Acute and Chronic Effects of Glue Sniffing

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• **Fifteen boys who were habitual sniffers of the kind of glue used for assembling model airplanes were investigated in regard to the acute and chronic toxicity of the substances in the glue. The acute effects of airplane glue were measured by serial psychometric testing in eight subjects and a transitory visual motor disturbance was found. In one case there was elevated spinal fluid pressure due to intoxication with the inhaled substance. No chronic renal, hematologic or hepatic changes were observed.**

AMONG CHILDREN, glue sniffing is a comparatively new fad which consists of the inhalation of the vapors from quick-drying glue of the kind used in assembling model airplanes. This is done by placing the glue in a paper bag or cloth and inhaling the vapors. Inhalation of the volatile components of airplane glue or plastic cement results in a syndrome resembling acute alcoholic intoxication.[4,6] The exact amount needed for inebriation has not been determined, but apparently is small.[2] Several recent reports reveal that this practice is widespread in the United States.[2,4]

The exact content of different model airplane cements on the market varies, but the effects appear to be similar. Table 1 lists the contents of several glues that are sold in California.[3]

Toxicology

Tricresyl phosphate, a component of some model-airplane glues, was used in illegal liquor during the days of prohibition. It causes so-called "ginger paralysis," a unique polyneuritis with flaccid motor paralysis but no sensory disturbances. Tricresyl phosphate can block cholinesterase and act like an organic phosphate poison.[3] It affects the peripheral nerves, the pyramidal tracts and spinocerebellar tracts of the central nervous system.[8]

Xylene and toluene are aromatic hydrocarbons. Both cause bronchial and laryngeal irritation on vapor inhalation. Although xylene and toluene resemble benzene in acute toxicity, they appear to have less chronic toxic potential.[9] Blood dyscrasias have been reported in toluene poisoning.[3,8] Xylene has not been associated with blood dyscrasia. Both solvents cause central nervous system depression, but the effect of xylene is more delayed and prolonged. Toluene causes conjunctivitis, headache, lassitude, loss of appetite and inebriation.[3] Wolf and co-workers, in 1958, found that repeated inhalation of the fumes of vinyl toluene by animals caused histopathologic changes in the liver characterized by fatty degeneration in the midzonal and central cells of the lobule.[9]

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Toluene may produce mild macrocytic anemia, but it does not cause leukopenia as benzene does.[3] Butyl and isopropyl alcohols are central nervous system depressants. Isopropyl alcohol can also cause hepatic or renal damage.[3] Vapors of isopropyl alcohol may produce rhinitis and bronchitis. The vapors of butyl alcohol can result in a fine punctate turbidity of the cornea.[8]

Acetone is a ketone which has effects similar to ethyl alcohol but has greater anesthetic properties. Twenty milliliters of acetone can be ingested without ill effect.[3] Hexane is a mild central nervous system depressant. Vapor of hexane causes anesthesia of short duration without ill sequela.[3]

Clinical Study

Because of the serious toxic potential of the ingredients of model-airplane glue, the acute and chronic effects of glue sniffing were studied in 15 boys ranging in age from 13 to 18 years. In most of these cases the miscreant's practice came to light

TABLE 1.—*Ingredients of Some Airplane Glues Available in California*

Testors Model Cement Formula A	
Cellulose acetate	Acetone*
Tricresyl phosphate*	
Testors Formula B	
Cellulose nitrate	Acetone*
Tricresyl phosphate*	Butyl acetate
Hexane*	Butyl alcohol*
Isopropyl alcohol	Toluol*
Isopropyl acetate	
Revel	
80 per cent toluene*	

*Indicates toxic product.

TABLE 2.—*Hematological Findings in 15 Patients Who Sniffed Airplane Glue*

Case	PCV (Per Cent)	Leukocyte (Per cu mm)	Reticuloeyte	WBC Differential					
				Eosinophiles	Stabs	Segmented	Normal Lymphocytes	Monocytes	Basophiles
1	43.5	6,526	....	2	3	62	32	1	0
2	43.0	5,569	....	1	2	71	25	1	0
3	45.0	8,960	0.9	2	1	66	30	0	1
4	45.0	6,997	1.2	0	7	54	30	4	0
5	44.0	6,114	....	0	5	51	42	2	0
6	45.5	5,301	....	1	1	56	36	5	1
7	39.0	5,202	....	4	1	44	46	5	0
8	45.0	7,389	....	2	2	70	22	4	0
9	41.0	5,765	....	0	0	46	40	13	1
10	41.5	5,577	4.3	3	0	71	22	3	1
11	39.0	7,130	2.8	3	1	75	20	1	0
12	44.0	7,267	0.8	1	0	62	37	0	0
13	44.0	10,495	1.4	3	0	71	17	8	1
14	42.0	8,991	1.3	3	1	44	45	7	0
15	....	5,300	0.9	1	2	57	39	1	0

Abbreviations: PCV=packed cell volume.

TABLE 3.—*Liver Function Tests in 15 Patients Who Sniffed Airplane Glue*

Case	BSP* (Per Cent)	SGPT†	Bilirubin**		Alk. Phosphatase‡		Ceph. Floce.		Serum§	
			Direct	Indirect	Initial	Last	24 Hr.	48 Hr.	Alb.	Globulin
1	....	....	0.0	0.5	....	....	....		5.5	2.1
2	1.4	....	0.1	0.3	7.0	5.3	Neg./Neg.		4.5	1.7
3	2.4	13	0.1	0.7	4.2	4.0	....		5.4	1.3
4	1.5	8	0.1	1.0	6.1	5.4	....		5.4	2.5
5	....	....	0.2	0.8	5.8	4.6	....		5.3	1.9
6	....	....	0.0	1.4	5.4	5.8	Neg./Neg.		5.1	1.8
7	....	....	0.0	1.5	6.3	....	Neg./1+		5.5	1.9
8	3.0	....	0.0	0.4	2.8	....	Neg./Neg.		....	....
9	....	....	0.0	0.9	5.8	5.9	Neg./Neg.		5.3	1.6
10	....	....	0.0	0.7	8.3	7.5	Neg./Neg.		5.5	2.2
11	....	....	0.1	0.4	4.3	....	Neg./Neg.		5.3	2.2
12	....	12	0.2	0.2	3.7	....	2+/2+		5.0	2.5
13	1.5	11	0.0	1.3	....	....	....		....	....
14	....	23	0.2	0.2	....	....	1+/2+		5.1	2.6
15	0.0	....	....	....	2.5	....	....		....	....

*Bromsulphthalein dye was given intravenously in the dose of .045 ml per pound of body weight and the test specimen was taken 45 minutes later.

**Milligram per cent.

†Serum glutamic-pyruvic transaminase (normal 5 to 40 units).

‡Bessey-Lowry units (*adult* normal .8-2.3 units).

§Gram per cent.

through law enforcement authorities, and several of the boys admitted stealing glue to keep themselves supplied. The boys referred by the juvenile authorities were also seen by a certified psychologist. Although no accurate estimate of the duration or quantity of glue used could be determined, as our patients tended to minimize their usage, many were known by the juvenile authorities to inhale extremely large amounts of glue.

Acute Toxicity

Eight patients in the series were interviewed in juvenile hall. They stated they inhaled glue "for kicks," or because "it made things become quiet around them." The intelligence quotient of these eight boys ranged from 103 to 79, the average being 91. These patients were apprehended while in the act of inhaling the vapors from airplane glue. Within three hours of admittance to juvenile hall the Bender Visual Motor Gestalt Test[1] was given. The identical test was readministered no sooner than seven days later to the same patients. The testing plan was made as unobtrusive as possible. Since the experimental design was to compare the initial test results with the second test results of the same subject, a simple scoring method was employed.[7] The total score of each test was the total number of deviations from normal. The deviations were gross in nature and obvious to any trained clinician. The total of deviations of all eight subjects on the initial examinations was 92, while the total of deviations on the second tests was 56. A comparison of the two examinations on each subject showed a reduction of deviation in six of the eight cases. There was no change in the number of deviations in two patients, one of whom had a

TABLE 4.—*Renal Functions Investigations in 15 Patients Who Sniffed Airplane Glue*

Case	Urine						BUN*	PSP† Excreted (Per Cent)
	Specific Gravity	Albumin	Glucose	Erythrocytes (Per high power field)	Leukocytes (Per high power field)	Casts		
1	1.021	0	0	0	Occasional	0	....	100
2	1.021	0	0	0	0-2	0	....	75
3	1.021	0	0	0	0	0	15	85
4	1.019	Trace	0	0	0-2	0	14	85
5	1.010	0	0	0	0	0	....	75
6	1.015	0	0	0	Occasional	0	....	95
7	1.021	0	0	0	0	0	....	85
8	1.016	0	0	0	0	0	14	85
9	1.022	0	0	0	Occasional	0	....	97
10	1.024	0	0	0	0	0	....	90
11	1.022	0	0	0	0	0	....	95
12	1.025	0	0	0	Occasional	0	13	100
13	1.021	0	0	0	2-3	0	14	....
14	1.020	0	0	0	Occasional	0	10	73
15	1.023	0	0	0	0	0	6	....

*Blood urea nitrogen milligrams per 100 ml.
†Phenolsulfonphthalein per cent of dye excreted in two hours.

TABLE 5.—*Results of Lumbar Punctures in Two Cases of Glue Sniffing. (See text)*

Case	Pressure (Water)		Spinal Fluid					
	Opening	Closing	WBC	Protein (mg per 100 ml)	Sugar (mg per 100 ml)	Colloidal Gold	Chloride (mEq per liter)	Date
2	170mm	130mm	0	26.3	105	++11000000	.....	2/13/62
8a	298mm	240mm	0	23.8	86	+12221+000	115	1/2/62
8b	172mm	....	2	25.4	61	.....	.....	1/9/62
8c	126mm	106mm	0	19.8	64	.....	115	2/7/62

diagnosis of epilepsy and the other an intelligence quotient of 79. In spite of obvious testing inadequacies, it was felt that inhalation of airplane glue caused a definite visual motor distortion of transitory nature characteristic of acute central nervous system intoxication.

The case of one boy illustrates the confusing manifestations of the acute toxicity to glue sniffing:

REPORT OF A CASE

A 16-year-old Caucasian boy (Case 8, Tables 2, 3, 4, 5) was first seen January 2, 1962, because of pronounced disturbance in behavior. Over a six-month period, the parents noted a decline in his performance at school, reduction of physical activity and mental depression. He cried frequently without apparent cause, and on one occasion he was found in bed screaming incoherently. Twice he had made suicidal gestures by cutting his wrists and face. The boy was unable to give any pertinent information in explanation of his behavior. He denied any neurological symptoms and did not divulge his clandestine habit of inhaling airplane glue.

Blood pressure was 92/50 mm of mercury and the pulse was regular at 50. The pupils were unequal but reacted to light and accommodation. First the right and then the left pupil was larger in size. Results of the rest of the physical examination, including a thorough neurological examination, were within normal limits, as were results of renal, hematological and hepatic studies. (See Tables 2, 3, and 4.) No abnormalities were noted in x-ray films of the head. A lumbar puncture was done and the fluid pressure was 298 mm of water. At this time, the diagnosis of brain tumor was strongly entertained. (See Table 5 for complete results of lumbar punctures.) By accident, however, it was learned that the boy had been inhaling a large amount of glue for six to eight months. There was no history of the patient using other solvents, narcotics or toxic substances. After seven days in the hospital and abstinence from the use of glue, lumbar puncture was repeated and the spinal fluid pressure was 172 mm of water. At that time, the patient's behavior had returned to normal and his pupils were equal in size. On February 7, 1962, lumbar puncture was carried out and the pressure was 126 mm of water. The patient was observed thereafter as an outpatient and his behavior and school work returned to normal.

This case describes a new entity in addition to the many others that must be considered in patients with increased spinal fluid pressure. The mechanism is probably cerebral edema resulting from the absorption of the toxic materials in glue. From the recent literature and the series of cases we observed, it is evident that the contents of airplane glue or similar solvents can cause acute neuropsychological changes which are reversible.[2,3,4,5,6,9]

Chronic Toxicity

Even though model-airplane glues contain several potentially toxic substances which could cause renal, hepatic or hematological damage, no definite reports of such damage have appeared in the medical literature. Done[4] reported abnormal urine in several boys, but these patients had been using other solvents and gasoline. In none of the patients in the present series was there medical history of abnormality, except for the inhalation of airplane glue, and the results of physical examination were within normal limits. With the exception of the patient in the case described, none of the boys had abnormal neurological findings. Hepatomegaly and splenomegaly were not found.

Extensive laboratory tests to investigate the possibility of asymptomatic renal, hematologic or hepatic damage were carried out in all cases in the series. The results are shown in Tables 2, 3, 4 and 5.

Because of the potential renal toxicity of glue and the report[4] of finding cells, casts and protein in the urine of boys using glue, we investigated renal functions in the present series. Routine urinalysis, determination of blood urea nitrogen, and phenolsulfonphthalein excretion tests were carried out on all patients, and the results (Table 4) gave no indication of renal damage.

A complete blood cell count and reticulocyte count were used in the comprehensive hematological survey. The results (Table 2) excluded any serious bone marrow depression.

The investigation of hepatic function was done in detail, using serum proteins, cephalin flocculation, alkaline phosphatase, bilirubin fractionation, serum glutamic-pyruvic-transaminase levels, and bromsulphthalein excretion tests. The results of all of these tests were within normal limits. As the alkaline phosphatase levels were borderline, determinations were repeated a month later (Table 3). Since there was no significant difference between the results, the levels were considered normal for adolescent boys.[10]

Because of the potentially toxic substances present in model-airplane glue and similar products, we believe that some systemic damage might occur with prolonged usage. The solvents and volatile materials in the glue have been shown to produce hepatic, renal and hematologic changes in industrial use and in laboratory animals.[3,8] It seems probable that the low concentration of these substances is the reason no systemic damage was revealed in the present series of cases. No one has determined what concentrations of toxic materials the person receives when sniffing glue.

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