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A REFERENCE HANDBOOK
OF
THE MEDICAL SCIENCES.

CHLORALAMID.—Introduced in 1889 by Professor von Mering as an hypnotic. It is formed by the combination of one part of formamide, CHO,NH_2, with two parts of chloral anhydride, CCl_3CHO. Its formula is $CCl_3CH,OH,CONH_2$, and would more correctly be named chloral-formamide, or formiate of chloral. The production of this compound is due to the efforts of chemists to introduce into chloral some known stimulant to overcome the depression of the circulation that accompanies the use of chloral. This von Mering thought he had accomplished, as, after absorption, chloralamid is decomposed by the alkalies in the blood into chloral and ammonium formate. The latter exercises a stimulating effect upon the heart and circulation. In addition to this absence of a depressing effect, other advantages over chloral are claimed: It is much less disagreeable in taste, and more soluble, characteristics which render it easy of administration. It is less irritating to the stomach, does not derange the digestive organs, and seldom causes headache, giddiness, or any disturbance of the nervous system.

It occurs in white crystals which have a faintly bitter taste and no odor, and are neutral in reaction. It is soluble in ten parts of cold water and in one and a half parts of alcohol. The salt should never be dissolved in hot water, nor heated above 120° F., as at that temperature it is decomposed. It is also decomposed by alkalies and alkaline carbonates. It is compatible with weak acids, which increase its solubility and render the solution more stable.

Chloralamid has not replaced chloral hydrate nor has it been very generally employed, as its advantages are not very evident. Whether it is less depressant than chloral hydrate or not, is a question that has caused much difference of opinion. Recent researches, however, seem to have shown that the formiate does exert a beneficial effect upon the circulation, especially when administered by the stomach. It is, however, not devoid of depressant action, and when introduced directly into the circulation, as in hypodermic use, it differs very little from chloral hydrate. In considering the differences between the two drugs, the relative proportion of chloral anhydride in each must be kept in mind, 1 part of the anhydride being present in 1.3 part of chloralamid and 1.1 part of chloral hydrate. With many it is thought that this difference in strength really represents the difference in action between the two drugs. It has also been found that chloralamid is less repidly absorbed from the stomach, which renders it more slow and gradual in its action.

Chloralamid is employed as a sedative and hypnotic in all the conditions in which chloral hydrate is indicated; notwithstanding its reputed safety when there is cardiac weakness, it is advisable to employ it in such cases with caution.

The dose advised when the drug was first used was from gr. xx. to xlv., and this has been very generally adhered to. The average dose employed is about gr. xxx. As a rule, it is advisable to begin with a smaller dose of gr. xv. to gr. xx., when the insomnia is not accompanied by pain or excitement. On account of its solubility in alcohol, chloralamid is easily given in solution diluted with some aromatic elixir. Brandy or whiskey is a favorite means and adds to its beneficial action. If alcoholic solution is not desired, dilute hydrochloric acid will be found to serve the purpose. It may also be given in cachets. For whooping-cough and other spasmodic affections, it is given in doses of gr. ij. every two hours. Enemata may also be employed when such a means of administering the drug is desired. The following formula is recommended for this purpose: chloralamid, gr. xiv.; dilute hydrochloric acid, gtt. iij.; alcohol, gtt. xx.; water, ʒ iij. *Beaumont Small.*

CHLORALIMID.—(Trichlor-ethyliden-imide), CCl_3, CHNH. This substance is obtained by the action of acetate of ammonia on chloral hydrate; it may also be formed by heating chloral ammonia. It is a crystalline acidular powder without taste, smell, or color, insoluble in water, soluble in alcohol, ether, and oils. It is not affected by heat or moisture. It possesses properties similar to those belonging to chloralamid, but is more active. As an hypnotic, it is given in doses of from gr. v. to xxx. It is introduced as a substitute for chloral hydrate and chloralamid. It has not the acrid taste of the former nor the bitter taste of the latter. In smaller doses it is said to have an antipyretic and analgesic action. This drug has not been used to any extent, and its superiority to chloralamid has yet to be determined. *Beaumont Small.*

CHLORATES. See *Potassium* and *Sodium*.

CHLORATES, POISONING BY.—When we speak of poisoning by chlorates we have in mind chiefly the poisoning by chlorate of potassium, of which there are already a goodly number of cases on record. It is, however, generally conceded that the poisoning is mainly due to the chlorate ion of this salt. We can also readily cause poisoning by the sodium chlorate, and it is even claimed that the ammonium salt is the most poisonous of all the chlorates. The greater frequency of poisoning by the potassium salt is due to its frequent use. On the erroneous supposition that the readily oxidizing potassium chlorate will give up oxygen to the tissues and fluids of the animal body, this salt was extensively employed throughout the entire nineteenth century as a therapeutic agent for all sorts of diseases (von Mering [1]).

It is, however, a noteworthy fact that, with a few exceptions, the record of poisoning by chlorate of potassium is practically not much older than the last two decades, *i.e.*, since the danger of this therapeutic agent was impressively brought to the minds of the medical profession by the writings of A. Jacobi [2] and F. Marchand [3] at the end of the seventies.

The first case on record is apparently that which occurred in Tulle, France, and which was described by Chevalier [4] in 1855. A man took 20 gm. of the salt for two days and died manifesting violent symptoms. This case attracted considerable attention, and was apparently the incentive for the toxicological studies of potassium chlorate which began in France earlier than in other countries.[5]

There is one other case that deserves especial mention. It is the tragic death of Dr. Fountain, of Davenport, Iowa. This physician, a great admirer of potassium chlorate, read a paper in 1859 at the meeting of the American Medical Association, enthusiastically recommending this salt in the treatment of pulmonary tuberculosis.[6] This paper called forth considerable discussion and not a little adverse criticism. As an answer to the statement of Osborne[7] that even fifteen grains of this drug sometimes cause serious symptoms, Fountain took repeatedly half-ounce doses without harmful effects. In 1860 Dr. Elsberg, of New York, prescribed potassium chlorate as a gargle. The patient took it internally (about 20 gm. daily) and died after four days. A coroner's jury of physicians gave the verdict that death was due to poisoning by potassium chlorate.[8] Incensed by this verdict and to prove the innocuousness of this salt, Fountain took on the 22d of March, 1861, an ounce of it in a single dose—and died on the 29th of the same month under complete anuria.[9]

The poisoning cases on record were brought about mostly by taking a large dose of the salt either to commit suicide or to induce criminal abortion; or it was taken by mistake instead of a cathartic salt, or the directions of the physician were misunderstood and it was taken internally instead of being used as a gargle. There is no doubt, however, that a good many cases of poisoning, and more than were reported, occurred when the salt was taken internally for therapeutic purposes; and a few, it seems, even when it was used as a gargle. But the symptoms of the poisoning resembled so much the symptoms of the disease for which the salt was taken—diphtheria, for instance—that the fatal outcome was often enough attributed to the disease rather than to the drug.

The clinical symptoms which attracted attention in the earliest observations were those pertaining to the gastro-intestinal tract. Later on, dysuric symptoms were recognized, and many writers spoke of hemorrhagic nephritis. In the last quarter of the century, however, the attention of writers, especially of experimental investigators, was attracted by the peculiar changes in the blood. Indeed, it had been early observed that extravascular blood becomes bright red when mixed with potassium chlorate, and this was taken as a sign of the oxygenation of the blood by the salt. The increased brightness, however, is due not to "arterialization" but to the greater reflexion of light on account of the diminished transparency of the chloratized blood. Moreover, the bright color very soon gives way to a chocolate or sepia color which was first observed by Isambert[10] in the extravascular blood as well as in the blood of animals poisoned by chlorate of potassium. Jäderholm[11] was the first to recognize that the dark color was due to the formation of methæmoglobin in the blood. This subject has been extensively studied by Marchand[12] and by many subsequent investigators.[13]

Methæmoglobin is neither an oxidation nor a reduction product of oxyhæmoglobin, as has been assumed, but is rather isomeric with it. Methæmoglobin, however, does not give up its oxygen as readily as oxyhæmoglobin. Methæmoglobin is recognized by an absorption band at the red end of the spectrum between C and D. Carbonic acid, higher temperature, and diminished alkalinity of the blood favor its formation. Potassium chlorate at first causes the formation of methæmoglobin within the red cells, but the latter is subsequently dissolved into the serum.

Besides its influence upon the hæmoglobin, potassium chlorate exerts also in some other respects a deleterious effect upon the red blood cells. They shrink, break down into small fragments, and conglutinate into large gelatinous masses. In bullock's blood I found that all the red blood corpuscles became smaller and more refractile, and lost their biconcavity. In such blood which I kept for over eight years, the cells never changed their shape and proved to be at all times considerably resistant to all chemical and mechanical manipulations. In my experiments blood mixed with potassium chlorate remained free from putrefaction for a considerable length of time. In experiments of Welch and myself,[14] in which it was established that a certain degree of shaking caused a molecular destruction of the red blood cells, we found that the addition of potassium chlorate made the red cells resistant to any kind of shaking.

The blood of different animals differs considerably in its sensitiveness to the influence of potassium chlorate. It is stated that the blood of the cat is eleven times more sensitive than that of the dog; human blood seems to be equal in its sensitiveness to that of the dog. The blood of rabbits and guinea-pigs poisoned by potassium chlorate shows neither during life nor soon after death the formation of methæmoglobin or destruction of the red cells. However, sixteen or twenty hours after death the blood of these animals, too, assumes a chocolate color and contains methæmoglobin. According to Falck,[15] by injections of concentrated sodium chlorate, serum globulin, bile, etc., the blood of these animals also responds to the poisoning by potassium chlorate with an intravital formation of methæmoglobin.

The prevailing view as to the main causes of poisoning by potassium chlorate presents itself as follows: In acute poisoning the hæmoglobin of a very large number of red blood corpuscles becomes converted into methæmoglobin which does not give up its oxygen to the tissues, and asphyxia is then practically the cause of death. In less acute cases, when there still remains a number of normal red blood cells sufficiently large to carry on an indispensable minimum of respiratory changes, the animal might survive this primary attack and the methæmoglobin might even gradually re-form into normal hæmoglobin. But then the secondary effect of the destruction of the red cells comes into play. The débris of the broken-down corpuscles plugs up the renal tubules, causing all forms of dysuria. In these subacute cases death is caused by uræmia. Outside of these main causes of death, charged to the account of the chlorate ion of this salt, it is assumed that the "salt action" might also play a contributory rôle in the fatal issue, *i.e.*, potassium chlorate causes, like all salts, irritation and inflammation of the gastro-intestinal canal, the kidney epithelium, etc. In poisoning with potassium salt, the depressing effect of potassium upon the heart might also come into consideration.

As to the process by which potassium chlorate causes the changes of the blood within the living animal, we have no definite knowledge. Against the supposition that the change is effected by the oxidizing property of the drug, seems to be the fact, as was shown by Isambert,[16] Rabuteau,[17] and von Mering,[18] that nearly the entire quantity of the administered potassium chlorate very soon reappears in the urine entirely unchanged. However, even very minute reductions of the chlorate salt are sufficient to bring about the changes in the hæmoglobin, as is indeed surmised by von Mering. Furthermore, there is no proof nor even any good reason against an assumption that potassium salt is indeed reduced within the blood but becomes reoxidized again while leaving the body.

Regarding the quantity, it is generally stated that from 15 to 20 gm. in a single dose are fatal. We have seen above that 30 gm. killed Dr. Fountain. In a series of well-conducted experiments by Professor Tully, of Yale College, as early as 1832,[19] we find, however, that he as well as his students had several times taken one ounce of this salt in single dose without serious after-effects. And Percy[20] is authority for the statement that in 1858 A. Jacobi had taken two ounces in two days without any more serious effects than nausea, slight diarrhœa, and increased diuresis. It seems that in the early part of the century 10 to 46 gm. used to be the therapeutic dose given internally within twenty-four hours (Herpin[21]). There are, however, cases on record in which 10 gm. have killed an adult, and 4 gm. given in the course of one night have killed an infant one year old. The effect seems to depend upon the condition of the stomach; on an empty stomach the drug is more poisonous (Tacke,[22] von Mering[23]). The condition of the kidneys is also an influential factor, as a pathological state of the

kidneys prevents the secretion of the salt and thereby favors its accumulation within the blood (Lewin and Posner[24]). Fever, dyspnœa, and other diseased conditions of the body also facilitate the poisonous effect of the salts (von Mering). In animals the poisoning is accomplished not only by administration by the mouth, but also and in a more marked degree by subcutaneous, intraperitoneal, or intravenous injections of the drug.

Symptoms and Course.—The poisoning has either an acute or a subacute course, according to the quantity of the chlorate salt administered. When a single large dose is taken the symptoms of poisoning set in quite soon and life is terminated within a few hours. The symptoms are violent and incessant: vomiting, the dark vomitus containing mostly bile, rarely blood; diarrhœa, sometimes bloody; intestinal and at times also vesical tenesmus; severe pain in the abdomen, thirst, great prostration, and dyspnœa. Sometimes convulsions, sometimes coma closes the scene. The mucous membranes, the skin under the nails, and sometimes also other parts of the skin show peculiar cyanotic discolorations. The blood is of a chocolate color and contains methæmoglobin. In other cases, especially when smaller but repeated doses are employed, the onset may be quite insidious and the poisoning run a protracted course with a fatal termination on the eighth or tenth day. In these cases, too, gastro-intestinal symptoms prevail, but are less violent and usually subside after a day or two. Here, however, the urinary disturbance is the predominant feature. After a short period of increased diuresis the urine becomes more and more scanty until complete anuria sets in, which lasts sometimes for many days, until death closes the scene. The urine is albuminous, is of a dark reddish or chocolate color, contains débris of red blood corpuscles, some "shadows," and casts of reddish-brown particles. It contains also, at least at the beginning, potassium chlorate, methæmoglobin, and hæmatin. The skin is of an extreme pallor and icteric, sometimes has copper-colored spots and multiform exudative erythema. The spleen and liver are enlarged. The blood contains débris of red cells which are greatly reduced in number; the white cells are increased at the beginning,[25 26] but they also decrease toward the end; methæmoglobin is present only at the beginning of the poisoning. Of the subjective symptoms are to be mentioned: headache, pains in the abdominal and lumbar regions, insomnia, great distress, dyspnœa, etc. The multiform manifestations of uræmia are usually the features dominating the closing scenes.

Autopsy.—In acute cases the sepia color of the blood and many organs and the presence of methæmoglobin are the characteristic features. In subacute cases the characteristic color is rarely present; but here we find depositions of broken-down red blood corpuscles in the bone marrow, spleen, and liver; the latter two organs are enlarged. The kidneys, too, are usually swollen, the tubules are filled up with the débris of the red blood cells, the epithelia are in a state of cloudy swelling, which is, however, according to Marchand, of a secondary nature and due only to the pressure of the plugs. Thrombi were not found in any part of the body. The mucous membrane of the gastro-intestinal canal is often found to be swollen and ecchymotic.

The *Prognosis* in well-developed cases of poisoning is quite bad. The mortality of seventy per cent., which is given by some authors, is too low, as the statistics include also quite mild cases. There is, however, no doubt that recovery can yet take place even in quite desperate cases. At the same time it should be borne in mind that in many cases of fatal poisoning a temporary rallying occurs which deceives both doctor and family.

In the preceding sketch I have followed closely the lines laid down by all recent writers on the subject of poisoning by potassium chlorate. I wish to add, however, that to my mind the view as it is stated here, and as it has been in undisputed vogue for the last dozen years—namely, that the changes in the blood are the sole cause of the poisoning symptoms and fatal outcome—is not entirely correct. I have seen animals die in half an hour after intraperitoneal injection of potassium chlorate, without any changes in the blood or the kidneys. Of what did these animals die? There are in the literature cases of poisoning by potassium chlorate in which clonic convulsions occurred before any signs of a disturbance of the kidney were present, and therefore without any cause for uræmia. What caused the convulsions? Results which I have obtained in a series of experiments[27] might offer an explanation of these and other symptoms. By injecting gtt. iij. to v. of a five-per-cent. solution of potassium chlorate into the brain of rabbits, the animals pass through a series of violent tonic and clonic convulsions which end in a paralytic and comatose state. A ten-per-cent. solution of sodium chloride does not have such an effect. This shows that potassium chlorate is a poison for the nerve cells, first exciting then paralyzing them. May it not also be that by introducing the potassium chlorate into the body by any other method, some of the poison finds its way into the brain and exerts there exciting and paralyzing effects?

Treatment.—As prophylactic measures it may be suggested that the sale of potassium chlorate should be restricted. Large doses or prolonged administration of the drug should be avoided. It should be taken on a full stomach. When prescribed as a gargle it should be marked "Poison." Potassium chlorate is excreted by the milk glands and should therefore be avoided by nursing mothers. When poisonous symptoms set in, thorough washing of the stomach and bowels should be practised first, to be followed up by the administration of an ounce of castor oil. Small doses of cocaine and morphine, an ice-bag on the epigastrium, and other measures appropriate to control vomiting, pain, etc., should be instituted. Drinking of water and alkaline solutions to stimulate diuresis, etc., should be encouraged, but acidulous drinks and lemonades should be avoided. Cardiac stimulants, to be administered hypodermically, are indicated; caffeine and sodium benzoate, which are both stimulant and diuretic, are especially serviceable. Oxygen might do some good. Venesection, followed by transfusion of an alkaline saline, might relieve the blood from the deleterious waste products and at the same time stimulate diuresis. Cautious use of pilocarpine to stimulate perspiration and salivation is recommended. Hot baths too will increase perspiration and relieve the blood and kidneys.

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CHLORIDES.—The chlorides used in medicine are: among the chlorides of the heavy metals, those, severally, of iron, mercury, gold and sodium, and zinc; among

the chlorides of the alkalies, those, severally, of sodium, ammonium, and calcium; and among the chlorides of the alkaline earths, the chloride of barium. With the single exception of mercurous chloride (calomel), the chlorides of the heavy metals are distinguished among their sister salts for comparatively free solubility and great intensity of action. The iron, gold, and zinc chlorides are, furthermore, deliquescent to a high degree. For detailed discussion of the metallic chlorides, see articles under title of the several metals, and for barium chloride, see under *Barium*. In the case of the chlorides of the alkali bases, the influence over nutrition which they derive from their chlorine element exceeds in medicinal importance what properties are due to the basic radicle. The chlorides of the alkalies, therefore, may properly be regarded as constituting a distinct group of medicines.

Sodium Chloride: NaCl.—Sodium chloride, well known as *common salt*, *table salt*, *sea salt*, or simply *salt*, is official in the United States Pharmacopœia as *Sodii Chloridum*, Sodium Chloride. It occurs as "colorless, transparent, cubical crystals, or a white, crystalline powder, odorless, and having a purely saline taste. Permanent in dry air. Soluble in 2.8 parts of water at 15° C. (59° F.), and in 2.5 parts of boiling water; almost insoluble in alcohol; insoluble in ether or chloroform. When heated, the salt decrepitates; at a red heat it fuses, and at a white heat it is slowly volatilized and partly decomposed. To a non-luminous flame it imparts an intense, yellow color. The aqueous solution of the salt is neutral to litmus paper" (U. S. P.). While, as described, perfectly pure sodium chloride is permanent in the air, commercial table salt, containing, as it does, variable proportions of magnesium chloride, is more or less hygroscopic, becoming damp on exposure to moist air. Salt is the principal saline ingredient of sea water, and occurs native, also, in enormous quantities as a mineral. It is obtained for commerce from salt mines, and also, to a certain extent, by evaporating the water of the sea and of saline springs.

Sodium chloride is an important normal constituent of the body fluids, and accordingly is perfectly harmless to swallow in any ordinary quantity. The only effects following its special administration are, in moderate dosage, an improvement of appetite and digestion, and probably also a quickening of assimilation and nutrition. In large single doses salt is decidedly emetic, especially if taken in a lukewarm draught. Therapeutically, it is in the first place important to remember the absolute necessity of salt in the dietary, and so to see to it that dishes for the sick-room are not made too insipid by lack of salt. Next, salt is a fairly serviceable emetic; but not sufficiently powerful for urgent requirements. Accordingly, it is used rather as an adjuvant to more active emetics, than as itself a vomiting agent. Another application of salt is its administration, dry, in quantity of a teaspoonful or so, in hemorrhage of the lungs, over which affection salt is supposed to have some control; but such use, although unobjectionable, should not be to the exclusion of more potent remedies. In the matter of external application, it is notorious that salt water is more stimulating to the skin than fresh, and that, for the purpose of the constitutional reaction to be obtained, salt baths are more serviceable than fresh, and are borne by weaklings with less danger of giving "cold." The dose of salt as an appetizer is about 0.65 gm. (gr. x.), but the dosage is obviously very indeterminable, and much may be left to individual peculiarities of taste. As an auxiliary emetic, 15–30 gm. (℥ss.–i.) should be given in a tumblerful of lukewarm water. For saline baths sea water is best, but when not available a good substitute is afforded by a three-per-cent. aqueous solution of common table-salt (a pound to four gallons). For the bathing of sensitive mucous membranes, such as the conjunctiva or the Schneiderian mucous membrane in its upper portion, a weak solution of common salt affords a fluid far less painful than simple water, for the reason that such solution approaches more nearly the normal specific gravity of the fluids of the part. Such solution should range between one-half and one per cent. in strength, but it is near enough for practical purposes to make the solution by adding to a couple of fluidounces of water as much salt as will lie on the thumb nail. For injection into the nasal cavity, the solution should be blood-warm.

Ammonium Chloride: NH_4Cl.—This salt, commercially known as *sal ammoniac*, and still often called by the old-fashioned chemical name *muriate of ammonia*, is official in the United States Pharmacopœia only in a purified condition, under the title *Ammonii Chloridum*, Ammonium Chloride. Commercial sal ammoniac is now most commonly obtained from an ammoniacal liquor that occurs as a by-product in the making of illuminating gas, and is in the form of fibrous crystalline cakes of a peculiarly tough texture, making the substance very difficult to pulverize. In this condition the salt is contaminated with chloride of iron, and has to undergo a purification therefrom to fit it for medicinal use. The purified sal ammoniac is thus obtained granulated, and presents itself as "a white, crystalline powder, without odor, having a cooling, saline taste, and permanent in the air. Soluble in three parts of water at 15° C. (59° F.), and in one part of boiling water, but almost insoluble in alcohol. On ignition the salt is completely volatilized, without charring" (U. S. P.).

Physiologically, ammonium chloride seems to combine to a certain extent the peculiar virtues of ammonia (see *Ammonia*) with those of the chlorides. In continuous full dosage it deranges the stomach and bowels, exciting vomiting and purging. Its medicinal applications have been very varied, but those which have best stood the test of well-observed experience are the use of the salt to relieve myalgia and some neuralgias, and to promote free expectoration in bronchial catarrhs in the second stage, especially in cases in which the secretion is thick, tenacious, and difficult to dislodge. By German practitioners the salt is much employed also in inflammatory affections, generally where there is some product of the inflammation whose reabsorption is desirable. The average dose of ammonium chloride is from 0.30 to 0.65 gm. (gr. v.–x.) every two or three hours. It is generally given in solution, as an ingredient of composite prescriptions, and, since its taste is very disagreeable, it is well to have a little licorice added to the mixture to disguise the flavor. *Troches of ammonium chloride* are official, each containing 0.10 gm. (gr. iss.) of the salt. Externally applied, sal ammoniac in solution is a gentle irritant, and an aqueous solution, from one to three per cent. in strength, may be used as a lotion to sluggish ulcers, etc., requiring a mildly irritant impression. A local application in respiratory catarrhs has also been devised whereby the patient inhales the salt, formed in a fine cloud in air, by an arrangement that brings together the vapors of hydrochloric acid and water of ammonia. Lastly, ammonium chloride furnishes a possible means of applying cold, since by solution in water it reduces the temperature thereof quite decidedly. Thirty-five parts each of ammonium chloride and potassium nitrate to one hundred of water will lower the temperature from ten to fifteen degrees of the Fahrenheit scale. In the absence of ice such a mixture may be put into a rubber bag and applied for purposes of refrigeration during the time that the salts are in process of dissolving.

Calcium Chloride: $CaCl_2$.—Calcium chloride, "rendered anhydrous by fusion at the lowest possible temperature," is official as *Calcii Chloridum*, Calcium Chloride. Such fused salt occurs in "white, slightly translucent, hard fragments, odorless, having a sharp, saline taste, and very deliquescent. Soluble at 15° C. (59° F.), in 1.5 parts of water, and in 8 parts of alcohol; in 1.5 parts of boiling alcohol, and very freely in boiling water; insoluble in ether. Below a red heat the salt fuses" (U. S. P.). Calcium chloride, because of its extreme deliquescence, must be kept in well-stoppered bottles.

This salt presents a combination of an acid and a basylous radicle, both of which are peculiarly effective in the determining of sound nutrition. Accordingly a course of calcium chloride has been found beneficial in cases of

indurated and enlarged glands, or of a manifest scrofulous cachexia, or of tabes mesenterica. In large dose the salt is a dangerous irritant. The therapeutic dose is from 0.65 to 1.30 gm. (gr. x.–xx.) taken preferably dissolved in a wineglassful of *milk* (Coghill: *The Practitioner*, vol. xix., p. 251) and after eating. *Edward Curtis.*

CHLORINE.—Chlorine is a greenish-yellow gas, soluble in water, possessed of a peculiar and disagreeable odor, and an intensely irritant action upon animal tissues. Even in the comparatively weak dilution of one per cent. in air chlorine excites violent spasm of the larynx, and if actually inhaled leads to irritation and inflammation of the air passages, accompanied, perhaps, by hemorrhages, and possibly followed by death. Habit, however, establishes considerable tolerance, so that workmen in bleacheries get to breathe without distress a chlorinated atmosphere impossible of respiration to one unaccustomed. Feebly chlorinated air excites only a glow of warmth in the air passages, and an increase of bronchial mucus. Taken internally, in the form of strong chlorinated solutions, chlorine is powerfully irritant and even corrosive. In poisoning by inhalation of chlorine, the sufferer should be made to breathe cautiously the fumes of ammonia, or a weak mixture of sulphureted hydrogen in air. In poisoning by swallowing, albumen should be given freely, and the lesions treated upon general medical principles.

Chlorine is valuable to the physician because of a consequence of the strong affinity of the element for hydrogen, with which body chlorine unites to form hydrochloric acid. By virtue of this affinity chlorine can decompose water, especially in the light, appropriating the hydrogen and setting free the oxygen. Such nascent oxygen is then active for oxidizing, and will attack and decompose by oxidation any organic matter that may happen to be within reach. Vegetable coloring matters and noisome products of putrefactive or fermentative processes fall particularly easy prey to active oxygen, and as a result of their oxidation the color of the one group and the smell of the other undergo complete abrogation. In a roundabout way, therefore, chlorine, in the presence of moisture, is a powerful bleacher of organic dyes and a deodorizer of organic foulness. Reasoning from the easily obtained deodorant action of chlorine, it is naturally hoped that the element may also, under the conditions that currently present themselves, oxidize and so disinfect the organic matter of particulate carriers or generators of contagium—disease germs, commonly so called. But while there is no doubt of the power of chlorine so to do, if in sufficient concentration and in the presence of moisture, yet clinical experience and exact experiments combine to prove that to disinfect a room occupied by one ill of a contagious disease, the chlorination of the air must be carried beyond the limit of respirability, and to a degree which will also determine the bleaching, more or less, of colored fabrics. Sternberg, experimenting with vaccine points, found that to destroy their potency by exposure to chlorine-charged air, a charge per volume of one-half of one per cent., perfectly maintained, was necessary, and an exposure to such atmosphere of six hours' duration.[1] Considering, however, the conditions presented by a sick-chamber, where tight closure of the room is difficult to effect and where the germs easily fall into places comparatively inaccessible, a percentage at least double the above—that is, one per cent.—should be regarded as the minimum of probable efficiency.

The therapeutic application of gaseous chlorine is to deodorize, disinfect, or both. For purposes of deodorizing simply, chlorinated lime or chlorinated soda are fairly efficient, but for aërial disinfection chlorine gas must be generated in greater volume than can conveniently be gotten from those preparations. At best, however, chlorine is inferior for this purpose to sulphur dioxide, since the latter is probably more efficient as a disinfectant, while less obnoxious to carpets and clothing. For a reasonably reliable effect, chlorine gas should be evolved in great excess of estimated minimum percentages, with the room as perfectly closed as possible, and with all articles to be disinfected as freely exposed on all sides to the atmosphere as may be. Much more commonly, however, chlorine has been used on the small scale in sick-chambers while still inhabited by the patient—a procedure which, from the point of view of genuine disinfection, is not merely futile, but leads to the positive danger of the omission of other and really potent disinfectant measures. Gaseous chlorine is most conveniently generated in considerable volume by Wiggers' method, as follows: "Mix 18 parts of finely ground common salt with 15 parts of *finely pulverized* good binoxide of manganese; put the mixture into a flask, and pour a *completely cooled* mixture of 45 parts of concentrated sulphuric acid and 21 parts of water upon it, and shake the flask; a uniform and continuous evolution of chlorine gas will soon begin, which, when slackening, may be easily increased again by *gentle* heat" (Fresenius). According to Squibb,[2] "about two hundred grains of the common salt mixture, and half a fluidounce of the sulphuric acid mixture, liberates in the course of twelve or twenty-four hours about fifty cubic inches of chlorine, giving it off pretty rapidly for the first two or three hours, and very slowly afterward." Estimating from these data, a cubic foot of chlorine requires for its yield about a pound and a quarter of the salt mixture, and a little over a pint of the acid; and, therefore, for a one-per-cent. chlorination, by volume, of the air of the average bedroom of about two thousand cubic feet capacity, twenty-five pounds of the salt mixture and about eleven quarts of the dilute acid would have to be used! And when it is remembered that the one-per-cent. impregnation thus obtained is probably the minimum of efficiency, comment is unnecessary on the common practice of setting a saucer or two, holding each a half-ounce of the salt mixture, under the sick-bed with a serious view to disinfection. All that such procedure can possibly accomplish is a slight *deodorizing*.

Locally, chlorine, applied in the form of chlorinated substances and solutions, operates as a disinfectant, detergent, and deodorant, and, by virtue of its irritant properties, also as a stimulant to healthy action in wounds and sores. The United States Pharmacopœial preparations of chlorine, available for the purposes thus suggested, are the following:

Aqua Chlori, Chlorine Water.—"An aqueous solution of chlorine, containing at least 0.4 per cent. of the gas" (U. S. P.). Chlorine gas, generated by the action of diluted hydrochloric acid upon black oxide of manganese, is conducted into a bottle of distilled water until the latter, after agitation, is saturated with the gas in solution. The product, from its extreme proneness to spontaneous change, must be put up in "dark, amber-colored, glass-stoppered bottles," and these completely filled and kept in a dark and cool place. Chlorine water, when freshly made, is a "clear, greenish-yellow liquid, having the suffocating odor and disagreeable taste of chlorine, and leaving no residue on evaporation. It instantly decolorizes dilute solutions of litmus, indigo, and other vegetable coloring matters" (U. S. P.). Chlorine water, especially on exposure to light, tends to lose strength by reason of the chlorine decomposing the water, and uniting with the hydrogen thereof to form hydrochloric acid; when wanted of full strength, therefore, the preparation should be freshly made.

Chlorine water is used in medicine mainly as a local application, either as a lotion for foul or indolent ulcerated surfaces upon the skin, or as a gargle in analogous conditions of the mucous membrane of the throat. If freshly made it is intolerably pungent of chlorine, and should be diluted several fold with water for use. Internally the remedy is occasionally given, generally in the so-called zymotic diseases, in the hope probably of a constitutional antiseptic action—a hope little likely to be fulfilled. From half a teaspoonful to a teaspoonful may be given at a dose, diluted with five or six volumes of water. Nothing organic should be added to the potion, such as syrup or glycerin, else the free chlorine will rap-