

PREVENTIVE MEDICINE

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ACUTE METHYL ALCOHOL POISONING

REPORT OF EIGHTEEN CASES

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Acute methyl alcohol poisoning has been encountered infrequently in the Navy. During the 10 years prior to 1943, only one report of this condition appeared in the *BULLETIN* (1). During a 6-month period, 18 cases were studied at a South Pacific fleet hospital; 6 of these patients died. This high mortality rate and relatively large numbers of patients made this condition the most serious single malady encountered at the activity.

All but one patient came from three different activities on the island, five patients coming from a Marine activity, three from a construction battalion, and nine from another construction battalion. The patients within each separate activity were admitted within a period of 24 hours.

The sources of the methyl alcohol, in all cases but one, were products intended for use in testing for leaks of Freon gas in refrigerators and labeled either "alcohol" or "methyl alcohol." None of the containers carried poison labels. In all cases the poison had been mixed with water and fruit juices, in undetermined proportions, and then consumed.

The estimated amounts of methyl alcohol ingested varied from an unknown volume to 750 cc. among the 6 patients who died, and from 90 cc. to 500 cc. (?) among the 12 patients who lived. The lethal dose of methyl alcohol cited in the recent literature (2) is from 100 to 250 cubic centimeters.

All of the patients were admitted from 24 to 72 hours after the ingestion of the poison. The commonest symptoms were those of

mild alcoholic intoxication within a few hours after drinking; and drowsiness, headache, photophobia, blurring of vision, dyspnea, nausea, and vomiting within 24 hours. In most patients blurred vision and dyspnea persisted up to 72 hours. Of the six fatal cases, one patient died within 12 hours and five within 48 hours.

The commonest physical findings on admission included various degrees of drowsiness and confusion, an odor of methyl alcohol on the breath, flushed face, low-grade fever with proportionately rapid pulse, and Kussmaul's respiration. The ocular abnormalities were observed in 10 of the 12 surviving patients. These findings consisted of various degrees of loss of color vision, initially of green color sense; thereafter of red, yellow, and of blue color senses, successively. The reduction of vision was the same in both eyes, with loss of central vision and of central color field; the peripheral vision remained initially intact in most cases. Unilateral or bilateral supraorbital or retro-orbital pain was experienced by most patients for 1 or 2 days after admission. The objective early abnormalities included slight conjunctival injection, slightly dilated and sluggishly reactive pupils, mild hyperemia of the disc and retina, haziness of the disc margins and slight engorgement of the blood vessels, less so in the periphery, more noticeable in the macular area, with a vessel ratio of two to three. The ocular tension and refractive media were normal in all cases.

LABORATORY FINDINGS

Most urines contained traces of albumin and acetone bodies, and numerous hyaline and granular casts. All urines were acid, pH 5.5 to 6.0. The blood in every instance showed an alcohol contents of from 1 to 5 mg. per 5 cubic centimeters. In several instances during the first few days a mild secondary anemia, slightly prolonged prothrombin time (determined 72 hours after ingestion of the poison), and an elevated sedimentation rate were evident. The blood of one patient who died approximately 24 hours after ingesting the alcohol, examined at the autopsy, showed a prothrombin time of 72 seconds. Facilities for the determination of the blood alkali reserve were not available. Lumbar punctures were performed on three patients. In one patient the initial pressure was 330 mm. of water; the following day it was 110 mm. of water. The spinal fluids were not otherwise noteworthy.

PATHOLOGIC FINDINGS

Macroscopic.—The salient postmortem findings and those common to all six patients included the following:

In all instances there was moderate to severe cyanosis, lividity

was present posteriorly and there was generalized and intensified postmortem rigidity. There was no evidence of postmortem clotting of the blood, although autopsy was performed in two instances 18 and 24 hours after death.

The lungs were voluminous, covering the anterior surface of the pericardial sac. Marginal emphysema was commonly present. Many subpleural petechial hemorrhages and larger ecchymotic areas were present. The lungs on palpation showed no areas of consolidation. Section exhibited edema and congestion of the lung parenchyma. The bronchi were congested, and in one instance contained aspirated food particles.

In each instance the heart revealed subepicardial hemorrhages but was otherwise normal.

The liver was moderately enlarged, the average weight being 2,000 grams. The capsular surface was smooth and glistening. On section the cut surface swelled forward, everting the capsule. In each instance the liver pattern was obscured by a yellow-brown mottling. The cut surface appeared greasy. Small areas of necrosis could be detected in one case. The gallbladder and biliary ducts appeared normal.

The mucosa of the stomach exhibited punctate hemorrhages, and the walls appeared edematous. The duodenum in each case showed mucosal congestion and edema, and edema of the wall. The remainder of the intestinal tract revealed only mucosal congestion at various levels.

The kidneys were uniformly increased in size, averaging 175 grams. On bisection the cut surface swelled forward, everting the capsule. The kidney markings were obscured by the degree of swelling present. The pelves all showed petechial hemorrhages.

The eyes were not examined because facilities for sectioning them were lacking.

On removing the calvarium, the dura was noted to be tense in all cases. Reflection of the dura revealed marked engorgement of the vessels of the pia-arachnoid. In most cases the latter was lifted above the convolution by accumulation of clear spinal fluid. There was herniation of the cerebellum into the foramen magnum. On removing the brain there was no asymmetry between the two hemispheres. Section revealed edema, swelling and congestion throughout the brain and brain stem. The vessels lining the ventricles were especially hyperemic. Small punctate hemorrhages could be discerned in scattered areas.

Microscopic.—Various degrees of edema and hyperemia were found throughout the brain and brain stem. The vessels in the floors of the ventricles were engorged, and there was desquamation of the ependymal cells. There was a severe subpial edema

with engorgement of the small cortical vessels, associated with rather extensive perivascular edema. Nissl's granules revealed degenerative changes, many appearing indistinct and fragmented. Small focal areas of hemorrhage could be seen in a few areas. Similar changes were observed in the brain stem.

Throughout the lungs there was considerable engorgement of blood vessels, both large and small. There were many small subpleural hemorrhages, and scattered throughout the lung parenchyma were numerous small focal hemorrhages involving several alveoli and usually associated with a degree of emphysema.

The liver cells appeared swollen and filled with small fat vacuoles. These changes distorted and in some instances nearly obliterated the sinusoids. Many nuclei were pyknotic and some showed degrees of karyolysis. Areas of focal necrosis in the midzonal area were present in two cases.

There was some superficial necrosis of the mucosa of the stomach with infiltration of the submucosa by plasma cells and by polymorphonuclear leukocytes. Small mucosal hemorrhages were common and there was engorgement of the vessels of the submucosa and wall, with concomitant edema.

Most of the tubules of the kidneys revealed extensive degeneration. In many areas the nuclei stained poorly or not at all. The cytoplasm appeared filled with small fat vacuoles. The collecting tubules did not appear to be severely damaged. Many of the glomeruli appeared intact; others were the seat of focal hemorrhage, or were destroyed by hemorrhage into the surrounding parenchyma.

TREATMENT

The initial treatment, in most of the patients who lived, included gastric lavage, enemas, magnesium sulfate, repeated intravenous infusions of 5-percent dextrose in saline, and the administration of large amounts of sodium bicarbonate, both orally and intravenously. No patients were treated with ethyl alcohol, as advocated by a recent writer (3).

All of the last five surviving patients were given from 4 to 6 gm. sodium bicarbonate (tablets) every 2 hours until the urines, tested at intervals of 2 hours, attained a pH of 7.5 (nitrazine paper). In addition a total of seven intravenous infusions of sodium bicarbonate were administered to four of these patients. Fifteen grams of sodium bicarbonate U.S.P. (unsterilized) were dissolved in one liter of 5-percent dextrose in saline. In view of the danger of decomposition of the bicarbonate by heat, the resulting solution was not sterilized. Each infusion was given by the drip method over a period of 1 hour. In none of the patients were there observed

any febrile or other reactions to these infusions. In every instance the decrease in the degree of acidosis, as measured by the change in the urinary pH, was paralleled by clinical improvement, diminished respiratory rate, and disappearance of mental confusion. The urinary volumes were satisfactory in all cases.

The degree of acidosis in these patients is shown by the data in table 1.

TABLE 1.—*Effect of sodium bicarbonate upon the acidosis*

Case No.	Severity of poisoning	Blood alcohol in mg. per 1 cc.	Total dosage of sodium bicarbonate orally and intravenously in grams	Period for urine to attain pH 7.5 in hours
14.....	Moderate.....	1.5	46	Less than 28
15.....	Moderate.....	1.0	61	Less than 28
17.....	Severe.....	2.5	124	40
18.....	Severe.....	3.5	126	44
16.....	Severe.....	5.0	162	56
Average for 5 normal individuals.....			6.4	3

Of the six patients who died, four died before reaching the hospital. A fifth patient arrived semi-comatose, markedly dyspneic, and died with failing respiration 2 hours after admission. The sixth patient arrived deeply comatose, markedly dyspneic, and exhibiting generalized clonic convulsions; he died with failing respiration 1 hour after admission. None of the patients who died were treated with sodium bicarbonate.

The results of treatment were satisfactory in 11 of the 12 surviving patients. Normal visual acuity was attained by these 11 patients within 4 weeks after admission, and they were discharged to duty. The ocular findings during recovery were characterized by the following changes: Within 4 or 5 days blue color sense returned, followed successively by yellow, red, and green color sense. The hyperemia of the discs and of the retina subsided. In six of ten patients visual acuity was normal within 1 week; five, when re-examined 2 months later, were found to have normal vision. Within 72 hours after the consumption of approximately 140 cc. of methyl alcohol, one patient showed light perception and projection present, complete loss of color sense, vision limited to hand movements at 1 foot distance, moderate edema and pallor of the discs, and marked hyperemia of the maculae. Three days later the discs appeared yellow-white and the retinal vessels were diminished to one-half of their normal caliber, with no change after the inhalation of amyl nitrite. During the following 3 weeks color sense and visual acuity showed slight improvement. During the fourth week after admission the discs began to appear slate gray; hyperemia

persisted around the macular areas. By the sixth week visual acuity was decreased and the caliber of the vessels was diminished to one-third of normal. By the eighth week color vision was limited to faint perception of blue; vision consisted of fingers at 2 feet on the right and 1/20 on the left; both nerve heads showed contraction.

In one patient a bout of benign tertian malaria with fever of from 102° to 103° F. lasting 1 day, was followed, within 12 hours, by decided subjective visual improvement. This suggested the use of intravenously administered typhoid vaccine as an adjunct to the treatment of amblyopia.

Three patients developed numbness of all toes about 6 days after ingestion of the poison. No significant disturbances of tactile or pain sensation were observed. Multiple vitamins and large doses of thiamine chloride were administered to these patients. The symptoms disappeared within 4 weeks.

COMMENT

These cases illustrate the tragic consequences of inadequate labeling of supplies of methyl alcohol, and re-emphasize the necessity, as pointed out by Voegtlin and Watts (1), of plainly marking this material "Wood Alcohol—Poison."

In common with early reports (4) (5) and more recent descriptions of this condition (1) (3) (6), these cases illustrate the presence of a profound acidosis as an important cause of much of the symptomatology and probably even of the fatal outcome. The likely cause of the acidosis is an accumulation in the tissues and body fluids of formic acid, derived from the oxidation of unexpired methyl alcohol (2). Formic acid is a poisonous corrosive, approximately ten times as strong as acetic acid (7). Other oxidation products, such as formaldehyde and lactic acid, may be operative in the intoxication.

These cases also emphasize the necessity for prompt and intensive treatment of the acidosis. The serious symptoms of the acidosis, as mentioned by Voegtlin and Watts, may be treacherously masked for many hours. Two of our patients were admitted to the ward in an ambulatory state. When seen by the medical officer about 15 minutes later they were found sitting on their beds, smoking, disclaiming any great discomfort, but 30 minutes later both patients were dyspneic and confused.

During this relatively asymptomatic latent period the rapid determination of the degree of acidosis is possible only by means of an estimation of the blood alkali reserve. But the absence of facilities for such a procedure need not delay the institution of

active treatment. Furthermore by the use of urinary pH estimations as a means of regulation of dosage of the sodium bicarbonate, the danger of significant degrees of alkalosis can be avoided.

The degrees of acidosis among these patients, as depicted by the amounts of alkali necessary for treatment (table 1), are strikingly similar to the findings in cholera by Sellards (8).

The intravenous administration of sodium bicarbonate (or of sodium lactate, if available (1)) is indicated in most cases. In the more severe cases nausea and vomiting present an obstacle to the oral administration of adequate amounts of bicarbonate.

Prompt treatment of the acidosis also may be important in the prevention of optic nerve injury, for a recent writer (3) has observed that the degree of amblyopia appears to depend on the degree and duration of the acidosis. The value of artificial fever therapy in the treatment of amblyopia is problematic and requires further critical investigation.

The role played by a possible prothrombin deficiency in the pathogenesis of the intoxication needs further elucidation. Nevertheless the administration of vitamin K, either in medicinal form or in the form of transfusions of whole blood, is probably indicated.

MANAGEMENT

The results of study of the cases lead to the following suggestions for emergency management:

1. Enforce complete bed rest; pulse and respirations to be taken every hour, urine pH determination every hour, intake and output to be charted.
2. Give magnesium sulfate, 3 oz., orally or through stomach tube, followed by sodium bicarbonate, 6 grams.
3. Give high saline enema (1 quart).
4. Insert inlying catheter; urine to laboratory for routine analysis and pH and acetone bodies determination.
5. Begin intravenous administration of 15 gm. of sodium bicarbonate dissolved in 1,000 cc. of 5-percent dextrose in saline. Repeat every 6 hours or oftener until urine pH reaches 7.0.
6. Take blood for alcohol content, coagulation and prothrombin times, erythrocyte count and hemoglobin. Type and cross-match.
7. Procure oxygen tank and mask, to be kept at bedside, and have available a syringe with intravenous needle, containing 1 gm. caffeine sodium benzoate, and another filled with 2 cc. nikethamide.
8. Transfuse with 450 cc. whole blood.
9. Give 6 gm. sodium bicarbonate (tablets) orally every 2 hours until urine pH reaches 7; thereafter reduce dose for maintenance at that level.

Postemergency management should include protection of eyes from exposure to strong light and the administration of multivitamins, thiamine, nicotinic acid, vitamin K, and transfusions. Repeat daily erythrocyte count and hemoglobin, coagulation and prothrombin times, and complete urinalysis.

SUMMARY

1. The clinical findings in 18 cases of acute methyl alcohol poisoning are presented.
2. The pathologic findings in 6 cases are reported.
3. The role of acidosis in the symptomatology of the intoxication is described.
4. A scheme of treatment is presented in detail.
5. The hazard of inadequate labeling of products containing methyl alcohol is strongly emphasized.

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