

## The Boice Report #6



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### A Study of One Million U.S. Radiation Workers and Veterans a New NCRP Initiative (DOE Grant Awarded September 2012)

**Q:** *What is the single most important question in radiation health concerns?*

**A:** *The level of risk when radiation is received gradually over time!*

The studies of the Japanese atomic-bomb survivors and patients who received radiological procedures and treatments have provided a wealth of knowledge on the late effects, mainly cancer, associated with moderate radiation doses received briefly at a high rate. But the issues faced today concern exposures delivered over years and not seconds, such as during occupation, medical imaging with computed tomography (CT) and nuclear medicine procedures, environmental releases such as occurred at the Fukushima accident, and the aftermath of a dirty-bomb terrorist detonation (O'Brien 2012). The existing epidemiologic data on human health effects (ICRP 2007; NCRP 2012) have been transformed and transported, modulated and manipulated, and there may be a procrustean problem (Mettler 2012). Procrustes was the mythological highwayman who cut off (or stretched on a rack) the legs of travelers so they would fit his iron bed (i.e., he forced conformity to an arbitrary set of conditions). For the Million Worker Study, there is little concern on generalizing the results to U.S. populations and circumstances, which is not the case for the atomic-bomb survivor study, which is of a Japanese population in 1945 (the year I was born) that survived a nuclear detonation, lived in a war-torn country, and was confronted with malnutrition, deprivation, infection, and other overriding health and psychosocial concerns. For the Million Worker Study, there will be no need to invoke a "dose and dose-rate effectiveness factor" to adjust risks from a brief exposure to situations involving gradual exposures to U.S. populations. The Million Worker Study is a national effort whose goal is to provide relevant, timely, and needed health data on the radiation risks derived from U.S. populations who received relatively high cumulative radiation doses, but delivered over many years and up to 70 years ago.



Procrustes the mythological highwayman, forcing conformity to his standard and arbitrary set of conditions (e.g., surgical amputation was required if your legs were longer than his iron bed).

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- **National Effort:** The U.S. Department of Energy (DOE) has for many years supported low-dose radiation studies<sup>1</sup> (Hall 2009), funded a pilot study of the Million Workers (Boice 2011), and now, with interagency support, the current study. The vision to conduct a study of the early U.S. radiation workers actually began over 30 years ago with requests to the U.S. Nuclear Regulatory Commission (NRC) to change its reporting requirements to facilitate possible future study of licensee workers. These changes were made, and the NRC is one of the major supporters of the study. NASA has provided support through an interagency agreement with DOE, and the U.S. Environmental Protection Agency (EPA) has initiated a similar agreement. The National Cancer Institute (NCI) has awarded a five-year grant to Vanderbilt University for the study of atomic veterans, with support and cooperation from the U.S. Department of Defense (DOD) and the U.S. Department of Veterans Affairs (DVA). National laboratory collaborators include scientists from

<sup>1</sup> Department of Energy Low Dose Radiation Research Program. Available at: <http://lowdose.energy.gov/>. Accessed 7 October 2012.

the Oak Ridge National Laboratory, the Los Alamos National Laboratory, and Oak Ridge Institute for Science and Education. Other academic involvement comes from the University of Southern California, Harvard University, and the Fred Hutchison Cancer Research Center. Private-sector contributors and collaborators are from the International Epidemiology Institute, the Risk Assessment Corporation, Landauer, Inc., and Oak Ridge Associated Universities. The new grant is to the National Council on Radiation Protection and Measurements (NCRP), chartered by Congress in 1964 to assist the nation in matters dealing with exposure to ionizing radiation and to collect, analyze, develop, and disseminate information about radiation that is in the public interest.

- **Manhattan Project and Beyond:** The DOE,<sup>2</sup> through a variety of mechanisms, has supported studies of the early workers at nuclear facilities, both those developing weapons and those developing nuclear technologies for “Atoms for Peace” and other programs.<sup>3</sup> Nearly 30 cohort populations have either been studied or data already assembled that facilitate follow-up to the present time. The model being followed is that of Rocketdyne (Atomic International), which captured career doses from all places of employment, obtained current mortality and vital status information on practically all workers, and included detailed dose reconstructions that incorporated hundreds of thousands of biological assay measurements (Boice et al. 2006, 2011; Leggett 2005). There are 196,000 workers potentially exposed to uranium and 155,000 to plutonium under evaluation. The incremental cost in conducting the extended follow-up is small compared to the decades of resources spent developing the cohorts.

- **Atomic Veterans:** The United States conducted over 200 above-ground atmospheric nuclear weapons tests during the Cold War, many of which involved military maneuvers at the Nevada Test Site and the Pacific Proving Grounds (e.g., Bikini Islands). The DOD and DVA have conducted and supported studies of the veterans over the years and over 300 million dollars have been spent in developing detailed exposure scenarios for each of the tests. The NCI, in a cooperative agreement with Vanderbilt University, is supporting the follow-up of 115,000 veterans with detailed dose reconstructions and an emphasis on leukemia, which was previously reported to be elevated in several test series (Caldwell et al. 1983; Thaul et al. 2000). Historical figures in the study include J. Robert Oppenheimer, General Leslie Groves, Enrico Fermi, and Hans Bethe.

- **Nuclear Power Plant Workers:** In 1957 the United States became one of the first countries to produce electricity using nuclear power reactors. To date, over 230,000 early workers in the nuclear industry, employed prior to 1985, have been identified from NRC files (the Radiation Exposure and Reporting System)<sup>4</sup> and from dosimetry records from Landauer, Inc. Additional records, including early microfilm files, are being used to enhance the population size. Over the years, feasibility studies have been conducted utilizing NRC, Landauer, Inc., and utility records (Jablon and Boice 1993; Muirhead et al. 1996). Regulation during the dawn of the nuclear age allowed workers to receive up to 30 mSv per quarter (120 mSv per year), and although infrequent, some workers did receive high cumulative exposures. To date, over 6 percent of the nuclear power plant workers have cumulative exposure greater than 50 mSv. Should there be a need to validate the recorded measurements, the film badges for workers covered by Landauer, Inc., are stored in underground salt mines in Kansas. Interestingly, the film negative for the 1939 movie *The Wizard of Oz* is similarly preserved—Dorothy is still in Kansas!

- **Medical and Other Workers:** Landauer, Inc., has provided radiation dosimetry services since 1953 for United States medical, nuclear, and other facilities. A computerized database of millions of workers is maintained, and over 2,500 rolls of microfilm on exposure measurements for earlier workers exist. Included in the database are radiologists, radiotherapists, cardiologists, interven-

<sup>2</sup> Department of Energy Low Dose Radiation Research Program. Available at: <http://lowdose.energy.gov/>. Accessed 7 October 2012

<sup>3</sup> Comprehensive Epidemiologic Data Resource. U.S. Department of Energy. Available at: <https://www.orau.gov/cedr/#.UHIH3K5siSo>. Accessed 7 October 2012.

<sup>4</sup> Radiation Exposure Information and Reporting System (REIRS). Available at: <http://www.nrc.gov/reading-rm/doc-collections/gils/rad-exp.html>. Accessed 7 October 2012.

tional radiologists and other medical professions, and industrial radiographers who experienced frequent radiation exposures during the course of their employment. The NRC REIRS database also includes industrial radiographers. Just over 300,000 medical and other workers with relatively complete and long-term dosimetry coverage are being selected for study. The pilot study evaluated a sample of 77,000 workers who had received >50 mSv. In this sample alone, there were 1,180 workers with >1,000 mSv cumulative exposures and 26,500 workers >100 mSv. For comparison, there were 18,443 Japanese survivors of the atomic bombings with exposures >100 mSv. The large numbers and broad range of doses in the Million Worker Study indicate more than adequate statistical ability (power) to detect any late-occurring health effects and distinguish any differences associated with radiation exposures experienced gradually over time compared with acute exposures for individual cancer sites.

• **The Million U.S. Radiation Worker and Veteran Study:** The study is 10 times larger than the study of atomic-bomb survivors and has more high-dose subjects. The title “Million” was chosen for impact and perhaps a bit of verve, but it also turned out to be the approximate number of workers available for study. An early title was the Atomic and Nuclear Energy Worker Study. Most of the included cohorts were previously evaluated, but over 20 to 30 years ago, and never combined to the extent proposed. The study is cost-effective, relying upon existing databases. Dosimetry records and bioassay measures of internal intakes exist for the majority of workers. Over 300,000 deaths have occurred to date. The study is timely in that many of the original investigators with knowledge of the past are still available for collaboration, but time is running out as the investigators, similar to the workers and veterans, are all aging! The NCRP is well placed to call upon national expertise to oversee the study. Stay tuned!

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## Study of One Million U.S. Radiation Workers



Workshop held 15-16 February 2012 in Bethesda, Maryland, with representatives from the National Cancer Institute, U.S. Department of Energy, U.S. Nuclear Regulatory Commission, U.S. Department of Defense, U.S. Department of Veterans Affairs, National Institute of Occupational Health and Safety, University of Southern California, U.S. Environmental Protection Agency, Radiation Effects Research Foundation (Japan), International Epidemiology Institute, and National Council on Radiation Protection and Measurements and Oak Ridge National Laboratory, Oak Ridge Associated Universities, Harvard University, Vanderbilt University, and Landauer, Inc.

Left to right, Kathy Gibson, Craig Yoder, Noelle Metting, Mike Mumma, Fumiyoshi Kasagi, Jen Sonderman, Jim Cassata, Betsy Ellis, Vince Holahan, Bonnie Richter, Brant Ulsh, Roy Shore, Dick Toohey, Jill Aanenson, John Boice, Terry Brock, Jerry Puskin, Dan Stram, Marilyn Diaz, Mark Salasky, Dave Schauer, Andre Bouville, David Pawel, Shin'chi Kudo; attending the meeting, but absent from the photo: Till Bullman, Stephanie Bush-Goddard, Keith Eckerman, Gladys Figueroa, Steven Garry, Doris Lewis, Howard Sesso, John Tomon, and Michael Weber ■



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