factors undoubtedly enter into the picture, such as improved understanding of the disease and of the function of the adrenal glands, improved sanitation, better living conditions, the use of vitamins, the better care of patients with tuberculosis, and the control of intercurrent infections by antibiotics. Singly or collectively, none of these factors can be considered more than contributory to survival. However, the prolonged survival times here recorded (no deaths under 9 years, and five of eight patients surviving 15 to 18 years) suggest that this extract may have special virtues in prolonging life. It also suggests that it warrants further study.

SUMMARY AND CONCLUSIONS

The survival time in cases of adrenal cortical hypofunction (Addison's disease) has generally been materially prolonged through modern methods of treatment. Eight of my patients have survived for over 15 years. This covers an experience in the treatment of more than 150 patients seen during the last 35 years. In a series of eight consecutive patients (1933-1940) treated with Swingle's suprarenal cortical extract and with an adequate intake of salt daily, all survived for at least 9 years, seven survived 10 years or more, and five survived from 15 to 18 years. Two patients recovered. In several patients recourse was made to other adrenal preparations; two received pellet implantations late in the course of their disease and two were given small doses of cortisone. The survival time in this series sets a new record in adrenal cortical hypofunction though the number of cases concerned is admittedly small. The results here presented suggest the desirability of finding ways and means to make Swingle's suprarenal cortical extract more generally available and at a lower cost or to compound some balanced mixture of adrenal hormones that will serve as an effective and inexpensive substitute.

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Housewives' Dermatitis.—[This] is one of the commonest of occupational hazards. All soaps and detergents degrease the skin to some extent, in proportion to their cleaning efficiency. The results are essentially the same, whether the skin fat is emulsified and rinsed off or whether it is removed by solution. The denuded keratin becomes exposed to the action of the cleaner, for a shorter or a longer time, depending upon the ability of the sebaceous glands to replace the lost fat and on the emulsifying and spreading properties of the sweat. . . . Once dermatitis has developed, avoidance of further exposure is essential, but at this stage rubber gloves are rarely tolerated. Mild cases recover with the use of bland applications; but in the severest forms recovery may take months or the dyskeratotic process may persist indefinitely because the germinal cells have been damaged. No cream can give back to denatured basal cells the power to form a normal keratinous layer. . . . Toilet soaps have a beneficial effect on the skin. . . . When the skin is cleaned with soap and water an adsorption layer of soap is formed and is converted in less than an hour into a layer of free fatty acids which cling tenaciously to the skin. These fatty acids have beneficial (bactericidal) effects as well as very occasional harmful (allergenic) effects. Toilet soaps rarely cause dermatitis although they may aggravate existing dermatitis as, for that matter, may water itself.—B. Russell, M.D., Advances in the Treatment of Skin Diseases, *The Practitioner*, October, 1955.

CLINICAL NOTES

FATAL POISONING WITH SODIUM FLUOROACETATE

REPORT OF A CASE

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and
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Extensive chemical research carried out in recent years has produced a rodenticide, sodium fluoroacetate, which has been found to be very effective and extremely toxic. Sodium fluoroacetate, or "1080" as it was called during the investigation period, is said to be one of the most noxious substances known, since it is toxic to all mammals, man included.[1] Sodium fluoroacetate was first reported by Kalmbach.[2] With this poison rat control can be much more easily and effectively carried out than ever before; however, because of its extreme toxicity (three teaspoons of the watered solution used for rats is sufficient to cause death in the adult human being) many necessary precautions have been taken in its employment and administration. It is distributed only to qualified members of governmental agencies and to properly insured and licensed pest control agencies and operators. In addition, strict regulations are imposed upon its use, and standard procedures are outlined in attempts to prevent the inadvertent poisoning of human beings and domestic animals. A technical bulletin is published by the manufacturers with instructions for usage.[3]

The drug is a colorless, odorless, and tasteless water-soluble salt. As a rat poison, it is prepared by dilution to one part in 300 or 500 parts of water. The drug is equally effective as a poison regardless of mode of entry. It may be absorbed through the intact skin but not readily; however, it is easily absorbed through cuts and abrasions.[4] It is rapidly absorbed in the gastrointestinal tract and may also be absorbed through the lungs by breathing dust containing the poison.[4] The theory has been advanced by several writers that sodium fluoroacetate acts as a metabolic poison producing its lethal effects, not as a free fluoride, but as an intact molecule.[4] The exact mechanism has not, as yet, been uncovered, but it is felt that sodium fluoroacetate competes in reactions where acetate normally takes part. It has been suggested

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Dr. Abraham Stolman, Toxicologist for the state of Connecticut, made the determinations of fluoride content. The Pathology Department of Hartford Hospital (particularly Dr. George McAdams) made the postmortem examination and synopsis of the findings.

1. Gajdusek, D. C., and Luther, G.: Fluoroacetate Poisoning: A Review and Report of a Case, Am. J. Dis. Child. **79**: 310-320 (Feb.) 1950.
2. Kalmbach, E. R.: "Ten-Eighty," War-Produced Rodenticide, Science **102**: 232-233, 1945.
3. Sodium Fluoroacetate ("Compound 1080") as a Rodent Poison, Monsanto Technical Bulletin no. 0-53, St. Louis, Monsanto Chemical Co., Organic Chemicals Division, 1948.
4. Sodium Fluoroacetate, Clinical Memorandum, Technical Development Branch, Communicable Disease Center, U. S. Public Health Service, Savannah, Ga., May, 1952.
5. Liebecq, C., and Peters, R. A.: The Toxicity of Fluoroacetate and the Tricarboxylic Acid Cycle, Biochim. et biophys. acta **3**: 215, 1949.

that this interference with acetate metabolism may cause a piling-up of citrate.[5]

Chenoweth and Gilman have studied extensively the reactions produced by sodium fluoroacetate in animals and have classified the animals in groups according to the reactions brought about in them by the agent.[6] The organ systems affected are chiefly the cardiorespiratory and central nervous systems. Briefly, the classification includes the following: group 1, in which the action is a cardiac one, with death due to ventricular fibrillation; group 2, in which there is both a cardiorespiratory and central nervous system response, with death in respiratory failure during convulsions or ventricular fibrillation; group 3, in which the primary effect is on the central nervous system, with no cardiac abnormality; and group 4, in which there is an atypical response, including bradycardia and respiratory depression. In man, sodium fluoroacetate has been found to produce a mixed response, with elements of cardiorespiratory and central nervous system damage similar to that produced in monkeys.[7]

According to the available literature, there have been 22 known cases of poisoning with sodium fluoroacetate, 16 of which were fatal [4]; however, only 2 cases have been reported in the medical literature to our knowledge. One of these was fatal, the other was not. Gajdusek and Luther in 1950 [1] reported a case of nonfatal poisoning in a 2-year-old infant, and in 1952 Harrisson and others [7c] reported a case of fatal poisoning. In each of these articles, the experimental and toxicologic literature was thoroughly reviewed, and the references are complete. Thus far there has been no case reported in which the exact quantity of the poison taken was known. Careful calculations in the cases mentioned have given approximations of the amount ingested. It has been estimated that about 5 mg. per kilogram of body weight is lethal to man. In the case reported by Harrisson and others a minimum of 6 mg. per kilogram was ingested.[7c] In this paper a case of fatal poisoning with sodium fluoroacetate is reported. We feel that this case is of particular interest because the patient lived for five days after ingesting the poison and extensive laboratory work was therefore possible. A postmortem examination with analysis of the organ contents was also obtained.

REPORT OF A CASE

A 17-year-old boy, son of a professional rat exterminator, entered the emergency room of our hospital at 4 a. m., Jan. 1, 1954, and told the nurse that he had ingested a solution of sodium fluoroacetate. The amount ingested could not be determined accurately, but a previously unopened 8 oz. can of the material was found in his room half empty. Apparently, the boy had dissolved a large amount of the poison in water and swallowed the solution, after which he promptly vomited. He stated that he had noted almost immediate epigastric pain. He came to the hospital about 45 to 60 minutes after this incident. At the time of admission the patient was alert and responsive but complained of epigastric pain. A gastric lavage with starch water and magnesium sulfate was carried out immediately. During this procedure, the patient gradually became more and more unresponsive, and by 5:20 a. m. he was comatose. A half hour later he had a grand mal convulsion associated with fecal incontinence.

Physical Examination.—Blood pressure was 110 mm. Hg systolic and 70 mm. Hg diastolic. The pulse was irregular at a rate of 72 per minute, and the respirations were 16 per minute. The patient was in deep coma, unresponsive to painful stimuli. The skin was warm and dry. There was dusky cyanosis of the nailbeds and lips. The pupils were constricted but reacted normally to light. The neck was supple. Lungs were completely clear throughout. Examination of the heart revealed the point of maximal impulse to be well localized in the fifth left intercostal space medial to the midclavicular line. There was a normal sinus rhythm, with frequent ventricular premature beats (about 16 to 20 per minute). The heart tones were of poor quality. No murmurs were heard. The abdomen was negative. Neurological examination revealed the cranial nerves to be intact, as far as could be determined. The abdominal reflexes were absent, and the Babinski sign was present bilaterally. There were frequent chewing movements of the jaws. The remainder of the examination was not remarkable. An electrocardiogram obtained at this time showed the rate to be 72 and showed occasional ventricular premature contractions, a prolonged Q-T interval, the QRS complex negative in lead 1, the T wave negative in leads 2, 3, and aVF, and the T wave notched in leads V_3, V_4, and V_5. This was interpreted as showing right axis deviation, ventricular premature contractions, and evidence of diffuse myocardial abnormality.

Drug Therapy.—The patient was given oxygen by nasal catheter and procainamide (Pronestyl) hydrochloride, 500 mg. in 500 cc. of 5% dextrose in water, intravenously. During the next four hours, the heart sounds improved in quality and the rhythm was completely regular. Phenobarbital sodium or amobarbital (Amytal) sodium was used to control the signs of cortical irritability. Eight hours after admission, the patient vomited some dark brown material, which gave a chemical reaction for blood by the benzidine test. Examination at this time revealed that the cyanosis had disappeared and the vital signs were normal. The skin was flushed. The heart seemed dilated as evidenced by a very diffuse point of maximum impulse, 2 or 3 cm. outside the midclavicular line. Coma persisted. The neurological signs mentioned above were again demonstrated.

During the next 12 hours, the patient became very restless, thrashing about in bed. There were frequent episodes of severe carpopedal spasm, while at other times all the muscles of the body became very spastic and it seemed that another grand mal seizure was imminent. These periods of neuromuscular hyperactivity were temporarily controlled by intravenous therapy with calcium gluconate, 10 cc. of a 10% solution. On the morning of the second day, acute pulmonary edema supervened. The patient was digitalized with lanatoside C. The pulmonary edema cleared readily, but coma persisted. The pupils were small and fixed to light, and the respiratory rate increased to 40 per minute. Blood pressure was 100/70 mm. Hg and the pulse 160 per minute and feeble. An electrocardiogram taken at this point revealed supraventricular tachycardia and the evidences of diffuse myocardial abnormality noted above. There were no premature beats. During the ensuing four hours, the pulse rate rose to 180 per minute and the blood pressure dropped to 84/0 mm. Hg. Cheyne-Stokes respirations became evident, and the heart became further enlarged. Suction of the upper respiratory tract had to be carried out frequently, and an endotracheal tube was inserted. Because of the hypotension, levarterenol (Levophed) bitartrate therapy, 4 mg. in 1,000 cc. of 5% dextrose in water, was started by intravenous drip. This produced no appreciable effect on the blood pressure, although the pulse slowed a little and seemed stronger. At 11:30 p. m. of the second day, examination showed no change in the physical findings, except that the pupils once again reacted to light. Levarterenol bitartrate therapy was discontinued, and procainamide hydrochloride, 500 mg. in 500 cc. of 5% dextrose in water, was again administered intravenously. Mephentermine (Wyamine) sulfate therapy, 15 mg. every two hours by intramuscular injection, was tried. Calcium gluconate was given repeatedly to control the carpopedal spasm.

Condition of Patient.—On the third day the clinical picture and forms of therapy remained unchanged except for a further drop in blood pressure to the point of being unobtainable. Another electrocardiogram showed no important changes when

6. Chenoweth, M. B.: Monofluoroacetic Acid and Related Compounds, J. Pharmacol. & Exper. Therap. **97**: 383-424, 1949.

7. (*a*) Footnote 1. (*b*) Footnote 4. (*c*) Harrisson, J. W. E., and others: Acute Poisoning with Sodium Fluoroacetate (Compound 1080), J. A. M. A. **149**: 1520-1522 (Aug. 23) 1952.

compared with the previous ones, except for the addition of digitalis effect. The temperature continued to rise and reached a maximum of 104.6 F (40.3 C) late on the third day. On the fourth hospital day there was a tremendous increase in the amount of tracheobronchial secretions, which necessitated almost constant suctioning. On this day it was decided to alternate 5% alcohol in 10% dextrose in water intravenously with procainamide hydrochloride intravenously. This treatment was carried on through the fifth day, when the patient's condition seemed to improve a little. The blood pressure was obtainable at 100/60 mm. Hg, though the pulse remained rapid (180 per minute) and feeble. The heart sounds remained "flabby" in character. The extremities became warmer and had a good color. The muscular and carpopedal spasms decreased remarkably after the start of intravenous therapy with alcohol. On the night of the fifth day, the tracheobronchial secretions became so copious and tenacious that an adequate airway was impossible without a tracheostomy. This procedure was therefore carried out. Thick yellowish-white mucoid material was suctioned from the lower trachea, and the airway immediately sounded clear and dry. Examination of the lungs at this time revealed them to be well aerated throughout. Coma, rapid and feeble heart action, hypotension, the neurological signs noted above, and a good urinary output remained the principal features of the clinical course, together with a steadily rising temperature. At 3 a. m. on Jan. 6, 1954 (the sixth hospital day), the temperature reached 108 F (42.3 C) in spite of all measures to reduce it. From this point on the patient's respirations became extremely labored and rapid, the blood pressure once again was unobtainable, and the pulse increased to such a rapid rate that it was impossible to count it with any degree of accuracy. At 8 a. m. on Jan. 6, the patient died.

Postmortem Examination.—Postmortem examination revealed mediastinal emphysema, obvious and moderate in amount. The lungs were heavy (right 950 gm., left 750 gm.), edematous, and congested, but there was no frank consolidation. The bronchi were hemorrhagic but without exudate. Hemorrhagic-appearing mucosa was noted in the stomach but not in the esophagus. The spleen weighed 320 gm. and was red in color and firm to the touch. The right kidney contained a 2 mm., red-yellow area just beneath the surface. Other than congestion, the kidneys were normal. Crepitation could be felt and air bubbles could be seen in the adventitia of the aorta and immediate branches. The brain weighed 1,600 gm. and showed marked edema, with flattening of sulci and upward herniation of the cerebellum through the tentorium. Culture from the heart blood showed a moderate growth of hemolytic Micrococcus pyogenes var. aureus, coagulase positive. The remaining organs were grossly unremarkable.

Microscopic examination of the esophagus showed denudation of the epithelium here and there, with a coagulation necrosis present and minimal acute inflammatory reaction. The stomach mucosa was intact and essentially not remarkable. The lungs revealed a striking bronchopneumonia, with marked alveolar hemorrhages, congestion, and small clumps of bacteria. The brain contained small perivascular hemorrhages and changes in the ganglion cells compatible with the general cerebral edema. Finally, there was a small recent infarction in the cortex of the right kidney. Portions of liver, brain, kidney, pericardiac fluid, gastric contents, blood, heart, urine, and bile were examined for fluoride by the sodium silicofluoride test. The bile alone contained detectable amounts—0.02 mg. per 100 cc. by the zirconium-alizarin red test. The final anatomic diagnosis made was poisoning with sodium fluoroacetate; bronchopneumonia, with hemolytic septicemia due to a pyogenes var. aureus organism; focal infarction of right kidney; and mediastinal emphysema.

COMMENT

Since there is no known antidote to sodium fluoroacetate, therapy must be directed toward prevention of (1) serious cardiac arrhythmias, (2) central nervous system irritability, (3) peripheral vascular collapse, and (4) the general complications encountered in any patient who is comatose. In our recent experience with this disease entity, we have found certain agents that proved to be of definite, though short-lived, benefit to the patient. Myocardial irritability responded, at least temporarily, in a rather striking manner to the use of intravenously given procainamide hydrochloride, which completely abolished the premature ventricular contractions. Clinically, there was a distinct improvement in the quality of the heart sounds during and after the use of this drug. Several writers have agreed that procaine hydrochloride should be given by the intracardiac route in the case of ventricular fibrillation, known to be one of the immediate causes of death in human beings subjected to the poison. The ectopic beats, presumably the first signs of myocardial irritability, which might have progressed to more serious arrhythmias, such as ventricular tachycardia and ventricular fibrillation, were controlled by the use of procainamide hydrochloride. We feel that the possibility of death by ventricular fibrillation was prevented by use of this drug. The use of a digitalis preparation in the face of what was known to be a "toxic myocarditis" might give rise to some discussion. We had hoped to avoid the use of this substance, but our hand was forced by the intervention of acute pulmonary edema representing the most serious threat to life at the time it occurred. Short-acting lanatoside C was used because it was felt that this would relieve the pulmonary edema, which it did, without producing a cumulative cardiotoxic effect. There seemed to be no ill effects on cardiac irritability produced by this agent.

Secondly, the central nervous system manifestations, carpopedal spasm and generalized muscular hyperirritability, had to be dealt with. The barbiturates, calcium gluconate and magnesium sulfate, seemed to provide transient alleviation of these manifestations. With the institution of intravenous therapy with alcohol, these signs disappeared entirely and rather remarkably. It would seem likely, therefore, that this agent might, along with procainamide hydrochloride, be valuable in the therapy of this condition. In the third place, it was necessary to attempt to prevent death due to peripheral vascular collapse. In order to combat shock and to maintain an adequate renal blood flow, we used the vasodepressor drug mephentermine sulfate. We were thus able to maintain the patient's blood pressure above 100 mm. Hg systolic for a good part of the time and a good urinary output throughout the patient's hospital course. Finally, as in all cases of coma, alert nursing care was essential. Constant turning, frequent suctioning of the nasopharyngeal and even the tracheal and bronchial passages, use of alcohol sponges for fever, and nearly constant checking of the patient's vital signs were some of the more important of the many duties falling under the term nursing care.

In this case of fluoroacetate poisoning we considered, also, the use of agents recommended in the literature, such as magnesium sulfate in doses of 50 mg. per kilogram. This is known to prevent death in rats if given intramuscularly before or immediately after the ingestion of the poison. We also considered the use of monoacetin, which provides acetate and, thereby, theoretically produces its beneficial effect by this mechanism. We were advised by personal communication [8] that these

8. Fairhall, L.: Personal communication to the authors.

agents were usually helpful only immediately after the intake of the poison; therefore, we relied on the therapy outlined herein and used much smaller doses of magnesium sulfate. Monoacetin was not available to us. It has also been suggested that chlorpromazine might be useful in that it provides an "artificial hibernation," which reduces central nervous system and cardiac irritability, as well as lowers the temperature.

SUMMARY

Certain drugs can be used with benefit in a case of sodium fluoroacetate poisoning. These are (1) procainamide (Pronestyl) hydrochloride for cardiac arrythmias, (2) intravenously used alcohol for central nervous system irritability, and (3) vasodepressor drugs such as mephentermine (Wyamine) sulfate to maintain blood pressure. In the future these drugs, which we feel prolonged the life of our patient, should be tried in cases of sodium fluoroacetate poisoning, as they may save the lives of patients who have ingested smaller amounts of the poison.

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TRANSILLUMINATORS AND ILLUMINATED RETRACTORS FOR RETINAL DETACHMENT AND SURGERY

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The need for a compact and practical source of illumination for certain eye operations and for diagnosis instigated the development of a set of plastic retractors and transilluminators. These devices have been found to be useful and practical for retraction illumination, focal illumination, and transillumination of the eyeball.

A set of five tips, a sturdy flashlight handle, batteries, and an extra light bulb are encased in a compact leather case (see figure). The flashlight handle is made in two sizes. The small handle accommodates the no. 912 Eveready batteries, and the larger handle accommodates the regular no. 915 Eveready batteries, as well as the new long-life mercury batteries. The handles are machined from aluminium and are clear anodized, to prevent tarnishing. They contain no springs nor switches to wear out and are controlled by turning the base of the small flashlight and the base or top of the larger one. The three metal parts of the flashlight may be boiled or sterilized in alcohol and the inexpensive standard bulb and batteries inserted after sterilization. Three of the plastic light tips have a metallic mirror coating and are covered with plastic lacquer, allowing light to emerge only at the light-emitting surface.

The illuminated retractor (figure, *A*) is a modification of a retractor previously described [1] and has proved invaluable in operations on the retina and the inferior oblique muscle,[2] in orbital operations, and especially in evisceration of the eyeball.[3] The curved plastic tip (figure, *B*) permits light to emerge from the tip of the inner surface of the curve and is useful for transillumination of the posterior part of the globe in cases where tumors are suspected and for locating posterior retinal tears. The plastic tip, which is bent at a right angle (figure, *C*), is especially useful in examining the eye and transilluminating teeth and has been recommended as an accessory for a pocket flashlight for physicians.[4] The focal illuminator (figure, *D*) provides oblique illumination for the eye and may also be used in the examination for Purkinje vascular images. A cobalt blue glass tip (figure, *E*) is used for examining a fluorescein-stained cornea. The plastic tips may be sterilized in C. R. I. germicide (methyldodecylbenzyltrimethyl ammonium chloride, 17.5%, and inert ingredients, by weight, 82.5%). Neither alcohol nor boiling water should be used for sterilization of the plastic parts.

Transilluminators and illuminated retractor for retinal detachment and muscle and tumor surgery. *A*, plastic retractor; *B*, transilluminator for posterior part of the eyeball; *C*, transilluminator for anterior part of the eyeball; *D*, focal illuminator; and *E*, cobalt blue glass illuminator.

The advantages of the flashlight include the sturdy construction with no springs or switch, which wear out, and the fact that the flashlight may be sterilized without harming the instrument. Standard bulbs and batteries are used and offer no problem in replacement. The various plastic tips provide excellent illumination for retinal and muscle and tumor surgery and focal illumination for examination. The plastic tips are easily changed and present no problem so far as breakage is concerned. The set of transilluminators and illuminated retractors, flashlight, batteries, and the cobalt glass tip are fitted into a compact leather case. The instrument is also available with a cord for use with a rheostat.

708 Park Ave.

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The apparatus described is made by R. O. Gulden, Philadelphia 20. The long-life mercury batteries are made by P. R. Mallory & Co., Inc., North Tarrytown, N. Y. The C. R. I. germicide is made by Storz Instrument Co., St. Louis.

1. Berens, C.: An Illuminated Retractor for Eye Operations Especially for Detachment of the Retina, Am. J. Ophth. **27**: 281 (March) 1944.

2. Berens, C.: Cole, H. G.; Chamichian, S., and Enos, M. V.: Retroplacement of the Inferior Oblique at Its Scleral Insertion, Am. J. Ophth. **35**: 217 (Feb.) 1952.

3. Berens, C., and Rosa, F. A.: Evisceration with Plastic Intrascleral Implants, Am. J. Ophth. **36**: 356 (March) 1953.

4. Berens, C.: A Pocket Flashlight for Physicians with a Focal Illuminator and Transilluminator, J. A. M. A. **155**: 124 (May 8) 1954.