A hot cell at Argonne National Laboratory was used to demonstrate a process for purifying molybdenum-99, an important diagnostic medical isotope. (Photo: Wes Agresta/ANL)

A critical shift in low-dose radiation research and communication

By Susan Gallier

The biggest impact of radiation in our lives may come not from radiation itself, but from regulations and guidelines intended to control exposures to man-made sources that represent a small fraction of the natural radiation around us.

Decades of research have been unable to discern clear health impacts from low levels of ionizing radiation, leading to calls for a new research program—one with a strategic research agenda focused on how the scientific understanding of the health effects of low doses (below 100 millisievert) and low dose rates (less than 5 mSv per hour) can best be augmented, applied, and communicated.

The American Nuclear Society has supported just such a study since a low-dose radiation research program within the Department of Energy's Office of Science was defunded and later terminated in 2016. In response to input from ANS and other stakeholders, Congress reauthorized DOE low-dose radiation research in the bipartisan Energy Act of 2020, and a new coordinated federal low-dose radiation research program is now underway. The program will be guided by a strategic plan developed by a committee of the National Academies of Sciences, Engineering, and Medicine and will integrate and expand on the research of past decades without treading the same well-worn path.

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A new direction


Kosti

Ourania "Rania" Kosti is a senior program officer at the National Academies' Nuclear and Radiation Studies Board with an educational and research background in biochemistry and molecular medicine. As the study director for the new committee, she is responsible for assembling a balanced group of experts and helping them issue a report.

According to Kosti, the benefits of the new program could be tremendous. "That's because low-dose radiation is everywhere, and it affects a lot of different decisions and disciplines in life," she said. "If you get the program right and you start understanding more about these very complicated questions about risks at low doses, you could start making more informed decisions about applications in medicine, emergency preparedness, waste management, and more."

The committee of about 10 individuals will include experts on radiation biology, radiation epidemiology, and radiation protection, as well as social sciences, communication, education, and program management.

A prescriptive approach is not part of the plan. "Instead, the committee will discuss the main questions that the program needs to try to address and current gaps in knowledge," Kosti said. "Then the Department of Energy hopefully will take that advice and make decisions about the exact topics that they need to fund." The committee may also make recommendations about how various federal agencies can coordinate their work with universities and international partners. Information about the Committee on Developing a Long-Term Strategy for Low-Dose Radiation Research in the United States, including opportunities for public comment, will be added to the committee's web page as it becomes available. Visit nationalacademies.org and search for the committee by name.

Patterns of the past

Central to current radiation protection regulations is the linear no-threshold (LNT) model, which assumes that radiation harm increases linearly with exposure and that zero harm exists only at zero exposure. The LNT model may result in overestimates of risk from low levels of radiation, and resources expended to meet LNT-based standards may yield little or no benefit. In fact, fear engendered by those standards, and well-intentioned protective actions—such as the evacuation of elderly and hospitalized people from the area surrounding the Fukushima Daiichi plant—may cause unintended harm to members of the public.

People are exposed to many cancer risk factors, including stress, genetics, pollution, and occupational hazards, and the difficulty of isolating the effects of specific risk factors can complicate research on low-dose radiation health effects. Some rigorous attempts to ascertain whether low doses of ionizing radiation can increase the risk of cancer have necessarily been inconclusive. Decision makers have repeatedly deferred decisions to replace the LNT model and instead have called for more research.


Piercy

"This is an issue that has been around as long as nuclear technology," said Craig Piercy, ANS executive director and chief executive officer. "There remains a fundamental lack of understanding of the health impacts at very low doses, so the scientific questions end up focusing on whether a particular impact is nonexistent or just too low to detect. A better question—the one being asked now—is, how do we apply what we already understand about radiation to drive better decision-making?"

The new research program could potentially lead to the adoption of new standards and new ways to communicate about low-dose and very-low-dose (below 10 mSv) radiation, even if the LNT model is not replaced. The strategic plan developed by the National Academies specifically calls for the program to "support education and outreach activities to disseminate information and promote public

understanding of low-dose radiation" and to "identify and, to the extent possible, quantify potential monetary and health-related impacts to federal agencies, the general public, industry, research communities, and other users of information produced by such research programs."

ANS grand challenge

Paul Dickman, a senior policy fellow at Argonne National Laboratory, has served for several years on the ANS Public Policy Committee and on the National Academies' Nuclear and Radiation Studies Board. He has been at the center of ANS's efforts to revitalize the DOE's low-dose research program.

Dickman

"The issue of low-dose radiation has always been a grand challenge for ANS [ans.org/challenges/radiation/] because we recognize that the current regulatory regimes are not risk informed," Dickman said, adding that overly conservative regulations are the result.

"Radiation is natural," Dickman said. "Humans evolved in a radioactive environment, and we are exposed to radiation every day. But radiation has become a thing of fear as opposed to being accepted as something natural."

A risk-informed approach to low-dose radiation would acknowledge that Americans receive a radiation dose of about 6.2 mSv each year (about half from natural background radiation and half from man-made sources).

"We regulate the amount of radiation you can get from drinking water but not from flying or going to the dentist," Dickman said. "Our regulations are inconsistent, not harmonized, and often not based on modern science. We need to understand how the low-dose science really applies and translate that into public health standards that make sense."

A catalyst for change

Dickman and Kosti agree that the Gilbert W. Beebe Symposium on the Future of Low-Dose Radiation Research in the United States, convened in May 2019, marked a turning point for low-dose radiation research.

"A lot of members of the radiation protection and research community were saying that it needs to be a decision-driven process," Kosti said. "In other words, you don't do research for the sake of research, but you do it because you try to ask, understand, and answer important questions about risks at low doses."

Government representatives participated in a panel discussion during the 2019 Gilbert W. Beebe Symposium on the Future of Low-Dose Radiation Research in the United States. Standing at the lectern is Jim Brink, of Harvard Medical School, who moderated the discussion. (Photo: NAS)

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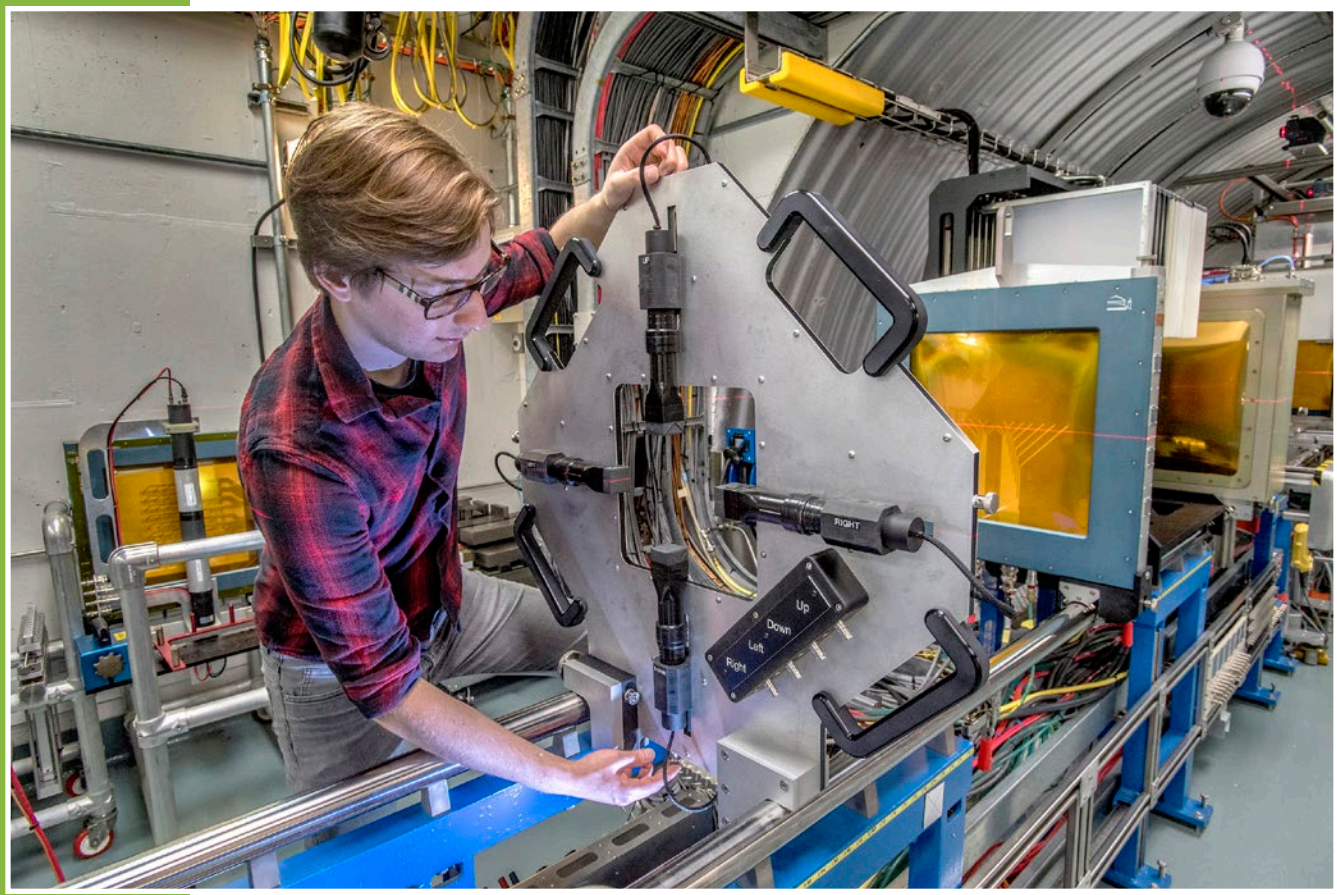
Dickman described the symposium as "the catalyst" that led ANS to organize a consortium with the Health Physics Society, the Clean Air Task Force, and Oak Ridge Associated Universities. That consortium worked with congressional and DOE staff to encourage the involvement of the National Academies in establishing a strategic research agenda. In July 2020, it participated in a National Academies' webinar to emphasize the need for research that has a direct impact on radiation protection policy.

"As a Society, our goal has been the establishment of a scientific basis for modern low-dose radiation regulation," Dickman said. "The NAS study is an important step in achieving that goal. But these programs don't happen overnight, and we need to stay engaged."

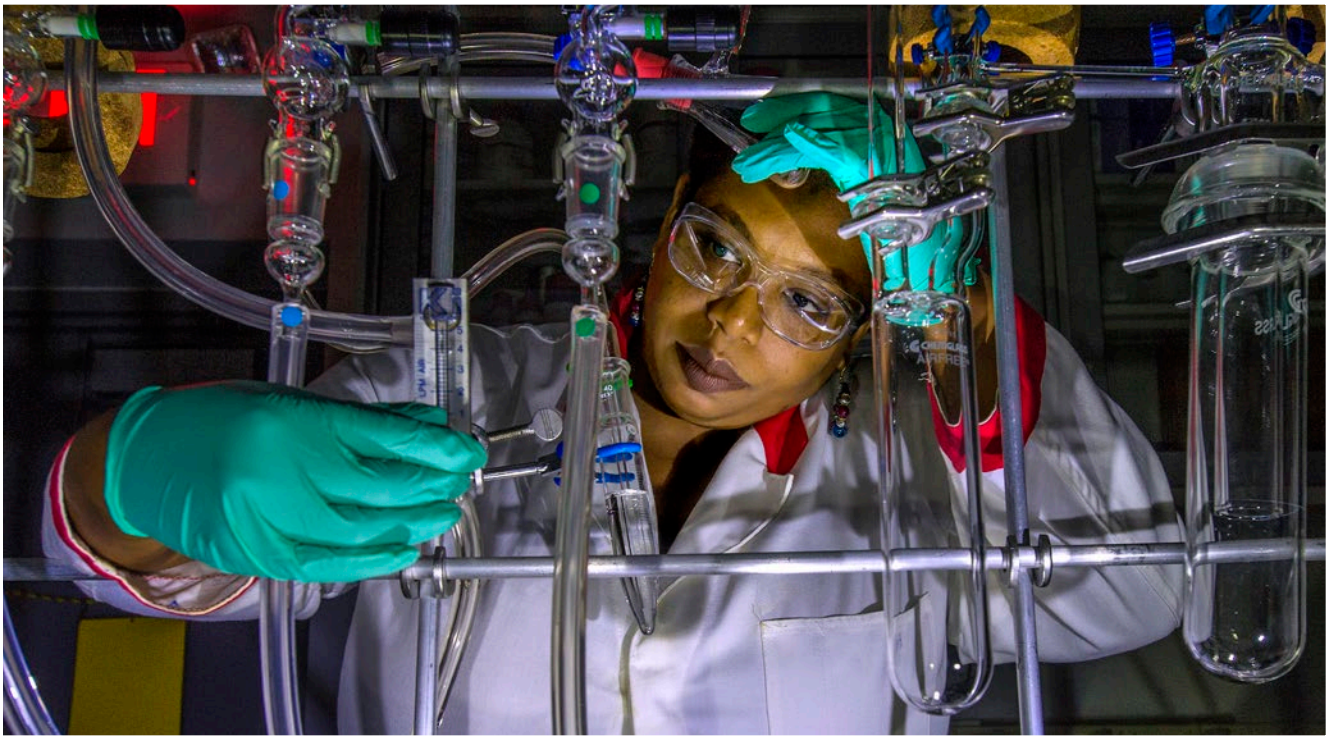
Potential applications

If new research leads to the conclusion that there is effectively a threshold below which no harm occurs, nuclear utilities and waste management programs could expend resources in a more balanced, risk-informed way, potentially saving billions of dollars and improving safety. Revised radiation protection guidelines could incorporate lessons learned from the response to the Fukushima Daiichi accident and ensure that actions undertaken in the name of public safety do not cause more harm than they prevent.

The ramifications of a coordinated federal low-dose research program would extend beyond the purview of the DOE, the Environmental Protection Agency, and the Nuclear Regulatory Commission. For example, NASA seeks to understand the impacts of radiation on astronauts for future missions, while the Department of Transportation and the Federal Aviation Administration have the authority to regulate doses received by transportation workers. Federal health agencies, including the



The NASA space radiation laboratory at Brookhaven National Laboratory. (Photo: BNL)



Doctoral student Jasmine Hatcher works in Brookhaven National Laboratory's Medical Isotope Research and Production Program in 2018. (Photo: BNL)

National Institutes of Health and the Centers for Disease Control and Prevention, have a key role in communicating about the health effects and benefits of radiation.

"Everybody is talking about personalized medicine," Kosti said. "If we understand more about individual susceptibility to low-dose radiation, this could be part of the decision-making process for a medical professional. The committee will be raising the health and safety issues that need to be guided by an improved understanding of low doses, and age, sex, genetic factors, and others will be part of the health and safety questions that we need to address."

A new BEIR report?

The primary mission of the National Academies' committee is to make recommendations to the DOE's Office of Science and add structure to the new low-dose research program. "One of those recommendations may say we need to develop a statement of work for a BEIR VIII report," Dickman said. The Biological Effects of Ionizing Radiation (BEIR) VII report, *Health Risks from Exposure to Low Levels of Ionizing Radiation*, released in 2006 by the National Academies' National Research Council, essentially upheld the LNT model.

"There's a fair amount of unanimity among the key research scientists in this field that we should be looking at how to incorporate studies done over the past 15 to 20 years into a new BEIR VIII," Dickman said. "But from an ANS perspective, we believe that we need to also consider how BEIR VIII can support harmonizing regulations and communication. This NAS study should help define future efforts."

Kosti expects the committee to hold its first meeting this summer and to issue a report in March or April 2022. "We're going to need input from absolutely every stakeholder out there," she said. "And it's not just the research and federal radiation protection community, but members of the public and anyone who cares about low-dose radiation. And that's pretty much everyone."

Susan Gallier is a Nuclear News *staff writer focusing on nuclear technology research and applications.*