

Epidemiology of Hematological Diseases of Adult Population Living in a Zone of Semipalatinsk Nuclear Test Site, 1994-2003

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Analyses of the dynamics of frequency of hematological diseases were conducted in the area of former Semipalatinsk nuclear test site and in different zones of radiation risk during the period of 1994-2003. Hematological diseases were diagnosed in 1,667 persons who were directly exposed to radiation, including their second and third generations. General morbidity of hematological diseases in this period gradually increased from 19.8 to 23.8 per 100,000 population. To observe dynamics of structure of hematological morbidity for the 10-year period we compared the proportion of each disease in 1994, 1999, 2003, i.e., at the beginning, the middle and the end of the observation period. In the analyses, the specific weight of chronic lymphoid leukemia for this period was reduced, the specific weight of acute leukemia increased in 1999 and then decreased in 2003, while chronic myeloid leukemia had no positive dynamics. The increasing tendency of specific weight of autoimmune diseases and pernicious anaemias was marked. There was still a high frequency of blood diseases in the zones of extreme and maximal radiation risk. The changes in structure of hematological diseases in a zone of the former Semipalatinsk nuclear test site are probably related to a hereditary predisposition of radiation induced immune imbalances.

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Introduction

From 1949 till 1989 on the Semipalatinsk nuclear test site (SNTS) about 470 explosions were conducted: 87 in air, 26 on the ground and 357 underground.¹ It is believed that those nuclear tests influenced the health of the population and the ecology of the regions. Exposed population and their children are still living in the regions close to the SNTS. That is why the problem of the distant consequences of effect of ionizing radiation remains actual.¹ The distant effects of ionizing radiation could induce carcinogenesis, genetic anomalies, reduction of lifetime, hematological and immunological disease.²⁻⁴ A feature of radiation in the region close to SNTS is the presence of long-lived chronic (at the expense of aged radioactive tracks) and acute effect on the population. The previous researches in term of the health of the population with past exposure to repeated combined radiation have shown that the specific weight for practically health does not exceed 3%.⁵

The data of the external, internal and total radiation exposure

doses for the period from 1949 to 1992 for residents of districts of the Semipalatinsk region allow to distinguish four different zones of radiation exposure (so-called "radiation risk zones") in the Semipalatinsk area near the nuclear test site (the zones of extreme, maximal, increased and minimal radiation risk).¹ Definition of each zone is described below.

1. The zone of extreme radiation risk, where the estimated dose equivalent to the population was more than 100 cSv.
2. The zone of maximal radiation risk, where the estimated dose equivalent to the population was in the range from 35 to 100 cSv.
3. The zone of increased radiation risk, where the estimated dose equivalent to the population ranged from 7 to 34.9 cSv.
4. The zone of minimal radiation risk, where the estimated dose equivalent to the population was less than 6.9 cSv.

In a series of research works, the authentic relation between morbidity of "indicator" disease in the irradiated population and zones of radiation risk was determined. Hematological diseases fell into to the

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given "indicator" illness.⁶ Now blood samples are stored owing to the concern about a condition of second and third generations of exposed persons in zones of radiation risk.

The purpose of the given research is to analyze dynamics of frequency of hematological diseases in the area of former Semipalatinsk nuclear test site and in different zones of radiation risk for the period 1994-2003.

Subjects and Methods

Dynamics of morbidity of hematological diseases were studied in the Semipalatinsk area of the East Kazakhstan region, the population of which was approximately 800,000. The statistical data of population were taken from the population census of the Statistical Center, Semipalatinsk. The statistical data of patients (history of diseases, outpatient clinic cards) were obtained from the hematology department of the Semipalatinsk hospital from 1994 to 2003. Only the new cases with the verified diagnosis were included. We calculated the morbidity rate as the number of patients with hematological disease over the population size.

All patients were classified into the following diagnoses: acute leukemia (AL), chronic lymphoid leukemia (CLL), chronic myeloid leukemia (CML), pernicious anemia (PA), hemorrhagic vasculitis (HV), idiopathic autoimmune thrombocytopenic purpura, i.e., Werlhof's disease (IATP), and other forms of hematological diseases. Analysis was not actuated for patients with iron deficiency anemia since many etiologies are involved in this disease.

Results

During the period from 1994 to 2003, hematological diseases were accumulated in 1,667 persons including 457 directly exposed persons and 1,210 second or third generation of the exposed individuals. The analysis of dynamics of the morbidity of hematological disease in the period of 1994-2003 showed a gradual increase from 19.8 per 100,000 of population in 1994 up to 23.8 per 100,000 of population in 2003 (Figure 1). To observe dynamics of component of hematological morbidity for the 10-year period, we compared the proportion of each hematological diseases in 1994, 1999, 2003 years, i.e., at the beginning, middle and end of the observation period. In 1994, the distribution of diseases of blood and hemopoietic organs was as follows: CLL 18.4%; PA 14.1%; HV 12.3%; CML 11%; IATP 8.6%; AL 6.7%; and others 28.8% (Figure 2). In 1999, PA morbidity increased up to 23.3%, and CLL and CML were approximately equally arranged to 13.8% and 13.2%, respectively. The increasing of frequency of IATP and HV (12.6% and 10.1%) were marked. The frequency of AL also increased at 2.7% in 5 years. The greatest morbidity in 2003 took 24.7% of PA, following 16.8% of IATP and 13.2% of HV. CLL was reduced in the period of 1994-2003, AL decreased in 2003 after increased in 1999, and CML had no positive dynamics. The rising tendency of autoimmune diseases

and PA was marked (Figure 3).

In the analysis of component of hematological morbidity in different zones of radiation risk in the former SNTS, excess risks were detected in zones of extreme and maximal radiation risk. There was still a high frequency of blood diseases in extreme and maximal radiation risk zones (Figure 4). Thus in both zones, in spite of the restricted number of the living population, within the last decade, it was shown that the essential growth of morbidity by PA, the high level of CLL, and considerably higher AL than the data in zone of minimal radiation risk (Figure 5). Also for the inhabitants, who lived in the period of atmosphere and ground tests in the given area, the greatest gain of a level of autoimmune diseases (IATP) and HV was marked, especially, for the second and third generation of the irradiated parents.

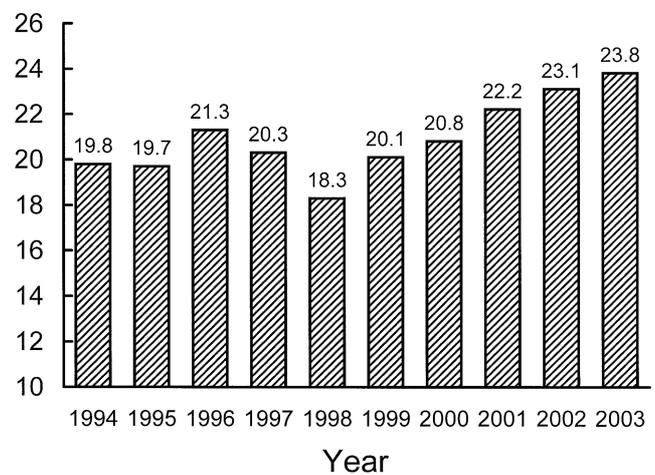


Figure 1. The dynamics of general morbidity by hematological diseases, 1994-2003, per 100,000 population.

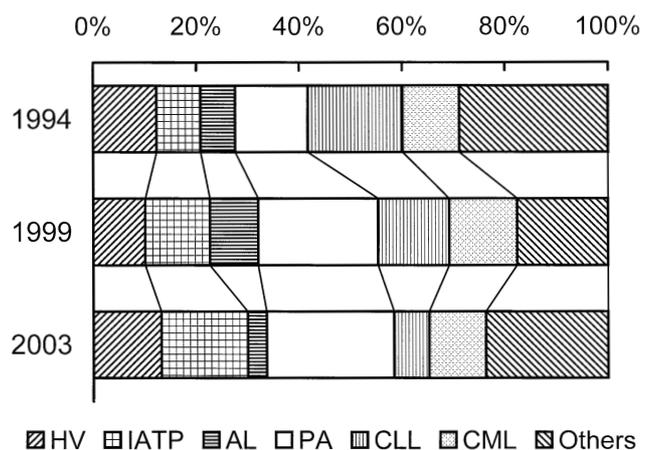


Figure 2. The structure of hematological diseases, 1994-2003.

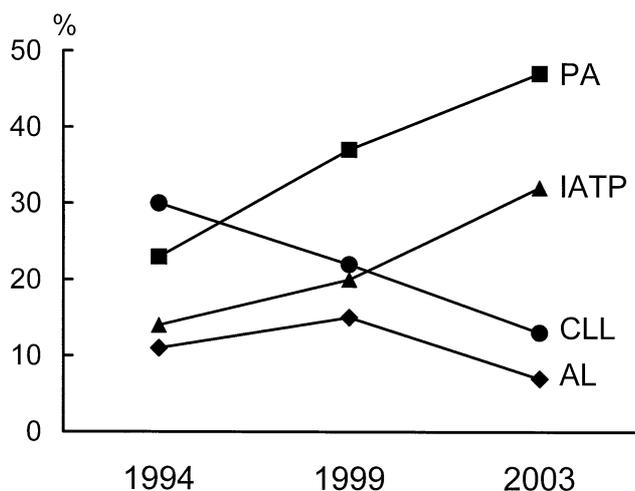


Figure 3. The dynamics of some hematological diseases, 1994-2003.

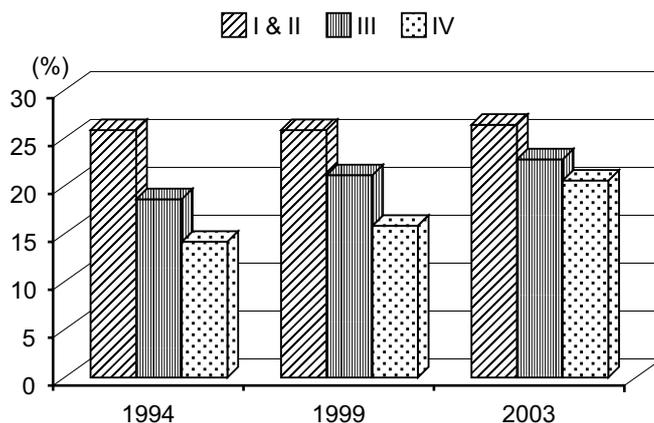


Figure 4. The dynamics of hematological morbidity in zones of radiation risk in the former Semipalatinsk nuclear test site. I the zone of extreme radiation risk; II the zone of maximal radiation risk; III the zone of increased radiation risk; IV the zone of minimal radiation risk.

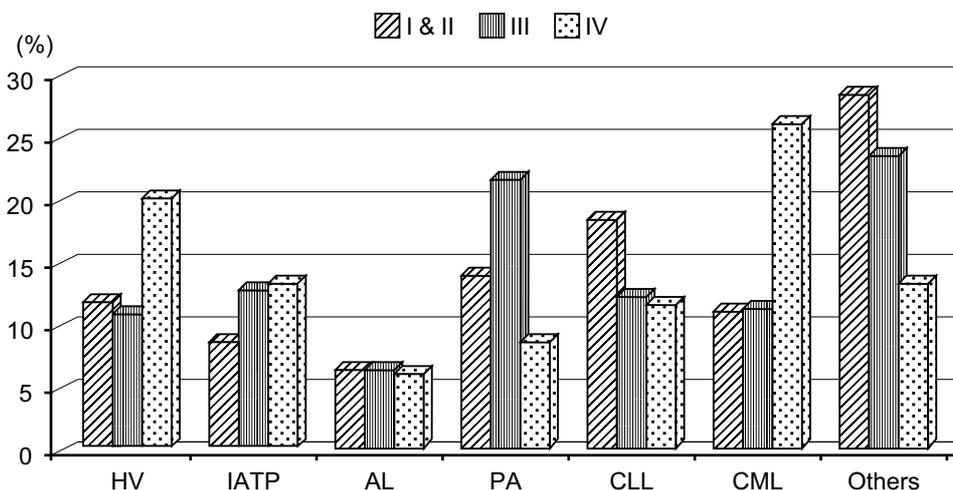


Figure 5. The structure of hematological morbidity in zones of radiation risk in the former Semipalatinsk nuclear test site. I the zone of extreme radiation risk; II the zone of maximal radiation risk; III the zone of increased radiation risk; IV the zone of minimal radiation risk.

Discussion

We may conclude that the frequency of blood diseases has still be increasing in persons living in the former SNTS even 10-15 years after the discontinuance of nuclear-weapon tests and 25-30 years after the atmospheric atomic explosions, which contributed to the formation of effective equivalent radiation doses for the surviving population. Thus the excess of morbidity in zones of extreme and maximal radiation risk is authentic for the following three types of blood diseases: PA whose genesis may be related to the potential inheritable predisposition and deficit of enzyme systems; leukemia that is so called "classic" radiation induced blood diseases both in older population and in the second and third generation of exposed parents; and autoimmune diseases of blood system which may be pathogenetically related with the radiation induced immune imbalance

in the second and third generation of exposed persons.

Conclusion

1. Dynamics of hematological diseases of the population in the Semipalatinsk nuclear test site showed an increasing frequency of PA and autoimmune diseases in the last 10 years.
2. There is still a high frequency of blood diseases in extreme and maximal radiation risk zones.
3. The changes in component of hematological diseases in a zone of former Semipalatinsk nuclear test site are probably related to a hereditary predisposition of radiation induced immune imbalances.

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