HEALTH EFFECTS

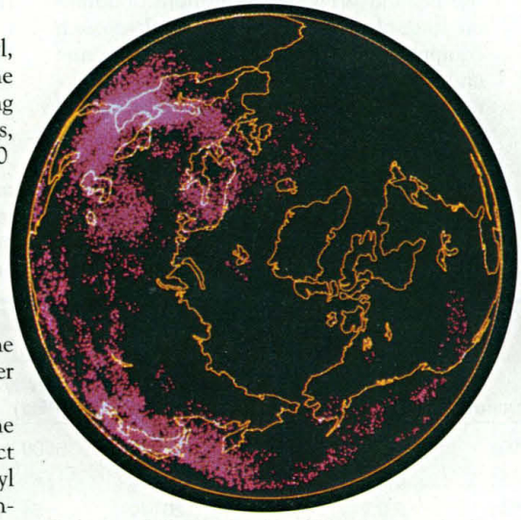
Chernobyl Research Becomes International Growth Industry

Ten years after the accident at Chernobyl, the social and psychological effects of the mass evacuations and cleanups are still being felt in the contaminated regions of Belarus, Ukraine, and western Russia. Some 270,000 people continue to live in areas with levels of residual radioactivity high enough to require expensive and disruptive measures to monitor and control foodstuffs. In addition, efforts are being made to monitor an estimated 800,000 people from all over the former Soviet Union, the "liquidators" involved in the cleanup, after they received substantial radiation doses.

But one of the most visible legacies of the accident is a profusion of studies of its impact on the health of local populations. "Chernobyl researchers have been appearing like mushrooms," says radiobiologist Eugene Komorov of the Institute of Radiation Hygiene in St. Petersburg. They have been drawn into the field by a unique opportunity to answer some of the most difficult questions in radiation biology. "We know very little about protracted, low-dose exposures—all we know is from Hiroshima and Nagasaki," where a large dose was delivered almost instantaneously, says Per Hall, a radiation epidemiologist at the Karolinska Institute in Stockholm, Sweden. In particular, he says, Chernobyl should help biologists "learn more about risks to the very young."

This growth industry has, however, been hampered by the initial secrecy that surrounded the event and deep suspicions among the local population of Soviet researchers who first came to study them. And there has been some friction between national and international agencies that have mounted major research programs on Chernobyl since the collapse of the Soviet Union.

These difficulties, however, are small compared with the scientific problems involved in trying to reconstruct radiation dose rates and spot relatively small changes in cancer incidence in a thicket of incomplete national cancer data. Indeed, only now are researchers gaining confidence that Chernobyl will provide valuable insight into the risks of exposure to low-level radiation, but others are not so sure. "It's been 10 years now, and it's probably too late to try to reconstruct what happened," says Valerie Beral, head of the Imperial Cancer Research Fund's Cancer Epidemiology Unit at Oxford University in the United Kingdom. But researchers hope lessons learned in the first 10 years will help get the most from the crop of projects planned for the coming decade.



LAWRENCE LIVERMORE NATIONAL LAB/PHOTO RESEARCHERS

Hot cloud. Computer simulation of atmospheric radioactivity 10 days after the explosion.

Secrecy and suspicion. Early studies of the accident did not get off to an auspicious start. Indeed, in the first days after the explosion, Soviet authorities denied there had even been an accident. Only as radiation monitoring experts—first in Sweden and Finland and then all over Western Europe—began detecting rising levels of airborne radioactivity did the Soviet government begin to release some information. And after the initial crisis and encasement of the reactor in its now-crumbling sarcophagus, there was increasing resentment and distrust among the population directed at scientists and physicians. There were "insufficiently substantiated and often contradictory statements on health effects, including leukemia and other forms of cancer," says hematologist Eugene Ivanov of the Institute for Hematology in Minsk, Belarus.

For 2 years the official block on information continued. Although there were sporadic contacts between Soviet scientists and their counterparts in the West and Japan, these rarely led to scientific collaborations, and few foreigners had access to the region. But as both domestic and international distrust grew, in 1989 the tottering Soviet government invited the first international team of experts—coordinated by the International Atomic Energy Agency (IAEA) in Vienna—to assess the radiological consequences for the populations most affected. The International Chernobyl Project, which involved 200 scientists from 23 countries and seven international organizations, began work in 1990. The project found no health effects that could be directly attributed to radiation, but did point out the possibility of rising levels of thyroid cancer in the exposed population.

But the project backfired. Locals were hostile because the agency was seen as a promoter of nuclear power, and the results did nothing to reassure them. "We got slammed by the press, who said we were downplaying the accident," says an IAEA insider. Licking its wounds, the IAEA has since scaled back its involvement in Chernobyl research.

An international project. As IAEA pulled back, however, other international organizations rushed in. The key event that opened the door to outside collaboration occurred in 1991: the collapse of the Soviet Union. The three most highly contaminated republics, Belarus, Russia, and Ukraine, were now independent, but their economies had collapsed and little money was available for research funding. All of a sudden, local scientists were eager to join international collaborations. "They were desperate for foreign exchange and desperate for help with the horrendous consequences of the accident," says Dillwyn Williams, a thyroid cancer expert at Cambridge University in the United Kingdom.

Outside collaborators—and money—soon began pouring into the three republics. One of the biggest spenders has been the European Commission (EC), which devoted a total of about $27 million between 1991 and 1995 to fund 16 pilot projects on health effects, environmental impact, and emergency management issues. Part of this money went to boost scientific infrastructure in the republics, including the purchase of computers and scientific instruments as well as boosting local researchers' salaries. "We had to offer direct help to make collaboration attractive," says Jaak Sinnaeve, head of the EC's radiation protection research group.

The World Health Organization (WHO) also joined the fray in 1991, when it launched the $20 million International Program on the Health Effects of the Chernobyl Accident (IPHECA), which was mostly funded by a grant from Japan. The program consisted of pilot projects in five priority areas: thyroid, hematology, brain damage in fetuses, epidemiological registers, and oral health. "Our aim was to strengthen national programs and help the collection of data," says Gennardi Souchkevitch, a radiation scientist who works on the IPHECA program in WHO headquarters in Geneva.

And more recently, the U.S. National Cancer Institute (NCI), Nuclear Regulatory Commission, and Department of Energy have all signed bilateral collaborative agreements with the three republics. Nevertheless, some American radiation experts express embarrassment at the relatively small U.S. contribution, which is only $1.8 million for 1996 and will be reduced to $1.2 million in 1997. "The Europeans are spending much more,"

says one U.S. official privately.

A division of labor of sorts has emerged between these agencies, although the boundary lines are very loosely defined. For example, WHO has chosen to stick to the health consequences of the accident, while the EC has spread its work broadly to include radioactive contamination in the environment and future emergency planning. In the studies of thyroid cancer, the United States is coordinating epidemiological studies with Eastern collaborators, while the EC is covering tumor pathology and diagnosis.

There is still some overlap, however: The International Agency for Research on Cancer (IARC) in Lyons, France—a specially funded WHO project—is also heavily involved in epidemiological studies of thyroid cancer as well as follow-up of the liquidators. And a number of turf battles have emerged, most notably between WHO and the EC over responsibility for thyroid cancer studies, considered by most scientists to be the hottest current area of research. This conflict, which one researcher says is due to "a clash of personalities" among the people involved, has led to the establishment of two "rival" thyroid programs: the WHO's International Thyroid Project and a separate EC program. Nevertheless, most Eastern and Western researchers working on thyroid cancer are collaborating with both programs.

Some agencies have avoided potential rivalries by going it alone, although this brings its own problems. For example, Japan's Sasakawa Foundation has spent $50 million on an aid package including measurement of radiation doses received by 100,000 children born between 1976 and 1986, using mobile instruments. But this work seemed to duplicate investigations in one of Germany's bilateral projects with Belarus. "We came across Japanese teams during fieldwork, but we didn't really know what they were doing," says Ralf Hille, one of the project researchers from the German National Research Center at Jülich.

Friction and lack of coordination have not been limited to Western organizations. In the newly independent states, competition rather than collaboration soon became the byword. "Cooperation at first between Russian and Ukrainian researchers was abysmal," says the Western coordinator of one of the EC pilot projects. And Belarus, the smallest of the three new republics, jealously guarded its bilateral collaborations for fear of being swamped by its larger neighbors. "Each country wanted to do it for themselves," says immunologist Daniel Gluzman of the Kavetsky Institute for Oncology and Radiobiology of the Ukrainian National Academy of Sciences (UNAS).

And within each country, there was competition between institutes to attract funds, such as between UNAS and Ukraine's ministry of health, Gluzman says. And although the EC and WHO spent millions of dollars on state-of-the-art diagnostic and research equipment, the impoverished infrastructure and lack of training made it difficult to make full use of it. "The quality of basic reagents and other materials was so poor that researchers had to spend a lot of time getting them up to the standards assumed in our laboratories," says one Western scientist working on one of the EC projects. "We just weren't able to work as quickly as we'd planned," he adds.

	Core inventory on 26 April 1986		Total release during the accident	
Nuclide	Half-Life (PBq)	Activity	Percent of inventory	Activity (PBq)
^{33}Xe	5.3 d	6,500	100	6500
^{131}I	8.0 d	3,200	50–60	~1760
^{134}Cs	2.0 y	180	20–40	~54
^{137}Cs	30.0 y	280	20–40	~85
^{132}Te	78.0 h	2,700	25–60	~1150
^{89}Sr	52.0 d	2,300	4–6	~115
^{90}Sr	28.0 y	200	4–6	~10
^{140}Ba	12.8 d	4,800	4–6	~240
^{95}Zr	1.4 h	5,600	3.5	196
^{99}Mo	67.0 h	4,800	>3.5	>168
^{103}Ru	39.6 d	4,800	>3.5	>168
^{106}Ru	1.0 y	2,100	>3.5	>73
^{141}Ce	33.0 d	5,600	3.5	196
^{144}Ce	285.0 d	3,300	3.5	~116
^{239}Np	2.4 d	27,000	3.5	~95
^{238}Pu	86.0 y	1	3.5	0.035
^{239}Pu	24,400.0 y	0.85	3.5	0.03
^{240}Pu	6,580.0 y	1.2	3.5	0.042
^{241}Pu	13.2 y	170	3.5	~6
^{242}Cm	163.0 d	26	3.5	~0.9

Before and after. Estimates by OECD of radionuclide releases.

Moreover, at the beginning, what some Western scientists call differences in "scientific culture" impeded collaboration between East and West. "They had a lot of good scientists, but very little history of doing cancer epidemiology," says IARC's Elisabeth Cardis. "They've had to learn our quality-control standards. At first, they were unhappy when we'd ask them to write detailed reports of how things were done, as if we didn't trust them." And NCI epidemiologist Gilbert Beebe, who has worked with colleagues in Belarus, says that "it's been an uphill battle for them to understand what the hell we were driving at with our 50-page protocols. But they've felt that this is the price they had to pay for Western assistance."

Some Eastern scientists, while welcoming collaboration with their Western counterparts, remain wary about the nature of the relationship. "Collaborations should be based on the equality of partners," says Alexei Okeanov of the Center for Medical Technologies in Minsk. "At present only the first steps have been made in this direction." For example, in discussions with *Science*, some Western researchers were privately critical of the approach taken by WHO's IPHECA program. "They acted as colonizers rather than collaborators," says one scientist.

In spite of these glitches and frictions, most radiation experts say they now have a much more sophisticated view of what happened after the accident, and both Western and Eastern scientists have learned how to collaborate more effectively. And they are gearing up for a long-term effort. With its 16 pilot projects now completed, the EC has already allocated about $15 million during 1996 to 1998 to push ahead with follow-up research, particularly full-scale epidemiological studies of the liquidators (see p. 360) and thyroid cancer victims (see p. 357). And the EC's Sinnaeve says he hopes that an equal amount will be raised from other parts of the EC budget and contributions from individual European countries. Seed corn funds of about $20,000 for each of three priority follow-up projects planned by IPHECA—studies of liquidators, thyroid cancer, and dose reconstructions—have been allocated by WHO, and proposals are being drawn up to attract further funds from donor countries. "I'm optimistic we'll get further funds," says IPHECA's Souchkevitch.

But while researchers hope that this catastrophe may reap rewards for future generations through a better understanding of radiation-induced cancer, that is scant consolation for today's victims. There is a chronic toll of ill health that results not directly from radiation, but from the anxiety and social upheavals the accident continues to cause—exacerbated by the huge financial costs to the republics of the cleanup operations. "The health problems in these countries are so bad that the emphasis on Chernobyl is completely distorting the overall picture there," says Beral. In a political landscape unimaginable 10 years ago, Alexander Lukshenko, president of Belarus, said in a television broadcast at the time of a recent Chernobyl conference in Minsk that anyone who has not dealt directly with this tragedy of radioactivity might think it is no longer a timely issue. But, he said, "for Belarus, Ukraine, and Russia this tragedy has a clear beginning, but no end is in sight."

–Nigel Williams and Michael Balter