Perspectives on Nuclear Weapons and Community Health

A Newsletter of the Community-Based Hazard Management Program

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The Community-Based Hazard Management Program operates on the principle that the empowerment and protection of a community affected by US nuclear weapons complex activities are directly dependent upon a community's ability to understand, evaluate, and provide input into the management of the complex health hazards associated with radiological and chemical contamination. We have a strong commitment to community-based research, education, and training activities and to the creation of public participation mechanisms that address public health concerns. Without an informed public, there will be no community pressure or oversight to guide implementation of meaningful government health responses and improve our scientific understanding of these hazards.

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Seth Tuler and Abel Russ

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A Critical Review of an ATSDR Public Health Assessment for Lawrence Livermore National Laboratory

By Abel Russ and Robert Goble

The Agency for Toxic Substances and Disease Registry (ATSDR) was created in the 1980s in the original Superfund legislation because Congress believed that vulnerable communities and state and federal agencies managing Superfund cleanups would need trustworthy information and advice about environmental health threats posed by Superfund sites. ATSDR was intended from the beginning to have a community health focus, including a mandate to work collaboratively with affected communities. This article deals with an ATSDR document that has still not been released in final form, a Public Health Assessment of two accidental releases of tritium, in 1965 and 1970, from Lawrence Livermore National Laboratory (LLNL) (ATSDR 2002). We begin with some background information and then discuss the Assessment. This presentation is largely excerpted from a review of the ATSDR document that we finished earlier this year.

Background

The Atomic Energy Commission began operations at LLNL in 1950. In 1952 LLNL was established as a separate part of the University of California Radiation Laboratory. LLNL currently occupies 821 acres of land approximately 40 miles east of San Francisco and 3 miles east of central Livermore. A variety of activities occur at the laboratory with special emphasis on nuclear weapons research and development. In addition to potential radiological health hazards which include concerns about plutonium containing sludge, LLNL poses chemical hazards. Because of these, it was placed on the Superfund list in 1987. One structure of particular concern is building 331, the Tritium Facility. This unit has operated since 1956 and the amount of tritium in the building averaged 200-300 grams (2-3 million Ci) through 1990, after which the inventory was brought under 5 grams (50,000 Ci). Both accidents considered here occurred in building 331.

On January 20, 1965 at 3:30 pm, roughly 350,000 Ci were released from a stack in building 331. We are told that this was the result of human error and that most of the tritium was in gas form ($^3H_2$). There is apparently no quantitative data describing the fate of the tritium, and this can be partly explained by the fact that LLNL staff at the time assumed that the tritium plume would not touch the ground (in retrospect it almost certainly did touch the ground).

On August 6, 1970 at 6:14 am another 300,000 Ci were released from the same stack when a component of a pressurized gas system failed. It appears from maps generated after the accident that the plume moved east and then southeast down the San Joaquin Valley. Sampling was done after this accident and we have a small amount of information concerning air, water, vegetation, milk, and urine concentrations over the next four days.

These two accidents were much larger than the routine releases from LLNL; it is plausible that these two accidental releases represent 80% of the total tritium released since the lab began operating, as claimed in the Public Health Assessment. Tritium released as water vapor poses a more substantial health threat per curie (this is because water vapor is retained in the lungs, while most of the hydrogen gas is exhaled), however, and much of the annual tritium released has been in the form of water vapor.

These releases have quite naturally led to public concern about their health implications. Because of such concerns, and because LLNL appeared to have no information about tritium in the environment (in the form of organically-bound tritium or OBT), community members requested that the Agency for Toxic Substances and Disease Registry (ATSDR) conduct measurements of OBT in the region. Instead, ATSDR chose to conduct a series of consultations and assessments to decide whether such measurements could be justified based on what ATSDR considered to be public health concerns. The first consultation to consider the accidents was criticized for its approach, methodology and presentation of results; the draft Public Health Assessment was released after consideration of comments on the consultation.

A group of concerned organizations, including TriValley CAREs (Communities Against a Radioactive Environment), San Francisco Physicians for Social Responsibil

ity (PSR) and Western States Legal Foundation, together applied for and received funds from the Citizens Monitoring and Technical Assessment Fund to hire us as independent reviewers of the Public Health Assessment. (We should mention that we also have an ongoing community education project in Western Shoshone and Southern Paiute communities affected by nuclear testing that is funded by ATSDR).

Our Critique of the Public Health Assessment

The overall message of the Assessment was that the accidents gave doses to a hypothetical maximally exposed individual that were "below public health concern" and therefore that no public health impact resulted from the accident. This conclusion was based on a set of mathematical models estimating the transport of tritium and potential human doses and on a brief review of the literature describing health risks from low doses of radiation. We spent some time reconstructing the dose model, estimating risks, and generally evaluating the assumptions underlying the conclusions of the Assessment. We also looked at earlier iterations of the document along with other related materials to evaluate the process that ATSDR followed in creating the health assessment and the suitability and effectiveness of their effort in informing the public. Our findings are as follows:

1) Process problems. The Assessment process was marked by a lack of responsiveness to community concerns, a series of contradictory documents, and very limited attention to establishing a record of what happened in the accidents and to informing the public in an understandable way about what happened. ATSDR lost its opportunity to serve as an honest broker on these issues and thus departed from its defined public health mission.

2) Calculation of dose estimates. The Assessment made mistakes in presenting its results- The models predict higher rather than lower doses for the 1965 accident contrary to assertions in the text. A significant factor in calculating dose, the dose and dose-rate effect factor (DDREF), was misused. We presented revised dose estimates that correct these errors. Our estimate for a maximally exposed adult was 82 millirem with a 90% confidence interval of 20-333 mrem. Our estimate for a maximally exposed 5-yr old was 134 mrem with a 90% confidence interval 0f 34-559 mrem. These estimates are 3-4 times higher than those presented in the health assessment. Population dose estimates, although small and highly uncertain, should have been made in the Assessment in addition to the estimates for the maximally exposed individual. This estimate is important to affected communities. We made a very rough estimate that within 50 miles of LLNL there were 15-300 person-rem of dose. Finally, these calculations involve a large degree of uncertainty, in part due to the unfortunate lack of information about the conditions around the accidents. ATSDR made no evaluation of the reliability of the available information, underestimated the uncertainty of key model parameters, and did not adequately explain the sources and implications of model uncertainties.

3) Discussion of health risks. In their treatment of risks from radiation exposure the authors of the Assessment contradict standard practice as described in the National Academy of Sciences BEIR V report (NRC 1990), in international commissions (ICRP 1991, UNSCEAR 2000), and in the ATSDR Toxicological Profile for Ionizing Radiation (ATSDR 1999). Specifically, despite a scientific consensus that with the present state of knowledge cancer risk should be considered to be proportional to dose even at very small doses (known as the 'linear, no-threshold' model of risk) the authors operate under the assumption that there is a threshold for radiation-induced cancer. The threshold that they propose is higher than the dose estimate for the maximally exposed individual; they thus estimate zero risk. The authors failed to acknowledge that they are advocating a fringe position and support themselves with a meager and selective review of the available literature on the topic, including ignoring evidence of effects below their proposed threshold. In contrast, using standard methods we found that within the range of uncertainty there was potential for cancer mortality risks that are considered 'significant' in common regulatory practice. Our best risk estimates, calculated using both ATSDR's and our estimates of dose for a maximally exposed individual, are in the vicinity of 1 in 10,000; within the uncertainty ranges the risks in some cases exceed 1 in 1,000.

4) Assessment conclusions. The Assessment relied on the concept of a 'level of public health concern', claiming that all accidental releases were below this level. The concept was nowhere defined and we have no way of knowing what the authors would consider to be a level of public health concern. The risks that we calculated were at levels generally taken to be significant by the agencies supervising Superfund cleanups and we assume that these do in

fact constitute a public health concern. The inferences drawn in the Assessment directly subvert the principle of reducing hazards to a level 'as low as reasonably achievable' (ALARA), a cornerstone of the social compact for managing radiological hazards. The impression left by the document is indifference to significant releases of tritium in a populated area and indifference to community concerns.

We have yet to see the final draft of the Assessment. If the above-mentioned flaws in the draft are left unaltered we believe that ATSDR will have significantly departed from its public health mission. The doses and risks that resulted from the accidents were modest relative to other encounters that humans have with radiation, but affected communities are capable of digesting quantitative information and have a right to an honest assessment of their experiences. If instead ATSDR persists in avoiding its public health mission the likely consequences are worsened community relations with LLNL, greater distrust of the government, and unnecessary community fears.

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Good Science and Empowerment Through Community-Based Health Surveys: The Example of Hanford Downwinders

This article is a summary prepared by Seth Tuler of a paper entitled *Community-Based Participatory HealthSurvey of Hanford, WA, Downwinders: A model for citizens empowerment*, accepted for publication in *Society and Natural Resources* by Rudi H. Nussbaum PhD[1], Patricia P. Hoover BS[2], Charles M. Grossman MD[3], and Fred D. Nussbaum BS[4]

Introduction

A community-based health survey can be an effective tool for simultaneously empowering communities and improving understanding of the legacy of contamination from industrial facilities. Community-based health studies can empower local communities by validating their concerns about the health effects of radioactive and chemical contamination and can put pressure on government agencies to design epidemiologic studies with more public participation. In addition, community-driven surveys can sensitize respondents to the underlying issues of harmful industrial or governmental practices and social injustice. They can spur government agencies to conduct larger scale studies or to revisit the data and analyses from prior studies. In particular, through community-based health surveys unexamined exposure pathways and the significance of exposures to multiple chemical and radiological contaminants may be revealed. Scientists studying the health effects of environmental toxins have only recently recognized the unique contributions that representatives of affected communities can provide to health investigations through their intimate knowledge of the social and physical context (Brown 1992, 1993, 2003; Arcury *et al.* 2000; Fischer 2000; Kriebel *et al.* 2001; Small *et al.* 2001; Wing 2002, 2003).

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Near nuclear weapons complexes community-based health surveys have been initiated by residents around, for example, the Fernald, Mound, and Hanford facilities.

The Challenges Of Community-Based Health Studies

A community-based collaborative mode of health studies has become part of a number of pioneering efforts in health research (Arcury *et al.* 2000; Brown 2003; Small *et al.* 2001; Wing 2002, 2003). At the same time, a community-based participatory research model challenges established practices of epidemiology and highly technical analyses, which may undermine its perceived validity among government scientists and other researchers (Brown 1992, 1993, 2003). Recently, this mode of inquiry has caught the interest of established social scientists (Brown 2003; Fischer 2000). Advantages and limitations are:

- Direct participation of affected persons in the design and execution of health research allows consideration of social context and human factors. These are important contributing factors to disease, which have been excluded from most traditional studies based on available medical statistics only.
- Lack of funding and research facilities greatly limit the statistical strength of community-based studies of large populations.
- Only a group of highly dedicated volunteers with a long-term commitment will have the stamina to successfully carry out such an extremely labor-intensive project.
- To achieve useful analysis, a great deal of early attention needs to be paid to producing a robust survey instrument.
- Health data for matched "unexposed" control populations may not be readily available, making it difficult to assess the link between ill health and environmental contamination. Comparisons with approximately matching populations require a firm knowledge of the clinical literature, and involve subjective judgment of comparability.
- Selection bias can undermine the validity of findings. Assessing the numerical effect of bias on the reported “excess cases of disease” is a challenge to the participating scientists.
- Analysis of a self-selected and -reported database cannot “prove” causal links of disease to exposure according to accepted epidemiological standards, since reliable information about internal radiation exposures for respondents and individual variations in susceptibility for radiation damage is not available. However, such analyses can suggest previously unexplored hypotheses about environment/disease associations.

A community-based health survey that hopes to have a positive impact must overcome challenges such as these. The participatory health survey conducted among Hanford Downwinders provides a good example of how they can be overcome.

The Northwest Radiation Health Alliance

There has been a long history of the federal government failing to acknowledge the health risks from operations at Hanford. Downwinders’ demands for reliable information met with denials that activities at Hanford could have any detrimental effects on their health. Most local physicians among the affected populations were ignorant about the nature of activities at Hanford and about the extensive but in part inconsistent literature on radiation health effects. The context changed drastically in 1986 when the Hanford Education and Action League used the Freedom of Information Act to force the government to acknowledge atmospheric releases of 730,000 Curie of Iodine-131 from the Hanford site from 1944 through 1951. Yet, state and federal health agencies continued to deny any possible association of these releases with serious health effects. In fact, questions raised by Downwinders in public meetings and with their local physicians were often met with suggestions that they were suffering from “radiophobia.”

In response to continued government denials and an inability to gain the constructive attention of the medical community, a group of Downwinders asked members of the Oregon Chapter of Physicians for Social Responsibility for help in the early 1990s. Physicians for Social Responsibility responded by sponsoring meetings in 1993 to bring together physicians and scientists, social justice activists and Downwinders under a new coalition, the Northwest Radiation Health Alliance (NWRHA). The group agreed to a primary goal of surveying the health status of Downwinders over a long enough period to check for anecdotally reported increased diseases after Hanford radioactive releases. Taking some cues from Alice Stewart’s pioneering Oxford Survey of Childhood Cancers in Great Britain (Greene 1999), NWRHA decided to collect data about medical diagnoses and relevant personal information. In order to support the questionnaire development, distribution, and data analysis NWRHA secured a number of small grants awarded by community foundations.

The group initiated a health-related database for as many Downwinders as possible within the limited means of a grassroots volunteer effort. Members of NWRHA developed a questionnaire in a slow, iterative process. In the end, the questions asked reflected both professionals’ input and the information that some Downwinders had gathered in previous efforts. With the assistance of a database expert, a final form was designed to elicit

discrete, unambiguous answers, facilitating both computer input and qualitative analysis. There were questions on 35 demographic items and 30 specific disease groups. Specific items on the forms included vital statistics of the respondent, years and locations of residence in the Hanford downwind area, information about smoking, sources of food, a list of specific illnesses and dates of diagnoses by a physician, information about children, and reproductive problems. Space for additional information and comments was provided.

The distribution of NWRHA questionnaires was handled through various networks among Downwinders. Contacts were asked to make copies and to distribute them to family members and friends, who in turn were asked to do the same. If the salient data were available, respondents were encouraged to include them for deceased close relatives. Family ties and personal acquaintance, or chance meetings at public hearings, determined the selection of recipients. Approximately 1,600 forms were distributed over a large area downwind of Hanford and more than 800 were returned. One can only speculate about the reasons several hundred questionnaires were not filled out and returned. Undoubtedly, some families received redundant forms. General distrust about “more useless studies” and poor health were mentioned to us by those who had contacted non-respondents.

Returned questionnaires were coded for computer input. NWRHA found that many respondents were uncomfortable with defining their physical and concomitant emotional maladies using only checkmarks and short text boxes. There was clearly a need to share extensive contextual narrative in the “Comments” section of the questionnaires, relating their family’s wrenching experiences. Key words from these narratives were entered into the database, where they can be retrieved. Any information that could be used to identify specific individuals was removed to assure the promised strict anonymity. Given the deep distrust among Downwinders toward official agencies or research teams, the relatively large number of respondents that included personal identifiers attests to the degree of trust NWRHA was able to build among the affected population. This information and trust allowed NWRHA to conduct follow-ups where responses were unclear, incomplete or inconsistent.

NWRHA’s final database includes 801 respondents (518 female, 283 male), born between 1881 and 1992, who were residents of the Hanford downwind area for at least 3 months after January 1945. They were diagnosed at varying ages over a period of about 70 years, starting in 1928, with a total of 1746 diseases. The analysis of possibly Hanford-related diseases was restricted to diagnoses after March 1945.

The community-based health survey carried out by Northwest Radiation Health Alliance attempts to compare disease rates with those observed in (at least approximately) similar unexposed populations. While such comparisons introduce uncertainties, they avoid the often equally uncertain assumptions on which individual, historical dose reconstruction is based (HEDR 1994; HTDS 2002). Findings from NWRHA’s community-based health survey have proven to be consistent with reports in the medical literature on the effects of low-dose exposures to medical X-rays, radioiodine, radioactive releases, and fallout from nuclear tests (Goldsmith *et al.* 1999; Grossman *et al.* 2001; 2002; 2003). Among the reported ailments are diseases that are considered to be only weakly or not at all associated with radioactive exposures, such as diabetes or atherosclerotic heart disease. Since occurrence rates for these two diseases in our study population were comparable to rates found in unexposed populations, it is likely that our sample of volunteer respondents is not too different in their health status from that of Downwinders in general. Also, comparison of occurrence ratios between pairs of different cancer types among Downwinders and other populations can be expected to be less affected by possible selection bias than direct comparison of incidence rates. For example, female thyroid cancer rates in various unexposed populations represent between 5 – 9 % of breast cancer rates. Among Downwinders exposed to Hanford radioactivity thyroid cancers were found to be 6 – 10 times more prevalent (50 % of breast cancer rates; see Grossman *et al.* 2003 Table 3). These observations are consistent with the authors' hypothesis that the large excesses in known radiation-related diseases among Hanford Downwinders are the consequence of living in a radioactively contaminated environment.

At a concluding NWRHA conference in Pendleton, OR, in April 1999, findings from analyses of the data were reviewed and discussed in detail with about 65 Downwinders and supporters. A critical element of a community-based health survey is providing the results back directly to those who participated in the study. In this case, a plenary session with a panel consisting of two primary care physicians, two epidemiologists and a radiation health scientist, was followed by small group discussions, each co-chaired by one of the five panel speakers and one of the founding Downwinder members. They dealt with reported disease groups, genetics, adverse birth outcomes and radiation risk in general. The enthusiastic and informative exchanges between the audience, the members of the expert panel, and the Downwinder co-chairs attested to the value of the participatory process. NWRHA’s analyses and their subsequent publications in refereed journals validated several of the Downwinders' major medical complaints and provided them with a belated sense of confirmation. Several commented how helpful NWRHA publications had been

in arousing their health care providers' interest. Professional participants, however, remained frustrated by the fact that they could not directly alleviate continuing suffering and premature deaths among this segment of the population in the absence of universally accessible health care.

The Participatory Health Research Process: Learning From The NWRHA Survey

Health surveys such as the one done among Hanford Downwinders can have important effects on individuals, the local community, and government and scientific researchers. In fact, as the NWRHA survey illustrates, community-based participatory studies are quite capable of noting large excesses of health effects that have not been adequately examined by traditional epidemiology (e.g., Hanford Thyroid Disease Study, HTDS, 2002). In addition, community based participatory research can establish more productive relationships between laypersons and scientists that are grounded on mutual respect and collaboration.

In several ways this effort helped to empower communities, addressed Downwinders' grievances, and helped individuals gain better medical attention. For example, Downwinders communicated to us that being able to express their concerns at public hearings, backed by NWRHA reports in the refereed environmental health literature, had strengthened their sense of self-worth, as well as their ability to communicate more effectively with their physicians. From the outset, NWRHA adopted the premise that professional members' formal scientific/medical knowledge about possible health effects associated with exposure to radioactivity lodged in the body provided an essential but incomplete basis for assessment of the needs of this population. The Downwinders' own intimate knowledge of family and community health history, rural life style, and local variations in micro-climatic conditions was essential for an interpretation of the data collected. In addition, Downwinders' geographically widespread network, along with the interpersonal relations they had developed in coping with their common plight, proved immensely valuable for both the design of the questionnaire and its distribution. The recognition that each member of the NWRHA core-group could bring essential information to the process established an atmosphere of mutual trust. A new mode of physician-scientist-lay person cooperation had to be created by a group of people, none of whom had prior experience with this kind of approach. To start with, members had to learn how to communicate effectively; avoiding emotional sensitivities linked to past experiences or acquired mutual stereotypes (for example, how to phrase questions about mental disorders).

The results of the health survey have also had broader effects. Publication of findings from the health survey has introduced the keywords "Hanford Downwinder" and "health impact of environmental radioactivity" into the environmental health literature. The NWRHA has been able to provide valuable support to members of citizen advisory committees in their continuing struggles for recognition of the needs of exposed populations. By its relative success, NWRHA's efforts have served as a model for other populations exposed to radioactive contamination, such as those around Oak Ridge National Laboratories, TN. Some Northwest Indian Tribes within the range of Hanford radioactivity are preparing to conduct their own health surveys, building on NWRHA's experience and methods.

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Coming Soon

Overview of Epidemiological Studies: Health Effects of Low-Dose Ionizing Radiation

The Community-Based Hazard Management team has been working on an epidemiological overview of studies that focus on the health effects of low-dose ionizing radiation. While risks associated with exposure to high levels of radiation are widely accepted, the health risks of exposure to low-level radiation are challenged within the scientific community. In this overview we highlight studies that have found positive associations between low-level exposure and risks, as well as summarize the available research.

Because the body of research on low-dose radiation is too large, we collected studies generally considered key for the various sources of exposure. We have organized the overview primarily by radiation source — fallout, occupational exposure, background, and medical irradiation, for example — but are also including sections on leukemia and thyroid cancer risk across types of exposures. This overview attempts to provide readers with a resource on what research has been done on low-level radiation exposure thus far, what the results of this research are, and where to find additional information. The intended audience is not necessarily one that has been scientifically trained, but rather the concerned and interested layperson. Our hope is that this document will be accessible to anyone who wishes to use it. ✦✦✦✦✦✦

RESOLVE Grant Awarded to CBHM

The Citizens Monitoring and Technical Assessment Fund has awarded the Community-Based Hazard Management Program a grant to work with three community-based advocacy groups over the next two years. The Fund was created as part of a 1998 court settlement between the US Dept of Energy and 39 nonprofit peace and environmental groups around the country. The purpose is "to provide monies to 'eligible organizations' to procure technical and scientific assistance to perform technical and scientific reviews and analyses of environmental management activities at DOE sites." CBHM will work with concerned Citizens for Nuclear Safety (CCNS) in New Mexico, the Native Community Action Council (NCAC) in Nevada and Utah, and the Snake River Alliance (SRA) in Idaho to review the findings and quality of prior studies characterizing risks at their sites. The CCNS was founded in 1988 to provide a voice for community concerns about the transportation of nuclear waste through New Mexico. The NCAC, initially founded in 1995 to advise and manage Nuclear Risk Management for Native Communities projects, has the goal of preparing community members to make informed decisions regarding managing the health risks of environmental hazards. The SRA, founded in 1979, works to ensure that the Department of Energy safely and responsibly remove from the ground, contain and monitor all of the nuclear waste at the Idaho National Engineering and Environmental Laboratories.

Review of the National Cancer Institute's Outreach Program for Fallout-Related Thyroid Disease

By Abel Russ

In 1997 the National Cancer Institute released the report "Estimated Exposures and Thyroid Doses Received by the American People From ^{131}I in Fallout Following Nevada Atmospheric Nuclear Bomb Tests". This signalled the beginning of an effort to synthesize, update, and communicate the results of a large scale dose reconstruction and risk assessment for nuclear weapons testing fallout. The focus of the 1997 report was iodine-131 (^{131}I), one radionuclide among many in fallout, and thyroid cancer, the health effect uniquely associated with ^{131}I. Thyroid cancer is expected to be the most common health effect of fallout exposures; although a newer draft report (NCI 2001) covers other radionuclides and other health effects, the education and outreach campaign is focused on thyroid cancer.

For outreach materials the NCI has created a series of pamphlets and other resources, most of which are available on the internet at http://i131.nci.nih.gov/ . The site includes:

- ^{131}I information, including an explanation of the link between ^{131}I and thyroid disease, a description of the milk exposure pathway, an explanation of the radiological decay of ^{131}I, and an outline of the key risk factors (age at the time of testing, milk consumption characteristics, and location).
- A decision aid for people at risk, including explanations of thyroid disease, national thyroid cancer rates and the added risk from nuclear testing, and a detailed description of diagnosis and screening options. The reader is given a good amount of information in a pros and cons format and in a short worksheet, but screening is not necessarily suggested or recommended. This is exactly what it claims to be, a decision aid. Other resources in this section are a link to the main NCI page for more details about thyroid cancer and a link to the clinical trials that are available to thyroid cancer patients.
- The dose calculator. This tool gives thyroid dose and thyroid cancer risk along with 90% uncertainty intervals and an explanation of what the uncertainty means. The reader is prompted for birth date, gender, counties of residence from 1951-1971, and details about milk consumption (what kind/ how much). The risk estimate is clearly presented in a context of national thyroid cancer risk statistics.
- The 1997 report is available for download, and so is a review of the report by the Institute of Medicine and the National Research Council.

There is a lot of other information here as well; much of it appears to be filler but is appreciated in these times of ridiculous levels of government secrecy. You can find a short article by Charles Land (and a separate memo) explaining risk calculations. There is a 1997 statement before a Senate subcommittee, a 28-minute teleconference (transcript or audio file), public service announcements, and a 2-page promotional brochure. There are also links to various places including the main NCI thyroid cancer page for a more detailed review, the CDC Hanford Thyroid Disease Study, websites of ongoing research, and a list of clinical trials. There is little information here about non-cancer thyroid disease (thyroiditis, hypo- and hyperthyroidism). This is in part a reflection of the state of the field (see for example Eheman *et al.*2003) but also to some extent represents a conscious decision on the part of NCI to focus their work on cancer outcomes.

The website is good; it is accessible, evenhanded, and informative. That said, I do have the following critiques, and the last one is very important.

- *Risk estimates.* Thyroid cancer risks were calculated using a pooled analysis of 5 previous external radiation studies for an estimated excess relative risk per gray (ERR/Gy) of 7.7 (95% CI 2.1, 28.7) for children exposed before age 15 (Ron *et al.* 1995). An alternative risk estimate for childhood exposures is provided by Jacob *et al.* (1999), who reconstructed ^{131}I thyroid doses for children in 2,729 settlements and 3 cities in Belarus and Russia and followed thyroid cancer incidence during 1991-1995. They report an ERR/Gy of 23 (95% CI 8.6, 82). There may be good reasons for choosing the lower estimate; the most obvious

explanation is that the latter estimate was published after most of the risk estimation had been completed. On the other hand, the Jacob *et al.* paper was not refered to at all in the 2001 NCI/CDC report. The higher estimate should be at least refered to and ideally an explanation of why it was not considered would be included.

- *Uncertainty.* There appears to be a small amount of confusion around the uncertainty of the dose estimates. In the 1997 article Land states that there is a two-fold uncertainty in national average dose, for a geometric standard deviation (GSD) of 1.4. This seems low, and in the memo available from the website (dated 1999) Land states that the dose has a GSD of 3 (8- or 9-fold uncertainty). The dose calculator provides doses with a roughly 3-fold uncertainty (GSD of ~1.8). The 1997 report claims that individual doses have a three-fold uncertainty and that national average dose has a two-fold uncertainty. It seems like the 1997 numbers are the ones still considered accurate and the high uncertainty claimed in the memo may be a mistake, but this will be confusing for anyone looking into this issue.
- *Regions of highest exposure.* The presentation of this information is slightly misleading and this has to do with the fact that the areas of highest ^{131}I deposition were not necessarily the areas of highest thyroid dose due to local variations in the milk exposure pathway. The areas of highest deposition were close to the test site, southern Nevada and southwestern Utah, but relatively high fallout was experienced in parts of New Mexico, Arizona, Wyoming and Colorado. The areas with the highest dose estimates include Idaho, Montana, Utah and Wyoming. These two separate topics seem to be confused when the website reports that 'larger amounts fell over Utah, Colorado, Idaho, Nevada and Montana'. This probably seems like an academic detail, but in light of the last concern it is more important.
- *Native Americans.* The website includes a power point presentation for Native Americans. When reviewing the presentation I was hoping that this would include reference to unique risks faced by Native Americans. Unfortunately this is just the same information accompanied by artistic images of Indians. We know from our research that the Western Shoshone and Southern Paiute communities near the Nevada Test Site experienced substantially elevated risk because of their lifestyle in the 1950s—they spent more time outdoors and ate a lot of wild game (see for example Frohmberg *et al.* 2000). The NCI has not yet recognized this fact. These exposure pathways are more direct and less likely to vary geographically than the milk pathway, so the areas of concern are those areas mentioned above that had the highest deposition of ^{131}I.

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