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THE NEW PANORAMA OF RADIOEPIDEMIOLOGY — PROBLEMS AND POSSIBILITIES THAT EMERGE IN A CHANGED EUROPE

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Abstract — The political change in the former Soviet Union and its sphere of influence has brought into the open information on various situations involving the radiation exposure of large populations, and has thus widened the field of radioepidemiological investigations that need to be performed. Three issues are considered. The consequences of the Chernobyl accident are still largely unresolved, and the hopes for radioepidemiological investigations have been gravely disappointed due to the lack of coordinated efforts. The steep increase of childhood thyroid carcinoma rates in Belarus is the only observed late effect so far; but even in the face of this alarming situation there is little readiness to accept help with regards to medical treatment and to scientific investigations. The attempts to block all information after the reactor accident in the former Soviet Union must be seen against the background of earlier occurrences that were successfully hidden for decades, and a particularly grave issue was the large scale contamination in the Southern Urals of the River Techa and adjacent villages. An epidemiological study on the affected population has led to first results; it may develop into a major body of knowledge on radiation risks from protracted exposures. A third broad task in the years to come will be the analysis of the health effects in the underground miners of the Wismut AG, the former Soviet–German uranium mining enterprise. Exposure data and health information on several 100,000 miners will need to be analysed, and this may further the knowledge of the effects of radon exposures.

INTRODUCTION

Microdosimetry is not a purpose in itself, but a tool that is essential — and will become even more essential — in the various branches of the science of radiation. New developments in radiation research are, therefore, relevant to microdosimetry and to those who work in this field, even if they lack apparent microdosimetric implications. The topics that are considered in this paper may, nevertheless, appear inappropriate for this symposium, because they call primarily for practical solutions and corrective actions and only on a second level of urgency for scientific investigations. However, the need for practical solutions and the scientific challenges are inseparable; they have arisen jointly from the use of nuclear energy, mostly for military purposes, in the former Soviet Union and its East European sphere of interest. The problems have been brought into the open during the dissolution of the USSR. They concern the grave problems of Chernobyl, still largely unresolved, the heritage of earlier extensive nuclear contaminations in the Southern Urals, hidden for decades, and finally the consequences of one of the largest programmes of uranium mining, concealed behind walls of secrecy until the end of the German Democratic Republic.

THREE ISSUES OF CONCERN

Chernobyl and its aftermath

To give even a rough outline of the unresolved issues after the accident at Chernobyl would require a broad discussion(1). Only the barest sketch can be presented here, but it includes several critical points.

On 26 April 1986, block 4 of the Chernobyl reactor station exploded and the 200 tons of its graphite core ignited to release a large fraction of the fission product inventory. More than 100,000 people were evacuated from the immediate vicinity of the reactor within the subsequent days, and their doses before evacuation were initially estimated to be about 50 mGy, and about 300 mGy for those evacuated with some delay from the more rural areas. The dose estimates were later reduced; they are still insufficiently documented.

The very candid information given by Soviet technicians and scientists at an international conference in August 1986(2) raised the hope of a concerted international project of radiation epidemiology. These hopes have now largely vanished. An All Union Institute of Radiology was founded in Kiev to coordinate dosimetry and the assessment of health effects. It made valid efforts in radiation dosimetry, but before it could start substantial work on health effects, the responsibility was — in a strange alliance of Soviet authorities and WHO, Geneva—shifted from Kiev to Obninsk, near Moscow, i.e. away from the real problems. The centre in Obninsk has since worked on a number of data banks, but the progress of the work remains undocumented, and consequently raises few expectations.

The early evacuees from the vicinity of Chernobyl were exposed to a collective dose not very different from that of the atomic bomb survivors in Hiroshima and Nagasaki, however, they are now dispersed and inadequately followed. In this cohort one lacks the considerable variations of dose and the relatively good dosimetry that are important features among the atomic bomb survivors. A meaningful evaluation of late effects is, therefore, unlikely. Owing to the poor health statistics and the lack of a systematic follow-up, information on a possible excess of childhood leukaemias—which would be the effect most likely to be seen—may be unobtainable. The lack of reliable information goes so far, that even the number of pre-natally exposed children among the early evacuees remains undocumented. There have merely been general statements that most of the pregnancies among the evacuees have been terminated.

About 300,000 people still live in the more heavily contaminated regions, the so-called narrow-control zone with initial caesium contaminations in excess of 0.5 $MBq.m^{-2}$ (15 $Ci.km^{-2}$). Dosimetric information on these people who were estimated to have received an added dose of about 50 mGy in 4 years after the accident has been given[3], but no evaluation of health data and of cancer rates has been presented.

The one critical group that may, with some expectation of success, be studied in Obninsk are the 'liquidators'. There appears to be a data bank for a subgroup of these emergency accident workers with a considerable collective dose, but here too, detailed reports are missing. With the absence of official information it is not surprising that unsupported assertions about a great number of radiation-induced deaths among the liquidators are spread, especially in the statements of the Ukrainian scientist Chernusenko[4].

The only visible late effect due to the reactor accident appears to be, so far, the dramatic increase of thyroid cancers (see Figure 1) among children in Belarus. The thyroid doses due to ^{131}I, and possibly due to the shorter lived iodine isotopes, were high, since no precautions were taken after the accident. Owing to the efforts of a special task group of WHO-Euro, the thyroid cancer incidence was published[5], but even this task group has been unable, up to now, to achieve the publication of the most basic information, such as the birth dates of the young patients, who were all treated at the centre in Minsk. The cohort effect that would be the real proof of a causal relation is thus still uncertain, and more detailed investigations will be required[6]. If, as it seems, health data are kept back as a mercantile commodity, effective help will be almost impossible, and there will be continued inadequate treatment of the children. The loudly announced IPHEKA project of WHO and the Russian authorities[7] may, if this deadlock is not broken, impede help rather than provide it.

The failure to deal adequately with the need for radioepidemiological studies is part of a larger problem. In fact the technical catastrophe of the burning reactor was paralleled and compounded by a second catastrophe, the complete blockage of information to the people of the Soviet Union for 2 years. When in 1988 increasing public pressure forced the release of information, the mistrust had become too engrained to get reliable information through to the people. The late effects, such as leukaemias, that had been expected are not seen due to the poor health statistics, while a multitude of other illnesses that have never been correlated with irradiations, are now generally ascribed to radiation. The abnormal living conditions and the continuing constraints, for example, in the production and consumption of food, and the grave apprehensions account for many health effects. The impossibility of focusing help on to those who are actually exposed to substantial radiation levels from external sources or from contaminated food, perpetuates the unresolved problems.

With regard to the justified apprehensions of the population, a special effort has been made by the German Government to provide a service of periodic whole-body screening for ^{137}Cs and of explanatory information to the people in the contaminated regions. This has led, from measurements on more than 200,000 people, to the result[8] that about 98% of those measured could be assured to receive less than 1 $mSv.y^{-1}$ from contaminated food. For

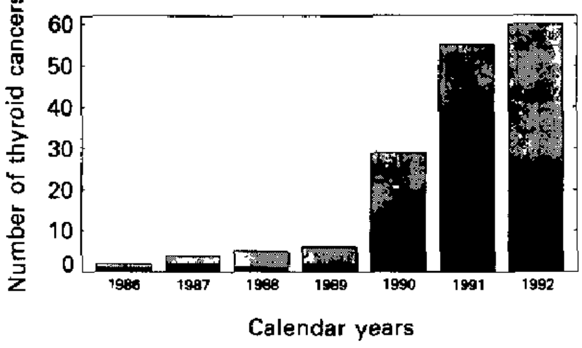

Figure 1. The number of childhood thyroid cancers in Belarus in the period after the reactor accident in Chernobyl. The data are from Kazakov *et al* (1992)[5]. The number for 1992 is an extrapolation; it equals twice the number of cases in the first 6 months of 1992; (■) Gomel, (□) other Belarus.

these people the return to more normal living conditions is facilitated, while the limited help that is possible can be focused more effectively on the group of people with high body burdens. The programme will need to be broadened into an international effort.

With regard to the 'liquidators' a similar effort is being made now to provide, through biological dosimetry, at least a rough assessment of the doses that they have incurred. To this purpose a project has been started in the Newly Independent States (NIS) to build up a network of institutions with the same state-of-the-art methods of chromosome analysis. This programme is based on continued exchanges of scientists from all relevant laboratories in the NIS to the Research Centre for Health and Environment, GSF, Neuherberg.

In summary, the aftermath of Chernobyl continues to be a history of grave failures and disappointments, with the people in the contaminated regions being the victims. The efforts to alleviate this situation need to be intensified, before there will be meaningful science.

The contaminations in the Southern Urals

The attempt of the Soviet authorities to block all information for years after the Chernobyl accident appeared too absurd to make sense. However, it is more comprehensible, if one knows that a contamination with considerably higher radiation exposures of the affected populations was hidden successfully for many decades in the former USSR. The plutonium for the first nuclear weapons of the Soviet Union was produced in the Southern Urals near Cheljabinsk (see *Figure 2*) in the period after 1948. In the subsequent years the workers in the reactor and in the radiochemical separation plant were exposed to high doses, causing frequent cases of radiation sickness. First publications are now available[9]. They give for a 1948–1953 cohort of 1286 male workers in the reactor a mean dose of about 1.2 Gy, and for the 1812 male workers at the radiochemical plant a mean dose of 2.5 Gy. Numerous workers in the radiochemical plant had substantially higher doses, up to about 4 $Gy.y^{-1}$. The epidemiological data and their still preliminary evaluation indicate significantly increased cancer rates for the workers in the radiochemical plant.

A separate epidemiological study conducted on the populations living on the River Techa is somewhat more advanced. In the years 1949–1956 all fission products from the radiochemical plant were dumped into the small river Techa[10]. The resulting dose rates on the heavily populated river banks are indicated in Figure 3. In one village,

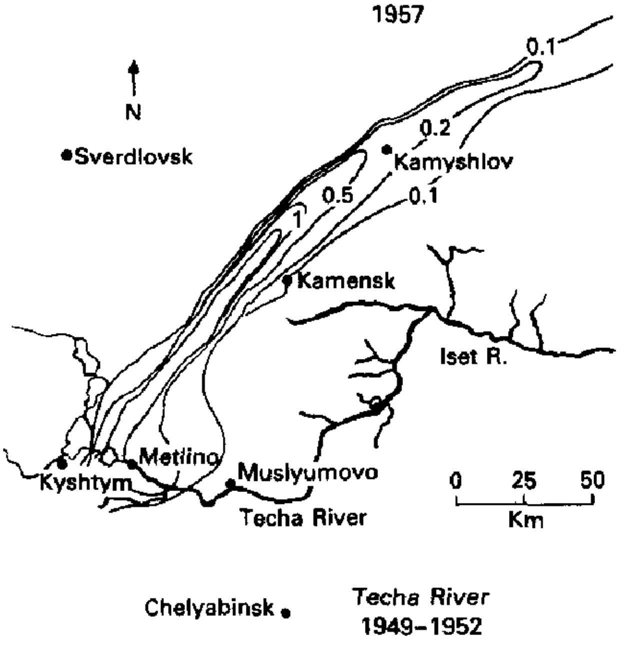

Figure 2. Diagram of the region around the plutonium production plants near Kyshtym and the River Techa which has been contaminated, predominantly in the years 1949–1952 by these plants. Included in the diagram is the distribution of the contamination due to the Kyshtym accident in 1957. The parameters of the isolines are the depositions of ^{90}Sr in $Ci.km^{-2}$[10].

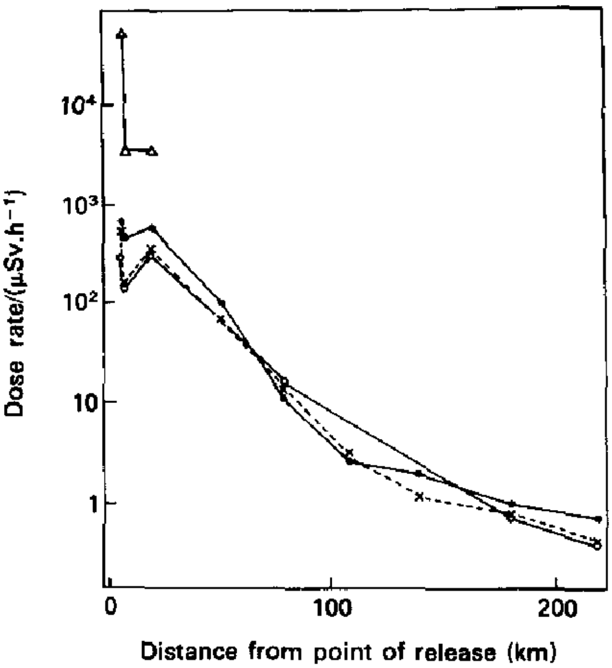

Figure 3. Dose rates from γ emitters on the bank of the Techa River during the years of contamination[10]: (–Δ–) 1951, (–●–) 1952, (--×--) 1953, (–O–) 1954.

Metlino, the average estimated effective dose to the inhabitants, partly from external exposure but predominantly from internal exposure to strontium, was 1.5 Gy. Many other villages had similar, if somewhat lower, mean doses and numerous people recieved considerably higher exposure. The populations on the Techa were never informed about the contaminations. In 1953 they were advised to build wells and to discontinue drinking the river water. However, the unexplained order was only partly followed. In 1956 various villages were evacuated and destroyed, again without explanation. Part of the population was resettled to the north. In the subsequent year the accident of Kyshtym happened; a tank with fission products exploded and released large amounts of radionuclides, and especially strontium, northeast from Kyshtym. After this accident, many people who had already been resettled were relocated again. But the evacuations were prompt, and the Kyshtym accident led, therefore, to much less collective exposure than the continuous earlier contamination of the Techa.

A third incident occurred in 1965. An extremely dry summer was followed by exceptionally strong storms. Part of the retaining ponds, then used for dumping enormous activities of radionuclides, had dried out, and activities from these ponds together with those from the closed contaminated region of the Kyshtym accident were resuspended and swept into inhabited regions. However, this third incident, too, contributed much less collective exposure than the Techa River contamination.

Thorough dosimetric studies had been performed surreptiously even in the early years of the fission product releases. Later more than 40,000 measurements of strontium body burdens were performed with phoswich detectors that registered the bremsstrahlung of yttrium. Figure 4 gives, as an example of the results, average values obtained in these measurements and extensive β ray *in vivo* measurements on teeth. Mira Kossenko and her

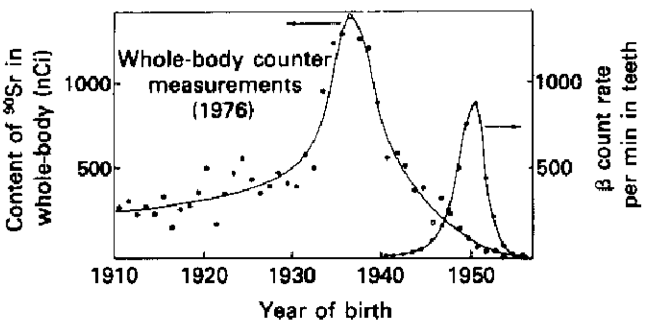

Figure 4. Averages of the measured body burdens of ^{90}Sr in 1975 in inhabitants of specified age cohorts in one of the villages of the Techa River[10]. The curve on the right gives the relative β ray counts on the teeth of the inhabitants.

colleague Marina Degteva conducted a thorough epidemiological investigation of late effects on the population of the River Techa[11]. They found a substantial increase of leukaemias. Altogether there were 38 cases, excluding younger persons who had been exposed pre-natally. The preliminary risk estimates are somewhat lower than those from Hiroshima and Nagasaki, and the study is, therefore, a first tentative confirmation of the dose reduction factor that is frequently employed in risk estimation. For the solid cancers one finds a dose-dependent increase, if one separates the different ethnic groups among the Techa River populations in the analysis.

The extensive health data collected on the Techa River population exist presently only in handwritten form. They need to be restructured into data banks, and this, as well as the continuation of the study and its more advanced analyses, will require extensive further efforts. The results are of great potential importance, as they can complement the data from Hiroshima and Nagasaki that relate to a brief one-time exposure.

The heritage of the Wismut AG

When the BEIR IV Committee of the National Academy of Science[12] performed its pooled analysis of the major cohorts of uranium miners, it was unable to include the Czechoslovak data. These data were still classified, although Czech colleagues had used the political spring of 1968 to publish part of the results. A scientific collaboration with these scientists was started even before the political relaxation, and the results of the new detailed analysis of their data have been published[13]. While largely in agreement with the earlier results, the Czechoslovak data indicate somewhat higher risk estimates, especially at young ages and at low exposures.

On the other hand, the German side of the ore mountains secrecy was far more strict and was preserved longer. The German–Soviet enterprise Wismut, is being liquidated subsequent to German unification, and the huge magnitude of its uranium production has become known during the course of this liquidation. It has now been learned that several 100,000 miners in Saxony and Thuringia, were exposed to extremely high radon levels in the early 1950s, and that many more were exposed to lower levels up to the end of the DDR.

The dimension of the problem may be illustrated by a straight comparison. According to the newest estimates, about 400 excess cancer deaths, have occurred among the atomic bomb survivors up to 1985; among the miners of the Wismut AG more than 6000 lung cancer cases have been compensated, even under the severely restricted criteria of the DDR.

In the years to come, previously rejected compensation claims of the miners need to be reassessed, and new cases will have to be examined. While these legal and social matters have priority, it will be essential to perform a thorough epidemiological investigation among the miners, and a large follow-up, with a nested case control study has been projected[14]. This will entail the need to perform detailed dosimetric reconstructions. Bringing the information on the miners of the Wismut AG into computer readable form requires, in itself, a huge effort. Years will, thus, pass before meaningful epidemiologcal results are obtained, but there is no doubt that the task needs to be undertaken.

CONCLUSION

The political dissolution of the Soviet Union and its sphere of influence has raised the veil of secrecy from major problem areas that arose from the military use of nuclear power. Three of these have been considered, but others, e.g. the problem of the nuclear test areas, or the problem of uranium mining within the former USSR itself remain largely unknown. Political, economic, and social problems impede the scientific investigations in all these areas. These problems need to be solved first, primarily in the interest of the affected people but also to prepare the ground for the radioepidemiological investigations that can further our knowledge of the risks of ionising radiations.

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