NCRP Forty-Eighth Annual Meeting on *Emerging Issues in Radiation Protection in Medicine, Emergency Response, and the Nuclear Fuel Cycle*

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About 250 radiation protection researchers and practitioners, physicians, engineers, emergency response planners, state and federal agency personnel, and members of the academic community gathered in Bethesda, Maryland on 12-13 March 2012 to attend the National Council on Radiation Protection and Measurements’ (NCRP) Annual Meeting on “Emerging Issues in Radiation Protection in Medicine, Emergency Response, and the Nuclear Fuel Cycle.”

This meeting was originally designed to focus attention on issues surrounding the increasing use of ionizing radiation in medicine and industry and possible adverse consequences from planned, accidental, and malicious uses. However, just after the meeting topic was selected last year, the accident at the Fukushima Daiichi nuclear power plant led to a merger of the emergency response and nuclear fuel cycle topics. Medical uses of radiation held their own as a topic, as evidenced by public interest in NCRP Report No. 160, “Ionizing Radiation Exposure of the Population of the United States” (2009), which showed that medical exposures now account for about 50% of the annual radiation dose received by the average resident of the United States.

Because each area of interest was rather broad with multiple sub-areas equally deserving of attention, each meeting session was designed to include three to four 30 min presentations, followed by a panel discussion/Q&A session with the speakers. The Ninth Annual Warren K. Sinclair Keynote Address was given by Dr. Fred A. Mettler, Jr. of the New Mexico Federal Regional Medical Center in Albuquerque, New Mexico, and the Thirty-Sixth Lauriston S. Taylor Lecture was presented by Dr. Antone L. Brooks, recently retired from Washington State University Tri-Cities in Richland, Washington.

In the Sinclair Address, which customarily begins the annual meeting, Dr. Mettler covered all the topical areas in his presentation “Childhood Exposure: An Issue from Computed Tomography Scans to Fukushima.” He noted that exposure of children is not a new issue: 41% of atomic-bomb survivors were 20 y of age or younger, 27% of the population evacuated from the Chernobyl area were 17 y or age or younger, and 13% of the Japanese population are 14 y of age or younger. Children have significant anatomical and physiological differences from adults that affect their response to radiation exposure: at birth the brain is 10% of body weight, while in adults it is only 2%; effective doses from intakes of radionuclides are influenced by differences in airway diameter, gastrointestinal tract absorption, and red marrow distribution, to name just a few. There is clear evidence of excess relative risk in children for leukemia and thyroid cancers, but data indicating a strong age-at-exposure dependence exist for only a few types of tumor. Of course when we

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have little or no data, we rely on models that may or may not correspond to reality. Based on the epidemiological data being reviewed for a future United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) report, it seemed that children compared with adults were more sensitive for seven tumor sites, at similar sensitivity for five sites, at lower sensitivity for two sites, uncertain for five sites because of the absence of good data and irrelevant for five sites not clearly associated with radiation at any age at exposure. Dr. Mettler asked whether a “procrustean” approach has been taken over the years where the risk assessments for some cancers are based more on the model choice than on the data themselves? Many attention-grabbing stories, such as heart disease in Chernobyl children, are simply not true. Can the concept of effective dose even be applied to children 5 y of age or younger? Nevertheless, parents are extremely concerned about radiation exposure of their children, regardless of the source; the Image Gently® campaign is an important step towards relieving these concerns while still providing adequate diagnostic information.

The first session of the meeting was focused on radiation protection of patients as an integral part of the quality of care, and was chaired by Dr. Julie E. K. Timins. The session started with Dr. Claire Cousins of Addenbrooke’s Hospital NHS Trust in the United Kingdom, who also serves as Chair of the International Commission on Radiological Protection. Dr. Cousins’ presentation described radiation protection as part of the medical dictum “first, do no harm.” The benefit-risk ratio is a strong function of age, and due to the growing number of diagnostic methods using ionizing radiation, some patients become a victim of modern imaging technology (VOMIT). Diagnostic reference levels (DRLs) are important to avoid radiation dose that does not contribute to clinical purpose, and pediatric DRLs are easier to implement in specialized pediatric radiography units. Unfortunately, there is little physician education about radiation outside of the radiology specialties. Dr. Dan Low of the University of California, Los Angeles then spoke on enhancing safety in radiation therapy. The complexity of therapy regimens is increasing, but quality assurance has not kept pace; the problem is that outcome data are delayed for 5 y. Registry projects have been setup, but establishing safety culture in medicine remains a challenge. The system needs to be managed from the bottom up, not top down, with a commitment to excellence and zero mistakes. After a coffee break, Dr. Donald Miller of the Food and Drug Administration (FDA) discussed efforts to optimize radiation protection in interventional fluoroscopy. Although procedures are more complex, higher doses are neither monitored nor recorded, nor is there any follow-up for adverse effects. In 1994 the FDA called for use of appropriate, dedicated equipment, dose monitoring and recording, training, quality assurance, credentialing, patient follow-up, defined procedures, and patient flow-sheets. Because innovation will continue, patient registries, reference levels, and possibly regulations are needed, as well as better tracking of occupational doses, especially to the eye. The final presentation of the session was by Dr. Cynthia McCollough of the Mayo Clinic on standardization vs. individuation in computed tomography. The ordering and radiology communities need to talk about the indication, patient, device, and protocol in order to “right-size” the dose. Technique charts, automatic exposure control, and xy- and z-modulation all contribute to optimization. Achieving standardization of nomenclature is critical, but will take a long time to accomplish.
The second session of the meeting began after lunch, with a focus on the Fukushima Daiichi accident and its implications for the United States. Dr. Steven M. Becker of the University of Alabama at Birmingham chaired the session and introduced the first speaker, Dr. Michael L. Corradini of the University of Wisconsin, Madison. Dr. Corradini discussed the recent report of the American Nuclear Society Special Committee on Fukushima, and began by stating the plant withstood the earthquake that exceeded its design basis, but the ensuing tsunami destroyed the backup power supplies and caused a loss of coolant circulation. However, Units 5 and 6 suffered no damage because they were situated 10 m higher than Units 1-4. The Chernobyl accident released about 10 times the activity released by the Fukushima Daiichi accident, and Three Mile Island released about 10 times less. U.S. reactors of similar design had been strengthened following the 9/11 attacks, particularly for safe release of hydrogen gas, but several hydrogen explosions occurred at Fukushima Daiichi, destroying auxiliary buildings. However, there were no significant releases from the spent-fuel pools. Lessons learned include that a risk-informed approach should be applied to extreme national events, and emergency planning for nuclear plants should be reviewed. Command and control of the accident response should be located close to the plant, and emergency operating procedures need to be harmonized. In addition, a risk-informed approach should be considered for hardware changes at operating plants.

Dr. Corradini was followed by Dr. Becker, who spoke on the community impacts, including the severe emotional trauma, of and responses to the accident. The tsunami produced 25 million tons of rubble, not including ships and vehicles, and contaminated soils and vegetation with various industrial chemicals as well as the activity released; this waste is hampering efforts to rebuild. In addition to the earthquake, tsunami, and reactor accident, socioeconomic stigma is the fourth disaster to befall the affected population. Screening certificates became absolutely necessary for public acceptance of displaced populations, and break-ins and theft are common in the “no-go” zone. In the midst of a crisis, no matter how much we know about risk communication, it is easy to lose sight of the importance of effective risk communication. Good risk communication is challenging enough without being overwhelmed by other issues, and we fall back on old myths: Myth 1: We don’t have enough information, so we need to wait. Myth 2: We don’t want to panic the public. And so public information was delayed or withheld, producing a loss of trust.

The final presentation of the session was given by Dr. Monica Schoch-Spana of the Center for Biosecurity of the University of Pittsburgh Medical Center. The “Rad Resilient City Checklist” is a local planning tool for fallout protection intended to overcome myths that death is inevitable, fleeing is the only solution, and people must wait for responders to help them. In fact, quickly sheltering in place is the best way to avoid radiation exposure after an accident. We need to:

- obtain broad community support for nuclear preparedness;
- conduct pre-event public education on fallout protection;
- equip building owners and operators with shelter rating guidance;
- be able to deliver public warnings on fallout post attack;
- build a rapid system for mapping danger zones;
- develop support for large-scale phased evacuations; and
• integrate, test, and train on all elements of fallout preparedness.

The goal is to develop a population of informed residents who seek shelter swiftly and independently.

The first day concluded with the presentation of the Lauriston S. Taylor Lecture on Radiation Protection and Measurements by Dr. Antone L. Brooks. Following an introduction by Dr. Roger O. McClellan, Dr. Brooks discussed the “From the Field to the Laboratory and Back: The What Ifs, Wows, and Who Cares of Radiation Biology.” He began with remembrances of his childhood in St. George, Utah when the sky would light up, the ground would shake, “Dirty Harry” came to visit, and no one worried about it. One of the first “wows” he encountered in environmental monitoring as an Atomic Energy Commission fellow was that there was fallout in and on everything. “What if” it could cause genetic damage? Studies of genetic effects in Chinese hamsters were followed by inhalation studies in dogs investigating the “hot particle” problem, which turned out not to be. “Wow”: Tissues respond as an organ, not as individual cells. “What if” indoor radon is the second leading cause of lung cancer? “Wow”: Only if you also smoke. There has been a significant paradigm shift in radiobiology: bystander effects, adaptive response, genomic instability, transitions in transcription profiles in the range of 1–2 mGy, systems biology, selective apoptosis, proteomics, metabolomics, and more all show that the linear no-threshold model is not tenable at the cellular level. “Who cares”? Regulators? Scientists? Reporters? The bottom line is that radiation is nowhere near as big a hitter in cancer as is lifestyle.

The second day began with the Annual Business Meeting where elections were held and officers delivered their reports to the members. Senior Vice President, Dr. Jerrold T. Bushberg, thanked outgoing Secretary-Treasurer Dr. David A. Schauer for his service, and presented him with an engraved glass plaque and an iPad® to acknowledge his many contributions to the success of NCRP during his tenure. Dr. Bushberg then presented outgoing President Thomas S. Tenforde with a crystal clock and an iPad® in honor of the conclusion of his 10 y of service to NCRP, and the membership gave Dr. Tenforde a standing ovation in acknowledgement of his outstanding leadership.

The final session, chaired by Dr. Richard Toohey, covered the U.S. government response to the Fukushima Daiichi accident and began with a presentation by Dr. Charles Miller, chief of the Radiation Studies Branch of the of the Centers for Disease Control and Prevention (CDC). Dr. Miller was preparing to travel to Japan when he was diverted to the White House to serve as an advisor to the administration on health protection of U.S. citizens, primarily in Japan, but also domestically. This was the first time that the CDC Emergency Operations Center was activated for a radiological incident, and several important lessons were learned:

• there is insufficient equipment and personnel to monitor potentially-exposed persons;
• there is no public health authority to detain or quarantine persons found to be contaminated;
• medical expertise and treatment capacity for radiological casualties is limited;
there is an insufficient number of subject matter experts in radiation health, particularly in environmental transport of radionuclides;
public health communications on radiological issues are inadequate;
national and international exposure guides and standards lack uniformity;
access to radiological emergency monitoring data is limited and procedurally complex; and
the policy on stocking KI should be revisited.

Dr. Miller mentioned that the public appears to accept radiation exposure if it comes from “God” or from your doctor, but has difficulty with the man-made sources regardless of the level. There is a disconnect between the fact of exposure and the amount of exposure in risk perception. Further, the aging of current radiation scientists and specialists in the United States and the absence of sufficient numbers replacing them in the ranks is such that the country will experience severe difficulties in coping with any future radiation emergency if something is not done in the near future to address this deficiency. The next presenter was Admiral Joseph Krol, Assistant Administrator for Emergency Response of the National Nuclear Security Administration (NNSA). Admiral Krol described the NNSA response to the Fukushima Daiichi accident, particularly the aerial monitoring and confirmatory ground monitoring efforts. The majority of fallout released was blown out to sea, but some small amounts were blown towards Tokyo for about 6 h, leading to incessant calls for revised and updated plume and dose estimates to the population. The use of a (80 km) 50 mile exclusion zone was extremely conservative, due to the narrowness of the plume carried to the northwest of the plant. The data gathered were considered to be the property of the Japanese government, and release decisions were theirs. The third speaker was Dr. Kazuo Sakai of the National Institute of Radiological Sciences in Chiba, Japan, who discussed the use of reference levels in the context of Fukushima. In an emergency management situation, a reference level is a dose that should not be exceeded, but is often misinterpreted as a permissible dose level. This misunderstanding complicated the use of playgrounds in Fukushima; the public and media thought the permissible dose levels for children were being increased by a factor of 20 to accommodate the accident situation. The reference level is a “starting point” for which the evacuated population may consider returning to their homes, and then optimization initiated to continue the lowering of levels. The international reference level for returning to contaminated areas is recommended to be 20 mSv y⁻¹. Unfortunately, there are areas to the northwest of the damaged reactors for which the levels exceed 50 mSv y⁻¹ and it will be some time before any populations will be able to return. A lesson learned is that when children are involved, reference levels need to be optimized and may need to be set lower. In addition, the use of collective dose to estimate the number of cancers that may result during the lifetimes of a population exposed to very low dose and low dose-rate exposures is to be avoided. Incorrect information on radiation effects, including sterility was rampant, and pregnancy termination at doses less than 100 mGy is not justified. Public communication materials have been developed showing radiation risks on a logarithmic scale.

The final speaker was Dr. Richard Meserve of the Carnegie Institution for Science, who spoke on the findings of the Blue Ribbon Commission on America’s Nuclear Future. The
Commission was chartered by Energy Secretary Chu at the request of the President to consider alternatives for nuclear waste disposal if Yucca Mountain remains a nonoption. We need a new approach to siting and development of a storage site using a consent-based process, and a new organization, solely concerned with implementing the waste management process is required. Funds paid by nuclear utilities for waste management ($27 billion) exist only as a bookkeeping entry, but have in fact been used to lower the federal deficit, and are not available without appropriation. Prompt efforts should begin to identify one or more geologic repositories, and current dry cask storage sites should be consolidated. Planning for large scale transport of waste to consolidated storage and eventual disposal facilities also needs to begin now. Research and development should continue, and workforce development is required. All this will require legislative changes to the Nuclear Waste Policy Act. The overall record of the U. S. waste management program is one of broken promises and unmet commitments, but the Commission finds reasons for confidence that we can turn this record around. We know what we have to do, we know how to do it, and we know we have to do it.

The meeting concluded with closing remarks by Dr. Tenforde, in which he thanked the participants for their excellent presentations. He then turned the gavel over to the incoming NCRP President, Dr. John D. Boice, Jr. Dr. Boice closed the meeting by informing the attendees of the 2013 NCRP annual meeting, "Radiation Dose and Impacts on Exposed Population" and encouraging them to attend on 11–12 March 2013.

The NCRP 2012 Annual Meeting presentations are available at http://www.ncrppublications.org/Annual_Meeting_Proceedings_and_Presentations/48