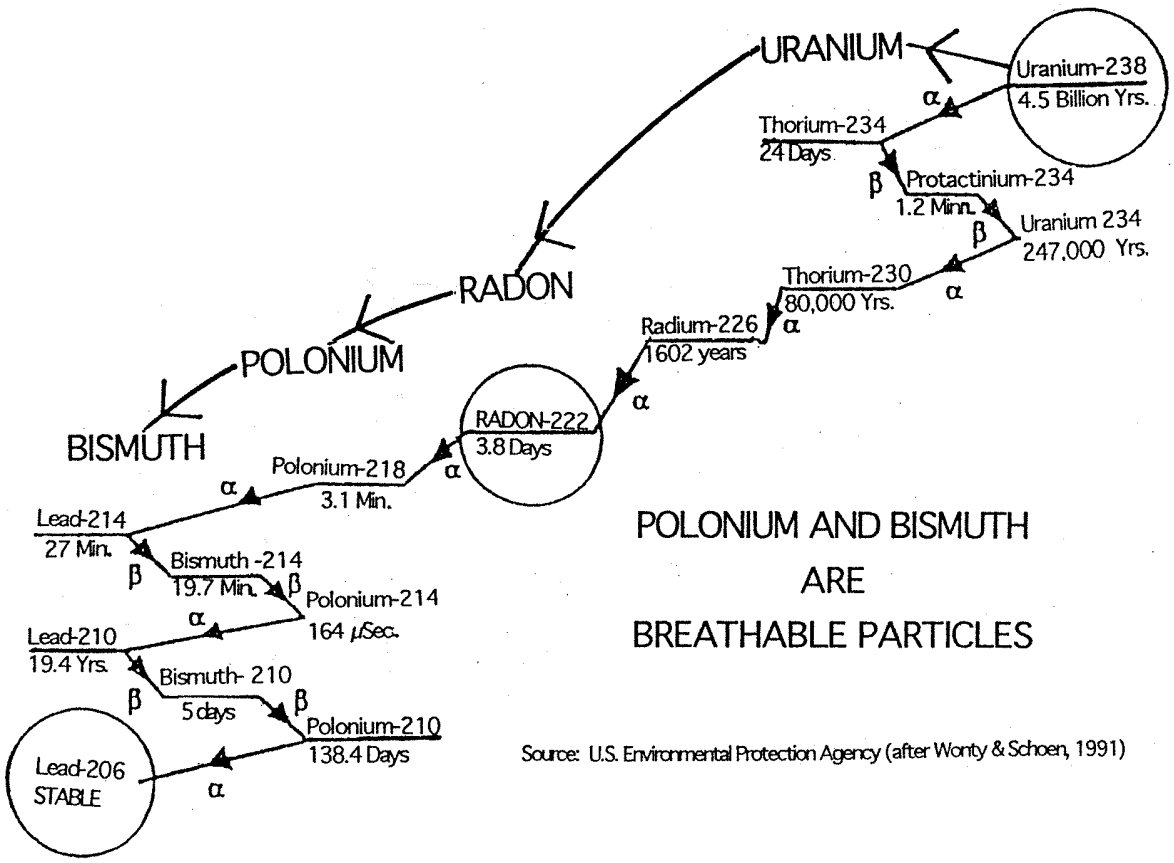
IONIZING RADIATION SOURCES

Figure 1



U. S. RADON EMISSIONS AND AVERAGE MULTIPLE SCLEROSIS PREVALENCE

Figure 2



URANIUM 238 DECAY SERIES

Figure 3