DEPARTMENT OF HEALTH & HUMAN SERVICES

Public Health Service

National Institutes of Health
National Cancer Institute
Bethesda, Maryland 20892

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The Honorable Pete Domenici
United States Senate
Washington, DC 20510

Dear Senator Domenici:

Thank you for your inquiry with Senator Bingaman on behalf of the Committee on Energy and Natural Resources. You requested information from the National Cancer Institute (NCI) on the number of baseline cancers and radiation-related illnesses from nuclear weapons testing in the Republic of the Marshall Islands (RMI). The Division of Cancer Epidemiology and Genetics (DCEG) was asked to develop this response because of its robust research program in radiation epidemiology, dose reconstruction, and risk estimation.

To conduct such a study in a comprehensive manner would require a fairly large, multidisciplinary effort undertaken over several years. While no study has been published that specifically provides the information you requested, there is a large body of published scientific literature and data from which to develop unrefined estimates. Therefore, our epidemiologists, statisticians, and dosimetrists used these data, their expertise, and tools developed in connection with other studies, to develop basic answers to your questions. Hence, while it may be possible to improve the estimation of average dose at the more distant locations, we believe such changes will make little difference to the number of excess cancers predicted.

Because our Institute's mission is focused on cancer research, these answers address cancer only. We have provided short responses below and referenced these to the location in the attached Appendix where our approach, assumptions, analyses, and findings are described in more detail.

Questions and Answers

(1a) Please provide an estimate (range) of the expected number of cancers and other radiogenic illnesses (both fatal and nonfatal cases) expected among the people of the Marshall Islands as a result of their exposures to radioactive fallout from U.S. weapons tests in the Marshall Islands.

Within the lifetimes of members of the cohort alive during the test years 1946-1958, we estimate that about 5600 *baseline* cases (i.e., unrelated to fallout exposure; see (2) below) may develop. As many as 500 additional cancers, related to fallout exposure, may also develop. Hence, exposure to fallout could result in about a nine percent increase – to a total of about 6100 lifetime fatal and nonfatal cancers. (Appendix Table 3)

Table 3 in the Appendix compares the baseline and excess numbers of cases of leukemia and cancers of the thyroid gland, stomach, colon, and other organ sites considered as a group. This grouping was driven by consideration of the time-related pattern of radiation-related risk, which is known to be different for leukemia than for the solid cancers, and by differential levels of exposure for the various organs. We estimated that the thyroid gland was the most heavily exposed organ because it is the target organ for radioactive iodine, a major component of fallout. The colon was the next most heavily exposed, followed by the stomach. These two organs were affected by ingestion of fallout particles, whereas the bone marrow and other organs were estimated to have received much lower, and roughly similar, doses from radiation sources external to the body.

Some key findings are highlighted below:

- About 400 of the 500 estimated radiation-related excess cases of all cancers may be expected to develop in the roughly 35 percent of the exposed population that was under 10 years of age at exposure. Since this age group is mainly between 50 and 60 years of age at present, most of their baseline and excess cancers are projected to occur in the next few decades as they reach ages at which baseline cancer rates are normally highest.
- Disproportionately higher excess cancer rates are expected to occur in the relatively small proportion of the population with the highest doses, particularly those exposed on the atolls of Rongelap and Ailinginae. However, we have less confidence in our estimates of excess risk for this group, because the estimated radiation doses to the most heavily exposed organs (thyroid, colon, and to a lesser extent the stomach) are so high that the literature is not a good guide to radiation-related cancer risk. Our conventional assumption -- that risk is proportional to radiation dose -- is unlikely to hold at such high doses, and our estimates for this heavily exposed subgroup should be treated as rough upper limits on risk (See Appendix Part V, Limitations of Our Procedures). For the other atolls, which received lower doses, conventional dose-response models should apply reasonably well.
- For similar reasons, our estimated distribution over time of the excess cancer cases among the most heavily exposed is uncertain.
- About five radiation-related leukemia cases would be expected. However, all exposure-related leukemia cases are likely already to have developed.
- About 260 cases of radiation-related thyroid cancer cases are predicted (67 percent of all thyroid cancers), and about 40 percent of them have not yet developed or been diagnosed.
- About 15 stomach cancer cases (3 percent of all such cancers) are projected to be radiation-related, with about 85 percent of those still to develop or to be diagnosed.

- About 160 colon cancer cases (25 percent of all such cancers) are projected to be radiation-related, and about 80 percent of them have not yet developed or been diagnosed.
- About 90 radiation-related cancers of other organs (2 percent of all such cancers) are projected, and 66 percent of them have not yet developed or been diagnosed.

(1b) Because this may require an estimate of future illnesses, can you describe the scientific consensus regarding the maximum limit of the latency period for these radiogenic illnesses?

Scientists have learned that radiation-related leukemia risk increases shortly after exposure, reaching its peak within 5-10 years, and then declines gradually thereafter. In contrast, risks of most radiation-related solid cancers (including thyroid, stomach, and colon estimated for this evaluation) increase gradually and continue to rise as the background cancer rate increases with age, and may remain elevated throughout life. (See Appendix Part IV, Number of Cancers Expected, organ-specific bullets.)

(2) Please provide an estimate (range) of the baseline risk for those diseases. That is, an estimate of the number of these illnesses that would be expected to occur naturally among the Marshallese population.

Using 1958 census statistics from the RMI to estimate a population size of 13,940 at the time of the 1954 BRAVO test, the total number of cancers expected to occur in the absence of fallout exposure (i.e., the *baseline* number) during the lifetimes of those exposed to the tests will be about 5600 (Appendix Table 3). About one-half of those baseline cancers are yet to develop, reflecting the predominantly young age distribution (35 percent under 10) of the population at the time of exposure (Appendix Part VI, bullet 3 under All cancers combined).

Some Details of Our Methodology

While some estimates of dose and risk of thyroid cancer have previously been made for residents of Rongelap, Ailinginae, and Utrik as a consequence of the 1954 fallout exposure, we developed revised thyroid dose estimates for these atolls in the course of estimating doses for other organs and for inhabitants of all inhabited atolls. The cancer risk estimates presented herein are calculated based on our estimates of doses, baseline cancer risks, and radiation risks derived from epidemiologic studies of various irradiated populations.

- In our attempt to estimate *typical doses* for each age group and atoll, our assumptions may over-estimate the average doses received at atolls farther from the test sites. (Appendix, Part III)
- In the absence of registry-based *baseline cancer rates* for the RMI, the SEER[1] rates representative of native Hawaiians are used as a surrogate. (Appendix, Part IV, Sources of Baseline Cancer Rates)
- *Lifetime and future lifetime risk coefficients* were calculated using an adaptation of a previously developed research tool to estimate the probability that given cancers were caused by radiation exposure. We judged this research tool to be sufficiently well developed to be used to estimate cancer risks for this evaluation. (Appendix, Part IV, Cancer Risk Estimation Methods)
- A simplifying assumption used in these calculations was to ignore the possibility of multiple radiation-related cancers of the same organ in the same person.
- The estimated number of cancers to be expected is highly uncertain, because (1) dose estimates are uncertain; (2) baseline cancer rates are approximate; and (3) organ-specific doses estimated for some atolls are so high that related radiation risks are not easily derived based on findings from studies of other populations such as the Hiroshima and Nagasaki A-bomb survivors. However, the doses were estimated so as to avoid significant under-estimation of the numbers of radiation-related cancers that might be expected to occur. (Appendix, Part III)

I hope this information is helpful to you. Please do not hesitate to contact me should you need additional information. An identical letter has been sent to Senator Bingaman.

Sincerely,

Andrew C. von Eschenbach, M.D.
Director
National Cancer Institute

Enclosure: Appendix, **"Estimation of the Baseline Number of Cancers Among Marshallese and the Number of Cancers Attributable to Exposure to Fallout from Nuclear Weapons Testing Conducted in the Marshall Islands"**

[1] SEER: NCI's Surveillance, Epidemiology and End Results Program (http://seer.cancer.gov/about/) currently collects and publishes cancer incidence and survival data from 14 population-based cancer registries, including the state of Hawaii, and three supplemental registries covering approximately 26 percent of the US population.