Mechanics, Physics, and Chemistry.

ON CHLORAL HYDRATE.

BY ROBT. F. FAIRTHORNE.

AMONGST the most desirable additions to the list of medicines employed for the relief of the frail or diseased portion of the human family, a substance giving repose to the excited brain and body, procuring calm, refreshing sleep, and followed by no baneful effect to those using it, would be considered of the greatest value.

It has been said, "Blest is the man who first invented sleep." I do not suppose that he who finds the means for obtaining the same at pleasure is any less deserving of benediction.

In vain we look over the *Materia Medica* of our *Pharmacopœia* for a somnific that is both reliable and free from dangerous effect. We find opium, belladonna, aconite, morphia, fish-berries, chloroform, ether, digitallis, and stramonium; all reliable narcotics; but none of which can be taken without danger, and none without being followed by some evil influence.

Then, again, we find lactucarium, (lettuce opium,) hemlock, lupulin, hyosciamus, and valerian, (although occasionally efficacious and without deleterious properties,) are so unreliable that they are principally employed in cases of but slight indisposition.

Should we find, then, something combining in its character the reliability of the substances named in the first list, together with the immunity from evil characterizing those last mentioned, we would regard it with the greatest interest.

It would be premature, perhaps, to claim chloral as a perfect hypnotic, as it is scarcely two years since it began to be employed as a medicine.

It was discovered by Liebig, about thirty years ago, but remained as a scientific curiosity on the shelves of the laboratories of Europe until Dr. Liebreich, of Berlin, made known its value as an anæsthetic to the medical profession.

He was led to experiment with it, knowing that upon addition to an alkaline solution, the constituents of chloral are separated into chloroform and formiate of potash. The blood being slightly alkaline, containing as it does small quantities of the carbonates of

soda and potassa, suggested to his mind the probability of this reaction taking place in the human subject.

It is found, however, that hydrate of chloral differs in its effect from that of chloroform in not producing complete anæsthesia, except during a very short period (a minute or two) after having been administered, and this only when very large doses have been taken. This can be accounted for by the fact that the blood contains so minute a portion of the alkaline salts that when chloral is decomposed by it chloroform must be very slowly developed.

That this production of chloroform really takes place, I think there can be no doubt, as has been conclusively demonstrated by the experiments of Dr. B. W. Richardson, (F. R. S.,) before a meeting of the British Association at Exeter, England. He produced that article upon mixing the hydrate with freshly drawn blood and distilling the same. Previous to distillation chloroform was perceptible, so that it must be generated immediately on contact with the blood. (See *Medical Times and Gazette*, Sept. 4, 1869.)

Dr. Demarquay of the French Academy, however, does not agree with this theory, thinking that the hydrate of chloral penetrates the system unchanged, but the weight of testimony of those employing it is in favor of Liebreich's idea. I would suggest, however, the possibility of but a small portion of the chloral being split up, so as to produce only a minute portion of chloroform, and the remainder entering the body unaltered.

It is noticed that after full doses of this substance have been taken, there is a short space of time during which complete anæsthesia takes place, and, although sleep is prolonged several hours, yet entire insensibility is confined to but a few minutes. This may be due to that period during which chloroform is first produced, being that moment when probably the largest amount is formed.

The hydrate of chloral given in moderate doses (from 10 to 35 grains) usually procures sleep of seven or eight hours' duration, which in appearance is natural, and in effect refreshing. Neither the frequency of the pulse nor of respiration are usually altered by it. No disagreeable effects, except in very rare instances are perceived upon awakening, and even in these only slight headache and nausea follow, and which soon pass off. Even in quite large doses, (from 50 to 80 grains,) it seldom causes any unpleasant symptoms, upon the patient resuming consciousness.

Dr. Lincoln, of Boston, having a patient who had been without

sleep for a week, with the exception of an hour a night, and who had taken opium, valerian, lupulin, cannabis indica, and hyoscinus in vain, gave 15 grains of hydrate of chloral nightly, with the procurement of seven hours' sleep in each nocturnal period.

It appears to be the most perfect hypnotic known, and the above is only a fair specimen of numberless instances where its administration has been followed by equally good results. With the exception of one or two cases, in which very large quantities were accidentally taken, no evil has been caused by it. "*The Lancet*," of Nov. 26, 1870, gives an account of a patient who took 160 grains of the hydrate of chloral without any unpleasant consequences. Dr. Jas. Rodman reports in the "*American Practitioner*," Oct., 1870, that 270 grains were taken without any other alarming symptom than that of 18 hours' sleep; and in another case the enormous quantity of 460 grains was taken by mistake by a female nurse at the Philadelphia Hospital, producing effects resembling those of an overdose of opium. She was supposed to have taken that drug, and was treated accordingly; by which treatment she completely recovered.

Dr. Penrose, of the University of Pennsylvania, had a patient who took 210 grains (in divided doses in the space of two hours,) which was followed by 7 hours' sleep, and no unpleasant symptom except headache and stupor, which lasted several hours after awakening. He also states that he has given another patient from 5 to 10 grains nightly for a year, and finds that the lady taking it is as susceptible to its sudorific influence now as when she began to use it, not requiring any increase of dose. No bad effect has been experienced in this case, except an occasional disposition to produce lachrymose secretion and slight obscurity of vision. This superabundant secretion has been noticed by others who have used it for some length of time.

An intelligent lady of my acquaintance informed me that, her husband having had occasion to take chloral, she noticed it caused a profound sleep of two hours duration. His respiration was sometimes very irregular, ceasing for so long a time as to be quite alarming. Occasionally I meet with persons who inform me that this medicine acts as a stimulant and excitant, tending to keep them wakeful.

So far as I am able to learn, only one death has been ascribed to the use of chloral. The account is given of this case in the "*Medical*

Times" for February 15, 1871. A woman suffering from great mental excitement, almost amounting to insanity, took 180 grains in doses of 30 grains each, at intervals of several hours, during the period of three days. She died two days after the last dose was taken. Dr. Jas. Tyson, and other physicians who have read this report, think that there is room for doubting the correctness of attributing the death of the patient to the effect of chloral.

According to Dr. Liebreich, one fact connected with its therapeutic action worthy of attention is, that it possesses the peculiar and valuable property of neutralizing the poisonous effects of strychnia. Another singular property it possesses is, that, like chloroform, it nauseates birds when given to them.

Doctors Richardson and Liebreich state that chloral acts first on the volitional centres of the cerebrum, next on the chord, and lastly on the heart.

Hydrate of chloral as found in commerce occurs in two conditions. One form is that of tabular pieces of various sizes, having a crystalline structure, which, when freshly fractured, presents considerable resemblance to spermaceti. Another form is that of loose acicular crystals, shining and transparent when recently prepared, but becoming more or less opaque by age, even when kept in tightly stoppered bottles. I think this change is probably due to the action of light, as the vapor of alcohol, if exposed to sunlight in the presence of chlorine explodes, accompanied by bright flashes of light. Chloroform is also partially decomposed by light, chlorine and hydrochloric acid being developed.

Chloral is formed by passing dry chlorine through alcohol until fumes of muriatic acid are no longer given off and the spirit has assumed a yellow color. This liquid is heated until it boils. It is then mixed with three times its bulk of sulphuric acid and distilled, and finally redistilled over quick-lime.

Its formation appears to depend upon the affinity that chlorine has for hydrogen, the former gas taking it from alcohol, and being disengaged during the process as hydrochloric acid. Alcohol composed of $C_4 H_6 O_2$ by abstraction of two equivalents of hydrogen, (which takes place at the beginning of the process,) becomes aldehyd $C_4 H_4 O_2$. As the chlorine continues to pass, it takes with it three more equivalents of hydrogen, leaving, however, three of chlorine in their place; the aldehyd, therefore, is decomposed, and $C_4 Cl_3 HO_2$ remains, which is chloral. This is a volatile, pungent

liquid, of nearly the same specific gravity as chloroform, being 1.500, that of chloroform 1.490. It has a strong affinity for water, with which it combines, and with one equivalent of it, forming the hydrate just described. It also forms a crystalline compound by the addition of an equivalent of alcohol, which resembles the hydrate in appearance, but can be distinguished from it by being much less soluble in water.

Chloral, even when confined in hermetically sealed tubes, after being kept for some time, gradually changes into a solid porcelain-like substance. When this is heated, however, it returns to the liquid state, and is of the same composition as previous to the change.

Pure hydrate of chloral, according to Dr. Rieckher does not take fire when heated in a spoon over a spirit lamp, but evaporates without residue. Solution of nitrate of silver should not be rendered turbid by it, thereby showing the absence of uncombined chlorine. Nitric acid, sp. gr. 1.20, either cold or hot should not produce any reaction with it. I find that it is readily soluble, when freshly prepared, in its own weight of water. After keeping and being occasionally exposed to the air it becomes less soluble, and sometimes its solution remains turbid for a few minutes after being made. With solution of subacetate of lead a dense precipitate is formed. The supernatant liquid becomes densely clouded upon further addition of the subacetate.

The hydrate is readily dissolved by alcohol, ether, oil of turpentine and benzole. It is also soluble in bi-sulphide of carbon and the fixed oils. The solution in the latter article might prove an important method in the hands of the physician for topical application, perhaps available in neuralgia and gouty affections. I find that benzine also dissolves it slowly.

When hydrate of chloral is added to a strong solution of bi-chromate of potassa and heated after the addition of a few drops of nitric acid, the olive-green color peculiar to the alcoholic test is gradually developed. After standing, this becomes blue, and if liquid ammonia is afterwards added in large excess, it assumes a currant-red color. Chloroform treated in the same manner, produces a deep orange, retaining this color even after the ammonia has been added.

As an evidence of the growth in its popularity as a remedy, I will state that in January, 1870, the price of an ounce of chloral

was greater than that of a pound at present, and that the last named quantity is at present consumed by druggists in compounding physicians' prescriptions in the same space of time as was required to dispose of an ounce at that period.

There are other methods for preparing chloral than that referred to in this communication. I would merely say that chlorine acting upon substances capable of undergoing the alcoholic fermentation will produce it.

ON THE USE OF HYDRAULIC MORTAR.

[Translated from "Die hydraulischen Mörtel" of Dr. W. Michaëlis, for the Journal of the Franklin Institute.]

By ADOLPH OTT.

(Continued from page 285.)

MANGER proposes the following excellent and simple experiment to ascertain the comparative quality of various descriptions of sand. He advises to form small heaps of sand on the bottom of a flat vessel, to pour water carefully around their base, and then to observe how the water rises in the heaps. Is the surface clean, the water will rapidly penetrate the sand in all directions, while if it contains earthy or clayey parts, the process will be much slower.

Wherever the sand at the disposal of the builder is found not to be sufficiently clean, it has to be washed; large quantities are best cleaned in vessels of 0^m .3 to 0^m .5, in lime chests, for instance. The sand must be thoroughly stirred up in water, and the latter then be rapidly drawn off, to be replaced by clean water, which experiment has to be repeated until the water flowing off appears clean.

Where sea-sand is used for structures above the water level, it must be carefully washed, in order to remove its saline parts, which would produce a strong effervescence.

All admixtures possessing considerably less hardness and solidity than quartz-sand, which soften in water, or become soluble in it, must be strictly avoided.

Pulverized glass, brick-dust and other substances have sometimes been used as substitutes for sand. Inasmuch as the first named materials possess an affinity to the quick-lime of the mortar, they may