ALCOHOL DEPENDENCE SYNDROME IN
CHERNOBYL NPP ACCIDENT CLEAN-UP WORKERS

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Abstract

The theoretical systematization and new solution of the current scientific problem of mental and behavioral disorders related to alcohol abuse in Chernobyl accident clean-up workers have been realized in the study. This involved the clinical and epidemiological pattern of the alcohol dependence syndrome (ADS) development following the Chernobyl accident. The secondariness of alcohol abuse and ADS among clean-up workers following to external exposure to ionizing radiation in doses of 0.0003–2.87 Gy on the background of mental, somatic and neurological abnormalities was shown. ADS was diagnosed in 26.8% of the clean-up workers while the ADS group risk includes 17.2% of them. Thus 44% of the clean-up workers faced with mental and behavioral disorders because of alcohol consumption.

Key words: Chernobyl accident, clean-up workers, alcohol dependence syndrome, ionizing radiation, mental disorders

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Introduction

There is the third decade since Chernobyl disaster, which had led to the wide range of health and social problems. Some of those are already solved due to the efforts applied by national researchers (Bebeshko et al. 2006, Bazyka et al. 2007, Buzunov et al. 2007, Kovalenko 2008, Loganovs’kyi 2008) and experts from near and far abroad (Bromet and Dew 1995, Ushakov et al. 1998, Bromet and Havenaar 2007). Mutual impact of ionizing radiation and alcohol on human remains however the extremely contradictory radiobiological issue.

There are two principal opinions regarding the alcohol effects under radiation exposure. Adherents of one of them insist on radioprotective effect of ethanol due to its both direct antioxidative effect (Ewing and Kubala 1987, Bonnefont-Rousselot et al. 2001) and antioxidative properties of some substances as the part of dry red wine (resveratrol) (Reagan-Shaw et al. 2008) and beer (Monobe et al. 2005). At the same time some data are available regarding synergetic toxicity of ionizing radiation (IR) and ethyl alcohol (Vorontsova et al. 2001, Ogony et al. 2008).

It is widely thought that alcohol at doses from 0.3 g/kg is a weak radioprotector with protection index of 1.15-1.18 and only under the acute exposure (Ushakov et al. 1998, Grodzinskiy 1991). Extreme events i.e. wars, natural and man-made disasters, terrorist attacks and so on lead to alcohol abuse and substantial deterioration of mental health in survivors (Napreyenko and Marchuk 2001, Leon 2004, Grynevich and Lins’kyi 2006).

Mental health disorders in survivors is the internationally recognized health and social problem of the Chernobyl disaster (Bromet and Havenaar 2007, WHO 2006). However whence of its neuropsychiatric consequences remains utterly debatable (Loganovs’kyi 2006, Gus’kova 2007).

Reasons of the incidence increase of non-cancer diseases and neuropsychiatric disorders in Chernobyl disaster survivors both with role of low-dose IR impact remain of current concern (Loganovsky et al. 2008). Though harmful effect of radiation has not been corrected for such risk factors as smoking, alcohol abuse and so on (Ivanov 2007).

Despite only single clinical/epidemiological studies of the alcohol dependence syndrome (ADS) in Chernobyl NPP accident clean-up workers (Shamov 2004, Sedimina 2009) there is a prevalent opinion about the alcohol abuse as the primary cause of mental disorders especially of psycho-organic circle in Chernobyl NPP accident survivors (Bromet and Havenaar 2007, Skavysh 2009). In equal measure the radiation-associated defects of opioid peptides (Bazyka et al. 2007, Tereschenko 2005) and liver detoxication capacities (Gasanov 2008) are found in the accident clean-up workers that can be involved to some extent in ADS pathogenesis.

Additive impact of the IR, stress, and somatoneurological diseases at the background of systematic alcohol abuse in remote consequences period of the Chernobyl disaster results in alteration of intellectual potential of survivors, deterioration of...
their functioning, working capacity and quality of life. Such processes require the specific correction within management and rehabilitation of the patients, at that during the entire life span in some cases (Yuryeva LN 2002, Sedinina 2007).

Thus the problem of mental and behavioral disorders related to alcohol abuse and to ADS particularly requires its solving in Chernobyl NPP accident clean-up workers. Research in this field was held within 1991-2010 in the framework of State Programs for the Chernobyl NPP accident clean-up and social protection of population, of the scheduled scientific research projects at the Sorption and Endocology Problems Institute of NAS of Ukraine, Radiation Hygiene and Epidemiology Institute and Radiation Psychoneurology Department of the Clinical Radiology Institute of the SE “RCRM of AMS of Ukraine”.

The clinical study in 1991-2009 involved the following groups of subjects:

1) main clinical group (n=194) of the Chernobyl NPP accident clean-up workers exposed to 0.01-0.96 Gy of IR and suffering ADS
2) clinical group of compare #1 (n=216) of the Chernobyl NPP accident clean-up workers exposed to 0.01-0.98 Gy of IR and suffering mental disorders but no ADS
3) clinical group of compare #2 (n=270) of not exposed to IR mental patients suffering ADS

There were 680 clinical study subjects in total.

The clinical-epidemiological study was based on data from the following groups of subjects:

1) main clinical-epidemiological group (n=500) of randomly selected Chernobyl NPP accident clean-up workers of 1986-1987 period (0.0003-2.87 Gy of IR exposure) being registered in the Clinical-Epidemiological Registry of SE “RCRM of AMS of Ukraine”
2) clinical-epidemiological group of compare #1 (n=200) of ADS patients not exposed to IR and receiving care at theTEMPerance and Health Association of Kiev city
3) clinical-epidemiological group of compare #2 (n=500) of randomly sampled not exposed to IR staff members of Kiev city and Kiev province works and enterprises.

There were 1200 clinical-epidemiological study subjects in total.

There were 1880 persons all in all i.e. 910 clean-up workers and 970 subjects in compare groups surveyed according to elaborated protocol.

Clinical characterization of the Chernobyl NPP accident clean-up workers who experienced mental and behavioral disorders at the background of alcohol abuse after the exposure to 0.01-0.98 Gy of IR exposure

After the participation in clean-up work at the Chernobyl estrangement zone the gradual onset of specific soreness or painful feelings complex occurred in study subjects. Under seeking the health care the anletic and sedative medications were typically prescribed to them. The widely accepted opinion of psychogenic origin of neuropsychiatric disorders in survivors was one among others reason of such a just symptomatic approach in patients managing.

The substantial part of clean-up workers had got used to psychotropic medications and later they became prone to iatrogenic substance abuse. Vast majority of subjects in the main study group for a variety of reasons at first occasionally and then systematically started to use the pharmacological properties of alcohol to overcome the soreness and ameliorate the psychological comfort. The analgetic effect of alcohol was helpful in headache and senestopathic events vanquishing. The tranquilizing effect favor to sleep improvement, anxiety feelings reduction, experience desactualization of social and living problems, and general strain reversal. The euphorisation properties had made possible to avoid the asthenodepressive manifestations and for the short time to improve the perception of situation.

Furthermore the consumption of alcohol as a non-medication factor stipulated the self-pacification and opinion arise about subjective health well-doing. The circulating by rumour mill wide-spread opinion about the radioprotective properties of ethanol was an important factor prompting to alcohol consumption.

All that had stipulated further the psychogenic component of neuropsychic disorders that led to systemic alcoholization and further dependence on alcohol (Postrelko 2001, Postrelko 2003).

Prospective survey of the course of mental disorders was carried out in ward and outpatient settings. Repeated clinical-psychopathological examination results were charted with assessment of respective symptoms in remote period upon the disaster (2006-2009). According to the BPRS data the psychopathologic symptoms cluster was revealed in the main clinical group. Intensity of symptoms was the highest within psychopathology spectrum (figure 1). Analysis of factors having impact on the psychopathologic symptoms testify its etiologic heterogeneity in the main clinical group.

The integral BPRS score increased along with the intensity of somatoneurologic disorders (r=0,33; p<0,029) and correlated with the presence of link between disease and participation in the accident clean-up work (r=0,26; p<0,049), education time (r=0,31; p<0,02), and decreased along with number elevation of bad habits (r=0,27; p<0,04). The last circumstance can testify to mental compensation seeking due to alcohol consumption.

Average integral BPRS score (M±SD) in the main clinical group was higher than in the clinical group of compare #1 (59,8±11,3 and 52,1±12,1 respectively; p<0,05) and in the clinical group of compare #2 (42,2±8,6; p<0,01) that is shown on figure 2.

The comparative analysis of psychopathological symptoms intensity in study groups revealed the discrepancies almost by all BPRS subscales (table 1). Presentation of clinical psychopathological symptomatic in clinical groups was peculiar with substantial divergences. Just the accident clean-up workers in the main clinical group and clinical group of compare #1 were different from the clinical group of compare #2 with more intensive somatic concern, anxiety, negative psychopathological symptomatic, cognitive disorders, depressive signs etc. The clean-up workers suffering mental disorders and ADS were different from those having no ADS with more pronounced somatic concern, anxiety, emotional withdrawal, depression, suspiciousness, tension etc. Higher intensity of psychopathology in general and of somatoform disorders in particular in the main clinical group can testify to the role of analgetic and ataractic effects of alcohol drinks as one of principal motivations of their use (Postrelko 2010).

Epidemiological analysis and risk factor assessment for ADS in Chernobyl NPP accident clean-up workers of 1986-1987 period

The ADS prevalence in clean-up workers cohort (rate of ADS patients) was 0,268 e.g. 26.8%. At that the ADS remission was in 61 (12.2%) subject and active ADS was diagnosed in 73 (14.6%) clean-up workers. Furthermore the risk group of ADS (alcohol abuse or harmful use) was identified, which included 86 (17.2%)
Alcohol dependence syndrome in Chernobyl NPP accident clean-up workers

**Figure 1.** Psychopathology according to BPRS in the main clinical group. BPRS score: 0 – no symptom; 1 – very mild; 2 – mild; 3 – moderate; 4 – moderately severe; 5 – severe; 6 – very severe

**Figure 2.** Average integral BPRS scores in clinical groups

**Figure 3.** Mental and behavioral disorders due to alcohol consumption in clean-up workers of the main clinical-epidemiological group

**Figure 3.**  
- ADS in remission: 61 (12.2%)
- Active ADS: 73 (14.6%)
- Alcohol abuse: 86 (17.2%)
- No substance dependence disorder: 280 (56%)
clean-up workers. Thus the alcohol problems (F10.1 i F10.2) were revealed in 220 (44%) clean-up workers (figure 3).

According to the data on ADS course the somatic diseases in ADS patients occur first. Then mental disorders appear and at the background of these health problems the ADS manifests itself. This trend is clear from figure 4. It was found that alcohol abuse and ADS are secondary issues and appear at the background of somatoneurological and mental disorders after the exposure to 0.0003-2.87 Gy of radiation dose.

Prevalence in population and risk level for ADS were assessed using data from two study groups i.e. the Chernobyl NPP accident clean-up workers exposed to IR and Kiev city inhabitants not involved in clean-up work after the Chernobyl NPP accident (not exposed subjects).

Upon respective calculations the statistically significant link was established between IR dose and the following ADS course in Chernobyl NPP accident clean-up workers.

Cumulative values of the odds ratio and 95% confidential interval were here 2.44 (1.84 … 3.23).

The meta-analysis results of ADS odds ratios depending on radiation dose are shown on figures 5-7.

The black squares on figures correspond to odds ratio values for each exposure level. The white rhombs correspond to cumulative (summarized) value of odds ratio. Square of any mentioned figure is equal to the weight calculated according to the meta-analysis procedure for each study (the so-called Mantel-Haenszel weight). Horizontal intervals crossing the figures demonstrate the CI values for the estimations received.

The fixed effects model means that all studies subject for estimation in a whole are held under equal conditions. difference between the studies is in the power variability for the result establishing. What is more, the casual effect approach is considered being

![Figure 4. ADS course in Chernobyl NPP accident clean-up workers at the background of somatoneurological and mental disorders](image)

**Figure 5. Odds ratios (meta-analysis data) for ADS onset depending on the dose (fixed effects model)**

- **0.05 Gy**: 3.17 (1.72, 5.70)
- **0.1 Gy**: 2.71 (1.18, 5.89)
- **0.25 Gy**: 1.92 (0.98, 3.60)
- **0.5 Gy**: 2.55 (1.25, 5.00)
- **1 Gy**: 2.05 (0.97, 4.09)

**combined (fixed)**: 2.44 (1.84, 3.23)
Alcohol dependence syndrome in Chernobyl NPP accident clean-up workers

According to the cohort epidemiological study the ADS prevalence in Chernobyl NPP accident clean-up workers of 1986-1987 period is significantly higher than in population not exposed to the Chernobyl disaster factors. Ads was diagnosed using narcological interview and testing in 26.8% of the clean-up workers and only in 15.6% of cases among the population control (p<0.001).

Other 17.2% of the Chernobyl NPP accident clean-up workers were attributed to ADS risk group (alcohol abuse or harmful use). Therefore mental and behavioral disorders because of alcohol consumption are found in 44% of the clean-up workers.

There is statistically significant link between the exposition to the complex of Chernobyl disaster factors and further Ads onset in the chernobyl npp accident clean-up workers (p<0.001). There is significantly higher probability of ADS in clean-up workers; thus Ads in them can be rated as a secondary disorder against present mental diseases.

Dependence between the received dose of external IR (0.0003-2.87 range) and following ADS risk in Chernobyl NPP accident clean-up workers is distinctly non-linear. Peak risk values are observed under the low (0.01 to 0.1 Gy) and medium (0.25 to 0.5 Gy) radiation doses. It means there are two local peaks in ADS risk dependence on dose, specifically (0.01; 0.1) Gy and (0.25; 0.5) Gy (Postrelko 2010, Postrelko 2005, Postrelko 2007, Postrelko and Konovalov 2003).

Conclusion

According to the cohort epidemiological study the ADS prevalence in Chernobyl NPP accident clean-up workers of 1986-1987 period is significantly higher than in population not exposed to the Chernobyl disaster factors. ADS was diagnosed using narcological interview and testing in 26.8% of the clean-up workers and only in 15.6% of cases among the population control (p<0.001).

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medium (0.25 to 0.5 Gy) radiation doses. Therefore mental and behavioral disorders because of alcohol consumption are found in 44% of the population of Kiev city and Kiev province. (0.25; 0.5) Gy (Postrelko 2010, Postrelko 2005, Postrelko 2007, Postrelko and Konovalov 2003) 0.5 Gy) radiation doses. It means there are two local peaks in ADS risk dependence on dose, specifically (0.01; 0.1) Gy and workers is distinctly non-linear. The highest risk values are observed in workers of the Chernobyl NPP accident clean-up period is significantly higher than in the population not exposed to the Chernobyl disaster factors. ADS was diagnosed using narcological interview and testing in 26.8% of the Chernobyl NPP accident clean-up workers; thus ADS in them can be rated as a secondary disorder against present mental diseases.

According to the cohort epidemiological study the ADS prevalence in Chernobyl NPP accident clean-up workers is distinctly non-linear. The highest risk values are observed under the low (0.01 to 0.1 Gy) and medium (0.25 to 0.5 Gy) dose range. There is statistically significant link between the exposition to the complex of Chernobyl disaster factors and further dependence between the received dose of external IR and following ADS risk in Chernobyl NPP accident clean-up workers.

Results under the casual effects model are subject to change between strata in a random manner (normal distribution). According to the cohort study analysis the 1.63 to 2.44 times higher relative risk can be asserted with 95% confidence for ADS onset in the Chernobyl NPP accident clean-up workers (cubic spline approximation).

Relative risks (meta-analysis data) for ADS depending on the dose in Chernobyl NPP accident clean-up workers (fixed effects model):

**Figure 8.**

<table>
<thead>
<tr>
<th>Dose (Gy)</th>
<th>Relative Risk (95% CI)</th>
</tr>
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<tbody>
<tr>
<td>0.05</td>
<td>2.37 (1.60, 3.38)</td>
</tr>
<tr>
<td>0.1</td>
<td>2.14 (1.25, 3.37)</td>
</tr>
<tr>
<td>0.25</td>
<td>1.68 (1.05, 2.58)</td>
</tr>
<tr>
<td>0.5</td>
<td>2.05 (1.28, 3.12)</td>
</tr>
<tr>
<td>1</td>
<td>1.76 (1.06, 2.77)</td>
</tr>
<tr>
<td>Combined</td>
<td>1.99 (1.63, 2.44)</td>
</tr>
</tbody>
</table>

**Figure 9.**

<table>
<thead>
<tr>
<th>Dose (Gy)</th>
<th>Relative Risk (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.05</td>
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</tr>
<tr>
<td>1</td>
<td>1.76 (1.06, 2.77)</td>
</tr>
<tr>
<td>Combined</td>
<td>2.02 (1.65, 2.46)</td>
</tr>
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</table>

**Figure 10.**

ADS relative risk depending on the dose of total-body external irradiation in Chernobyl NPP accident clean-up workers (cubic spline approximation).

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