FORMALDEHYD POISONING

WITH REPORT OF A FATAL CASE *

B. S. KLINE, M.D.
CLEVELAND

Although formaldehyd has been extensively used in a number of industries since its discovery in 1867 by Von Hoffmann, there are on record, including the one at Mt. Sinai Hospital reported here, only twenty-seven cases of formaldehyd poisoning.

Of these twelve patients (seven males and five females) died in from twenty or thirty minutes to four weeks. In the case of the males, formaldehyd was taken by mistake for whisky or water. In the case of the females, it was taken with suicidal intent.

The amount of formaldehyd ingested in the fatal cases varied from a few drops to 3 ounces (89 c.c.) of concentrated solution. The largest amount from which a patient recovered (case of Hale) was 120 c.c. of concentrated commercial formaldehyd.

Below is a summary of the clinical and pathologic records of the fatal cases. The first four are quoted from MacLachlan,[1] who reviewed the literature to 1909 and in his report summarized the clinical features of formaldehyd poisoning.

REPORT OF CASES

Severe epigastric pain
heart failed
Cyanosis

CASE 1 (Reported by Bock[2] in 1899).—A man, aged 26, took 3 ounces (89 c.c.) of solution of formaldehyd U. S. P. (formalin 100 per cent.) and died in thirty-two hours.

Clinical Course.—The patient immediately vomited blood tinged mucus and had severe epigastric pain. Demulcents and apomorphin were given at once resulting in free emesis. The patient continued weak and vomited repeatedly. Sixteen hours later the pulse first weakened. The patient remained in status quo until the twenty-ninth hour, when the heart failed rapidly. At the thirty-second hour, there was cyanosis, coma and then death.

Pathology.—The lower end of the esophagus showed marked erosion. The stomach wall and duodenum were very much congested and cut like leather. Microscopic examination was not made. Other findings were not abnormal.

Cardiac failure

CASE 2 (Reported by Levison[3] in 1904).—A man, aged 60, took 3 ounces (89 c.c.) of solution of formaldehyd U. S. P. (formalin 100 per cent.) and died in twenty-nine minutes.

Clinical Course.—The patient was found writhing in pain and unable to speak. He did not vomit even after three-tenths grain (0.018 gm.) of apomorphin. Lavage was attempted, but the tube could not be passed on account of spasm of the pharynx. The patient died of cardiac failure in twenty-nine minutes after taking the poison.

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* From the Laboratory Service of Mt. Sinai Hospital.

1. MacLachlan: Cleveland M. J. **8**:606, 1909.
2. Bock: Fort Wayne M. J. **19**:249, 1899.
3. Levison, L. A.: J. A. M. A. **42**:1492 (June 4) 1904.

Pathology.—The esophagus, stomach and small intestine were literally "hardened."

CASE 3 (Reported by Bose[4] in 1905).—A man, aged 47, took 3 ounces (89 c.c.) of solution of formaldehyd U. S. P. (formalin 100 per cent.) and died in thirteen hours.

Clinical Course.—The patient was found shortly after taking the poison, unable to speak, with hands on abdomen and apparently in great pain. He did not vomit before admission to the hospital. After a lavage he was able to talk rationally. He started to vomit almost at once and continued all that night, the vomitus being blood tinged. The patient gradually sank but developed no other symptoms and died the next day, thirteen hours after the ingestion of the poison.

Pathology.—The esophageal and gastric mucosa was intensely congested, as was that of the small and large intestines. Some slight changes in the parenchymatous organs were noted.

CASE 4 (Reported by Palmer[5] in 1906).—A man, aged 29, took about 7½ ounces (222 c.c.) of solution of formaldehyd U. S. P. (formalin percentage not given), and died in three days.

Clinical Course.—Shortly following ingestion, the patient experienced intense abdominal pain and collapsed. When admitted to the hospital, he was tender over the epigastrium. He vomited blood tinged fluid, was slightly delirious and had a marked feeling of constriction of the throat. He was given a dilute solution of ammonia followed by demulcents. The next day his mind was wandering but he was in no special pain. Two days later, he became markedly delirious, noisy, and at times maniacal. During one of these attacks, his pulse failed, his breathing became shallow, and his heart stopped.

Pathology.—The blood everywhere was found dark colored and fluid. The mucous membrane of the lower end of the esophagus and the gastric mucosa were tanned, and the parenchymatous organs were somewhat congested.

CASE 5 (Reported by Ely[6] in 1910).—A boy, aged 3 years, took a few drops of solution of formaldehyd U. S. P. (formalin 100 per cent.) and died in about forty-eight hours.

Clinical Course.—The patient was immediately seized with a paroxysm of coughing and choking, but the attack soon ceased. The child's mouth was rinsed out thoroughly with water, and he was soon at play as if nothing had happened.

On the next day, there was a hoarse laryngeal cough with accelerated and labored breathing. The pulse and temperature were normal and in every respect the child seemed to be in perfect health. A laryngeal application of epinephrin was employed with temporary benefit. Inhalations of steam were advised, and frequent teaspoonful doses of olive oil were ordered to allay any pharyngeal or esophageal irritation. Fifteen hours later, the child was deeply cyanosed and showed every sign of laryngeal obstruction. Repeated applications of epinephrin were made and the breathing became somewhat easier, but during the night, eight hours after admission to the hospital, the child died.

Pathology.—Marked thickening of the mucous and submucous coats of the epiglottis, larynx and trachea, with a superficial necrosis that extended to the bifurcation of the trachea were found. The esophagus showed no pathologic changes, nor was there evidence of destruction of the mucosa of the mouth and pharynx.

4. Bose: Indian M. Gaz. **40**:139, 1905.
5. Palmer: Australian M. Gaz. **25**:188, 1905.
6. Ely, F. A.: J. A. M. A. **54**:1140 (April 2) 1910.

CASE 6 (Reported by Watt[7] in 1912).—A man, aged 63, took 1 ounce (30 c.c.) of solution of formaldehyd U. S. P. (formalin 100 per cent.) and died in two and one-half hours.

Clinical Course.—The patient left home about 8:00 a. m. without taking any breakfast. He was seen about 9:15 a. m., when near a well in a public park. to become rapidly ill. He staggered, doubled up over a low railing and retched viscid mucoid material. He was put on a seat and soon was unconscious with his body stretched out and his head bent back over the seat. The man was supposed by bystanders to be in a "fit," and was laid out on the grass with his collar loosened. He was breathing "heavily," with chest heaving and eyes rolling, and was perspiring moderately. Accounts differ about pallor or flushing of the face. No convulsions or twitchings of the muscles were noticed nor was any attention drawn to coldness of the hands and face. After being unconscious for about fifteen minutes, he gradually became conscious. The

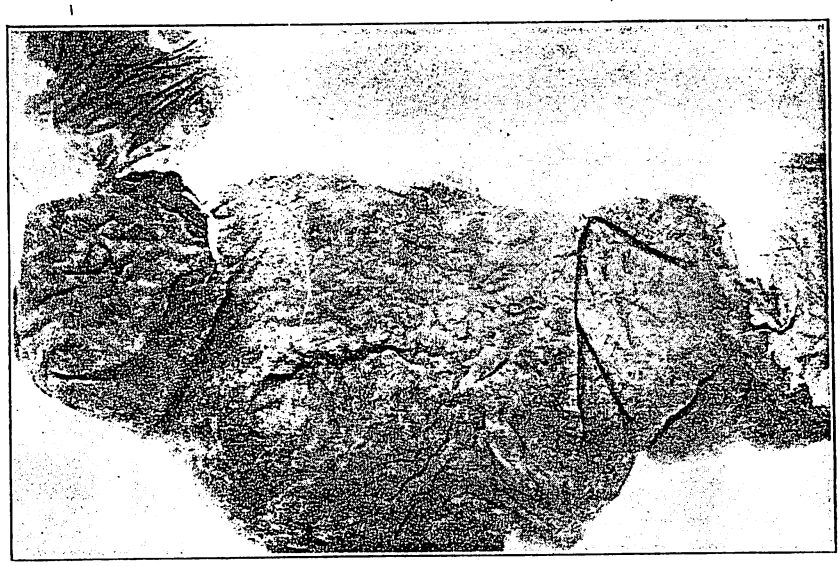

Fig. 1.—Esophagus, stomach and duodenum after formaldehyd poisoning of three hours' duration.

man did not again vomit, but was now suffering very severe abdominal pain. This caused him at intervals to double up almost on his hands and knees. There was some froth about the mouth, but no discoloration of the lips or mouth was noted. He staggered along with assistance for about 100 yards. He then fell to the ground writhing with pain, and relapsed into unconsciousness, from which he did not again emerge.

At 11:00 a. m. he was admitted to the hospital, unconscious, collapsed and almost pulseless. The skin was pale, cold and clammy. The mouth was opened with a gag but showed no discoloration and did not smell of formaldehyd. All reflexes were absent on admission except the corneal reflex. This also was lost in a few minutes, and respirations stopped. The stomach was washed out, stimulants were given and artificial respiration applied, but death ocurred at 11:53 a. m.

Pathology.—No necropsy was done.

7. Watt: Brit. M. J. 2:350, 1912.

CASE 7 (Reported by Moorhead[8] in 1912).—A man, aged 30, took 3 ounces (89 c.c.) of solution of formaldehyd U. S. P., 10 per cent., and died in four weeks.

Clinical Course.—The patient was admitted to the hospital suffering from acute perforative appendicitis. An operation was performed immediately, and a gangrenous appendix was found along with diffuse suppurative peritonitis. Improvement after the operation was rapid and in a week the temperature had almost reached normal, though there was a profuse local discharge of pus. When in this condition, the patient went to a cupboard in the ward and drank the formaldehyd from a bottle there. About five minutes later, he was quite unconscious. The face was strongly flushed, the breathing stertorous, the pulse 96 to the minute, but steady and rather full. There was no discoloration of the lips or mouth, but there was a strong odor of formaldehyd from the breath. The pupils were dilated; conjunctival reflex was present, and the conjunctivae were injected. The skin over the chest and abdomen was pale and moist.

A stomach tube was passed and the stomach was washed out with strong ammonium acetate. The first washing smelled most strongly of formaldehyd, in fact, overpoweringly so, and contained much altered blood. The washing was continued until no smell of formaldehyd could be detected from the water as it siphoned back from the stomach. Before this stage was reached, however, the patient recovered consciousness; in fact, he began to revive as soon as the first quantity of formaldehyd had been evacuated. He slept well that night and the next day he seemed almost completely recovered, except for some slight pain in the throat. No abdominal pain whatsoever was complained of. The first motions after the incident were tarry and contained a little mucus, but later, though fluid, were free of blood.

The subsequent history was unfortunate; burrowing abscesses formed in the neighborhood of the appendix wound and general septicemia ensued. Death took place five weeks after admission.

Pathology.—Patches of fat necrosis were found in the abdomen; the interior of the esophagus and stomach were extremely corroded, the most marked corrosion being found close to the pylorus. No signs of irritation were found in the duodenum or elsewhere in the alimentary canal. Apart from the changes commonly found in the organs in fatal cases of septicemia, nothing else abnormal was detected.

CASE 8 (Reported by Shaposhnikoff[9] in 1912).—A woman, aged 21, took 30 c.c. of solution of formaldehyd U. S. P. (formalin 100 per cent.) and died in nine days.

Clinical Course.—The patient, not knowing that she would become unconscious, lay without help until the next morning after she had taken the dose. She then had a severe burning in the abdomen and in the throat; she cried for help. She was brought to the hospital. In a short time, she had her stomach washed out. A strong odor of formaldehyd came from her mouth. On examination there was marked hyperemia around the uvula and, in a few places, small white areas without epithelium. Laryngoscopy showed widespread hyperemia. There was shortness of breath. The pulse was 126; the temperature, 38.5 C. Lungs and heart were negative. There were tracheal rhonchi. The pain in the abdomen decreased. The urine in output, color and odor was normal; there was no albumin. She was given soda water and milk. Three days after admission, she was fully conscious; the pulse was 120; the temperature, 39.5 C. Pneumonia was found in the left upper and lower lobes. The urine, 1,000 c.c., contained albumin. On the fourth day, there was pneumonia on the other side. The temperature was 40.8 C.; the sputum was

8. Moorhead: Brit. M. J. **2**:1470, 1912.
9. Shaposhnikoff: Terap. Obozr., Odessa, **5**:537, 1912.

gangrenous and had a putrid odor; the pulse was 130. Heart sounds were very weak; there were no murmurs. The amount of the urine was 800 c.c. The patient was in marked stupor.

On the ninth day after admission, there was a marked putrid odor of the mouth. She could not be aroused, and died during the day in asphyxia.

Pathology.—The diagnosis was diffuse bilateral bronchopneumonia. No report of the abdominal organs or esophagus was made.

CASE 9 (Observed by Christie[10] in 1914).—A woman, aged 33, took an unknown quantity of solution of formaldehyd U. S. P. (formalin percentage unknown), and died in nine and one-half hours.

Clinical Course.—The patient was admitted shortly after drinking solution of formaldehyd (formalin percentage and quantity unknown). There was con-

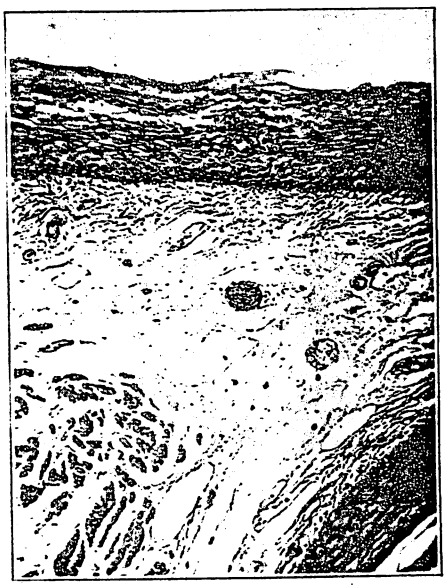

Fig. 2.—Edema of the submucosa and muscle of the esophagus after formaldehyd poisoning of three hours' duration.

siderable abdominal distress. The pulse was not obtainable at the wrists. The temperature rose steadily to 101.5 F. just before death.

Three and one-half hours after admission, the patient was extremely nervous and flighty.

Fifteen minutes before death, no pulse was obtained at the wrists. There was extreme cyanosis and marked restlessness.

A heavy trace of albumin and granular casts were noted in the urine.

Pathology.—No necropsy was done.

CASE 10 (Reported by DeRechter[11] in 1914).—A woman, aged (?), took 1½ ounces (45 c.c.) of solution of formaldehyd U. S. P. (formalin 32 per cent.) and died in between twenty and thirty minutes.

Clinical Course.—The patient had immediate pain and vomited black, bloody masses; the pulse was feeble. She died in between twenty and thirty minutes.

10. Christie: Personal communication from the author. The patient died in Lakeside Hospital, Cleveland, in 1914.

11. DeRechter: Arch. Int. de Med. Legale **5**:44, 1914.

Pathology.—The hardening to a leathery consistency of the mucosa of the tongue, cheeks, esophagus, stomach and the uppermost meter of the small intestine was observed. There also was hardening of portions of organs neighboring the stomach (lung, spleen and pancreas).

CASE 11 (Reported by Marx[12] in 1919).—A woman, aged 27, took 4 ounces (118 c.c.) of solution of formaldehyd U. S. P. (formalin 47 per cent.) and died in sixty-two hours.

Clinical Course.—The patient had pain in the chest and epigastrium, followed in fifteen minutes by vomiting. These symptoms continued for a few hours. The gastric lavage was followed by dyspnea, cyanosis of the face and hands and a feeble pulse. There was no loss of consciousness. There was no improvement of the pulse following stimulation.

No disturbance of micturition occurred. The temperature was normal for the first few days, rising to 100 F. shortly before death.

Pathology.—Marked hyperemia and edema of the brain and lungs and ecchymosis of the pleural epicardium were present; 200 c.c. of purulent exudate was observed in the abdominal cavity. No abnormalities of the mucosa of the

Fig. 3.—Early acute inflammation of stomach, showing linear ulcers, hemorrhage and edema, after formalydehyd poisoning of three hours' duration.

lips, floor of the mouth or cheeks were seen. That of the pharynx and larynx was injected but intact. The esophageal mucosa was grayish red, dry and somewhat wrinkled, with changes most marked toward the stomach. The stomach, contracted and grayish-red, contained about 100 c.c. of brown matter with intermingled flecks of sloughed mucosa. The mucosa of the stomach was markedly tumefied and on the crests of the folds was converted into a friable eschar. In the region of the pylorus, the sloughs were white. These peeled off readily. The underlying areas were grayish red. In portions of the fundus, the mucosa in places was completely absent. The stomach wall was everywhere thickened and infiltrated by dark blood.

Microscopic Examination.—Parenchymatous and fatty degeneration of the liver parenchyma was observed with degeneration of the kidneys and patchy necrosis of the tubal epithelium, especially in the region of the pyramids, with marked hyperemia. The heart muscle showed no abnormalities. In the lower portion of the esophagus in places, there was loss of surface epithelium with necrosis of the tunica propria in these areas. In other places the epithelium

12. Marx: Med. Klin. **15**:925. 1919.

was perfectly intact. The stomach showed marked alteration. The entire surface epithelium was necrotic. In many places the necrosis reached the muscularis mucosae. The submucosa showed extensive hemorrhage and small mononuclear round cell infiltration reaching to the serosa.

CASE 12 (author's case).—A woman, aged 33, took from 2½ to 3 ounces (74 to 89 c.c.) of solution of formaldehyd U. S. P. (formalin 100 per cent.) and died in three hours.

Fig. 4.—Linear ulceration, hemorrhage and marked edema of stomach after formaldehyd poisoning of three hours' duration.

Clinical Course.—The patient, who was unconscious, was brought to the hospital forty-five minutes after drinking the formaldehyd.

She was a slender, white woman, unconscious and in shock. Her pulse was thready; her eyes were half opened; the conjunctivae were injected, and the skin was cold and clammy. Gastric lavage was performed. Stimulants were given intravenously. The patient did not respond and died three hours after the ingestion of the formaldehyd.

Pathology.—Necropsy was performed eighteen hours postmortem. The anatomic diagnosis was early acute gastritis (marked) following ingestion of formaldehyd solution; early acute enteritis (moderate); acute cardiac dilatation (right) moderate; terminal pulmonary edema (slight), and healed peritoneal adhesions. The probable cause of death was shock following formaldehyd poisoning, with marked early acute gastritis and moderate early enteritis.

Of interest in the necropsy were the following points: There were a few hemorrhages observed in the mucous membrane of the inner surface of the lips. The mucosa of the esophagus throughout was whitish, perhaps slightly thickened. The submucosa showed some thickening by clear fluid. The stomach was several times the average size, contained about a liter of partially digested food and brownish, somewhat oily fluid, which on distillation gave the typical reaction for formaldehyd. The walls were greatly thickened, from 5 to 10 mm. This was most marked in the mucosa and submucosa, especially near the cardia, which was watery and gelatinous in appearance. The mucosa had a pigskin appearance with linear ulcerations and an almost diffuse dull reddish appearance suggesting hemorrhage. The duodenum showed moderate swelling, injection

Fig. 5.—Early inflammation with marked edema of duodenum after formaldehyd poisoning of three hours' duration.

and hemorrhage of the mucosa. The cecum and ascending colon also showed some injection. The remainder of the colon and rectum showed no appreciable abnormalities.

Microscopic Description.—Section of the esophagus showed an intact surface epithelium. The submucosa and to a less extent the muscle showed a moderate amount of amorphous pink stained material separating the fixed tissue. The blood vessels were engorged and contained somewhat more numerous nucleated cells than normal. There were a few wandering cells in the regional fixed tissue.

One section of the stomach showed in two places superficial ulceration of the mucosa a few hundred to 500 microns in width, extending only half way through the mucosa. About these ulcers there was marked infiltration of the tissues by red blood cells (not laked). In the base of each there were abundant wandering cells. The striking change in the mucosa was apparently the marked edema. The mucosa was 2.5 mm. in width. The blood vessels were everywhere engorged. There were areas of hemorrhage and a moderate number of wandering cells in the loose stroma. The hemorrhage about the ulcerations continued for a small distance into the submucosa. This coat was strikingly

edematous apparently, in places 4 mm. in width. The muscle and serosa showed a similar picture of marked edema. The blood vessels were somewhat engorged. There were no wandering cells in the fixed tissue of the outer coats. A second section, from 7 to 8 mm. in width, showed a similar picture with areas of linear ulceration, one of which continued to the submucosa. The blood in the mucosa was in striking contrast to that in the serosa. In the former position the red cells were intact; in the latter they were laked. Both sections showed striking engorgement of the vessels in the inner portion of the submucosa.

Section of the duodenum showed a picture of moderate edema of the mucosa and marked edema of the submucosa. The engorged blood vessels in the latter coat, with the blood in great part, was laked, and there were a moderate number of wandering cells in the mucosa and submucosa. The innermost portion of the mucosa, especially of the villi, was in great part necrotic, with considerable separation of the tissue by amorphous, pink stained material. The picture resembled postmortem change.

Section of the jejunum showed considerable desquamation of the surface epithelium. There was slight edema of the mucosa and apparently moderate edema of the submucosa. A number of blood vessels showed within and about them a moderate number of wandering cells. The blood in great part was laked.

SUMMARY OF PATHOLOGIC CHANGES IN FATAL CASES

Of the twelve fatal cases, ten came to necropsy. In all these, the changes were most marked in the lower esophagus and to an even greater extent in the stomach. The changes in these organs varied from simple hardening of the tissues to extreme corrosion. Frequently, marked congestion and edema were present with areas of erosion and of hemorrhage. Occasionally similar but less marked changes were observed in the duodenum and even jejunum. The remainder of the alimentary canal rarely showed any abnormality. In cases continuing thirteen hours or longer after ingestion of the formaldehyd, degenerative changes in the parenchymatous organs were noted, varying from slight cloudy swelling to fatty degeneration and even patchy necrosis. In a few cases the blood was still fluid and was dark red at the time of the necropsy. One case of sixty-two hours' duration showed 200 c.c. of purulent exudate in the abdominal cavity. In this case there was considerable involvement of the stomach with inflammatory changes reaching to the serosa. In one case death was apparently due to diffuse bronchopneumonia. In a few others, there was a terminal pulmonary edema. In one case the changes were practically limited to the respiratory tract as far as the bifurcation of the trachea.