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16. Abstract (Limit: 200 words)

Medical interviews were conducted with 79 firefighters (SIC-9224) present at a pesticides warehouse fire in July, 1974, in Alliance, Ohio. The survey was requested by the International Association of Firefighters, and was performed during December 1979 and January 1980. A questionnaire to evaluate the current psychological conditions of the firefighter was also administered. A high incidence of cough, memory loss, tension, depression, fatigue, and confusion, was found in the personnel at the fire when compared to firefighters from another city. The author suggests that the adverse health effects resulted from exposures during the fire. He recommends periodic physical examinations for firefighters, use of protective equipment, and provision of means for the outlet of tensions and pressures that build during periods of inactivity between calls.

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TECHNICAL ASSISTANCE REPORT
TA 79-50

INTERNATIONAL ASSOCIATION OF FIREFIGHTERS
ALLIANCE, OHIO

September 1980

I. SUMMARY

In August 1979, the National Institute for Occupational Safety and Health (NIOSH) was requested to investigate current physiological and psychological effects in firefighters who were present at a fire in Alliance, Ohio, at the Universal Cooperatives Inc. pesticide warehouse in July 1974. Also included in the investigation were other personnel such as volunteer firefighters, police, and ambulance drivers present at the fire.

An initial survey was undertaken to determine if there was an excess prevalence of adverse health conditions that merited further evaluation. Seventy of 79 personnel who were present at the fire were administered questionnaires designed to review body systems and health conditions. A questionnaire to evaluate the current psychological condition of those at the fire was also administered.

To evaluate these data, a reference group comprised of firefighters from a comparable Ohio city was also included and given the same questionnaire.

An excess prevalence of adverse health effects and untoward feelings (including persistent cough, memory loss, tension, depression, fatigue, and confusion) were found in the personnel at the fire when compared with firefighters from another city. This pattern was more extensive and consistent in those personnel who were at the fire and who experienced adverse health effects at the scene. These people accounted for the majority of the excess prevalences. The data are consistent with, but not decisive, in supporting the hypothesis that exposure to the fire was the cause for the current adverse conditions.

Based on the data collected during this investigation, NIOSH has determined that the fire at the Universal Cooperatives was a health hazard and may have been the cause of the currently reported adverse health effects.

II. INTRODUCTION

The International Association of Fire Fighters requested an investigation to determine if symptoms experienced by its members in Alliance during the last few years were related to exposures to various pesticides and other chemicals at a fire in a pesticide warehouse in 1974.

The request was received on August 28, 1979. An initial survey was conducted in December 1979, and January 1980. A letter detailing the preliminary findings was sent to the requestor in July 1980.

III. BACKGROUND

The fire started at about 8:30 PM on July 14, 1974. It occurred as a result of lightning striking a Quonset-type hut that was a warehouse for various pesticides, herbicides, and grain fumigants, including kerosene. Several large explosions occurred; smoke and flame were extensive. It has been reported by the company that more than 50 pesticides or related substances were present in the warehouse, including such compounds as toxaphene, chlordane, malathion, 2,4,5-T, lindane, carbon tetrachloride, carbon disulfide, and pentachlorophenol. About 233,000 pounds of material were destroyed. The Alliance Fire Department and volunteer departments from three nearby townships responded to the fire. Also present at the fire were police from Alliance, ambulance drivers, and a person from the Alliance Water Department. Spectators from the adjacent neighborhoods were present at a distance.

During the early stage of the fire, all smoke was venting straight up. But after about an hour, heavy rains moved in and forced the billowing smoke to ground level, and it remained that way until the fire was extinguished 6 hours later. Almost immediately after smoke came to ground level, firefighters complained of nausea; dizziness; burning of eyes, nose, and throat; headaches; and chest pains.

Most of the Alliance Company wore the usual firefighting equipment which consisted of hats, coats and boots; but some of the volunteers wore shorts and sandals. Respirators were not available to anyone until about 2 hours after the fire began, and then only a few were available for use. At least 17 firefighters were taken to a local hospital for treatment for smoke inhalation, and some received atropine injections for possible organophosphorus pesticide poisoning. Some were hospitalized.

During the years subsequent to the fire, and particulary during 1979, some members of the Alliance Fire Department have experienced feelings

of mental distress, depression, anger, violence, suicide, and memory dysfunction. Some firefighters also reported experiencing chest tightness and shortness of breath.

On the basis of these feelings and symptoms, NIOSH was requested to perform a medical evaluation of the firefighters.

IV. EVALUATION DESIGN AND METHODS

Two questions were of concern in this investigation. First, was there an excess prevalence of adverse health effects or untoward feelings being experienced by those who attended the fire? And second, did the these effects and feelings occur as a result of the fire exposure? Also of concern was whether future adverse health effects, such as cancer, might occur because of exposure at the fire.

1. Environmental

Environmental measurements were not performed since the event occurred over 5 years ago.

2. Medical

In order to evaluate whether the complaints of the firefighters were inordinately frequent and in need of further investigation, a preliminary survey was designed. The survey contained two parts: (1) a self-administered health questionnaire to ascertain body functioning, and a series of questions (which was part of a Profile of Mood States (POMS), Ref 2) about how the respondent was feeling, and (2) personal interview to gather information on health history, smoking, drinking, and presence at the fire. In all, information on as many as 209 different health conditions, symptoms, and psychological and behavioral factors was gathered. The POMS is an analytically derived inventory which measures identifiable mood states: Tension - Anxiety, Depression - Dejection, Anger - Hostility, Vigor - Activity, Fatigue - Inertia, and Confusion - Bewilderment. These scales have been used for assessing psychiatric outpatients. Normative data have been amassed from repeated administration of the POMS questionnaires to college students.

This study included not only the Alliance Fire Department (Group I), but also the volunteer firefighters (Group II), and police, ambulance drivers, and water department personnel (Group III). A reference group (Group IV) of 24 firefighters from a similarly sized city in the same region was chosen to provide a group similar in most ways except for exposure to any fire involving pesticides.

The basic assumption of the study was that if there was an excess prevalence of adverse health effects, it would appear consistently in all the exposed groups. It was also assumed that all of the groups had similar exposures.

V. EVALUATION CRITERIA

The pesticides and their components involved in the Universal Cooperatives' fire represent a variety of classes and are capable of producing a variety of toxic effects. Exposure at the fire to these substances could have occurred by inhalation and in some cases, by ingestion. A list of the substances and the amounts present is shown in Table 1.

Pesticides have caused diverse toxic effects on various human and animal organs and organ systems, including the liver, kidneys, skin, lung, brain, nervous system, and eyes. Certain pesticides are carcinogenic in humans. They also have caused structural and functional defects in unborn experimental animals, and mutagenic changes in hereditary characteristics in both in vivo and in vitro test systems.

Of particular concern in this investigation is the effect of a single exposure to a variety of pesticides, their components, and their pyrolysis products. There have been reports of occupational exposures of short duration that have resulted in serious effects, but few cases where nonmalignant effects were delayed for years. (1) Little information is available about delayed behavorial effects of acute exposures to pesticides. Many pesticides, however, are particularly toxic to the nervous system. No data is available on the toxic effects of pyrolysis products of pesticides.

VI. RESULTS AND DISCUSSION

1. Alliance Firefighters

Complete data were collected on 25 of 31 Alliance career firefighters who were present at the Universal Cooperatives fire. This group reported a statistically significant (Chi-square tests with $P < 0.05$) history of memory and concentration loss, and nervousness when compared with other unexposed career firefighters. Of the 25 firefighters, 13 (52%) had experienced some type of deliterious health effect at the scene of the fire. Of the 209 conditions and symptoms investigated, the proportion of statistically significant conditions was 10% in the group with health effects at the scene and 4% in the group without health effects. When this affected group was compared with the reference group, there was a statistically significant difference for the reported history of wheezing, persistent cough, loss of memory, days sick, and past hospitalization. The Alliance firefighters did not differ from the reference group in age, smoking, drinking, or medication histories.

Evaluation of the Profile of Mood States (POMS) showed that the Alliance firefighters were significantly different from the reference group for the variables describing tension, vigor, fatigue, confusion, and for all the mood variables taken together. These differences were accounted for by those firefighters at the scene of the fire who had adverse health effects. The means (averages) of the Alliance firefighters for any of the mood factors were not considered abnormal, i.e., more than one standard deviation from the mean of a validated group of college students. There were, however, four firefighters who had three or more of the six mood factors that were greater than two standard deviations from their group's mean.

2. Volunteer Firefighters (Washington, Lexington, and Sebring)

This group was found to show the least adverse effects of any group at the scene of the fire. Except for statistically significant reported histories of heart disease and cough, no other health condition was significant. On the POMS scale, only variables pertaining to decreased vigor were significant. A comparison of those with and without health effects at the scene showed that the former group had 8% of the study conditions significantly increased; while the latter group without health effects at the scene had only 2% of conditions significant.

3. Alliance Police, other police, ambulance personnel, and water department personnel.

This group showed the largest number of adverse health conditions of all groups at the fire. Overall, the group had a significantly higher prevalence of ulcers, memory loss, nervous system dysfunction, and respiratory problems including coughing blood and significantly different ratings on the POMS when compared with the unexposed reference firefighters. The mean of the POMS, however, was not different from that of the validated control group of college students.

When this exposed group was evaluated in terms of more homogeneous sub-groups (i.e., police or other than police), the results were relatively similar to those obtained for the whole group. One sub-group, consisting primarily of the Alliance Police, showed the same pattern of excesses as the overall group. The other sub-group, ambulance and water department personnel, consisted of only four people, but showed most of the same excess prevalences as the overall group except for the POMS, which was only significant for variables pertaining to increased fatigue.

The classification of the whole group by presence or absence of health effects at the scene of the fire showed the proportion of statistically significant conditions to be 24% and 6%, respectively. Caution must be exercised in the evaluation of this group since it only contained 13 members.

4. All Groups Combined

In all, there were 70 people studied who were at the fire. Of this group, 30 (43%) had adverse health effects at the scene. There was no significant difference in mean age between those who had health effects at the scene (40.6 years) and those who did not (41.3 years), or between either group and the reference group (39.1 years).

When those, in all groups, who had no adverse health effects at the fire were compared with the reference group, only occasional loss of memory, prevalence of hemorrhoids, and decreased vigor appeared as significant (Table 2). A much different picture was observed when the sub-group that had adverse health effects at the scene was compared with the reference group. This group showed significantly greater prevalences of heart disease, respiratory problems including coughing blood, severe headaches, loss of memory, more sick days, and more hospitalization. All the POMS variables were significantly different individually or taken together. In all three groups, a larger proportion of significantly more prevalent conditions existed in the sub-groups that had health effects at scene. This finding supports the contention that those people who became ill or affected at the scene of the fire were either more heavily exposed to the toxic gases, or initially more susceptible, or both.

The data are consistent enough to conclude that for those who had health effects at the scene of the fire, chemical exposure could account for their current ill-feelings and adverse health conditions. Those without health effects at the scene may also have current ill feelings and conditions that are linked to the fire, but this cannot be shown with the available data.

Table 3 shows the proportion of prevalent conditions which were significantly different from the reference group. These, in statistical terms, constitute an excess since more than 5% were found to be significant in the three groups: 10%, 8%, and 24%, respectively, in those with health effects at the scene. The value of this observation, on data that is not completely independent, is that it provides a criterion for evaluating the various subgroups of the fire for consistency of effect. For Groups I, II, and III, many of the significant conditions were reported by more than one group, which supports a common exposure hypothesis. Selected health and psychological conditions that were investigated are shown in Table 4.

It is possible that the exposed groups differed initially from the reference group in their general health and susceptibility before the fire. This cannot be excluded from consideration; however, the groups did not differ from the reference group in smoking and alcohol history except that, in some cases, they had less usage. Further, the proportion of conditions where the reference group's prevalences exceeded, though not necessarily significantly, the

exposed group's were 51%, 61%, and 41%, respectively, in Groups I - III. It does not appear that the groups were of different prior health status.

The data also do not support the existence in the three groups of a strong "talk up" effect, that is, in this case, the group discussion, reinforcement, and augmentation of notions or feelings due to concern about previous exposure to toxic materials. This could account for a part, or even all, of the reported data; however, the consistency of responses among diverse groups reduces the likelihood that a "talk up" effect was responsible for the observed pattern of responses in the exposed groups. This pattern is better supported by a hypothesis of common effects from a common exposure.

The presence of a consistent pattern of excess prevalent conditions indicates the possibility of common exposure or some common mediating factor as the causal condition. The data, the study design, and ultimately the nature of the problem does not allow for a more precise conclusion at this time. It remains that the exposure that occurred at the Universal Cooperatives' fire may be linked to the high prevalence of mood disturbances and abnormal health conditions in those present. Certainly, this possibility cannot be ruled out.

VII. CONCLUSIONS

1. The personnel present at the Universal Cooperatives' fire had a greater than normal excess prevalence of adverse health effects. This finding was accounted for by those who had health effects at the scene of the fire.

2. The mean (average) values for psychological indicators were not more than one standard deviation from the means of a validated standard group. Hence, on the average, and for the standard used, the results were not abnormal. The mean values of the personnel at the fire, however, did differ from those of the reference group of firefighters which indicates that those at the fire show more psychological strain.

3. It is likely that the patterns of health effects observed resulted from a common exposure at the Universal Cooperatives' fire. This cannot be proved or disproved at this time.

VIII. RECOMMENDATIONS

(1) Periodic physical examinations, as a general practice for firefighters, and specifically as surveillance for developing health effects should be provided. Special attention for firefighters who attended the Universal Coorperatives' fire should be given to the cardiovascular, respiratory, and nervous systems.

2. All those who were present at the fire, and who desire a psychiatric interview, should be given one, on request, on an annual basis for at least 3 years.

3. Firefighters and other personnel who attend fires should be apprised before hand of the types of fires that could occur in their district so that appropriate precautions may be taken. Protective equipment should be present at the time of arrival on the scene.

4. Efforts should be made to enhance the waiting time in the firehouse to allow for a broader range of activities and projects when no department-related work is scheduled. This could provide an outlet for tensions and pressures that occur as a result of waiting in a ready state.

IX. REFERENCES

1. Criteria for a Recommended Standard...Occupational Exposure During the Manufacture and Formulation of Pesticides, U.S. Department of Health, Education, and Welfare; PHS; CDC; NIOSH, July 1978, Publication Number 78-174.

2. EITS Manual for the Profile of Mood States: McNair DM, Lorr M, Droppleman LF, Educational and Industrial Testing Service, San Diego, California.

X. ACKNOWLEDGEMENTS

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We gratefully acknowledge the participation of the Marion Ohio Fire Department which served as the reference group.

XI. DISTRIBUTION AND AVAILABILITY OF DETERMINATION REPORT

Copies of this complete Determination Report are currently available upon request from NISOH, Division of Technical Service, Information Resources and Dissemination Section, 4676 Columbia Parkway, Cincinnati, Ohio 45226. After ninety (90) days, the report will be available

through the National Technical Information Service (NTIS), Springfield, Virginia. Information regarding its availability through NTIS can be obtained from NIOSH, Publications Office at the Cincinnati address.

Copies of this report have been sent to:

1. Alliance Firefighters Association, Alliance, Ohio
2. International Association of Firefighters, Washington, D.C.
3. Lexington Township Fire Department
4. Sebring Fire Department, Sebring, Ohio
5. Washington Township Fire Department
6. Alliance Police Department, Alliance, Ohio
7. Alliance Water Department, Alliance, Ohio
8. Universal Cooperatives, Inc., Alliance, Ohio
9. U.S. Department of Labor
   Occupational Safety and Health Administration, Region V, Chicago, Illinois.
10. National Institute for Occupational Safety and Health, Region V, Chicago, Illinois
11. Marion Fire Department, Marion, Ohio.

TABLE 1

PESTICIDES AND COMPONENTS PRESENT AT THE FIRE
AT THE UNIVERSAL COOPERATIVES PLANT

July 1974

TECHNICAL PESTICIDES	QUANTITIES
BANVEL-D	733 Lbs.
BAYGON	2,500 Lbs.
BAYTEN	2,800 Lbs.
CHLORDANE	40,000 Lbs.
CIODRIN	16,000 Lbs.
DDVP	1,000 Lbs.
2,4-D (Low Vol. Ester)	6,700 Lbs.
2,4,5-T	7,900 Lbs.
2,4-D	3,400 Lbs.
KORLAN (Ronnel)	1,400 Lbs.
LINDANE	1,400 Lbs.
METHOXYCHLOR TECH. 39%	1,700 Lbs.
DIAZINON	1,300 Lbs.
PRAMITOL	2,900 Lbs.
PYRETHRIN	3,500 Lbs.
THIODAN	6,000 Lbs.
TOXAPHEN	26,000 Lbs.
CYCLOHEXANOL	2,400 Lbs.
KEROSENE	11,300 Gals.

FORMULATED PESTICIDES	QUANTITIES
2,4-D (Low Ester)	1,734 Gals.
2,4,5-T (4 Lbs/Gal)	2,450 Gals.
MONURON	570 Gals.
TOXAPHEN (6 Lbs/Gal.)	425 Gals.
CHLORDANE (4 Lbs/Gal)	183 Gals.

TABLE 1 (cont'd)

PESTICIDES AND COMPONENTS PRESENT AT THE FIRE
AT THE UNIVERSAL COOPERATIVES PLANT

METHOXYCHLOR (2 Lbs/Gal)	1,406 Gals.
LINDANE (1 Lb/Gal)	342 Gals.
MALATHION (5 Lbs/Gal)	1,747 Gals.
MALATHION (5 Lbs/Gal)	650 Gals.
THIODAN (2 Lbs/Gal)	2,572 Gals.
CHLORDANE (8 Lbs/Gal)	96 Gals.
BONNEL (2 Lbs/Gal)	93 Gals.
CIODRIN	746 Gals.
CYGON (2Lbs/Gal)	700 Gals.
CIODRIN Plus DDVP	301 Gals.
PYRETHRIM (1% Plus P.B. (1%)	127 Gals.
TOXAPHENE (5% W; 1/3 Lb/Gal)	564 Gals.
DDVP (0.25% Plus PYRETHRIM (1%)	372 Gals.
CIODRIN (1% by WT.)	638 Gals.
PYRETHRIM (0.1%) Plus P.B. (1%)	285 Gals.
VAPONA (1% by WT.)	4,400 Gals.
GRAIN FUMIGANT MIXTURE OF CARBON DISULFIDE PLUS CARBON TETRACHLORIDE	3,700 Gals.
PENTACHLOROPHENOL (42%)	1,574 Gals.
PENTACHLOROPHENOL (5%)	1,000 Gals.
MALATHION (5%)	1,000 Gals.
RODENT PELLETS (PROLIN)	----
RONNEL (5%)	5,600 Lbs.
METHOXYCHLOR (50% W.P.)	4,300 Lbs.
CHLORDANE (50% W.P.)	3,500 Lbs.
DACTAL (75% W.P.)	8,000 Lbs.
SEVIN DUST (5%)	1,000 Lbs.
COPPER SULFATE	1,400 Lbs.
MESSEROL	5,400 Lbs.

TABLE 2

CONDITIONS SIGNIFICANTLY MORE PREVALENT
IN THOSE WITH AND WITHOUT HEALTH EFFECTS
AT THE SCENE OF THE FIRE THAN IN THE REFERENCE GROUP*

Grp. I, II, and III (Health effects at scene)	Grp. I, II, and III (No effects at scene)
Heart disease (history)	
Increased phlegm	
More sick days	
Persistent cough	
Coughing blood	
Wheezing	
Severe headache	
Dry mouth	
Sore wrist	
Loss of memory	Loss of memory (occasionally)
More hospitalization	
Tension	
Depression	
Anger	
Decreased vigor	Decreased vigor
Fatigue	
Confusion	
	Hemorrhoids

*Significant at $p < 0.05$

TABLE 3

SUMMARY OF EXCESSIVE PREVALENCE CONDITIONS INVESTIGATED

	GROUP I Alliance Firefighters	GROUP II Volunteer Firefighters	GROUP III Police and Ambulance Personnel	GROUP IV Reference Firefighters
Number of People	25	32	13	24
Number of Conditions Investigated	209	208	207	209
Percent of Conditions Where the Prevalence in the Exposed Group was Greater Than in the Reference Group	49%	39%	60%	___
Percent of Conditions with Statistically Significant Prevalence Excess*	7%	5%	15%	___
a. With health effects at the scene	10%	8%	24%	___
b. Without health effects at the scene	4%	2%	6%	___

*p <0.05

TABLE 4

PREVALENCE RATES AND OTHER INDICATORS FOR SOME OF THE HEALTH AND PSYCHOLOGICAL CONDITIONS INCLUDED IN THE INVESTIGATION

	GROUP I W(N=13) H E*	GROUP I N(N=12) H E*	GROUP II W(N=8) H E	GROUP II N(N=24) H E	GROUP III W(N=9) H E	GROUP III N(N=4) H E	GROUP IV (N=24) Reference Group
VARIABLES							
Age (yrs.)	36.2	43.1	46.9	41.0	41.4	37.9	39.14
POMS (score)							
Tension	15.1**	11.3	13.8**	7.1	15.9**	14.7	7.8
Depression	13.1**	9.2	9.5	5.6	14.2**	8.3	5.8
Anger	10.9	7.2	7.8	6.9	16.4	12.5	6.5
Vigor	13.3**	16.2	15.6**	16.2**	16.1	14.0**	19.4
Fatigue	12.2**	7.9	10.1	4.6	13.6**	12.3	5.9
Confusion	9.7**	7.2	7.0	4.8	10.7**	5.5	4.2
HEALTH CONDITIONS (%)							
Asthma	0	8	13	9	13	0	21
Bronchitis	8	25	13	4	13	0	13
TB	0	0	0	11	0	0	0
Cancer	0	0	0	0	0	0	4
Skin Disease	23	25	25	0	11	25	12
Heart Disease	15	0	25	17**	11	0	0
Migraine	15	8	13	13	22	0	8
Back Trouble	61	42	43	30	44	50	35
Nervous Brkdwn	8	8	0	0	33**	50**	0
Hsptlzd in 1st 5yrs	25	17	33	9	25	33	19
Cough	31	8	14	5	50	50	30
Phlegm	38	27	25	15	57**	25	13
Incrsd Cgh/Phlgm	9	17	14	12	29	25	7
Wheezing w cold	55**	25	25	23	50	25	20
Whzng aprt from cold	60	29	17	14	67	25	21
Smoking (now)	54	25	25	38	89	75	54
Alcohol	92	91	83	65**	71	50**	96

TABLE 4 (CONT'D)

PREVALENCE RATES AND OTHER INDICATORS FOR SOME OF THE HEALTH AND PSYCHOLOGICAL CONDITIONS INCLUDED IN THE INVESTIGATION

	GROUP I		GROUP II		GROUP III		GROUP IV
	W(N=13) H E*	N(N=12) H E*	W(N=8) H E	N(N=24) H E	W(N=9) H E	N(N=4) H E	(N=24) Reference Group
Condition of Health							
Fair or Poor	46	17	13	17	11	50	9
Hospitalized (past 6 months)	24**	8	13	8	11	0	0
Days Sick (past mo.)	50**	25	25**	5	25**	0	4
BODY FUNCTIONS (% reporting frequently or constantly)							
Trouble Breathing	25	17	29	8	67**	25	8
Persistent Cough	24**	9	14	8	50**	0	0
Coughing Blood	0	8	0	4	0	0	0
Nervousness	8	17**	0	4	38**	25	4
Pressure in chest	0	8	0	4	33	0	8
Hemorrhoids	0**	17	17	4**	33	0	25
Eye Strain	0	0	17	0	33**	25	4
Trembling Hands	8	0	0	0	11**	0	4
Loss of Memory	25**	17**	0	0	11**	0	4
Loss of Concntrtn	25	17	17**	0	0	0	0

*WHE = With Health Effects at Scene of Fire
NHE = No Health Effects at Scene of Fire
**Significantly different at $p < 0.05$ from comparison group (Grp. IV).