OPTIMISATION OF INFORMATION INFLUENCES ON PROBLEMS OF CONSEQUENCES OF CHERNOBYL ACCIDENT AND QUANTITATIVE CRITERIA FOR ESTIMATION OF INFORMATION ACTIONS

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Abstract
Consequences of Chernobyl NPP accident still very important for Belarus. About 2 million byelorussians live in the districts polluted by Chernobyl radionuclides. Modern approaches to the decision of after Chernobyl problems in Belarus assume more active use of information and educational actions to grow up a new radiological culture. It will allow to reduce internal doze of radiation without spending a lot of money and other resources. Experience of information work with the population affected by Chernobyl since 1986 till 2004 has shown, that information and educational influences not always reach the final aim - application of received knowledge on radiating safety in practice and changing the style of life. If we take into account limited funds and facilities, we should optimize information work. The optimization can be achieved on the basis of quantitative estimations of information actions effectiveness. It is possible to use two parameters for this quantitative estimations: 1) increase in knowledge of the population and experts on the radiating safety, calculated by new method based on applied theory of the information (Mathematical Theory of Communication) by Claude E. Shannon and 2) reduction of internal doze of radiation, calculated on the basis of measurements on human irradiation counter (HIC) before and after an information or educational influence.
Information and educational actions on territories of Belarus polluted by radionuclides can solve many problems, dedicated to consequences of accident on the Chernobyl NPP. Now the government of Belarus reconsiders approaches to informing the population and experts on problems of consequences of Chernobyl accident. We can use information and educational influences as counter-measures for decrease internal reception of radionuclides in human organism. In the previous State programs of Belarus information and educational influences didn't use as counter-measures, and didn't possess as the important action in overcoming consequences of accident at Chernobyl NPP. Meanwhile, according to the international framework research, 1991-1995, cost of internal dose of radiation prevented by educational actions 5 times cheaper then by entering additional dozes of fertilizers. The government wanted to find out new approach to informing on problems of Chernobyl accident using new information technologies allowing to reach the aims (reduce internal dose of radiation) for limited time and resources.
Core of new information policy on Chernobyl problems is its addressing. It means, that any information or educational influence should be designed for the target audience with real purposes and ways of their achievement.
If we want to find out optimum strategy in the field of informing population about Chernobyl consequences, it is necessary to estimate efficiency of each information action quantitatively. We should have an objective quantity indicator of information work. Then it will be possible to range information influences by criterion of an expense - efficiency, and to select the optimal ones.
There are two effects from information or educational influence with population of Belarus living on polluted areas.
1) Increase of knowledge on radiating safety.

2) Application of this new knowledge in practice to decrease internal radionuclide reception.
So, we need two quantity indicators of efficiency of an information work. One - to know how well the population learned the material, the second - to find out, whether new knowledge are applied and what protective effect it brings.
For definition the quantity of increase of knowledge on radiating safety, we can use methods and approaches of the applied theory of the information (Mathematical Theory of Communication) by Claude E. Shannon.
Shannon's approaches are applicable in all cases when we can construct probability model of the source of messages. Such model can be constructed easily if we use standard test to control knowledge on radiation safety.
This test should be uniform for all the population and should contain questions on all aspects of safety living on polluted territories. Therefore its development is especially important problem that should be done by highly skilled experts.
Testing has many advantages in comparison with other quality monitoring of knowledge. For limited time it is possible to receive data on knowledge level of big group of people. Much more people can participate in testing if we use computer testing with Internet technologies. However, procedure of testing can be carried out traditionally, using questionnaires. One more advantage is objectivity of the estimation of efficiency of information and educational actions.
It's very important that test with variants of answers allows to construct probability model of source of messages (means tested group in our case). This is necessary condition to apply Shannon's methods.
According to the mathematical theory of communication we can calculate **entropy** (measure of uncertainty) when the test is finished:

$$H(X) = \sum_{i=1}^{n} P(x_i) \log P(x_i)$$

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where n - number of possible outcomes, p_i - probability of i consequence of experience. Using it, we can analyze information properties of sources of messages. The outcome of experience in our case is a choice of this or that variant of the answer to a question of the test.
Entropy grows when freedom of a choice (or uncertainty) increases, but decreases, when freedom of a choice and uncertainty are limited. In our case it is possible to mean "disorder" of knowledge of group as uncertainty.
Entropy accepts the maximal value in that case, when all outcomes of experience (all variants of the answer to a question) are equiprobable. It means, that "average" person knows nothing in the subject and chooses answers completely chaotically. Minimum of entropy (zero), is reached when knowledge are completely ordered (all tested choose the same variant of the answer).
If we calculate entropy of all the questions in the test we obtain *disorder of knowledge* of group

$$D = \sum_{i=1}^{k} H_i$$

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where H_i - entropy of i question, k - amount of questions in the test.
Let's assume, that the trained group has been tested before carrying out of educational process and after it. It is possible to calculate disorder of knowledge of group before and after training. Difference of these values gives us the efficiency of information (educational) influence

$$E = D_{before} - D_{after} .$$

It can be used as a quantity indicator of efficiency of the information influence describing increase of knowledge (elimination of disorder of knowledge) for the group.
By definition entropy is tolerant to sense, *truthfulness* and reliability of the information. It means, that an estimation of efficiency of the information and educational influences, based on this approach, can be used not only in radiating safety, but in any other problem area.
This method has one defect. The following example is showing it. Let's assume, that the people answer any question of the test incorrectly, thus everyone choose the same (wrong) variant of the answer. It is possible to say that the steady error of group takes place. After information or educational action people answer correctly, and all of them choose the same (correct) variant of the answer. The level of disorder of knowledge before and after information or educational action is equal to zero. This example shows that not always efficiency of elimination of disorder of knowledge will be correct estimation of efficiency of information or educational process.
To get indicator of application of new knowledge on radiation safety in practice, we can offer a difference of an average doze of internal irradiation before carrying out of information or educational influence and after it. Quantity of average doze of internal irradiation can be calculated from human irradiation counter (HIC) measurements.
Thus, the following mechanism of a quantitative estimation of efficiency of information and educational influences on radiating safety is offered.

1. Testing of radiation safety knowledge and internal dose of radiation measurement for the group.
2. Carrying out of information (educational) action.
3. Final testing and internal dose of radiation measurement.
4. Calculation of quantitative estimations of efficiency of information influence.
5. Ranging information actions on problems of consequences of Chernobyl accident on the basis of received quantitative estimations of efficiency of information influences and their updating.

This mechanism will allow to optimize an information policy on problems of Chernobyl accident.