THE KAINAR SYNDROME: HISTORY AND MODERN UNDERSTANDING

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Introduction: More than 60 years has passed since the first nuclear test was made at the Semipalatinsk Nuclear Test Site (SNTS) in the former Soviet Union, and several hundreds of other explosions, both of atomic and hydrogenic types were made in this area from 1949 to 1989 [1,2]. Due to these explosions several hundred thousand people in our country were exposed to various doses of ionizing radiation. As exposure continued for 40-years period, and 23 years has passed after the last nuclear test, three generations of exposed people are now available for epidemiological and clinical studies at the present time. Even now thousands of people are battling diseases, both somatic and psychological, caused by radiation [3,4].

Brief history: Generally speaking, two periods of nuclear tests were made in the Semipalatinsk region. According to modern data, compiled mainly from former classified military sources, in the technical area III of the SNTS 26 above ground and 87 atmospheric nuclear explosions were conducted during the period from 29 August 1949 to 30 December 1962. One of these tests occurred on 24 September 1951, and mainly affected the Kainar village, located in the area [5].

During the period from 11th October 1961 to 10th October 1989, 223 underground nuclear explosions were conducted at the technical area "G" of the SNTS, and during the period from 19th June 1968 to 19th October 1989 an additional 123 underground nuclear explosions were conducted at the technical area "B". The total number of these explosions and the peculiarities of radiation dose formation are shown in the table 1.

Table 1.Radiation explosions number and the peculiarities of radiation dose formation (in comparison with atomic bombs, exploded in Hiroshima and Nagasaki)

	Semipalatinsk, and it's vicinity	Hiroshima	Nagasaki
Number of explosions	1st period: Atmospheric and on-the-ground tests: 1949-1963 (125 tests, among them 26-on-the-ground, 91 – in the air, 8 – from the plane); 2nd period: Underground tests: 1963-1989 (343 explosions);	1	1
Exposure duration	Chronic type, 40 years	Acute type	Acute type
Type of exposure	External and internal (X-rays, +α, + β particles)	Mainly external (X-rays + neutron)	Mainly external (X-rays, and only partly neutron)

On August 5th, 1963 the Limited Test Ban Treaty was signed by the United States, Great Britain, and the Soviet Union. After Senate approval, the treaty came into effect on October 10th, 1963 banning nuclear weapon testing in the atmosphere, in outer space, and under water [6, 7].

Several years after the tests had been started, the authorities received several letters from local residents complaining for some strange symptoms, that were unknown in this area before [8]. The letters were passed to President of Kazakhstan's Science Academy Professor Kuanish Satpaev. In 1958 he ordered to send a group of medical researchers to check the reason of "strange conditions". The group was guided by Professor Bahiya Atshabar, who was at that time the Director of the Research Institute for Local Pathology. The task was very dangerous: only 5 years passed since 1953, when hundreds of physicians were shot or sent into prisons in "Physicians Affair", as Stalin suspected them in lack of loyalty [9, 10].

As a result of the studies, the group described patients with symptoms like increased bleeding, hair loss, fainting and fatigue. In the blood tests the main finding was leucopenia. As it was impossible to attribute the findings to nuclear tests, the way was found. These symptoms were combined in "Kainar syndrome" as the group provided their studies in nearby villages, but most patients were exactly from Kainar village itself. Brucellosis, local infectious disease from sheep, combined with lack of vitamins, was named as the reason of newly described condition.

Authorities didn't believe to the results of this study, so another group was send to the area in 1959, but they returned with the same results. So, the secret Dispensary N4, which was opened in Semipalatinsk in 1957, was renamed into "Antibrucellosis Dispensary" and had the task to study health condition of those affected by nuclear tests. Nowadays this is our Research Institute for Radiation Medicine and Ecology (renamed in 1991). Unfortunately, in 1965, according to Order from USSR Health Ministry, the studies in Semipalatinsk itself were strictly forbidden [3].

The story of "Kainar syndrome" became popular again in the early 90-s, when the former communist leader, Chief of Semipalatinsk area Mr. Boztayev, published a book "The Kainar Syndrome", describing this story [8].

The book from the library of the Research Institute for Radiation Medicine and Ecology, Semipalatinsk.

As it is written in the book, "…Clinical medical detachment conducted health examination of Abay region, Dolon village of Beskaragay and Barshatas region residents. Most frequent symptoms were bleedings from the nose, mucous membranes of upper respiratory tract, mouth; stomach bleeding; vomiting; colon, gums and genital bleeding, dystrophic changes in the skin of the open areas, weakness.

As a rule, all these symptoms were present at the same patient. These symptoms were called "The Kainar syndrome" in the name of the village, where this symptoms were diagnosed for the first time.

The history and modern understanding of Kainar Dosimetry:

In the first reports, that were presented to Semipalatinsk region authorities by military officials the dose from all nuclear tests was interpreted as low, and in average equal to 0,3 cSv. It was said that it was as low as one month background exposure and it's better to neglect them [11].

Shortly after that, in 1992 the government of independent by that time Kazakhstan Republic requested the data about the total radiation, including radiation doses for the whole 40-years period of explosions from

the authorities of the Semipalatinsk Nuclear Test Site.

These data allowed distinguishing the four different zones of radiation exposure, so-called "radiation risk zones" in the Semipalatinsk region [3].

The first zone is an extreme radiation risk zone, where the dose equivalent to the population exceeded 100 cSv, for example 12.1cSv in Chagan.

The second is the maximal radiation risk zone, comprising populated areas within the most exposed places of the Semipalatinsk vicinity, namely the Abaisky and some other districts. The estimated dose equivalent to population was in range from 35 to 100cSv. It was named as high as 94,5cSv in Zulkarash village of Abaisky district, 87.7cSv in Karaul and 68.1 cSv in Kainar. These are the exact villages, where the group of Prof. Atchabarov provided their studies.

The third - is the zone of increased radiation risk, comprising the population of 6 districts in the Semipalatinsk vicinity and the city itself. The radiation doses of these areas population ranged from 7 to 34.9cSV.

The fourth zone of minimal radiation risk - comprising five most distant districts of the Semipalatinsk region, including Makanchinsky, Urdjarsky, Taskeskensky, Kokpektinsky and Aksuatsky districts. The dose equivalent to the population of this radiation risk zone was less than 6.9cSv.

To be sure, the distinguishing of all these zones was rather conventional. It was difficult to set any clear territorial borders for specific doses of external or internal radiation exposure. The "behavior" of radionuclides within the radioactive cloud is unknown. Also it's not fully understood , why radioactive fallout occurred in the territories, which are hundreds kilometers away from the hypocenter [12]. The total number of exposed in Kainar is shown in table 2.

Table 2. Population of Kainar village, exposed to external radiation doses (Number of people)

Population study group	**External radiation dose, cSv**				
	<1	**1 - 5**	**5 - 10**	**10 - 15**	**15 - 20**
Children	**1729**	**86**	**1003**	**214**	**-**
Adults	**2079**	**90**	**513**	**293**	**480***

According to the newly unclassified in 1995 archival data, the effective equivalent and absorbed doses to thyroid gland of some residents were recalculated. The results are shown in table 3.

After 1994, when the famous Japanese physicist Professor M. Hoshi was approved as the principal researcher in the field of Semipalatinsk Dosimetry, the new era began. The determination of external dose to teeth of inhabitants of settlements near the SNTS was made by many methods. One of the most reliable today is the EPR dosimetry. In the studies made after 1994, tooth doses have been reconstructed for dosens of persons with teeth having been formed before the first nuclear test in 1949. In brief, the mean external gamma doses for residents of most studied settlements were in the range from a few tens of mGy to approximately 100 mGy.

Table 3. Calculated effective equivalent and absorbed doses to the thyroid gland of some residents of Abay region in1965 (mSv, mGy)

Villages	Effective equivalent dose, mSv	The absorbed dose to the thyroid gland, mGr	
		Adults	Children
Kainar	**558,6**	**1 399,5**	**11491,6**
Karaul	**451,8**	**1 326,8**	**10 326,8**
Sarzhal	**665,4**	**1 472,3**	**12 656,3**
Arhat	**234,8**	**896,5**	**9 836,1**
Kaskabulak	**445,2**	**1 024,7**	**10 124,5**
Kokbay	**312,6**	**810,6**	**9 126,3**
Medeu	**318,8**	**924,3**	**9 472,1**
Kyzyltu	**288,4**	**1 126,8**	**12 276,8**
Orda	**302,6**	**836,2**	**9 423,5**
Kundyzdy	**225,2**	**1 226,5**	**13 226,4**
Average-weighted dose	**361,1**	**1071,3**	**10 718,7**

The Kainar problem discussion

The threshold levels of radiation exposure for determining radiation effects are well known [13,14] and shown in table 4.

Table 4. The threshold levels of radiation exposure

Radiation effects	Threshold dose (mSv)	Kainar dose (mSv), external and internal
Bleeding	1000	Below 700
Hair loss	2000	Below 700
Dystrophic changes of skin and mucous membranes	2000	Below 700
Asthenia, weakness	1000	Below 700
Leucopenia	500	Below 700

But the results of independent studies of 2 researcher groups in the Karaul area in late 50's of the last century clearly described such effects as mucous bleeding, hair loss, fatigue, dystrophic changes of the skin and mucous membrane.

What was the possible reason of these discrepancies? To our understanding, it could be due to the following causes. Firstly, it was quite possible for some of the exposed to have higher doses, as they probably several times crossed the radioactive tracks with heavily exposed spots (Prof. Stepanenko V.F., personal opinion, 25th January, 2012). Secondly, according to the data of the Kazakh National Institute of Nutrition, the list of following peculiarities of the exposed in Kainar area people diet was named:

a) the invariable diet with lack of essential vitamins, especially vitamins C, B, A;

b) lack of Iodine intake with average consumption was 68.9 mkg/day and daily requirement in our area more than 160 mkg/day;

c) lack of other essential microelements, especially iron consumption.

All these diet peculiarities were combined with high level of infectious diseases among the exposed people due to poor hygienic traditions [15].

Our previous studies provided at the heavily exposed zones in the Semipalatinsk vicinity showed that with the increased level of exposure the increased incidence of respiratory allergy was registered, including bronchial asthma, hay fever and allergic rhinitis [16].

We also found the peculiarities of hay fever among the exposed to ionizing radiation, including its early formation (in many cases even infancy, which is quite uncommon in the non exposed population) more common concomitant asthma increased sensitization structure. It was impossible to explain these peculiarities simply by dose as the threshold for deterministic effects is generally higher than 1000 cSv and in the most cases less than 100mSv. So, we proposed that in many cases radiation exposure was aggravated by psychological stress.

As allergic diseases are more likely to be formed in patients who underwent stress factor influence, we proposed that damaged psychology was one of the mostly underestimated factors in the Semipalatinsk area. Many modern researchers think in the same way. Thus, in his short report from the Chernobyl area V.Stephan emphasized that poverty and stress were much bigger threat to public health than radiation itself [17]. Recent studies of the psychological consequences of Chernobyl accident concluded that mental health effects were the most significant public health consequences of this disaster.

Another study of Chernobyl liquidators, who were in reality the most exposed clean-up workers, reported that among them the rates of depression and posttraumatic stress disorders remain elevated even two decades later. But the findings on prenatally exposed remain inconsistent. Thus, recent studies in Kiew, Norway and Finland point to specific neuropsychological and psychological impairments associated with radiation exposure, but other studies found no significant effects. General population studies report increased rates of poor self-rated health as well as clinical and subclinical depression, anxiety and posttraumatic stress disorder [18].

A new wave of interest came after Fukushima power plant accident in March, 2011 [19]. This disaster further heightened scientific interest for hazards, associated with radiation. For example, S. Takahashi described the challenge of a 36 weeks pregnant lady-physician specialist in obstetrics-gynecology who felt herself powerless because she had a responsibility to warn patients of the risks, but had no clear way to quantify them [20].

In conclusion, we want to stress, that it is difficult to explain the clinical signs, that were seen in some of the Kainar area residents. Some explanation may come from better understanding of Dosimetry, and another

one – from damaged psychology of the exposed.

Our data concerning "the Kainar syndrome" in some of the exposed may be used in possible future studies. We propose the need of experimental studies, where the known threshold levels of various effects of chronic radiation exposure would be compared in 2 groups, one with good diet and another one with experimental hypovitaminosis. This data may be important in interpretation of radiation incidents among the population of developing countries with similar to ours experience of poor diet and bad hygiene.

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ABSTRACT

Several years after the tests at the SNTS had been started, the authorities received several letters from local residents complaining for some strange symptoms, that were unknown in this area before. The letters were passed to President of Kazakhstan's Science Academy Professor Kuanish Satpaev. In 1958 he ordered to send a group of medical researchers to check the reason of "strange conditions". As a result of the studies, the group described patients with symptoms like increased bleeding, hair loss, fainting and fatigue. In the blood tests the main finding was leucopenia. As it was impossible to attribute the findings to nuclear tests, the way was found. These symptoms were combined in "Kainar syndrome" as the group provided their studies in nearby villages, but most patients were exactly from Kainar village itself. Brucellosis, local infectious disease from sheep, combined with lack of vitamins, was named as the reason of newly described condition. Authorities didn't believe to the results of this study, so another group was send to the area in 1959, but they returned with the same results. So, the secret Dispensary N4, which was opened in Semipalatinsk in 1957, was renamed into "Antibrucellosis Dispensary" and had the task to study health condition of those affected by nuclear tests. Nowadays this is our Research Institute for Radiation Medicine and Ecology (renamed in 1991). It is difficult to explain the clinical signs, that were seen in some of the Kainar area residents. Some explanation may come from better understanding of Dosimetry, and another one – from damaged psychology of the exposed.