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LOCAL ANÆSTHESIA.—The diminution of the cutaneous sensibility, by the application of ice and freezing mixtures, has long been practiced. It was not, however, until Richardson's method by the hand-ball spray apparatus had been proposed, that there had been much use made of local anæsthesia.

This method consists in directing a current of atomized ether against the part to be anæsthetized. The ether employed for this

purpose should have a specific gravity not to exceed 0.723. Rhigolene, the lightest liquid known, a product of the fractional distillation of petroleum, is more effective than ether, but great difficulty attends its use, owing to its extreme volatility. When a current of atomized ether or rhigolene is directed against the skin, the rapid evaporation produces an intense degree of cold, in consequence of which the nerves lose their power of transmitting impressions to the sensorium.

A serious drawback to the process of producing local anæsthesia is the unpleasant burning which follows in the part when it recovers from the freezing, and also the great pain which attends the application of ether-spray to certain parts.

THERAPY.—For small operations, such as *extraction of teeth and opening abscesses*, the method of local anæsthesia is extremely useful. It has been and can be used with entire success in much larger operations, but it is generally employed for merely minor ones.

The application of ether-spray to the spine is an extremely serviceable remedy in *spinal irritation* and in *chorea*. In the latter disease it alone suffices to effect a cure. In *neuralgia* of superficial nerves, *lumbago*, *muscular rheumatism*, etc., the ether-spray affords relief very quickly, which may be permanent.

Nitrous Oxide.—Protoxide of nitrogen. Laughing-gas.

COMPOSITION AND PROPERTIES.—A colorless, inodorous gas, having a slightly sweetish taste, and a specific gravity of 1.527. It consists of one equivalent each of nitrogen and oxygen. It increases the rate of combustion of inflammable substances. Water at ordinary temperature absorbs about three fourths of its bulk of the gas. By pressure and cold the gas may be condensed into a liquid, and can then be stored up in suitable vessels for transportation and use. The quantity of the gas taken up by cold water may be much increased by pressure, and the water will then yield it up on heating. Hence this constitutes a convenient mode of storing the gas for preservation. The ordinary mode of storing the gas is in gas-bags holding about eight gallons, in gasometers, or in the liquid form in strong metallic casks.

PHYSIOLOGICAL ACTIONS.—The first surgical operation performed with a modern anæsthetic was the extraction of a tooth, the subject being unconscious from the inhalation of nitrous oxide. It had long been known that this gas produced decided exhilaration when inhaled to a certain point. It has a very short anæsthetic stage, unless the inhalation of the gas be continued.

The first effect of the inhalation of nitrous oxide is a subjective dizziness, whirring noises in the ears, and tingling and loss of sensation throughout the body. Extraordinary illusions beguile the senses, and the intoxicated subject suddenly breaks forth into singing, declamation, sobbing, melancholy, or manifests a pugnacious tendency and

assaults those about him. As the effects quickly cease, and as the return to consciousness is very abrupt, the subject is surprised and ashamed to find himself in some ridiculous or *grandiose* position quite foreign to his usual demeanor.

When used to produce anæsthesia for surgical operations, the inhalation of the gas is forced, and the stage of excitement is very brief. The countenance assumes a frightful aspect, most alarming to those who have not witnessed the inhalation of the gas. The face becomes deadly pale, the respirations, at first shallow, soon assume a stertorous character, the jaw becomes fixed, the eyes protrude, and the pallor of the face is presently replaced by a bluish and purplish tint.

So far as the exterior phenomena can afford any indication of the nature of the action, the condition produced by nitrous oxide is an asphyxiated state. The blood ceases to be oxygenated, carbonic acid accumulates, and the centers of conscious impressions are rendered inactive in consequence of the deficient supply of oxygen and the excess of carbonic acid. The rational indications of the nature of the narcosis produced by nitrous oxide are confirmed by physiological experiment. It has been found that the exhalation of carbonic acid is decidedly diminished by the inhalation of nitrous oxide, and that animals live no longer in an atmosphere of this gas than in an atmosphere of nitrogen.

The inhalation of nitrous oxide appears to be almost free from danger, and it is rare that unpleasant after-effects follow its administration. Two fatal cases have certainly occurred, which can with propriety be attributed to the lethal action of this gas, and various cases have fallen under the observation of the author in which nervousness, vague mental symptoms, and headache, have been experienced after the inhalations.

THERAPY.—The very prompt action of nitrous oxide and the quick subsidence of the narcosis render it a very useful anæsthetic agent when small operations, quickly executed, are to be performed. It is especially adapted for the *extraction of teeth, opening of abscesses, and similar minor operations*. But it has also been used successfully for maintaining prolonged anæsthesia for the *performance of capital operations*. There is no difficulty in keeping up insensibility from fifteen minutes to a half-hour, since the introduction of liquefied gas and of apparatus for its suitable application.

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Chloral.—Chloral. Hydrate of chloral. *Chloral*, Fr.; *Chloralhydrat*, Ger.

Separate, rhomboidal, colorless and transparent crystals, slowly evaporating when exposed to the air, having an aromatic, penetrating, and slightly acrid odor, a bitterish, caustic taste, and a neutral reaction. Freely soluble in water, alcohol, or ether; also soluble in four parts of chloroform, in glycerin, benzol, benzin, disulphide of carbon, fixed or volatile oils. It liquefies when mixed with carbolic acid and camphor.

Dose, grs. v— ʒj , or more, but it should not be forgotten that 3 ss has produced toxic symptoms.

ANTAGONISTS AND INCOMPATIBLES.—The depression of the heart and respiration caused by chloral is antagonized by alcoholic stimulants, ammonia, atropine, by galvanism, and by artificial heat. These are, therefore, appropriate remedies to be employed in cases of poisoning. Strychnine is held by Liebreich to be antagonistic, and hence it may be administered hypodermatically when the measures above mentioned are being used.

Alkalies decompose chloral with the production of formic acid and chloroform, hence all agents having an alkaline reaction are incompatible.

SYNERGISTS.—The hypnotic medicines, notably opium, and the anæsthetics, deepen the effects of chloral when they are simultaneously administered.

PHYSIOLOGICAL ACTIONS.—Chloral has considerable antiseptic property, and is preservative of animal textures. It produces redness and inflammation of the skin, when kept in contact with it for a lengthened period. The taste of chloral is hot and pungent, and it excites an abundant flow of saliva. In the stomach it causes first a cooling sensation, followed by warmth, and when taken in large quantity may set up a high degree of gastric irritation, nausea, and vomiting. In moderate quantity chloral rather stimulates than impairs the appetite, and indigestion and nausea do not, as a rule, follow as an after-effect.

Chloral diffuses into the blood rapidly. The changes which occur after its entrance into the vessels are much disputed. Liebreich, as is well known, was led—by observing the reaction when chloral is brought into the presence of an alkali—to the deduction that the soda of the blood would split up chloral into chloroform and formic acid, and that, therefore, the effects belonging to chloroform might be produced by the administration of chloral. It is probably true that this reaction does take place to some extent, but there are several insuperable objections to the theory of Liebreich :

1. The effects of chloral differ from those produced by a corresponding quantity of chloroform.
2. After the administration of chloral, there is no elimination of chloroform by the breath or urine.

3. Chloral is more decidedly hypnotic, and much less anæsthetic, than chloroform.

4. Crystals of chloral have been recognized in the blood, and the products of the decomposition of chloral have recently been recovered from the urine.

The effects which follow an ordinary medicinal dose (fifteen to thirty grains) are not the same in all subjects, although it must be admitted that a great degree of uniformity exists. When there is present an insusceptibility to its hypnotic action it produces headache, and in some subjects a delirious excitement. Immediately preceding its hypnotic action there is developed in all subjects a stage of excitement, usually very short in duration, and followed by sudden and complete sopor. The sleep produced by chloral is extraordinarily like natural sleep, and is calm, dreamless, and refreshing. It is not a condition of narcotism, and the patient may be easily aroused to take food and nourishment, and will quickly and without difficulty fall asleep again. As a rule no unpleasant after-effects are experienced from a dose of chloral—no headache, faintness, giddiness, nausea, and constipation, so common after morphine. The quantity of chloral necessary to produce sleep, without dangerous narcotism, ranges from fifteen to forty grains, and the duration of the effect varies in different subjects from two to eight hours. Chloral does not destroy the sensibility to pain, unless administered in a quantity sufficient to suspend the functions of the cerebrum. It is not a pain-relieving agent in the sense that morphine is.

When sleep is produced by proper medicinal doses of chloral the pupil contracts a little, the pulse may remain unaltered or become slower, and the respirations are unaffected. When a dangerous or lethal dose is taken, profound narcotism will follow; the respirations will be slower and shallower, the pulse will become weak, rapid, and irregular; sensibility and the reflex movements will be abolished, and complete muscular relaxation will ensue. The mode of dying is by suspension of the functions of the cerebrum, and, finally, by paralysis of the respiratory center, and of the cardiac motor ganglia. Death may be suddenly produced by paralysis of the heart, in cases of fatty degeneration of the muscular tissue of this organ, without proceeding so far as to involve the lower centers of the brain.

A marked reduction in temperature, notably in rabbits—so much as 8° Fahr.—is produced by chloral, but this effect may be considerably lessened by enveloping the body in non-conductors (Brunton), which act by preventing the cooling of the blood by the atmosphere. The first effect of chloral is to raise the arterial tension (stage of excitement), but this action quickly ceases, and a decided lowering of the tension results. The diminished arterial tension and the weakened action of the heart are the principal factors in the reduction of

the body temperature, for the combined action of these agencies is to lessen the combustion process. After death from chloral, congestion of the meninges of the brain and cord, of the lungs, and distention of the right cavities of the heart, have been observed. The arrest of the heart's action takes place in the diastole.

Chloral does not affect the motor nerves nor impair the contractility of muscle; hence the paralytic phenomena both of animal and of organic life produced by it are due to its direct action on the nervous centers.

Very large quantities of chloral have been taken without producing fatal symptoms. I have seen a patient who took daily from two drachms to three drachms of chloral for many months, without any symptoms of acute poisoning. While it is true that enormous doses (several hundred grains) have been taken without producing lethal effects, it is equally true that serious symptoms and death have resulted from very moderate doses (twenty to thirty grains). Great care should therefore be taken in prescribing an agent of such uncertain power. A fatty heart, atheromatous degeneration of the vessels, advanced disease of the lungs, and instability of the nervous system, are contraindications of the use of chloral.

CHLORAL-HABIT.—The habitual use of chloral constitutes a disorder, which, if not as persistent as the opium-habit, has its own difficulties and dangers of no little importance. Those who take chloral habitually have irritable, injected, and rather brilliant eyes, and are voluble in speech, and have a rather excited and hurried manner. They complain usually of singing in the ears, of an empty or vacuous feeling in the brain, and are subject to sudden attacks of vertigo. They are wakeful, and very nervous and excitable, without chloral, when the time for sleep arrives, and they are usually entirely unable to sleep without the usual dose of the hypnotic. During the day they are melancholy, easily fatigued, and their voluntary movements are apt to be uncertain and disordered. The appetite is always capricious, frequently wanting; digestion is labored; the secretion of bile is deficient, the stools being rather white and pasty; the urine stained with the bile-elements, and sometimes albuminous.

An increasing weakness and irregularity in the action of the heart; dyspnoea, chiefly when the stomach is distended; redness, injection, and ecchymoses of the skin, have been occasionally observed to occur in cases of the chloral-habit.

The best method of managing these unfortunate cases consists in the very gradual diminution of the daily quantity of chloral; in regulation of the diet and administration of a suitable supply of food; air, exercise, and change of scene; chalybeate tonics; hyoscyamus and lupuline as calmatives, strychnine and picrotoxin as nerve stimulants; occasional purgatives.

THERAPY.—Chloral is a remedy of great value in *sea-sickness*. From fifteen to thirty grains every four hours, the recumbent posture for a short time, and suitable nourishment, are the most effective means we now possess for this troublesome disorder. In some cases of *sickness of pregnancy* chloral is equally effective, but, like other remedies for this condition, it often fails. According to the author's observation, it is most effective when there is much dizziness, faintness, and repugnance to food, and but little vomiting. When the odor of chloral invites nausea, as is not unfrequently the case, it may be given advantageously by enema. And, furthermore, rectal injection of fifteen to thirty grains, properly diluted, is an effective remedy for nausea and vomiting of reflex origin, as occur in cases of uterine fibroids, gastro-enteritis of children (Kjelberg), etc.

In severe cases of *cholera-morbus*, with cramps, coldness of the surface, cold breath and cold tongue, remarkable relief is procured, and the patient not unfrequently wrested from a condition of extreme danger, by the hypodermatic injection of chloral. There is no means of treatment of *cholera* now known so effective as this, as the author has personally witnessed. The effectiveness of chloral is increased by combination with morphine. ℞ Chloral. hydratis, ʒ iij; morphinæ sulph., gr. iv; aquæ laur.-cerasi, ʒ j. M. Sig.: *From fifteen to thirty minims—for cholera, cholera-morbus, etc.* This injection produces considerable burning pain and an indurated lump, but in the author's experience suppuration has not followed.

As chloral produces a lowering of the temperature, and, according to Richardson, diminishes the coagulability of the fibrin, good results may be expected from its use in *inflammations and fevers*. It is especially indicated when the temperature is high and there are much delirium and restlessness present. The author has observed excellent results from its use under these circumstances in the *eruptive fevers, pneumonia, etc.* It should not be forgotten, however, that chloral must be prescribed with caution when there is ischæmia of the arterial system—a condition which must necessarily exist when a considerable portion of the lung-space is blocked up by fibrinous or caseous deposits. In *pleuritis, endo- and pericarditis, and in peritonitis*, much good will result from the use of moderate doses of chloral—five grains every three hours. It is useful because it allays restlessness, causes sleep, lowers the fever, and limits or prevents fibrinous deposits and exudations.

The most important uses of chloral are in diseases of the nervous system. As an *hypnotic*, pure and simple, it is quite unrivaled. Cases of *sleeplessness*, due to mental overwork, anxiety, or physical fatigue, are entirely relieved by fifteen to twenty grains of chloral. The refreshing sleep thus obtained not unfrequently leads to repeated and long-continued use of chloral, and thus the chloral-habit is formed. It

follows that sleep should be procured by proper hygienic methods in such cases, if possible, and chloral should be resorted to only after the failure of such means. No hypnotic is so uniformly successful in procuring sleep in *delirium tremens*; but this remedy, as other remedies of the same class, not unfrequently fails. It is more particularly adapted to those cases in which the delirium has succeeded to a debauch, and is less useful, and may, indeed, produce serious symptoms, in old, worn-out drunkards. Violent excitement not unfrequently is produced by it when it fails to cause sleep. The author must caution his younger readers against the too large administration of chloral in this disease. Sleep may be procured which will end in fatal exhaustion. Especially should caution be used in the old drunkard, whose heart and vascular system may have undergone serious fatty and calcareous degeneration. In suitable cases there is no doubt chloral is a remedy of the highest value, but it should not be used to the exclusion of suitable hygienic and dietetic treatment.

Various forms of mania, in which delirium and wakefulness are prominent symptoms, are largely benefited by hypnotic doses of chloral. This remark is true of *acute mania, acute melancholia, puerperal mania, acute maniacal delirium*, and the excitement which occurs in *general paralysis of the insane*. When it agrees, and produces refreshing sleep, marked improvement in the mental state not unfrequently follows its use. In incurable and intractable cases, chloral often renders the greatest service as a calmative and an hypnotic.

Puerperal convulsions, when the patient is in a condition to swallow, may be arrested by full doses of chloral—twenty grains every two hours; also, subcutaneously in five-grain doses, it is highly effective, according to Purefoy, and by the rectum its acts admirably in many cases. *Infantile convulsions*, when due to reflex irritation, may be suspended by the same means. When the jactitations of *chorea* are so incessant as to prevent sleep, or when they occur during sleep, chloral may be administered with advantage. It is not a curative agent in *chorea*, but when it produces quiet and refreshing sleep it indirectly contributes to the cure.

Some of the respiratory neuroses are greatly benefited by chloral. The paroxysms of *spasmodic asthma* may be arrested by it, and the *spasmodic attacks of difficult breathing* which accompany *emphysema* may be decidedly ameliorated by timely doses of chloral. It must not be forgotten, however, that the use of chloral is not unattended with danger in pulmonary diseases with ischæmia of the arterial system. In the spasmodic stage of *whooping-cough*, great relief to the paroxysms may be obtained by the use of this agent. From five to ten grains will generally be a suitable quantity for administration in these cases. Impending attacks of *laryngismus stridulus* may be prevented,

and seizures already in action can be quickly arrested, by a full dose of chloral—five to fifteen grains.

We have no remedy more effective in *tetanus* than chloral, but it must be given in large doses. Nocturnal attacks of *epilepsy* may not unfrequently be prevented by a full dose of chloral at bedtime. In *paralysis agitans*, good effects have been attained by hypnotic doses at bedtime. Chloral is a physiological antagonist to *strychnine*, and may, therefore, be used with advantage in poisoning by this substance.

Chloral is not unfrequently prescribed to relieve *pain*, but under a mistaken notion of its physiological powers. It can only relieve pain by suspending the functions of the cerebrum, and in doses, therefore, which are dangerous. It has no direct pain-relieving power, like morphine. When pain is to be relieved and sleep procured, the combination of chloral and morphine is extremely effective. Although chloral does not directly suspend the functions of the sensory nerves, it relieves certain kinds of pain due to irregular or overaction of unstriped muscular fibers. Very great relief is afforded by chloral to the irregular pains of the first stage of labor, which cause suffering but do not advance the case—the so-called “nagging pains,” in popular obstetric language. *Rigidity of the os uteri and soft parts* may be corrected by the timely administration of chloral, and exhaustion may be prevented by giving it in such a way as to suspend irregular uterine action and to procure sleep. *After-pains* are stopped by chloral. In all these cases of obstetric diseases, large doses are generally required.

A solution of chloral is an excellent *antiseptic application to foul wounds*: it destroys the odor of putrefaction, arrests fermentative changes, and promotes the formation of healthy granulations. It may be used to preserve anatomical preparations and morbid specimens. A weak solution of chloral (gr. j to grs. iv— $\frac{3}{4}$ j) is an excellent injection in *gonorrhœa*.

Equal parts of chloral and camphor, triturated together, form a clear fluid, which is often of great service in *neuralgia*, applied to the affected part. It is painted lightly over the surface with a camel's-hair brush, and is allowed to dry on. It is said to allay *spasmodic cough* when painted over the larynx. The solution of camphor and chloral thus prepared has decided solvent properties. Morphine sulphate will dissolve in it in the proportion of a scruple to two drachms, and chloroform can then be added without a separation of the ingredients. A mixture thus prepared is a very effective local application in superficial *neuralgia*, and as an internal remedy in *colic, cholera-morbus, cholera*, etc.

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Croton-Chloral Hydrate.—This substance occurs in rather small and brilliant tabular crystals. It is soluble in water, but not freely so; and, as respects antagonists and incompatibles, may be classed with chloral hydrate. Dose, grs. ij—grs. xv, largely diluted in water. It may also be conveniently made into pills with glycerite of traga-canth.

PHYSIOLOGICAL ACTIONS AND THERAPY.—Croton-chloral resembles chloral in its hypnotic action, but it is feebler and also less certain. As in lethal doses it causes death by paralysis of respiration, it is admissible in cases of weak heart. It differs from chloral, especially in the singular property which it possesses of causing anæsthesia of the head. Croton-chloral is much less certain in its effects than chloral: sometimes one or two grains will relieve severe trigeminal neuralgia; and often from five to fifteen grains are necessary. When pain is to be relieved and sleep procured, the best results are obtained by a combination of the two agents.

Croton-chloral has proved very effective in various *neuralgiae*. It has been especially useful in *tic-douloureux*, in which it should be given in doses of two to five grains every hour or two, until fifteen grains have been taken. It is probably not safe to exceed this amount at one time. The pains of *dysmenorrhœa* and *sciatica* have also been relieved by the use of this remedy.

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