Peer reviewed article

Chronic Cs-137 incorporation in children's organs

Y. I. Bandazhevsky

Summary

In Belarus's Gomel region, which was heavily contaminated by fallout from the Chernobyl disaster, we have studied the evolution of the Cs-137 load in the organisms of the rural population, in particular children, since 1990. Children have a higher average burden of Cs-137 compared with that of adults living in the same community.

We measured the Cs-137 levels in organs examined at autopsy. The highest accumulation of Cs-137 was found in the endocrine glands, in particular the thyroid, the adrenals and the pancreas. High levels were also found in the heart, the thymus and the spleen.

Key words: Chernobyl children; radiocaesium; thyroid; adrenals; pancreas; thymus; myocardium

Introduction

Children who have lived in radiocontaminated districts of Belarus since the explosion of the Chernobyl atomic power plant (26 April 1986) suffer from chronic diseases rarely encountered in children from areas of Belarus not contaminated with Cs-137. Much has been written on the pathogenic role of the so-called radioiodine shock, which is due to some tens of short-lived radionuclides the principal of which is iodine-131. The iodine shock may also initiate processes which continue to evolve under chronic low-level radiation due to incorporated Cs-137. The artificial radioactivity which has persisted for the last 17 years in the organisms of people living round Chernobyl is due to long-lived radionuclides, mainly strontium (Sr-90), caesium (Cs-134 and especially Cs-137) and uranium derivatives including plutonium.

When studying the effect of Cs-137 in children it is important to select those born after March 1987 who have not suffered from the iodine shock even *in utero*. During normal pregnancies, the placenta takes up circulating Cs-137 in the maternal blood protecting the foetus. If the Cs-137 concentration in the placenta exceeds 100 Bq/kg, the foetus suffers.

Newborns take up Cs-137 in the maternal milk. Children drinking cow's milk and vegetables produced in local villages accumulate increasing amounts of Cs-137. The highest Cs-137 concentration is found in wild berries, mushrooms and game, which are an important resource for poor families.

Methods

Methods used at Gomel Institute of Pathology

Caesium is both a gamma and a beta emitter. Since beta rays are more radiotoxic for the genome and cell structures than gamma rays, the latter are used to measure the specific activity of caesium in humans. For either whole body measurement or during autopsies we used different equipment to measure the level of Cs-137 accumulated in various organs.

The accuracy of measurements by the mobile teams of the Belrad Institute, the independent radioprotection agency, is guaranteed by compulsory annual state inspection of the equipment. Furthermore, as part of a joint German-Belarussian project it was possible by intercalibrations to verify the different items of equipment (the 7 whole-BC "Screener-3M" of Ukrainian origin from the Belrad Institute, and the 2 mobile whole-BC laboratories of Juelich Research Centre ["Canberra Fastscan Whole BC", Germany]). While initially the error limit was as high as 11%, later it did not exceed 7%. Below 5 Bq/kg bodyweight measurements become less accurate.

For laboratory measurement of specific activity in samples, such as organs examined during autopsy, Belrad provided Gomel State Medical Institute with automated Rug-92M gamma radiometers. The duration of measurement is one minute for samples >100 Bq/kg and 10 minutes for samples of 50–100 Bq/kg. Below 49 Bq/kg precision decreases. Samples were also doubled-checked in France to validate the findings.

No financial support declared.

Results and discussion

Anatomo-pathological approach

At the Institute of Pathology the Cs-137 concentration was systematically measured in different organs. Throughout pregnancy the foetus appears to be relatively well protected by the placenta, which takes up and accumulates circulating Cs-137 from the blood of the mother. High foetal levels of Cs-137 were found in cases of abortion with multiple malformations.

High levels were found in infants aged up to six months. Table 1 shows Cs-137 levels in 13 organs of infants.

Cs-137 accumulation in organs of adults and children

We studied at autopsy the level of Cs-137 incorporated in eight different organs of adults and children residing in rural areas of the Gomel region. The average levels of Cs-137 measured were two to three times higher in the organs of children than in those of adults living in the same environment (Figure 1).

In all organs examined the average levels of radiocaesium were higher in children than in adults. In rural communities of the Gomel oblast the average whole body count was also higher in schoolchildren than in adults.

Figure 1

Radioisotopes accumulation in the organs of adults and children, died in 1997:
1: myocardium;
2: brain;
3: liver;
4: thyroid gland;
5: kidneys;
6: spleen;
7: skeleton muscles;
8: small intestine.

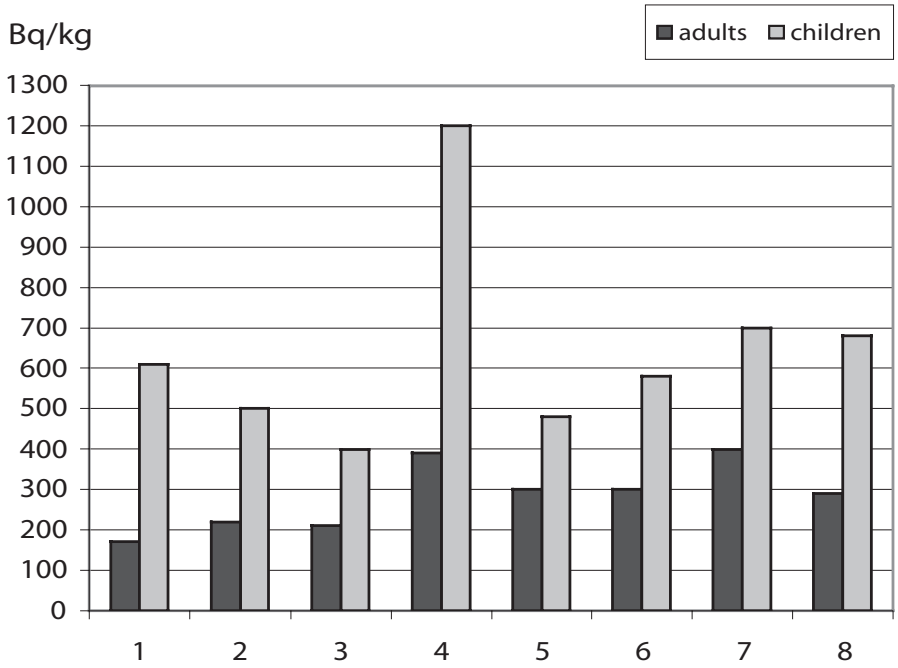

Table 1

Cs-137 level measured in 13 organs of 6 infants. Very high specific activity of Cs-137 is found in pancreas, adrenals, heart, but also thymus, stomach and intestinal wall. In cases 1 and 2 the concentration of Cs-137 in the pancreas is respectively 44 and 45 times that in the liver.

	1	2	3	4	5	6
Cause of death:	sepsis	premature malform.	sepsis bleeding	cerebral malform.	cardiac	sepsis
Organs:						
heart	**5333**	4250	625	**4166**	1071	1491
liver	250	277	525	851	882	1000
lung	1125	2666	400	1195	1500	2610
kidneys	1500	1687	259	2250	812	583
brain	3000	1363	305	90	1693	714
thyroid gland	4333	**6250**	250	1900	n.d.	1583
thymus	3000	3833	1142	**3833**	714	833
small intestine	2500	1375	571	3529	2200	590
large intestine	3250	3125	261	3040	**4000**	2125
stomach	3750	1250	**1500**	n.d.	n.d.	n.d.
spleen	3500	1500	428	1036	2000	2125
adrenals	1750	2500	n.d.	2500	**4750**	**2619**
pancreas	**11 000**	**12 500**	**1312**	n.d.	n.d.	**2941**

n.d. = not done
The highest two values are underlined in each case

Table 2

Average levels of specific activity of Cs-137 in 13 organs of 52 children aged up to 10 years from the Gomel region in 1997.The highest average Cs-137 levels are found in the endocrine glands including the pancreas. The Cs-137 concentration in the thyroid gland is 6 times that in the liver. Next to the endocrine glands comes the thymus, with an average of 930 Bq/kg.

Organ	Bq of Cs-137/kg
1. Thyroid	2054 ± 288
2. Adrenals	1576 ± 290
3. Pancreas	1359 ± 350
4. Thymus	930 ± 278
5. Skeletal muscle	902 ± 234
6. Small intestine	880 ± 140
7. Large intestine	758 ± 182
8. Kidney	645 ± 135
9. Spleen	608 ± 109
10. Heart	478 ± 106
11. Lungs	429 ± 83
12. Brain	385 ± 72
13. Liver	347 ± 61

Children aged up to 10 years studied in 1997

From April 26 to June 1986 the radioactive fallout from Chernobyl was intense. Two-thirds of the radioactivity was due to short-lived radionuclides, the most important of which was iodine-131. Children born after March 1987 did not suffer from this "iodine shock" even *in utero*.

At the Institute of Pathology we studied 51 children from Gomel rural communities who had died from various causes. This group had not had iodine shock. If chronic internal irradiation was responsible for these children's pathology it would be ascribable to long-lived radionuclides such as radiocaesium. The decreasing average levels, with the standard deviation for the 13 organs tested, are shown in Table 2.

The Medical State Institute of Gomel studied cellular damage caused by the accumulation of radiocaesium in organs. The functional disorders or diseases caused by chronic accumulation of this radionuclide in organs were presented in 20 theses based on clinical, epidemiological, anatomopathological or experimental studies in rats and hamsters [1–4].

Conclusion

The Cs-137 burden in the organisms of children must be further investigated and the pathogenesis of different diseases intensively studied. This is an urgent need, as radiocontaminated agricultural land is being increasingly cultivated and radiocontaminated food is circulating countrywide.

Schoolchildren in contaminated areas received radiologically clean food free of charge in school canteens and spent a month in a sanatorium, in a clean environment, each year. For reasons of economy the annual sanatorium stay has been shortened, and communities in some contaminated areas have been classified as "clean", thus ending the supply of clean food from the state.

Correspondence:
Institute for Radioprotection, Belrad Charity House,
Staroborisovsky Tract 11,
220114-Minsk, Belarus

References

1 Zhuravlev F. Toxicology of radioactive substances, Second Ed. pp 336, Energoatomizdal, 1990.
2 Bandazhevsky Yu I. Pathology of incorporated radioactive emission. Gomel State Medical Institute 2001; pp. 91.
3 Bandazhevsky Yu I. Radiocaesium and congenital malformations. Internat J Radiation Medicine 2001:3:10–11.
4 Bandazehvsky Yu I & Lelevich V V. Clinical and experimental aspects of the effects of incorporated radionuclides upon the organism. Gomel 1995; pp 128.