Epidemiological survey of the medical consequences of the Chernobyl accident in Ukraine

V.A. Buzunov, a N.P. Strapko, a E.A. Pirogova, a L.I. Krasnikova, a V.N. Bugayev, a N.A. Korol, a T.V. Treskunova, a B.A. Ledoschuk, b N.A. Gudzenko, a E.I. Bomko, a O.A. Bobyleva, c & G.I. Kartushin a

The Chernobyl Nuclear Power Plant accident, its sequelae, and the potential harm to the health of the population have specific characteristics.

The radioactive material in the form of gases, aerosols or "fuel particles", consisted of a wide spectrum of short- and long-lived radionuclides, which were thrown out into the environment and exposed the population to doses of radiation. The long duration of the ejection of material from the active zone of the reactor (16 days), and changeable meteorological conditions caused irregular pollution patterns in large areas of Ukraine, Russia and Belarus. Superficial soil pollution by radionuclides caesium-134 and caesium-137 occurred in about 37 million hectares in Ukraine.

The Chernobyl accident was unusual because of the numerous population groups affected by ionizing radiation. The total number of adults affected by the accident at the Chernobyl Nuclear Power Plant (CNPP) in Ukraine was 2,365,465 persons as of January 1, 1994, including 25,753 persons in Category 1 (persons who had acute radiation sickness (ARS), group 1, 2, 3 disability) and 336,992 persons in Category 2. In the near future, persons in Category 2 will be the main reservoir for an increasing quantity of disease, disability and death. The high-risk population is the children, who totalled 750,809 on January 1, 1994. In the near future the health condition of these population groups will be determined by the coverage and quality of social, economic and medical help.

It is very important, from an epidemiological and medical viewpoint, that the affected population should not be classified only by length of irradiation (short term, delayed, chronic), type of radiation (external, internal, fetal), or the nature of the radionuclides and doses of irradiation. For medical, biological and epidemiological study, main groups of registrants have been defined: accident clean-up workers (ACWs); evacuees; inhabitants of radioactively contaminated regions (RCR); and children born to irradiated persons. A special system of epidemiological study was designed and developed to deal with the radiological and ecological peculiarities of CNPP in Ukraine.

The organization, information and methodological basis of this system is the State Register of Ukraine (SRU), for prospective monitoring, and some specialized scientific sub-registries: "medical-demographic", "oncological", "clinical-epidemiological", "children", "pregnant and newborn", "thyroid gland", and "haematoblastosis". These sub-registries are instruments for conducting a retrospective-prospective study and an epidemiological analysis. SRU covers 408,344 individuals, including 108,758 ACWs, 61,432 evacuees, 135,047 in RCR and 23,087 children born to irradiated persons.

According to basic estimates and prognoses for radiation-induced stochastic effects, the health of affected persons will change drastically after the accident, because the latency period of the somatic-stochastic effects is 5-10 years, with the exception of leukaemia. The study revealed that the health of the affected population deteriorated during the period 1986-1993. The proportion of healthy people among ACWs dropped from 78% to 26.6%; among evacuees from 58.7% to 27.5%; and in the RCR from 51.7% to 31.7%. In 1988 60% of the children evacuated from the 30-km zone were healthy compared to 38% in 1992, while healthy children in the RCR represented 62% and 32% respectively.

The overall level of primary morbidity of ACWs was 377.9 (cases per 1,000 persons) in 1988, 806.2 in 1992, and 545.8 in 1993. Owing to an increasing proportion of chronic diseases, the overall level of morbidity in affected contingents increased dynamically in the post-accident period. In 1988 morbidity among children in the RCR was 934.0 cases per 1,000 and in 1993 it was 1,375.3, while for adult evacuees and adults in the RCR it was 499.2 and 1,514.9 in 1988, 434.2 and 1,518.9 in 1993.

Increases in total morbidity from 1986 to 1993 were caused by an increase in diseases of the nervous, digestive, musculoskeletal and urogenital systems. A definite dependence was established between the morbidity of chronic form non-tumour pathology and doses of external irradiation.

The overall level of pathology in ACWs was 685.1 per 1,000 in persons with doses of 250 mGy and over, and 580.6 per 1,000 in persons with doses less than 250 mGy in the 1986-1991 period. A higher level of mental disorders and diseases of the nervous, digestive and musculoskeletal systems was also seen in persons with higher radiation doses.

---

a Radiation Medicine Research Centre, Kiev, Ukraine.
b Ministry of Emergency Situations, Kiev, Ukraine.
c Ministry of Health, Kiev, Ukraine.

Rapp. trist. statist. sanit. mond., 42 (1996)
Of course, these data need further analysis. In this period, 141 cases of hematoblastosis were recorded among ACWs, including 86 cases of leucosis. A relationship between leucosis morbidity and length of residence in the 30-km zone was observed: the rate of disease was 3.4 cases per 100,000 for ACWs who worked in 1986 and 7.04 for those who worked in subsequent years. Excess morbidity continued for up to 5 years after participation in the post-accident clean-up.

The morbidity structure of the adult population varies over different periods of the survey. At first, diseases of the respiratory and nervous systems, as well as mental disorders, were found in evacuees and after that, diseases of the digestive, cardiovascular and musculoskeletal systems. In adults in the RCR, pathology of the cardiovascular, musculoskeletal, respiratory and endocrine systems ranked first; in children, diseases of the respiratory, digestive, nervous and cardiovascular systems, along with blood and congenital defects. The crucial group in the child population consists of children who were irradiated in the thyroid gland (radioiodine 2 Gy and more) and children born to irradiated persons. Increasing morbidity in the affected population from the Chernobyl NPP accident led to increasing disability and mortality.

In 1988 disability among ACWs was 2.7 per 1000, increasing in 1992 to 74.4 per 1000 and in 1993 to 100.1 per 1000. Disability among female ACWs was 1.5-2 times higher than in males. In 1988, traumas and poisoning were a main cause of disability in ACWs (25%), including radiation pathology; in 1992, cases of the nervous system accounted for 50.2%, and of the cardiovascular system for 22.8%. In 1993, cases of the cardiovascular system were 51.2% and of the nervous system 23.4%. The main causes of disability among adult evacuees and residents of RCR were connected with diseases of the nervous, cardiovascular, respiratory, digestive and musculoskeletal systems.

The main period of growth in mortality among ACWs was from 1987 (0.95 per 1000) to in 1993 (4.65 per 1000). Mortality among ACWs approached the mortality level of the able-worker population in Ukraine in 1991.

Cardiovascular and nervous-system diseases were the leading contributors to mortality.

The mortality among inhabitants of the RCR has exceeded mortality in the Ukrainian population since 1988. The main causes of mortality were neoplasms, diseases of the cardiovascular and respiratory systems, trauma and poisoning. In estimating these data an important role was played by relative aging of the population of the RCR caused by emigration of young and middle-aged persons and an increasing proportion of elderly persons. Now the question is also being studied.

The mortality of children affected after the CNPP accident is not above general mortality of children in Ukraine. But a higher mortality level is seen among children born to irradiated persons, caused by diseases of the nervous, respiratory and digestive systems, congenital defects, and complications in the postnatal period.

According to the literature and world experience in follow-up periods, great attention should be given to the epidemiological study of neoplasms, teratogenic effects, and leading forms of non-tumour diseases among contingents affected by the Chernobyl accident. It is very important to consider the possible contribution of non-radiation factors (stress, pesticides, heavy metals), but not only dose-dependent effects.

Some words now about the quality of life among persons affected by the CNPP accident and the importance of these factors in epidemiology and optimisation of medical care. According to results of deeper clinical and epidemiological monitoring, it was determined that the 60% of ACWs from Kiev had unfavourable working conditions, 76% unfavourable housing conditions, 15% smoked, 2% abused alcohol, 15% had low physical activity, 20% had dietary alterations, and 40% had psychological or emotional difficulties. Forty percent of ACWs needed treatment in hospital, 72% in sanatoria (resorts), 38% needed an improved diet, 40% needed more long-term rest, 27% needed physical training and sport, and 10% required psychotherapy.

A similar situation was seen in evacuees and in RCR residents. These data do not sufficiently describe the quality of life of affected persons, but they convince us that one important and definite role of the optimisation system for post-accident medical care and quality of life is the estimation of health risk factors.

What is very important at this period? First of all, it is necessary to organize and conduct an analytical retrospective-prospective epidemiological study to reveal and estimate the risk factors for common somatic diseases, disability and mortality from 1983-1987. Secondly, it is necessary to concentrate the efforts of scientists and public health institutions on timely diagnosis, registration, qualitative verification and treatment of oncological pathology, because the latency period of radiation-induced cancer cases is drawing to its term.

In a later paper we would like to discuss other problems: psychological intelligence of irradiated children and the genetic effects in the irradiated generation, first of all in ACWs from 1986-1987.

Summary

The characteristics of the contamination resulting from the Chernobyl accident are defined, as a basis for epidemiological investigations. Due to loss of integrity of the nuclear fuel and thermal buoyancy from fire and
nuclear heating, a large quantity of radioisotopes were released over a period of up to 16 days. The areas affected were very large, 37 million hectares in Ukraine alone. About 5 million persons were affected in one way or another, over 2 million of them in Ukraine.

For registration and follow-up of health consequences from the accident, 4 main groups were distinguished, namely: (1) the participants in the containment of the accident and its cleanup ("liquidators"); (2) evacuees; (3) residents of contaminated areas; and (4) children born to parents with significant radiation exposure.

Registration and epidemiological follow-up in the former USSR and the three republics afterwards are presented with an emphasis on Ukraine. Considering the long incubation times for some of the expected illnesses and relatively low average doses, the difficulties of confirming significant effects become evident. For example leucosis morbidity among cleanup personnel within a 30 km zone around the accident was 3.4 per 100,000 before the accident and 7 per 100,000 afterwards. The question of the statistical significance of such numbers is discussed by the authors, in the context of confounding factors. For some of the observed effects it has already been established that stress and anxiety caused by the accident and living conditions in the affected areas are the principal cause rather than radiation. According to the authors, more detailed retrospective and prospective epidemiological studies are needed in the future, in order to clarify the causes of observed health effects.

Résumé

Enquête épidémiologique sur les conséquences médicales de l'accident de Tchernobyl en Ukraine

Cet article décrit les caractéristiques de la contamination due à l'accident de Tchernobyl en tant que base des recherches épidémiologiques. Du fait de la perte d'intégrité du combustible nucléaire et de la flottabilité thermique liée à l'incendie et au réchauffement nucléaire, une multitude de radioisotopes ont été libérées pendant une période d'au moins 15 jours. Les zones touchées étaient très vastes, dont 37 millions d'hectares dans la seule Ukraine. Environ 5 millions de personnes ont été affectées d'une manière ou d'une autre, dont 2 millions en Ukraine.

Aux fins de l'enregistrement et du suivi des conséquences sanitaires de l'accident, on a distingué quatre groupes principaux, à savoir: i) les participants aux opérations visant à limiter les conséquences de l'accident et à remettre le site en état (les liquidateurs); ii) les personnes évacuées; iii) les résidents des zones contaminées; et iv) les enfants nés de parents ayant subi une exposition considérable aux rayonnements.

L'enregistrement et le suivi épidémiologique dans l'ex-USSR et les trois républiques après l'accident sont présentés ici, l'accident étant mis sur l'Ukraine. Etant donné la durée du temps d'incubation pour certaines des maladies prévues et les doses moyennes relativement faibles, il devient difficile de confirmer des effets marquants. Ainsi, la morbidité par leucoses parmi le personnel chargé de la remise en état dans une zone de 30 km autour de l'accident était de 3.4 pour 100,000 avant l'accident et de 7 pour 100,000 après celui-ci. La question de l'importance statistique de ce type de nombre est mise en question par les auteurs compte tenu des facteurs de confusion. En ce qui concerne certains effets observés, il a déjà été établi que le stress et l'anxiété provoqués par l'accident et les conditions de vie dans les zones touchées sont, plus que les rayonnements, les causes principales. Selon les auteurs, il faudra procéder à l'avenir à des études épidémiologiques rétrospectives et prospectives plus détaillées afin de clarifier les causes des effets que l'on a observés sur la santé.