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Lessons From Chornobyl For the Veterinary. Domestic Animals Protection Measures and Radiation-Affected Livestock Treatment

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The experience of eliminationthe consequences of the Chornobyl nuclear disaster proved the possibility to run agricultural production on the territory of the radioactive track made by the nuclear release with safety. In order to run it, it is necessary to have special subdivisions in authorities managing agriculture at different levels and staffed with specialists being competent in the area of agricultural radiology. Their preparation is an important element of preventive measure of anticipating nuclear accidents. Herewith, a special attention must be paid to protecting animals from the radioactive effect and treating the damaged livestock.

Key words: Chornobyl Nuclear Power Plant, nuclear accident, diagnosis of radiation damage of animals, veterinary evaluation, treatment of damaged animals.

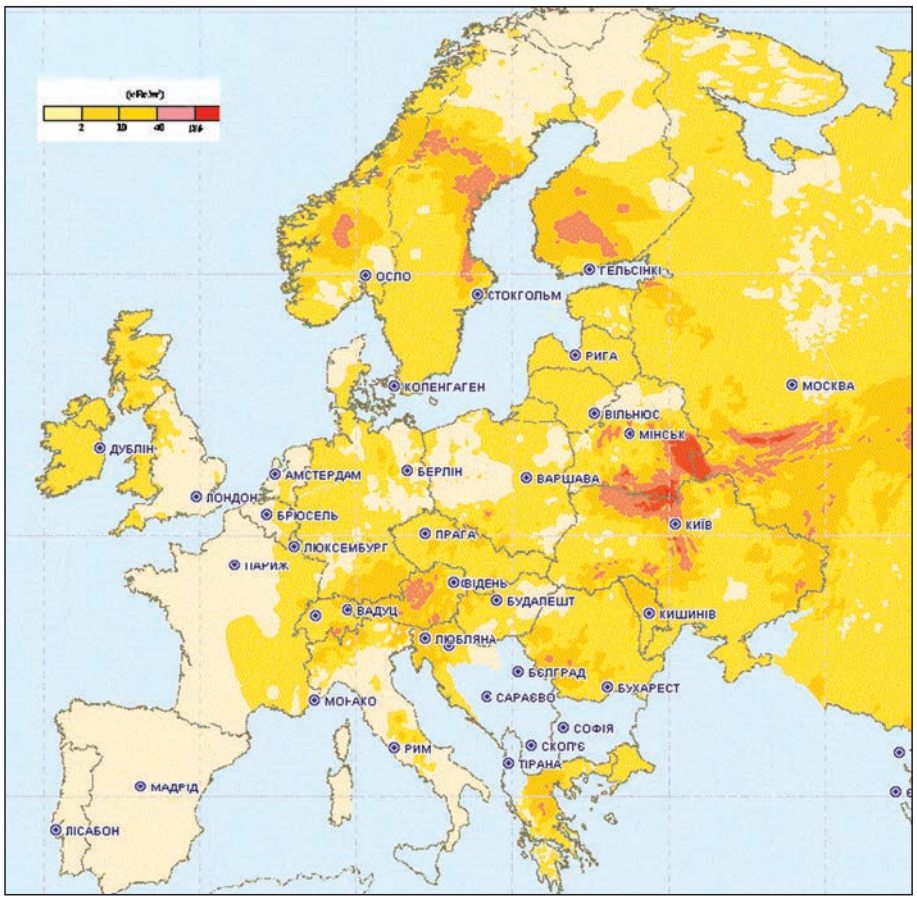
On the first day after the disaster at Chornobyl Nuclear Power Plant (ChNPP), the decision on the population evacuation from the zone which radius was determined in 30 km. Herewith, the capacity of the gamma radiation doze on the external border of the specified zone was 10 milliroentgen per h. The decision about resettlement was dictated not only by the danger of irradiating the population in dozes being higher than 0.3 Sv under the radiation situation that had already been formed but with the possibility of its sudden worsening. At that time the nuclear reactor of the block 4 had already appeared to be unmanaged, there was a possibility of additional releases and even development of self-supporting chain reaction. Accidental releases caused radioactive contamination of many European countries (Figure).

No special decisions on evacuating animals from the contaminated territories due to the danger to their health were actually made: they were evacuated together with the people. Operations on evacuating animals did not have a form of an emergency veterinary event; they attended the evacuation of people in a very complicated social and psychological situation. The main reason of it was extremely limited and not always objective information about the events that took place and possible medical and biological consequences of the disaster. The transportation of evacuated animals through less contaminated territories redoubled the development of stress with the people living there for it was perceived as a confirmation of great danger of the radioactive affection.

The primal task of the Veterinary Service was to define the animals' fate, first of all, in their keeping further economic use. During the disaster animals were outdoors for some time and their skin was contaminated by settings of radioactive clouds that were created. Treating them was related to danger of staff's considerable radiation and contamination.

At that time Veterinary Services of the Ukrainian Soviet Socialistic Republic and the Republic itself had radiological laboratories; however their staff like in the majority of countries of the world did not include specialists specializing in dosimetry and being able to estimate and forecast dozes absorbed by animal's bodies. Unfortunately, nowadays' Veterinary Services do not include them, either.

A very limited number of researchers are involved in studying the problems of dosimetry even in radiobiology and radioactive medicine. The very few researches study these problems in veterinary radiology, and un-



The map of contamination of the European soils with ^{137}Cs after the Chornobyl disaster [15]

fortunately, the situation after the disaster has hardly changed. In the critical period of the Chornobyl tragedy in order to solve the problems related to people safety, even specialists from agricultural radiology were involved. This fact proves obvious scarcity of scientific support in veterinary dosimetry. This conclusion must be regarded as one of the most important lessons of Chornobyl which must be taken into account, first of all, by the countries owning nuclear energy and production facilities.

The second, not less important veterinary lesson taught by the Chornobyl disaster that no official radioactive standards for veterinary services were introduced either prior to it or after. These documents were necessary for predicting radiation injury and sorting out animals, making decisions about the possibility of their economic use, treating or slaughtering and defining the utilization ways on their basis. It was related not only to direct damages because of livestock loss but also to considerable secondary radioactive danger for the human being as a result of contamination of slaughter sites and sections as well as radiation of the stuff. Particularly, the accumulation of cows' gastrointestinal contents especially scar with the weight up to 50 kg can be a serious source of gamma radiation for people. In this case animals' carcasses and other wastes must be buried in accordance with the regulations of treating radioactive wastes of medium and even high level of radioactivity.

Animals that underwent contamination were partially slaughtered onsite and buried. Due to the situation complexity, they were often buried with the violation of veterinary regulations, the cattle remnants could be accessed by wild animals that could cause incidence.

The following facts display how much unreasonable slaughter of animals cost Ukraine. About 15 thous cattle were slaughtered on the first days after the disaster only in Ukraine. More than 50 thous cattle evacuated from households situated in the resettlement zone to conditionally pure territories caused secondary contamination and social instability. The basic part of this livestock was given to meat cutting plants within short

period of time, although the content of radionuclides in the muscular tissue considerably exceeded the accepted levels for meat products that forbid its selling. By the end of 1986 packers had processed 97 thousand cattle from the Ukrainian regions being controlled according to the radiation situation. As a result, 6,405 tons of meat and 279 tons of byproducts with the content of radioactive substances from 7.4 up to 33 kBq·kg^{-1} at the level of 3.7 kBq·kg^{-1} were accepted for that moment [1, 2].

About 150 thous. contaminated animals were slaughtered in three Union Republics (Belarus, Ukraine and Russia). The contaminated meat was forwarded to Armenia, Georgia and other republics to prepare sausages. However, they refused to use it in these republics and it was returned. The problem of utilizing this meat continued 9 years. During this time carcasses were transported in refrigerator trains in the country. It finished only after constructing a special mortality digester in 30-km zone where contaminated carcasses from all CIS countries were buried.

Over the years after the disaster it becomes obvious there definitely was a need to introduce scientifically explained criteria for making decisions. On the basis of the above experiments related to studying biological effect of fission products to the cattle organism, the principles of early predicting radiation damage of cows were developed. The methodology of predicting radiation of animals according to dosimetric control, clinical examination and laboratory researches on the 3rd–7th day as of the radiation as well as according to hematologic indicators was created. As a result of generalizing proper experimental and literature data our research team developed recommendations on early predicting the damage of animals and their sorting out [3]. The possible level of radiation damage could be predicted during the first days of consumotion of contaminated foodstuff due to dosimetric, clinical and laboratory examination of the livestock.

Principles of sorting out cattle according to radiometric examination data [3, 4]

Capacity of gamma-radiation doze on the body surface in the left area of "hunger hallow", cGy·h^{-1}	Fission products in the body, Bq·10^{10} (Curie)	Damage expectancy
0.2−0.5	0.74−1.85 (0.2−0.5)	Easy (chronic level I)
0.5−1.0	1.85−3.7 (0.5−1.0)	Easy (chronic level II)
1−3	3.7−11 (1−3)	Easy (chronic level III)
3−6	11−22 (3−6)	Medium
6−10	22−37 (6−10)	Difficult
>10	>37 (>10)	Extremely difficult

Method of special approximate estimate of average tissue absorbed dozes of γ-radiation of the body, β-radiation of gastrointestinal tract and thyroid gland, as well as the presence of fission products in cows' bodies, according to measuring the capacity of gamma radiation on the surface of animals' bodies in the left area of the "hunger hallow" (figure) allows to examine a great number of animals quite quickly. According to the figure data, it is possible to classify animals in accordance with fission products containing in the body during the first five days of their flow.

Data about the effect of a young mixture fission products to cows' organism received on the Mayak experimental research station was acknowledged by the Ministry of Medium Machine-Building Industry of the USSR and the Ministry of Public Health of the USSR that in 1970 ordered the experiments as very important for the problem of radiation safety in case of large nuclear incidents and use of nuclear energy for military purposes. They were published in public media in 1973 [5]. That very year they were published in the USA as well.

In 1973 the Ministry of Agriculture of the USSR, the Ministry of Public Health of the USSR and National Committee for Nuclear Energy Use of the USSR approved "Recommendation on conducting agricultural and forest husbandry at radioactive contamination of the environment" which were sent to all managers, up to regions. In 1978 recommendations on conducting cattle breeding under conditions of polluting the environment with fission products mixture were published [3].

The information specified in these documents has a recommendatory character and, as a result (for by the disaster it had been 13 years as of the moment they

were published) it happened to be practically forgotten and non-demanded in the critical phase of the accident. State Agricultural Committee of the USSR and its Veterinary Service did not issue orders as for putting the recommendations in force directly after the accident. It is one more lesson as today the information characterizing the critical period of the accident has not been deeply analyzed, and it remained unused properly in order to develop veterinary standards in case of nuclear incidents.

Thus, the importance of this problem is beyond the consequences of the Chornobyl disaster itself and deserves the attention of international organizations. It would be rational to establish an international project related to reconstruction veterinary and cattle breeding aspects of the ChNPP disaster. In spite of the fact than much has been omitted, there are still direct participants and witnesses of these events. The participants of the International seminar hold by the International Union of Epizootology Specialists on October 5, 1988 in Kyiv stated that materials on the specified issues that were accumulated and generalized in CIS countries can become a serious basis for the development of international standards and recommendations to governments non organizing the operations of veterinary services in case of the nuclear or radiation accident.

Radiation doses of the thyroid gland and other sensible internal organs were formed quickly, basically during the first week after the accident, as it is stipulated by the radiation of short-life nuclides from the young mixture of fission products. The evacuation of animals could have been an effective protection method only in case they had been placed to livestock premises immediately after the accident and transferred to the reserved foodstuff or in the starvation mode during 3–4 days as recommendations prescribe [6]. The biggest part of animals was evacuated on the 5–8th day after the accident during which the livestock was on pastures and ate contaminated foodstuff including with iodine radionuclides. Before being evacuated the animals have already received not less than 70 % of the doze that could be formed for the first year after the disaster subject to staying in the contaminated zone.

Iodine prophylaxis could become an efficient protection method. The works of Korneev and others [7] display that cows' and sheep's oral use of stable iodine in the form of ion iodide in the amount of 1–5 mg·kg^{-1} of the body weight simultaneously or 10 days prior to radioactive iodine flow decreases the accumulation of radionuclides in the thyroid body by more than 20 times. Even considerable smaller effect would be enough to decrease the radiation dose of the cows' thyroid glands to the safe level. It is important to note that iodine prophylaxis of animals' radiation damage simultaneously considerably (up to twice) decreases in the transfer of the radioactive iodine to milk and thus provides specific protection of the human being's thyroid gland.

The importance of the issue was defined by the fact that in the accident close zone the radiation situation was really dangerous for animals on pastures. So, on the first day after the accident the gamma background on the distance of 10–15 km from ChNNP in the Khoiniksky district of Belarus was 300–400 millio rentgen·h^{-1}. The flow of iodine radionuclides to the organism stipulated the capacity of the gamma radiation dose of 350–700 millio rentgen·h^{-1} on the body surface in the area of the thyroid gland [8, 9]. Thyroid glands of fetus underwent massive radiation prenatally. The capacity of the doze in the area of this organ with all new-born calves at the age of up to 3 days was in average only twice lower than with their dam. The capacity of doze in the area of the thyroid gland with the evacuated animals was 10–15 times higher than in the area of the metasternum of the keel bone while animals at the evacuation places it was only 2–3 times.

The analysis showed that the evacuated animals could get no more than 50 cGy of the doze of the whole body external radiation and a little smaller doze due to the internal one. Consequently, they could not get acute radiation syndrome. This conclusion was proved by the data of clinical research of animals conducted by N. P. Astasheva and employees of the Ukrainian Research and Development Establishment of the Agricultural Radiology in the mid-May 1986 in the village of Vladimirovka, Polisskiy District, Kyiv Region. They did not detect any deviations from the physiological standard including according to data of hematologic, biochemical and radio immunological researches [10]. At the same time the doses of thyroid glands radiation only from ^{131}I was 40−70 Gy and could not cause the abnormality of animals' metabolic processes.

The generalization of data provided by Burdakov and others, Khonuhov et al., the results of watching the health of cows and sheep from areas of Belarus (Narovliansky, Khoiniksky, and Vetkovsky) being close to the accident epicenter [8, 11, 12] led to the conclusion that the symptoms developed with some animals can be characterized as chronic radiation syndrome. It is stipulated by uneven internal radiation with the selec-

tive damage of thyroid gland and organs functionally connected with it.

Pathomorphological studies of organs of cattle from the Polisskiy District of the Kyiv Region prove the points stated above the most clearly [13]. Strong enlargement of connective and sometimes fat tissue in the area of the thyroid gland, deferent flux, cytoplasm desolation and deformation of epithelial cells nucleus up to their necrosis were typical together with changes being characteristic of the thyroid gland hypofunction in areas with endemic micro nutrient (microelementosis) deficiency.

Vascular abnormalities contributing to the development of the hemorrhagic syndrome being characteristic of the radiation syndrome – capillaries hyperemia, blood stasis, large vessels sclerosis were noted. The noticed changes were the most expressed with the cattle owned by locals and consumed much more fresh foodstuff for much longer period and received a big iodine load. Animals whose thyroid glands were entirely destroyed were detected: the remnants of parenchyma were in the mass with connective and fat tissues and consisted of single follicles filled with colloids [13].

Therefore, hypothyroidism developed with the cows from regions that underwent radioactive contamination. It was associated with morphological changes which appeared for quite long time. Hypothyroidism was observed till 1989 not only in the areas of the Gomel Region but also in contaminated households of the Briansk region (Russia). Ilyazov et al. [12] determined the abnormality of the reproductive function as a result of hypothyroidism with cows that stayed in the 30-km zone during 4.5 months after the accident and got radiation dose of the indigestible tract that reached 180–280 Gy.

The thyroid function of calves remained if the fetus antenatal radiation took place before the third month of development when the kernel starts creating. It was determined that calves that were born in 2 months after the accident (the fetus radiation took place on month 7) had implicit hypothyroidism with thyroxine T_4 in average up to 20 % from the standard. Morphological changes in the kernel were found in 1.5 months after the accident. After that the follicles were destructed. Autoimmune processes simultaneously developed, particularly they included the increase in the frequency of detecting antibodies to thyreoglobulin.

From the point of view of the estimate of possible consequences of cattle stay in the accident zone, the results of long-term observed clinical and physiological condition of three cows and one Black Spotted Jutland bull that were kept on the distance of 4–5 km from the ChNPP are of great interest [14]. It is calculated that the radiation doze was 2–2.5 Gy from the external radiation and about 10 Gy in the gastrointestinal tract from the internal radiation that allowed to predict the development of the slight level of the radiation syndrome. During three years clinical and physiological indicators remained within the standard. In the first 2–4 months hematological indicators were not stable and pointed at somehow anemic condition of the hematopoiesis but they normalized during next months.

Viable offspring was received from animals in March–April 1989. No anomalies in the offspring's development and physiological condition were detected. The authors made the conclusion that cattle who survived in the disaster period in the close zone of ChNPP can be used for reproduction and receiving milk products. Animals should not have been slaughtered without sorting out and predicting possible damage.

The evacuation of animals was undoubted righteous from the point of view of providing staff with safety. It also excluded the possibility of additional radiation of both people and animals in case of unforeseen events. The omission was to continue to graze animals. However, we want to recall that it was informed about the radioactive pollution of the environment too late.

Today, analyzing the working experience related to minimizing the accident consequences and the scientific results, we can conclude the uselessness of mass slaughter of evacuated animals without prior radiation-measuring and clinical examination.

Slaughter of animals on the first days and even months after the accident according to "body contamination" criteria cannot be thought to be righteous due to two reasons. Firstly, hemorrhagic syndrome can be developed only in case of acute radiation syndrome. Against the increase in leakiness of blood vessels and capillaries, weakening of autoimmune processes, hemorrhagic syndrome comes amid bacteriaemia and increased bacterial load of tissues and organs that can cause animals' illnesses and death, and make the human consumption of meat and especially byproducts dangerous. Secondly, the transfer of animals to straight foodstuff allows to get out of system and above all of muscular tissue a considerable number of radionuclides within one or two months due high speed of their exchange. The fulfillment of this condition could prevent undue radiation of the staff in-

volved in maintaining and processing animals, avoid secondary contamination of meat cutting plants and refrigerators, and production of products containing radionuclides above the norms.

Veterinary lessons of Chornobyl must not be forgotten. They must be used as much as possible in order to improve the rules of veterinary and sanitary examination and expertise of foodstuff, animals and livestock products. Only in this case the heroic work of a great number of researchers and practitioners who did their best to minimize the consequences of the Chornobyl catastrophe will be literally absolved.

In the future in case of possible accidents, veterinary mistakes can be made again unless statutory documents are prepared and other measures specified above are regarded on their generalized basis.

Ветеринарные уроки Чернобыля. Меры по защите животных и обращение с пораженным скотом

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Опыт ликвидации последствий Чернобыльской аварии доказал возможность безопасного ведения сельскохозяйственного производства на территории радиоактивного следа, образованного аварийным выбросом. Для его реализации необходимо наличие специальных подразделений в органах управления сельским хозяйством разного уровня, укомплектованных компетентными в области сельскохозяйственной радиологии специалистами. Их подготовка является важным элементом превентивной меры предупреждения ядерных аварий. Особое внимание при этом следует уделить защите животных от радиационного воздействия и обращению с пораженным скотом.

Ключевые слова: ЧАЭС, ядерная авария, диагностика лучевого поражения животных, ветеринарная экспертиза, обращение с пораженными животными.

Ветеринарні уроки Чорнобиля. Заходи із захисту тварин та поводження з ураженою худобою

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Досвід ліквідації наслідків Чорнобильської аварії довів можливість безпечного ведення сільськогосподарського виробництва на території радіоактивного сліду, утвореного аварійним викидом. Для його реалізації необхідна наявність спеціальних підрозділів в органах управління сільським господарством різного рівня, укомплектованих компетентними в галузі сільськогосподарської радіології фахівцями. Їхня підготовка є важливим елементом превентивних заходів із запобігання ядерним аваріям. Особливу увагу при цьому варто приділити захисту тварин від радіаційного впливу та поводженню з ураженою худобою.

Ключові слова: ЧАЭС, ядерна аварія, діагностика променевого ураження тварин, ветеринарна експертиза, поводження з ураженими тваринами.

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