The Boice Report #20

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Atomic Bombs, Asbestos, and Healthy Warriors

Crossroads test viewing on the ship USS Fall River, Bikini, 1946

The United States during the Cold War conducted 230 above-ground atmospheric nuclear weapons tests between 1945 and 1962 at the Nevada Test Site and the Pacific Proving Grounds. Over 250,000 military personnel participated. An ongoing epidemiologic study of 115,000 atomic veterans is examining the mortality statistics over 65 years after exposure. The study is funded by the National Cancer Institute and the Department of Energy with support from the Defense Threat Reduction Agency (Department of Defense) and the Department of Veterans Affairs (VA). Scientific workshops were held in October 2013 in Tennessee in Oak Ridge and Nashville (Vanderbilt University) and in November 2013 in South Carolina at Kiawah Island (Risk Assessment Corporation). A year ago I provided an overview of the study (see Boice Report #7 in the December 2012 issue of *Health Physics News*) and now I can provide a few preliminary observations in a question-and-answer format:

- **How can you estimate radiation absorbed doses from such complex exposure scenarios?** With great difficulty! However, the Department of Defense has spent over $300,000,000 in collecting comprehensive information and responding to inquiries on all tests and we have convinced the most talented dosimetrists in the nation to work with us (see the photos on pages 22 and 23; can you pick out the 10 members of HPS?). Dose reconstruction is challenging and expensive, but we're nearing completion of bone marrow doses (for 400-plus leukemia deaths) and breast doses (for 30 male breast-cancer deaths). Unique approaches to uncertainty in the dose estimates account for both shared (e.g., exposure to fallout and contamination from ship hulls) and unshared (e.g., variations in shielding) components.
- **This is a low-dose study so how do you expect to find anything?** Great question (since I asked it)! Previous investigations have reported significant increases in leukemia (Caldwell et al. 1980) and we are now determining whether this increase is related to radiation dose. Also, not all exposures were low; e.g., exposures greater than 300 mSv occurred during the 1954 Bravo test at Operation Castle, where the wind blew the wrong way and personnel stationed at Rongerik Atoll were exposed to direct fallout before they were evacuated (DTRA 2007).
- **What about medical examinations; won't they confound the findings?** It is a rare epidemiologic study that is able to account for medical exposures, such as computed tomography (CT) and nuclear imaging examinations that are so frequent today. However, we have linked to the electronic records of the VA medical care system and are evaluating radiological procedures for all veterans. Preliminary findings indicate that the frequency of CT examinations was the same between leukemia cases with the cohort and did not differ by years prior to death. Veterans who died of lung cancer had more CT examinations than the cohort; however, the increased numbers were entirely due to procedures performed within 1–2 years of death, indicating that they were conducted for the purposes of diagnosis and treatment planning. Not everyone was covered by the electronic files, so we have recently requested all hard-copy medical records for those who died from radiogenic diseases (e.g., leukemia) and a sample of the entire cohort. Working within the VA system is remarkable!

- **Are veterans healthier than the general population?** Definitely! They are "healthy warriors" and live longer than comparable people in the general population. We've demonstrated this in following most veterans up to age 95 years and to the end of life. Over 74,000 have died. The all-cause standardized mortality ratio (SMR, the ratio of observed deaths to the expected deaths based on general population rates) was 0.95 overall or a 5 percent reduction in risk compared with the general population (1.00 would indicate the same mortality rate as the general population). The reduced rate of dying was entirely due to a reduced rate of heart disease (SMR 0.86), likely related to the selection factors of who is allowed to serve in the military; i.e., persons must be physically fit and mentally sound or they will not qualify. It is interesting that these selection factors for young people in their 20s can predict a low mortality even to age 95. The effect of these selection factors, however, diminishes with time. In 1965 the SMR overall was 0.80 and it increased to 0.95 up through 2010. General Douglas MacArthur wasn't completely correct in saying that "old soldiers never die; they just fade away" in that they eventually die but at a lower rate compared with the general population.

Dosimetry Meeting, 20 November 2013, Kiawah Island, South Carolina, left to right: Shawn Mohler, Justin Mohler, Andre Bouville, John Till, Art Rood, Nicole Martinez, Kathleen Meyer, Helen Grogan, Jill Aanenson, and John Boice

- **Who lives longer, enlisted men or officers?** Officers, hands down. This has been known for some years and has been related to differences in lifestyles, such as tobacco consumption. The enlisted men all-cause SMR was 1.03 compared with a much lower 0.70 for officers. This difference is due to a significant increase in lung cancer mortality among enlisted men (SMR 1.18) compared with a significantly low risk among officers (SMR 0.62).
- **Why should military veterans have high rates of lung cancer?** The most likely explanation is because cigarettes were included in military rations from World War I until 1975, which encouraged tobacco use at a young age. The daily K-rations contained small packets of cigarettes, and Camel, Chesterfield, and Lucky Strike were popular brands with the troops.
- **Can these selection factors for healthy individuals be related to future risk of cancer?** Only in the early years after induction or enlistment into the military. While the SMR for all cancers in 1965 was about 0.6, over the years it rose to 1.00 (comparable to the U.S. general population) in 2010. It is interesting that while selection of healthy individuals to serve in the military can be predictive of low rates of heart disease for the rest of their lives, this is not the case for cancer, where after long times the cancer rates approach and equal those in the general population.
- **Were any cancers notably elevated?** Yes. Mesothelioma (cancer of the pleura or lining of the lung) was significantly elevated (SMR 1.51).
- **What service had the highest risk of mesothelioma?** The U.S. Navy with an SMR of 2.08, or a risk twice that of the general population.
- **Why would the Navy have an increased risk of mesothelioma?** Asbestos is the likely explanation. Asbestos was used on the naval vessels for insulation in the boiler room and other areas. We evaluated all sailors who died from mesothelioma and their ratings (occupations) practically all involved ship areas where asbestos exposure was likely (e.g., in the boiler room). These substudies indicate the importance of confounding factors that could produce spurious radiation associations if not accounted for, while at the same time validating in a sense our dose-reconstruction approaches by correctly assigning military personnel to areas of assumed increased exposure, whether to asbestos or to radiation.
- **What movie star died of mesothelioma?** It was Steve McQueen (for those who remember, the "King of Cool"). His possible exposures to asbestos include a stint as a merchant mariner,

service in the Marine Corps, where he supposedly stripped asbestos off pipes on Navy ships, and as a race car driver with possible brake lining and insulation exposure. He died in Mexico, seeking alternative treatments such as laetrile.

- **What's on the immediate horizon?** Case-cohort studies of leukemia and male breast cancer to evaluate dose response. With the Centers for Disease Control and Prevention, we are planning a partnership to evaluate the original cohort that generated the concern about cancer risk in atomic veterans, i.e., the Smoky cohort where a significant increase in leukemia was reported (Caldwell et al. 1980). Stay tuned for "Smoky—60 Years Later." With the National Cancer Institute, a biodosimetry study is in the works including those high-dose veterans mentioned above at the Bravo test shot.
- **And the future?** Given the reductions in government funding over the years, we weren't able to accomplish all our goals, so we are planning a five-year renewal request. The future will emphasize dose-response analysis for myelodysplastic syndrome (a condition just recently associated with radiation at Nagasaki; see ncbi.nlm.nih.gov/pubmed/21149671) and radiogenic cancers such as bone, thyroid, salivary gland, and liver. A unique population of 37,000 military personnel who participated in the underground nuclear weapons tests from 1962 to1992 will be studied where the potential for exposure includes radioactive dust and gas venting such as occurred at the Baneberry test in 1970. Cancer incidence and noncancer diseases will be evaluated for all veterans who reach the age of 65 and thus are eligible for Medicare. Using the Medicare system, we will be able to evaluate conditions such as cataracts and heart disease (see ncbi.nlm.nih.gov/pubmed/15533190). Remember that the atomic veterans are "healthy warriors" and 60 percent of the cohort has reached the age of 65 and are eligible for Medicare coverage.

The study of atomic veterans provides a service to the veterans and their families in obtaining sound information on the possible health risks related to service to our country. It also is relevant to understanding the consequences of possible terrorist attacks with dirty bombs or improvised nuclear devices, since the nuclear exposures in these circumstances are similar to those from weapons testing. It is the relevant population for evaluating compensation claims and radiation risks among atomic veterans. Finally, this study is one part of the much larger national effort to provide information on the risks of low-dose radiation exposure experienced gradually over time, the One Million U.S. Radiation Worker and Veteran Study (see Boice Report #6).

Don't forget to register for the upcoming National Council on Radiation Protection and Measurements annual meeting 10–11 March 2014 in Bethesda, Maryland. Celebrate our 50th year since being chartered by Congress in 1964. Free registration remains open at civclients.com/ncrp.

References

Caldwell GG, Kelley D, Zack M, Falk H, Heath CW Jr. Mortality and cancer frequency among military nuclear test (Smoky) participants, 1957 through 1979. JAMA 250(5):620–624; 1980. Available at: ncbi.nlm.nih.gov/pubmed/6345829. Accessed 15 December 2013.

Defense Threat Reduction Agency. Operation CASTLE fact sheet. July 2007. Available at: dtra.mil/documents/ntpr/factsheets/Castle.pdf. Accessed 12 December 2013.

Atomic Veterans Study
9–10 October 2013
Vanderbilt University
Nashville, Tennessee

Front row, left to right: Ken Kopecky, John Boice, John Till, Andre Bouville, and Randy Brill; back row, left to right: Dick Toohey, Heidi Chen, Mike Mumma, Helen Grogan, Harold Beck, and Clark Heath. Not in picture: Dan Stram