

ASSESSMENT OF THE ADAPTATION OF PATIENTS WITH ARS, VICTIMS OF CHNPP AND DIFFERENT RADIATION ACCIDENTS, PAST PSYCHOPHYSIOLOGICAL EXAMINATION

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Abstract. The work was aimed to evaluate the adaptation of acute radiation sickness patients, victims of the Chernobyl Nuclear Power Plant (ChNPP) accident and different radiation accidents, who underwent follow-up psychophysiological examination. Clinical and psychophysiological follow-up examination covered 32 acute radiation sickness patients – 11 with severe and extremely severe grade, who underwent Chernobyl nuclear power station accident, and 21 acute radiation sickness patients from other radiation accidents. The authors demonstrated the leading role of such psychological traits as hypochondriasis, anxiety about health, emotional tension, anxiety, inclination to depression, frustration tension, low self-confidence, suspiciousness, diffidence, affective rigidity, discontentment about the situation and personal position in it, restriction of contact with others - decrease of the stenicity and integration of behavior, that caused adaptation disorders in a distant period among acute radiation sickness patients victims of the Chernobyl nuclear power station accident and in acute radiation sickness patients from other radiation accidents. Intellectual faculties (according to the Cattell test) and imaginative and logic thinking (Raven's test) in the patients who underwent radiation accidents were not affected, but were higher than the average in acute radiation sickness patients victims of the Chernobyl nuclear power station accident, especially in the first 15 years of observation, and equaled to the intellectual level of acute radiation sickness patients from other radiation accidents in the following 15 years of observation.

Key words: Acute radiation disease, ionizing radiation, adaptation, local radiation injuries

1. INTRODUCTION

The role of a person when working on potentially dangerous objects remains decisive. On the one hand, 20 to 80% of incidents in the nuclear industry and energy industry are associated with staff errors, and on the other hand, it was human actions in 70% of the risk of accidents that prevented the disaster. The Chernobyl accident showed to what tragic social, medical and economic consequences the erroneous actions of Nuclear Power Plant (NPP) personnel can lead. The reliability of personnel activity began to be considered as the leading problem of nuclear energy.

The aim of this work is the clinical and psychophysiological assessment of the adaptation of patients with Acute Radiation Sickness (ARS) victims of the Chernobyl accident and various radiation accidents in different time periods (1986–2002) and (2003–2016).

2. MATERIALS AND METHODS

Clinico-psychophysiological examination was carried out in the dynamics of 32 patients with ARS, 11 of whom were severely and extremely severely sick, severely injured in the Chernobyl accident and 21

patients with ARS from various radiation accidents. Older patients were ARS patients from different accidents (mean age 62.8 ± 2.4 and 74.9 ± 2.3). Estimation of the average dose to the whole body of uniform gamma and gamma-neutron irradiation, obtained from the results of physical measurements and cytogenetic studies in patients injured in radiation accidents, showed (Table 1) that the largest average dose for the whole body was for patients with ARS who were injured in the accident at the Chernobyl NPP.

Among them, there were 2 (18.2%) patients with ARS of I degree of severity, ARS II – 4 (36.4%), ARS III – 4 (36.4%) and ARS IV degree – 1(9%) person; 7 (63.6%) of them had local radiation lesions of I-IV severity, 1 (9%) of them requiring limb amputation.

Table 1. Average doses for the whole body, obtained from the results of physical measurements and cytogenetic studies in patients affected in radiation accidents ($M \pm m$), Gy

Name	Dose, Gy			
	$M \pm m$	σ	min	max
patients with ARS (ChNPP) n=11	3.86 ± 0.97	2.89	1.20	9.80
patients with ARS (different accidents) n=21	2.47 ± 0.38	1.25	0.80	4.10

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Among the patients with ARS from other radiation accidents, 8 (38%) patients had ARS I degree of severity, ARS II – 9 (42.9%) and 4 (19.1) patients had ARS III, 4 (19.1) of them had severe and extremely severe LRI of III and IV degree, requiring amputation of the extremities.

Psychophysiological examination was carried out using the automated program-methodical complex “Expert”, designed to investigate personal characteristics, cognitive and intellectual personality. The evaluation of the effectiveness of mental adaptation according to the Minnesota Multiphasic Personality Inventory (MMPI) test [1] was carried out taking into account the height of the T-score. The boundaries of the population statistical standard on the T-score scale are 70 points (M + 2 sigma) and 30 T-points (M-2 sigma), with a probability of restricted to 95% of the studied population. MMPI increases for 70 T-points with a high (up to 95%) reliability indicating an increased likelihood of mental and social adaptation disorders. The height of the indicators between 70 and 80 T-points indicates an unstable psychic adaptation, above 80 points - on the overstrain of mental adaptation. Deviations from the mean MMPI for the lower values are less predictive than for the higher values. Unlike MMPI, in the Cattell test, both the ups and downs of individual factors can be prognostically significant. The average value of any factor of the Cattell test is 5.5 wall. Expressed deviations from the mean are the values of factors greater than eight and lower than three.

Statistical processing of the parameters of the two groups in the dynamics was carried out using non-parametric criteria for Wilcoxon sign rankings for coupled samples and the Mann-Whitney U test for independent samples.

3. RESULTS OF THE STUDY AND DISCUSSION

Evaluation of the indicators of multiphasic personality research in patients with ARS victims of the Chernobyl accident in different time periods (1986-2002) and (2003-2016), comparing the first 15 years with the subsequent 15 years of follow-up according to the averaged analysis of MMPI, is shown in Figure 1 and Table 2.

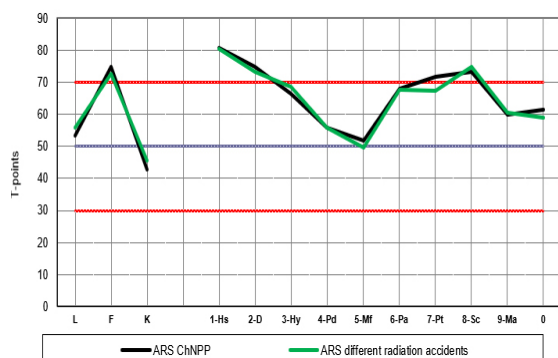


Figure 1. Averaged profiles of the MMPI test in patients with ARS victims of the Chernobyl accident and in patients with ARS from different radiation accidents

Table 2. Minnesota Multiphasic Personality Inventory research (MMPI) of patients with ARS who have experienced a radiation accident at the Chernobyl nuclear power plant and various radiation accidents in different time periods (M ± m)

Name	patients with ARS (ChNPP) 1986-2002 n=10	patients with ARS (ChNPP) 2003-2016 n=11	patients with ARS (different accidents) 1 observation n=14	patients with ARS (different accidents) 2 observation n=21	Total n=32
Age	47.60** ±2.45	62.82 ±2.38	64.21 ±1.84	68.86 ±2.35	74.90 ±2.31
L	53.48 ±2.74	52.44 ±2.40	55.98 ±2.22	53.51 ±2.15	54.57 ±1.90
F	74.80 ±6.28	69.71 ±4.30	72.67 ±7.59	69.52 ±4.38	69.33 ±4.46
K	42.78 ±2.68	45.35 ±2.14	45.66 ±2.81	45.15 ±2.09	44.95 ±2.04
1Hs	80.71 ±4.56	78.23 ±3.73	80.53 ±3.96	78.71 ±3.73	79.19 ±3.72
2D	74.73 ±2.65	70.77 ±2.53	73.24 ±2.48	70.31 ±2.60	69.84 ±2.66
3Hy	66.58 ±4.13	65.58 ±3.02	68.72 ±2.73	66.41 ±2.69	67.24 ±2.36
4Pd	55.98 ±2.47	54.47 ±1.89	55.75 ±2.69	53.34 ±2.13	52.20 ±2.37
5Mf	51.66 ±1.71	52.6 ±1.55	49.72 ±2.83	50.4 ±2.00	48.2 ±2.44
6Pa	68.04 ±4.27	64.83 ±2.97	67.76 ±4.81	64.12 ±3.03	63.41 ±3.08
7Pt	71.80 ±3.05	68.35 ±2.34	67.39 ±2.04	66.28 ±2.19	64.20 ±2.03
8Sc	73.20 ±5.53	69.35 ±3.73	74.73 ±4.52	69.80 ±3.50	70.25 ±3.26
9Ma	59.85 ±2.68	60.30 ±1.86	60.43 ±2.55	59.04 ±1.93	57.78 ±2.00
o	61.59 ±2.79	57.00 ±2.97	59.06 ±2.89	57.18 ±2.49	57.35 ±2.00

Scale of reliability: L - lies, F - reliability, K - correction. The basic scales of MMPI: 1Hs - hypochondria, 2D - depression, 3Hy - hysteria, 4Pd - psychopathy, 5Mf - masculinity, femininity, 6Pa - paranoia, 7Pt - psychasthenia, 8Sc - schizophrenia, 9Ma - mania, o-introversion.

Comparative evaluation of Minnesota Multiphasic Personality Inventory (MMPI) indicators in patients with ARS victims of the Chernobyl accident and various radiation accidents and incidents (Table 2, Figure 1) showed that, according to the averaged data of the MMPI test, the disturbance of mental adaptation due to the expressed concern about the physical condition health is determined by the leading scale of 1-Hs both in patients with ARS victims of the Chernobyl accident, and in patients with ARS victims of various radiation accidents (78.23±3.73 and 79.19±3.72), causing strain and overstrain of mental adaptation, more pronounced in patients with ARS from different radiation accidents (57.1% and 64.9%), with a predominance overstrain of mental adaptation in it.

For the majority of other factors, the indicators were higher in ARS patients affected by the Chernobyl accident, in the form of an increased level of internal tension (scale F), denial of difficulties, conflicts, any forms of social unhappiness (K scale), anxiety,

propensity to depression (scale 2-D), trends towards neglect of social norms and rules (4-Pd scale), affective rigidity (6-Pa scale), suspicion, self-doubt (7-Pt scale), activity level and optimism (O scale). Indicators characterizing demonstrative behavior (3-Hy scale), originality of thinking (8-Sc scale), a pronounced tendency to draw attention to existing symptoms and problems (scale L) were more pronounced in patients with ARS victims of different accidents. In the statistical treatment of MMPI parameters of two groups in dynamics using nonparametric criteria for Wilcoxon sign rankings for coupled samples and the Mann-Whitney U criterion for independent samples, no significant differences were obtained.

As a result of a comparative evaluation of the character traits of individuals affected by the Chernobyl nuclear accident and by various radiation accidents, according to the Cattell test, the following significantly different character characteristics of personality in ARS patients affected by the Chernobyl accident as compared to the patients with ARS from different radiation accidents are observed (Table 3, Figure 2): the factor E - the level of dominance, ($p < 0.01$), factor G - conscientiousness, commitment to sense of duty, responsibility, ($p < 0.01$), factor L - inclination to increased self-esteem, distrustfulness, coldness, inclination to rivalry and affective rigidity ($p < 0.05$), factor O - anxiety, tension sensitivity to remarks and reproaches, discontent with the situation and position, ($p < 0.01$), factor Q4 - high tension, anxiety about unsatisfied needs, ($p < 0.05$), factor F1 anxiety, ($p < 0.05$); Factor F2 - a tendency to introversion, to limiting social contacts and maintaining interpersonal ($p < 0.05$).

A comparative assessment of the indicators of the ability to abstract-logical thinking and the solution of logical problems in the conditions of a time deficit in victims of radiation accidents (Raven's test) showed that the answer was correct in 44% of patients with ARS injured in the Chernobyl accident and in 33 % of patients with ARS from different radiation accidents. This number of surveyed people has the ability to abstract-logical thinking and solving logical problems in a short period of time.

Evaluation of the time parameters of a simple sensorimotor reaction (SSR), a complex sensorimotor reaction (CSR), and a reaction to a moving object (RMO) showed that, according to the averaged data, the time of a simple sensorimotor reaction was significant ($p < 0.05$) in patients with ARS from different radiation accidents (312.06 ± 14.94) compared with patients with ARS victims of the Chernobyl accident (326.04 ± 34.27).

When the complex sensorimotor reaction was performed using the averaged data, the patients with ARS victims of the Chernobyl accident completed this test with a longer response time (608.31 ± 166.70), while allowing more passes (1.60 ± 1.60) and errors (4.20 ± 2.80).

When analyzing the individual data of the time parameters of a complex sensorimotor reaction, it can be noted that the rate of a complex sensorimotor reaction at the upper limit of the norm was in 60.0% of patients with ARS victims of the Chernobyl accident

and in 60.0% of patients with ARS from different radiation accidents, however, the number of unacceptable passes (40.0%) and unacceptable errors (50.0%) was greater in patients with ARS from different radiation accidents.

Table 3. Average indices of the Cattell test (16 PF) in patients with ARS victims of the Chernobyl accident and different radiation accidents (M ± m)

Name	patients with ARS (ChNPP) 1986-2002 n=10	patients with ARS (ChNPP) 2003-2016 n=11	patients with ARS (different accidents) 1 observation n=14	patients with ARS (different accidents) 2 observation n=15	Total n=26
Age	47.60 ±2.45	62.82 ±2.38	64.21 ±1.84	72.42 ±3.34	67.62 ±2.86
A	5.91** ±0.41	6.84 ±0.39	6.21* ±0.42	5.73 ±0.37	6.29 ±0.38
B	7.09 ±0.46	6.32 ±0.45	5.95 ±0.59	6.40 ±0.51	6.36 ±0.48
C	3.73 ±0.35	4.42 ±0.38	3.95 ±0.30	4.47 ±0.61	4.45 ±0.50
E	5.73 ±0.54	6.05 ±0.52	4.95* ±0.32	3.93 ±0.40	4.99 ±0.46
F	4.73* ±0.74	5.37 ±0.57	4.47* ±0.23	4.00 ±0.31	4.69 ±0.44
G	5.55 ±0.34	5.79 ±0.22	4.89* ±0.35	4.27 ±0.42	5.03 ±0.32
H	5.00 ±0.76	5.74 ±0.68	4.53 ±0.29	4.27 ±0.32	5.01 ±0.50
I	4.73 ±0.30	5.21 ±0.36	5.26 ±0.29	5.67 ±0.48	5.44 ±0.42
L	7.18* ±0.48	7.42 ±0.33	6.26* ±0.32	6.00 ±0.48	6.71 ±0.41
M	4.00 ±0.57	3.95 ±0.36	4.89 ±0.43	4.53 ±0.52	4.24 ±0.44
N	5.18 ±0.58	5.95 ±0.47	6.63 ±0.46	5.47 ±0.56	5.71 ±0.52
O	8.27 ±0.47	8.00 ±0.33	6.53** ±0.38	6.00 ±0.52	7.00 ±0.43
Q1	4.18 ±0.48	3.68 ±0.41	4.42 ±0.55	4.27 ±0.52	3.98 ±0.47
Q2	5.73 ±0.65	4.84 ±0.64	5.47 ±0.47	5.60 ±0.51	5.22 ±0.58
Q3	6.09 ±0.51	6.58 ±0.41	6.89 ±0.40	6.40 ±0.50	6.49 ±0.46
Q4	8.27 ±0.47	7.89 ±0.41	6.89 ±0.43	6.47 ±0.45	7.18 ±0.43
F1	8.06 ±0.38	7.49 ±0.36	6.69* ±0.34	6.36 ±0.43	6.93 ±0.40
F2	5.05* ±0.97	6.13 ±0.86	4.58* ±0.28	3.84 ±0.35	4.99 ±0.61
F3	5.57 ±0.26	5.41 ±0.25	5.08 ±0.29	4.67 ±0.43	5.04 ±0.34
F4	4.57 ±0.41	3.81 ±0.36	4.56 ±0.45	4.30 ±0.47	4.06 ±0.42

* $p < 0.05$ ** $p \leq 0.01$

Scales of the methodology: A - emotionality, B - intelligence, C - behavior integration, E - dominance, F - freedom of behavior, G - strength or weakness of the Super-Ego, H - risk appetite, I - realism - imagination, L - rigidity affect, M - practicality, N - upbringing, O - discontent with the situation and position, Q1 - conservative - realistic, Q2 - self-sufficiency, Q3 - conscious self-control, Q4 - frustration tension, F1 - tension, anxiety, dissatisfaction of needs, F2 - introversion - extraversion, F3 - threshold of frustration, F4-level of internal independence.

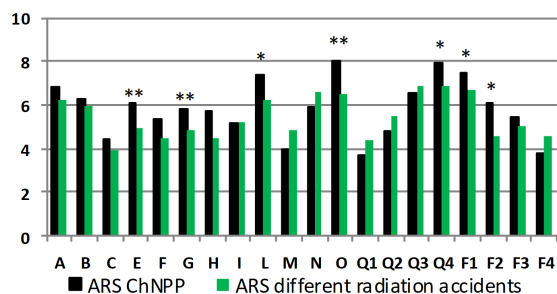


Figure 2. The average indices of the Cattell test in patients with ARS, victims of the Chernobyl accident and in patients with ARS from different radiation accidents

The average response time to a moving object showed that the reaction to a moving object in patients with ARS from different radiation accidents took less time (988.81 ± 6.02) than in patients with ARS victims of the Chernobyl accident (1015), 56 ± 13.77), while the accuracy of the reaction was approximately the same (7.40 ± 2.09 and 8.41 ± 0.82). With an individual assessment of the response time to a moving object, the accuracy of the reaction was higher than 8% in 40.0% and 41.7% of the ARS patients affected by the Chernobyl accident and in the ARS patients from different accidents, respectively.

Thus, the time for a simple sensorimotor reaction to light, a complex sensorimotor reaction to color and sound, as well as to a moving object in ARS patients affected by the Chernobyl accident was spent a little more than in patients with ARS from different radiation accidents, allowed more passes, inaccuracies and errors.

A comparison of the personality structure from the MMPI test of patients diagnosed with ARS in the Institute of Biophysics (IB) Clinical Department 30–50 years ago, the so-called ARS group from different accidents, and the most severe small group of ARS patients affected by the Chernobyl accident who were under observation and treatment in the IB Clinic for 30 years showed significant differences with the data given in the thesis and articles by Loganovsky et al. [2, 3, 4]. So, Loganovsky notes that from 1990 to 1995, according to MMPI, in patients with a diagnosis of ARS, the structure of the patient's personality reflected the asthenic type of response complicated by hypochondriac and paranoid inclusions. However, after 10–15 years, personality disorders got worse, there was a decompensation of the asthenic type of response with social disadaptation and patients had a characteristic psychopathological loss that reflects the formation of psycho-like disorders of the asthenic pole, which the author classifies as an apathetic variant of the psychoorganic syndrome. At the same time, personality changes occurred due to the impact of a complex of consequences of the Chernobyl disaster on the radiation and non-radiation nature of somato-neurological pathology and mental disorders, as well as socio-economic changes. The personality profile of the patients examined by us according to the MMPI data, as mentioned above, has an asthenic and asthenic-neurotic type of response with a significant dominance of hypochondriacal tendencies and relatively less expressed anxiety-depressive tendencies. Is it doubtful

that such a progressive deformation of personality took place in the remote period of ARS in patients with initially high educational and professional level becoming psychologically unfit for almost all types of professional activities, especially related to administrative management, responsibility and communication with people?

As a result of our studies, it can be noted that according to the Cattell test, the intellect (factor B) in patients affected by radiation accidents did not suffer, but was higher in ARS patients affected by the Chernobyl accident, especially in the first 15 years of observation and equal to the level of intelligence of ARS patients from different radiation accidents in the next 15 years of observation, which, in their comparative plan, had a slight decrease in intelligence. According to the Raven's test, it can also be noted that the logical-figurative thinking was and remained in the dynamics better in patients with ARS victims of the Chernobyl accident.

Perhaps, the difference in the data obtained by Loganovskiy is that even the majority of surveyed persons continued and continue to work (out of 21 people injured in various radiation accidents 30–50 years ago (49.2%). For example, 1 person with a diagnosis of ARS III degree and LRI III–IV degree with amputated lower limbs continued to work at The Kurchatov Institute of Atomic Energy for 39 years until 2010, the other - having only one hand, was growing vegetables for kindergarten children and was coming to the clinic during the Chernobyl accident to support the patients mostly affected by the ARS and liquidators of the Chernobyl accident. One person with a diagnosis of ARS II degree affected in the Chernobyl accident (disabled group III) worked as a chief specialist from 1987 to 2015 at the Concern Rosenergoatom. The remaining 10 people led an active lifestyle, were employed as long as possible either in the public sector or in the private sector (disabled group II). Perhaps in Ukraine, in addition to the reluctance to work, the difficulty of finding a job and insufficient socioeconomic support exacerbated the personality disorder discovered by Loganovsky as in patients with a diagnosis of ARS, and in the liquidators of the Chernobyl accident.

4. CONCLUSION

Clinico-psychophysiological examination was carried out in the dynamics of 32 patients with ARS, 11 of whom were severely and extremely severely sick, severely injured in the Chernobyl accident and 21 patients with ARS from various radiation accidents.

As a result of the conducted studies, the leading role in reducing the stenicity and integrative behavior of such psychological manifestations as hypochondria, concern with the state of health, emotional tension, anxiety, propensity for depression, frustration, tension, suspiciousness, lack of confidence, affective rigidity, discontent with the situation and limited contact with others - caused the long-term violation of adaptation processes in patients with ARS, the victims of the Chernobyl accident, and in patients with ARS from various radiation accidents, with the peculiarities of

manifestation, depending on the stressful situation and the personality of the examined person. The intellect, according to the Cattell test, and the image-logical thinking Raven's test in patients affected by radiation accidents did not suffer, but was above average in patients with ARS who suffered in the Chernobyl accident, especially during the first 15 years of observation and equal to the level of intelligence of ARS patients from different radiation accidents in the next 15 years of observation, which, in comparative terms, had a slight decrease in intelligence. The speed of a simple sensorimotor reaction to light, a complex sensorimotor reaction to color and sound, as well as reactions to a moving object were reduced and they led to a large number of omissions, inaccuracies and errors. The degree of severity of asthenic and asthenic-neurotic type of response is represented by the predominance of hypochondriacal and anxious-depressive types of response, especially pronounced in patients with ARS victims of the Chernobyl accident, and in patients with ARS from various radiation accidents, with the addition of demonstrative and original trends, and depended on individual characteristics of the surveyed contingent, causing tension and overstraining psychophysiological adaptation.

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