[THERAPEUTIC GAZETTE.]

THE TREATMENT OF PHTHISIS BY SULPHURETED HYDROGEN.*

By H. C. WOOD, M.D.

It has not been many years since the faces of patients in a consumptive hospital were merged into a uniform ugliness, each, in fact, being cased in a mask of greater or less proportion, with various machinery in its center, which was dignified by the name of a respirator. It is noteworthy that the respirator was armed with germicides or antiseptics, and was to cure consumption antiseptically. Now, the destroyer of phthisis germs and the characteristic phenomenon of the pulmonary hospital bids fair to be a caoutchouc bag, a bottle of bad-smelling solution, and a rectal tube and nozzle. Whether this last claimant for therapeutic favor shall, as is not improbable, finally follow the respirator into oblivion or not, is at present uncertain. But the matter certainly is of sufficient importance to require careful treatment at the hands of the *Therapeutic Gazette*.

In 1883, M. Debove, professor at the *Hopital de la Pitié*, declared in one of his clinical lectures that consumption being due to the presence of a parasite, the proper treatment of it was the use of a parasiticide. It was left, however, for M. Bergeon (of *L'Ecole de Médecine de Lyons*) to put into actual practice this suggestion, and on the 12th of July, 1886, he gave his results to the French Academy of Science. He rejected the lungs themselves as the channel through which the parasiticide should find entrance into the system, on account of the rapidity of absorption from them, and of the fact that medicines taken up by them are carried immediately in a concentrated form to the right side of the heart, and, moreover, exert in the lung itself a too great local irritant influence. The disagreeable tastes of most of the antiseptics render their administration through the mouth and stomach difficult, while the work of Claude Bernard has shown that gaseous substances taken into the large intestine are absorbed with great rapidity and go into the general system. M. Bergeon, led by this train of thought, used various substances, such as chloroform, turpentine, ether, ammonia, and bromine injected into the rectum, but found them all so violently irritating that they had to be abandoned, but at last he discovered that a mixture of carbonic acid and sulphureted hydrogen was perfectly tolerated by the intestines, if the gases be pure and be unmixed with atmospheric air. Under these circumstances the role of the carbonic acid was to act as a diluent to the sulphureted hydrogen.

The apparatus of M. Bergeon consisted of a caoutchouc bag having a capacity of four or five liters, which was filled with pure carbonic acid and connected with a Wolff's bottle, which was in turn connected with the tube inserted into the rectum of the patient, so that by compressing the bag the carbonic acid could be forced to bubble through the solution of sulphureted hydrogen, natural or artificial, in the Wolff's bottle, and pass into the intestines. The common sulphurous waters, especially Eau de Bonnes or Eau de Challes, were thought by Bergeon to be superior to any artificial waters, but this is probably a mistake.

In the *Hopital Cochin*, where the method has been much practiced, the following two solutions have been employed:

SOLUTION NO. 1.

R Sulphide of sodium, pure, 10 grammes, or 10 parts by weight;
Distilled water, enough to make 100 cubic centimeters, or 100 parts by weight.

One cubic centimeter of this liquid engages exactly ten cubic centimeters of sulphureted hydrogen when there is added to it one cubic centimeter of the following solution (No. 2):

SOLUTION NO. 2.

R Acid, tartaric, 25 grammes, or 25 parts by weight;
Acid, salicylic, 1 gramme, or 1 part by weight;
Distilled water, enough to make 100 cubic centimeters, or 100 parts by weight.

This solution in the *Hopital Cochin* is used by an apparatus which, under the directions of Dujardin-Beaumont, is made by H. Gallante, of Paris, and which, though much more complicated, is, no doubt, more convenient than the apparatus of Bergeon. A description of this apparatus, with figure, may be found in *Les Nouveaux Remèdes*, November 24, 1886.

By M. Bergeon himself four or five liters of carbonic acid gas, which had been passed through two hundred and fifty to three hundred grammes of the sulphurous mineral water, were thrown into the rectum twice in each twenty-four hours. In the *Hopital Cochin* the amount of gas injected varies from one to four liters at each seance. The apparatus used at this hospital is superior to that used in the original method, because it allows a definite amount of sulphureted hydrogen to be introduced with the gas. The amount of sulphureted hydrogen used in the *Hopital Cochin* is not positively stated, but about fifteen cubic centimeters of the solution of sulphide of sodium (equivalent to one hundred and fifty cubic centimeters of sulphureted hydrogen) seems to be the amount employed at a seance.

In his original communication, M. Bergeon claimed that the success of this mode of treatment is very rapid and remarkable. It is stated that the cough immediately diminishes, the expectoration lessens or even ceases, the appetite increases, the sleep becomes undisturbed, the fever abates, and the bodily weight greatly increases.

In the discussion before the *Société de Thérapeutique*, at the meeting of December 8, 1886, Dujardin-Beaumont confirmed the statements of M. Bergeon, and, further, said that the amelioration must be due to the sulphureted hydrogen, as he had repeatedly tried injections of pure carbonic acid without doing good.

The French reports indicate very strongly that the drug acts, not as was originally expected, upon the parasite of phthisis, but upon the inflamed diseased lung tissue itself, since Dujardin-Beaumont states that there is no lessening in the number of bacilli in the sputa; moreover, great benefit is obtained in the treatment of cases of simple chronic bronchial catarrh. This is also con-

firmed by the studies of M. Chentemisse, of the *Hopital St. Antoine*, who affirms distinctly that there is no lessening of the bacilli, and that very marked relief has been afforded to asthmatic patients. Moreover, no evidence is forthcoming to show that sulphureted hydrogen is poisonous to the tubercular bacillus. It is, so to speak, the natural gas of putrefaction, and, without definite proof, cannot be considered to be even probably inimical to low organic forms.

Dr. James Henry Bennett has published in the *British Medical Journal*, December, 1886, a paper upon Bergeon's method of treatment, in which, however, he adds nothing to our knowledge of the subject, merely stating his own experience in a single case of asthma.

In this city the method of treatment has been used in the *Philadelphia Hospital* in a large number of cases, especially in the wards of Dr. Bruen. A personal inspection of the result shows that the statements made by the French observers are correct, and there seems to be no doubt that under the treatment there is rapid alteration of some cases of phthisis for the better. In the *Philadelphia Hospital* the solution at first used contained five grains of the chloride of sodium and five grains of the sulphide of sodium, but at present the strength has been doubled, so that in the Wolff's bottle, through which the carbonic acid passes, ten grains of each of the chemicals are put. Once charging of the Wolff's bottle is made to suffice for a number of patients, each of whom receives at each treatment from three to five pints of carbonic acid. It will be seen at once that in this method the amount of sulphureted hydrogen received by the patient is unknown and variable, and is very small. A personal inspection of the carbonic acid used showed that it is very impure, the odor indicating that it contains sulphurous acid. Chemical testing has shown that the gas coming from the Wolff's bottle contains sulphureted hydrogen, the odor of which is also distinctly present. The chloride of sodium in the solution would appear to be superfluous, the carbonic acid reacting directly with the sulphide of sodium. The following formula represents the probable change:

Such is the evidence which I have been able to gather from the experience of others in regard to Bergeon's treatment, and it is sufficient to indicate that we are in the presence of a very important improvement of, or rather a very important addition to, medical therapeutics. It is of vital importance to decide the mode in which the treatment acts. The experiments of Dujardin-Beaumont show that the carbonic acid is not the active agent, and that the good achieved is produced by the sulphureted hydrogen. Reasons already assigned are sufficient to make it improbable that the good achieved is the result of any parasiticide influence. All clinical experience indicates that heredity is in the production of consumption a vastly more important factor than is any poison introduced into the body from without. Only a portion of the medical profession believes in the active contagiousness of phthisis, while the experience of any life insurance company affords a firm foundation for the belief in the heredity of the disease. If the bacilli really are the exciting cause of phthisis, the susceptibility to their action must be a more important factor in the production of phthisis than are the bacilli themselves. There is at present, then, no proof that the sulphureted hydrogen, when it does good in phthisis, acts by killing the bacilli, and there is still less proof that it in any way increases the direct resistive powers of the individual to the action of the bacilli. In some acute and chronic diseases of the skin, local applications of sulphur act with astonishing rapidity and effectiveness, and the thought naturally suggests itself that in Bergeon's treatment of consumption good is achieved by the action of the sulphureted hydrogen upon the inflamed lung tissue, or, in other words, that the plan of treatment is simply a means of making an application of sulphur to the pulmonary mucous membrane and tissue. This thought is not merely of speculative interest, but also of practical importance, for it suggests that the method of treatment will prove of value not only in consumption but in various forms of chronic or subacute affections of the lungs. This is confirmed by what experience we have. Cases of asthma and pulmonary catarrhs have already been quoted in this article as having been published in the French journals, in which the remedy has proved of the greatest service.

I saw in the *Philadelphia Hospital* one case of asthma with chronic catarrh and emphysema, in which the administration of the rectal injections had been followed by the most pronounced relief. In another case, of catarrhal pneumonia, with an enormous amount of purulent expectoration, and general symptoms so bad that a fatal prognosis had been given, the administration of the remedy was at once followed by rapid lessening and even cessation in the purulent secretion, and in a short time by convalescence.

As an important illustrative case, I cite one from my own recent experience. Mrs. L., over 70 years of age, received a severe contusion of the side in a railway accident, which was followed by pleurisy, in turn followed by bronchial pneumonia, with an enormous expectoration. She has been under my care for nearly three months, and though often temporarily benefited by various remedies, had failed to properly respond to the most careful treatment that I could give her. The expectoration remained exceedingly profuse, amounting sometimes to a pint in the course of twenty-four hours, although very irregular. The general symptoms were very bad; sinking spells were frequent and alarming. I finally told the family that she would die, unless the gaseous injections would do something for her. Within forty-eight hours after the use of the gas, the expectoration notably decreased; the expression of the patient's face changed entirely, and at present writing, fifteen days after the use of the sulphureted hydrogen, she is expectorating not one-sixth the quantity she did formerly, has regained the natural expression of her face and color of her skin, as well as her appetite and a fair amount of strength, and seems to be convalescent. A notable fact in this case is that the injections of gas relieve in a few minutes the sense of suffocation and sinking the patient formerly felt in the mornings. The secretion of urine was sensibly increased. As tested on three occasions, the subnormal temperature rose 0.4° F. within the half-hour after the exhibition of the gas either by the mouth or rectum.

One difficulty with Bergeon's method of treatment

in private practice is the cumbersomeness of the apparatus and the skilled labor required for the preparation of the carbonic acid. A plan which would avoid this and reach the same result in regard to the lung disease is certainly a desideratum.

According to Gay-Lussac and Thenard, water at 52° Fahrenheit will absorb three times its volume of sulphureted hydrogen. To prepare this solution, the gas, previously washed with water, is passed alternately through each of two bottles half filled with water; while it is being passed through one, the other is closed with the stopper and shaken, to insure complete absorption; and thus the process is continued till the water is completely saturated. One of the bottles is then completely filled with the liquid, and removed with the mouth downward. The resulting solution is a colorless liquid, having the odor of putrid eggs and a sweetish taste. When heated, it evolves the whole of the gas. Bottles containing the solution of sulphureted hydrogen should be habitually laid upon their side.

A priori, there is no evident reason why this solution, if injected into the rectum in proper doses, should not exert all the influence upon the pulmonary tissue obtained by Bergeon's treatment. I have tried the solution thrown into the rectum, and found it free from any irritant action. The habitual use of injections two or three times a day is, however, very disagreeable to most patients, and the questions naturally arise, Is there any necessity of administering the drug by the bowels, and Will not sulphureted hydrogen water be taken without too much repugnance by the mouth and without nauseating? At the various sulphur springs large quantities of such water are habitually drunk by the patients. Led by such considerations, I have tried the sulphureted hydrogen water in as many cases as I have been able to get, and so far, when properly given, it has been usually taken readily, and has not disagreed with the stomach. Some persons, however, will not tolerate it at all. The effects upon the disease have seemed to be entirely similar to those produced by the injections. At first a half ounce, afterward an ounce, of the saturated solution of the sulphureted hydrogen should be placed in a tumbler, and two or three ounces of carbonic acid water be run into it from a highly charged siphon, the whole being drunk while effervescing. This may be given three to five times a day, so that the patient will receive daily between a half pint and a pint of the sulphureted hydrogen gas. Injections of gas into the rectum produce, in some persons, more or less violent attacks of colic, especially if given at a time when the food is well down in the intestinal tract. Thus, in the case of Mrs. L., the night injection caused so much pain that it could not be borne, although the injection in the morning was actually pleasant. The two methods of administration were then combined, the gas injection being given in the morning and the sulphureted hydrogen water in the afternoon and evening. Within the last forty-eight hours, at Mrs. L.'s earnest request, the gas injections have been entirely abandoned in favor of the exhibition by the mouth. Of course, the two methods are simply different ways of accomplishing the same result, and may be variously combined or substituted for one another, according to the peculiarities of the individual cases within the last day or two.

It is a matter of the greatest importance to fix definitely the dose of sulphureted hydrogen gas. With the method employed in the *Philadelphia Hospital* this cannot possibly be done. The solution employed in the *Hopital Cochin*, whose formula is given in the first part of this article, seems to be superior to the solution of the chloride and the sulphide of sodium, in affording known quantities of sulphureted hydrogen. Even with it, however, the chemical reactions are so slow that practically it is scarcely possible to decide how much of the gas is evolved in a brief time. The substitution of sulphuric for tartaric acid would largely obviate this. When the medicine is given by the mouth, exact dosage is possible. In Mrs. L., five ounce doses appeared to be too much. She is now taking three doses daily.

In a recent number of the *British Medical Journal* it is stated that M. Morel affirmed before the Biological Society of Paris that the dose of the gas is twenty-five cubic centimeters. That it is not incapable of doing harm is shown by the experiments of M. Peyron, who injected into the rectum of a dog one hundred and fifty cubic centimeters of a saturated solution of sulphureted hydrogen in two doses at intervals of three minutes. Symptoms of poisoning began to be manifested within two minutes, and death took place in ten minutes.

Another dog died quickly after two injections of the same strength, given at intervals of twelve minutes, while two others, in whom only very small quantities of the gas, or large quantities very much diluted, had been injected, experienced only slight inconvenience, and rapidly recovered. Not long since, in the University Hospital in Philadelphia, about one quart of a mixture containing equal quantities of carbonic acid and sulphureted hydrogen were injected into the rectum of a patient; within three minutes the man was unconscious and apparently dying. The breathing rate was one hundred per minute, and the respirations so shallow that they could scarcely be observed. The pulse at once became very rapid and feeble, and even imperceptible at the wrist, while a very marked odor of sulphureted hydrogen appeared in the breath. Under treatment the symptoms all subsided in about fifteen minutes. The rapidity with which these symptoms developed and with which they subsided indicates that when the gas is thrown into the rectum its effect is very immediate and fugacious, and it is entirely possible that the more continuous influence of rectal injections of the aqueous solution of sulphureted hydrogen may act better in pulmonary diseases than does the short influence of the gases now administered. Of course, poisoning by overdoses of sulphureted hydrogen is a no more valid objection to its proper use than is opium poisoning to the employment of opium.

1925 Chestnut St., Philadelphia, April 2, 1887.

NOT the least of the many novel uses to which paper, so-called, has been put in the arts, is the manufacture of pulleys for transmitting power. The advantages gained are lightness and, it is stated, increased draught. In weight alone the saving is great: a paper pulley weighing only 50 lb. against 90 lb. for cast iron of the same size.

* Dr. V. Morel, "Nouveau Traitement des Affections des Voies Respiratoires," Paris, 1886. *Gazette Hebdomadaire*, December 17, 1886. *La Semaine Médicale*, July 14, 1888; October, 1886.

THE CASTNER SODIUM PROCESS.*

HAVING been engaged professionally during the past few months in assisting in the development of this process, through the kind permission of Mr. Castner I am enabled to present to this society its details, together with a few facts concerning the uses and cost of manufacturing sodium and potassium.

The process heretofore exclusively used for the production of these two metals is so well known that anything more than a brief reference is hardly necessary.

By the older process, carbonate of soda, charcoal, and lime, in the proportion of 30, 13, and 7, are made into the finest and most intimate mixture, and then calcined at a red heat, to render the mixture more compact, which also expels a considerable amount of carbonic oxide. This calcined mixture is then introduced into wrought iron cylinders of small diameter, and heated to a temperature of about 1,400 deg. C., whereby the alkaline metal is reduced and distilled from the cylinder containing the charge through a small tube provided for the gases and vapors into the receptacle known as the condenser. Through a variety of causes, not more than forty per cent. of the metal contained in the charge is obtained, and in the manufacture of potassium very much less. The wear and tear on the metal cylinders is enormous, and forms a large proportion of the cost of manufacture. To carry out this process and arrive even at these results, requires—

As near as I can ascertain at present, sodium costs about 4s. per pound to produce, the following being the chief items:

	s.	d.
Wear and tear to furnaces, cylinders, etc.	2	0
Materials—owing to loss and waste	1	0
Labor	0	8
Fuel	0	4

Since Mr. Castner's paper upon his process, which was read before the Franklin Institute of Philadelphia, October 12, 1886, several slight changes in the mode of carrying on this process have been made. These have been brought about by the experience gained from the actual working of the process upon a commercially large scale.

The reactions by which the sodium and potassium are produced are somewhat difficult to describe, as they vary somewhat, according to the mixture of materials and temperature employed in the reduction. The mixture and temperature which it is now preferred to use is represented by the reaction:

In place of using an actual chemical compound of iron and carbon, as expressed by the above reaction, a substitute or equivalent is prepared as follows: To a given quantity of melted pitch is added a defi-

the platform of the elevating gear, as shown in the drawing, and raised to its position in the heating chamber of the main distilling furnace. The cover, which remains stationary in the furnace, has a convex edge, while the crucible has a groove round the edge, into which the edge of the cover fits. A little powdered lime is placed in the crucible groove just before it is raised, so that when the edges of the cover and crucible come together, they form a tight joint, and, at the same time, will allow the crucible to be lowered easily from the chamber when the operation is finished, to give place to another containing a fresh charge. From the cover projects a slanting tube (as shown) connected with the condenser. The condenser is provided with a small opening at the further end, to allow the escape of hydrogen, and has also a rod fixed (as shown), by means of which any obstruction which may form in the tube during distillation may be removed. After raising a crucible in its place in the furnace, the hydrogen escaping from the condenser is lighted, and serves to show by the size of the flame how the operation is progressing in the crucible, the sodium actually distilling soon after the crucible is in its place. The temperature of the reduction and distillation has been found to be about 823 deg. C. The gas coming off during the first part of the distillation has been analyzed and found to consist of pure hydrogen. An analysis of the gas sample taken when the operation was almost completed gave as a result: hydrogen, 95 per cent.;

CASTNER'S SODIUM FURNACE.

1st. The most careful grinding and mixing of ingredients.

2d. The addition of lime to prevent fusion.

3d. An excess of carbon to insure contact between the particles of soda and carbon in the refractory charge.

4th. Previous calcination to make the charge less bulky.

5th. Wrought iron must be used in constructing the cylinders, being the only metal practical to use that will stand the high temperature.

6th. Cylinders must be used of small diameter, so as to allow the heat to penetrate to the center of the refractory charge.

7th. The exit tubes from the cylinders to the condensers require the most careful attention to keep them open, owing to the formation of the black compound formed by the action of carbonic oxide upon the vapor of the alkaline metal, which combination takes place at about the condensing point of the metallic vapor.

This is one of the most serious obstacles to be met with in the course of manufacturing sodium, not only causing a large loss of metal, but interfering generally with the operation. In the making of potassium, the formation of this compound, which is exceedingly explosive, and which is produced even more readily than when making sodium, is the chief reason that this metal costs almost ten times as much as the same quantity of sodium.

nite proportion of iron in a fine state of division. The mixture is cooled, broken up into lumps, and coked in large crucibles, giving a metallic coke, consisting of carbon and iron, the proportions of each depending upon the relative quantities of pitch and iron used. This metallic coke, after being finely ground, provides a substance having the iron and carbon in a like proportion to an iron carbide, and from which neither the iron nor carbon can be separated by mechanical means. The fine iron is conveniently prepared by passing carbonic oxide and hydrogen, in a heated state, as obtained from an ordinary gas producer, over a mass of oxide of iron, commercially known as "purple ores," heated to a temperature of about 500 deg. C.

In producing sodium, caustic soda of the highest obtainable strength is used, and there is mixed with it a weighed quantity of the so-called "carbide," sufficient to furnish the proper amount of carbon to carry out the reaction indicated above. The crucibles in which this mixture is treated are made of cast steel, and are capable of containing a charge of 15 lb. of caustic soda, together with the proper proportion of the "carbide."

After charging a crucible with the above mixture, it is placed in a small furnace, where it is kept at a low heat for about thirty minutes, during which time the mass fuses, boils violently, and a large part of the hydrogen is expelled by the combined action of the iron and carbon, the "carbide," owing to its gravity, remaining in suspension throughout the fused soda. At the end of the time stated, the contents of the crucible have subsided to a quiet fusion. The crucible is then lifted, by a pair of tongs on wheels, and placed upon

carbonic oxide, 5 per cent. It has been found advisable to use a little more "carbide" than the reaction absolutely requires, and this accounts for the presence of the small quantity of carbonic oxide in the expelled gas, the free carbon acting upon the carbonate formed by the reaction, thus giving off carbonic oxide, and leaving a very small percentage of the residue in the form of peroxide of sodium. This small amount of carbonic oxide rarely combines with any of the sodium in the tube, and so the metal obtained in the condensers is pure, and the tubes never become choked with the black compound. In the preparation of potassium a little less "carbide" is used than the reaction requires. Thus no carbonic oxide is given off, and all danger attached to the making of potassium is removed. After the reduction and distillation the crucible is lowered from the furnace, and the contents poured out, leaving the crucible ready to be recharged. The average analyses of the residues show their composition to be as follows:

Carbonate of soda	77 per cent.
Peroxide of sodium	2 "
Carbon	2 "
Iron	19 "

The average weight of these residues from operating upon charges of 15 lb. caustic soda and 5¼ lb. of carbide is 16 lb. These residues are treated either to produce pure crystallized carbonate of soda or caustic soda, and the iron is recovered and used again with pitch in the formation of the "carbide." From this residue, weighing 16 lb., is obtained 13 lb. of anhydrous

* An address read by Mr. James Mactear, F.C.S., at the meeting of the Society of Chemical Industry, London, March 7, 1887.