ounce of compound mixture of iron three times daily. Soon after the change of medicine, he began to gain strength, and to improve, in every way, very rapidly.

June 14th. The quantity of urine was three pints in twenty-four hours; of specific gravity, 1017; the colour was natural, the albumen much diminished. It contained a few casts, with epithelium more or less disintegrated, and scarcely a trace of oil.

At the beginning of July, the urine was free from albumen, and presented no trace of oil, but a very few casts with disintegrated epithelium; he was gaining strength, and was much improved in appearance. Once after this, there was a temporary return of albumen, but it soon disappeared, and he completely regained his health and strength. He has occasionally since been under my care for trifling ailments; I have several times examined the urine, and have found it, in every respect, quite healthy.

3, Woburn-square, Dec. 31, 1850.

ON THE INHALATION OF VARIOUS MEDICINAL SUBSTANCES.

By JOHN SNOW, M.D.

THE following are the chief reasons why it may be desirable to give medicines, in some instances, by Inhalation, in preference to the more ordinary method by deglutition.

1. As the influence of the medicine appears immediately, and a greater surface is offered for absorption, a larger dose may be given, and a more sudden and profound effect produced on the economy than it would be safe, or, in some cases, even possible to produce in any other manner. An instance in point is the insensibility induced by chloroform and ether.

2. The process of digestion is less interfered with, than by taking medicines into the stomach.

3. Many medicines which have a disagreeable taste—as turpentine, creasote, and camphor—are not unpleasant when inhaled in the form of vapour.

4. Agents, such as benzoic acid, and some of the gum-resins, which are believed to exert a local action on the mucous membrane of the air-passages, may be expected to have a greater effect when inhaled, than when they are taken into the stomach in the same doses, and reach the lungs only through the circulation.

5. Some agents, as chlorine and ammonia, have a local action when inhaled, which they could not exert if exhibited in any other way.

It was almost solely with a view to their local action that medicines were inhaled, prior to the discovery at Boston, in America, of etherization, which established a new era in inhalation; and even at the present time, with the exception of ether and chloroform, hardly any medicines are exhibited by inhalation, unless in affections of the lungs; although there evidently ought to be no such limitation of the practice.

It must be acknowledged in the outset, however, that it is a much less simple and easy matter to have medicines properly inhaled, than to direct them to be swallowed; and it is the object of the present communication rather to attempt the removal of difficulties, and to point out the physical conditions under which certain medicines can be inhaled, than to detail the results which have been obtained by inhalation.

Owing to neglect of the physical properties of a medicine, it has sometimes been supposed to be inhaled, when in fact it was not, unless in a quantity almost infinitesimal. It has not been unusual, for instance, to direct a drachm or two of tincture of hyoscyamus or conium to be put into half a pint or a pint of hot water, in order to be used for inhalation. Now the virtues of an infusion of these plants remain in the extract, after the water is all evaporated at a moderate temperature; and if the patient had inhaled day after day from the same water (having it made hot for the purpose), till it had all been consumed, the medicine would have been found at the bottom of the vessel in the form of an extract, to which water might have been added for the process to be commenced afresh. It is obvious, therefore, that any effects which have been produced by inhaling in this manner, were due either to the vapour of the water, which is very beneficial in irritable states of the mucous membrane, or to physical causes depending on the construction of the inhaler, and the mode in which it was used.

The most important of the additions to the mechanical means for inhalation, which followed the discovery of etherization, is the flexible face-piece, to include both the nostrils and mouth. Dr. Sibson introduced this, although Dr. Hawksley contrived a similar one about the same time. It is shewn in the engraving, which accompanies this paper, in the modified form in which I use it. The sides and margin, which form the flexible part, consist of thin sheet lead, lined with oiled silk, and covered with leather. The expiratory valve can be moved more or less to one side from the opening it covers, so as to admit unmedicated air, whenever the vapour feels too pungent. The advantages of a face-piece of this kind are, that it can be fitted to every variety of face; that the patient requires no instructions, having nothing to do but to continue breathing in his usual way, either by his mouth or nostrils, as he pleases; and that it imposes no labour on the respiratory muscles, for when applied to any suitable form of inhaler, it may be kept attached to the face for any length of time without fatigue. As I recommend the face-piece in every kind of inhalation (except where substances have to be drawn into the larynx in the form of powder, when a glass tube may be used), it has been described before treating of individual medicines, to which attention may now be directed.

I. INHALATION OF MEDICINES WITH THE AID OF HEAT.

A. IN THE DRY WAY. OPIUM, it is well known, is very extensively inhaled, in China and India, as an indulgence; but it has not been much used in this manner in the practice of medicine, so far as I am aware. I sought to ascertain the temperature at which the active ingredients of opium are given off, and whether the effects of the fumes are due to morphia, or to new products generated by the heat applied. For this purpose, I heated morphia and the meconate of this alkaloid in an oil bath, using a long narrow

test-tube, on the recommendation of Dr. Bence Jones. I find that neither pure morphia nor the meconate are volatile, unless the heat be raised till they begin to be decomposed. This occurs at about 400° Fahr., when they become brown, and a brown sublimate begins to be condensed in the interior of the tube. The sublimate obtained from morphia is slightly reddened by nitric acid, but is not altered by the perchloride of iron. The sublimate from the meconate gave the same results, except on one occasion, when some minute colourless crystals were sublimated from it, at a temperature of from 380° to 400° . These were rendered of a deep red by nitric acid, and were reddened also by the perchloride of iron. We may conclude, therefore, that the effects produced by the inhalation of opium are chiefly, if not altogether, due to the generation of new products by the heat applied.

For the inhalation of opium, the Chinese use a pipe of a peculiar construction, which they heat over a spirit lamp. The preparation which they use is the watery extract, and the quantity employed at one time is said to be a piece about the size of a pea; but whether the dose requires to be increased with the habit of using it, as happens when opium is taken into the stomach, I have not been able to learn. The Chinese opium-pipe is too complicated for general use by patients, and anything in the form of a pipe would be liable to misuse; as Europeans, with the exception of the Turks, use a pipe merely to draw the air into the mouth and puff it out again, instead of inhaling with it, as I believe is the practice in all eastern nations. I have therefore contrived an inhaler, which is adapted for a great number of other medicines as well as opium. (Fig. 1.)

1. Larger Inhaler.

2. Smaller Inhaler.

It is made chiefly of tin, and consists of a cylindrical chamber, between four and five inches in diameter, and three or four inches deep, under the centre of which a spirit lamp is placed. The bottom of the inhaler consists of a thin piece of talc, on which is placed a small capsule of Berlin-ware, for the purpose of holding the extract of opium. A porcelain funnel-holder, which is placed on the talc, keeps the capsule exactly over the flame of the lamp. The talc allows sufficient heat to be transmitted to the opium, without conducting it to the sides of the inhaler, and, consequently, the air which is inhaled is not unduly heated. The lid of the inhaler is moveable; it is provided with a delicately balanced valve for the admission of air, and is connected with the face-piece before mentioned, by means of an elastic tube of wide calibre, as shewn in the engraving.¹

The extract of opium, in the form of a pill, is placed in the capsule without any addition, and the spirit-lamp is lighted beneath it with a very small flame, which may be increased if requisite. The patient begins to inhale immediately the lamp is lighted, and continues to do so as long as anything is given off. The moisture contained in the extract is first expelled by the heat and inhaled, then follow the active principles of the opium, accompanied, after a time, with some smoke, and nothing is left but a porous carbonized mass. The process, being conducted slowly, usually lasts about ten minutes. If the volatile products be too irritating at any time, and excite coughing, the spirit-lamp should be removed for a minute, the inhalation being continued, however, in the mean time. The patient learns very soon to accommodate the process to his tolerance of the vapour, the pungency of which is very slight.

At the Hospital for Consumption at Brompton, the physicians to which institution kindly invited me to assist in contriving and superintending the inhalation of medicines, a considerable number of patients have inhaled opium during the last twenty months,—some of them having inhaled every evening for several weeks in succession, and discontinued only on leaving the hospital. Three or four of the patients had emphysema with chronic bronchitis; but the majority had phthisis, with cavities in the lungs—cases, in which the cough was more than usually troublesome, being generally chosen. The cough was relieved by the inhalation in the greater number of cases, and many of the patients increased in weight, and improved considerably in general health. Other remedies were used at the same time, and contributed to the improvement, but it seemed to be in part due to the inhalation. It has caused constipation of the bowels in only two or three of the patients; I have, however, experienced that effect when I have inhaled it for experiment. The quantity of watery extract of opium inhaled at one time has generally been two grains; but, in a few cases, three grains have been used. Crude opium was used in one case, instead of the watery extract; but the fumes it gives off are more irritating to the bronchial membrane, than those from the latter agent.

MORPHIA is, in my opinion, the most suitable preparation of opium for inhalation; but I have not recommended it at the Brompton Hos-

¹ The Inhalers are made by Matthews, Portugal Street.

pital, on account of its expense. It has, however, been inhaled by one patient, in the dose of half a grain, and I have inhaled it in the same quantity. It is much easier and pleasanter to inhale than the extract of opium, the extractive matter of which supplies some smoke, which is probably quite inert. It is of service to mix the morphia with a little dry plaster of Paris, to give it more weight and bulk.

With respect to the doses just mentioned, it should here be remarked that a medicine, when inhaled, cannot be all absorbed, as usually happens when it is taken into the stomach, for only part of it reaches the lungs, whilst another part is expired again with the air which has occupied the nostrils or mouth, the larynx, trachea, and larger bronchi. I am inclined to believe that about one-half of what is inhaled is usually absorbed; for, on inhaling air charged with vapour of chloroform from a bladder or small balloon, I experienced as much effect from ten minims, when it was breathed backwards and forwards for a minute or two, as from twenty minims, when the air was only breathed once.

EXTRACT OF STRAMONIUM has been inhaled in the Brompton Hospital, with more or less relief, by five or six patients affected with asthma. Four grains were used, in the same manner as opium. The spirituous extract of aconite was used also by one patient, in the quantity of a grain; and it is probable that other extracts might be employed with advantage, in the same manner.

GUM-RESINS. The fumes given off by these medicines may be inhaled in the same way as opium; but, as these fumes are pungent when in large quantity, it is advisable to powder two or three grains of the gum-resin, and mix it with about ten times as much of some inert powder, as gypsum, before exposing it to heat in the capsule. Used in this way, ammoniacum gives off a very fragrant odour, and, though rather pungent, can be inhaled very well by most persons. With steam the gum-resins can be easily inhaled, as the quantity of vapour which they give off, at the temperature of boiling water, is small. In this way, however, the patient gets no great amount of the medicine; but probably enough to exert some local action.

B. WITH VAPOUR OF WATER. For the inhalation of medicines along with the vapour of water, I employ the above-described inhaler, using a somewhat larger earthenware capsule than for inhalation in the dry way. Into this capsule or dish, about half an ounce of water is put, together with the medicine to be inhaled. The water is heated by the spirit-lamp, sometimes till it boils gently, but generally to a point rather short of boiling. This quantity of water yields as much vapour as a patient can conveniently breathe in about half an hour; and a much greater amount of the medicine can generally be inhaled than if it were placed in a larger quantity of water. In the case of some substances, indeed, as iodine, oil of turpentine, and camphor, which are particularly adapted for inhalation in this manner, the medicine is all inhaled before the water is finished.

IODINE may be most conveniently inhaled, by adding a small quantity of a strong spirituous solution of it to half an ounce of water. Twelve minims of the iodine tincture of the *Dublin Pharmacopœia*, containing one grain of iodine, are a suitable dose. The advantage

of adding the iodine in the form of tincture is, that it becomes equally diffused through the water. As the patient inhales, the water becomes less and less deep in colour, and by the time that he has inhaled about three-fourths of the water, he has inhaled the whole of the Iodine; and the remaining water is colourless. On account of its irritating effects on the stomach, it would probably be advisable that iodine should be given by inhalation, in every case in which its exhibition is required. Allusion is here made only to iodine, and not to the iodide of potassium, which, not being volatile at the heat of boiling water, cannot be inhaled in this manner. I very much doubt whether phthisis be one of the diseases to be benefited by iodine. It was inhaled by eighteen patients at Brompton, in the summer of 1849, and the following autumn and winter; they generally commenced with half a grain, and it was increased, in one or two cases, to two grains; but the usual dose was a grain once a day. In two or three cases it was discontinued, as it seemed to increase the cough, and one or two of the patients complained of head-ache from its use. It was continued, however, for more than a month, in ten of the cases; and I was present on nearly every occasion, to see it inhaled. It may consequently be said to have had a fair trial; but no benefit could be observed to follow its use. It was not inhaled as above recommended, but from a Woulfe's bottle, over the interior of which its spirituous solution was diffused; no artificial heat nor vapour of water was employed; the inhalation was continued till the iodine had disappeared. There were consequently no extraneous circumstances to interfere with its action.

OIL OF TURPENTINE has been inhaled in a few cases, by putting twenty drops of it, with about half an ounce of water, into the capsule; the spirit-lamp being placed underneath, as usual. The boiling point of oil of turpentine is much higher than that of water; but owing to the great density of its vapour, as compared with steam, it evaporates more quickly than water, as happens with iodine, and consequently it is all inhaled before the water is consumed. The cough has appeared to be relieved in the cases in which it was used. One was a case of hæmoptysis, which subsided under its use, as, however, it might have done without it.

CAMPHOR can be conveniently inhaled by putting thirty or forty drops of the tincture into half an ounce of water. It is usually consumed as soon as the water with which it is mixed. It has appeared to relieve the cough, in a few cases in which it has been used.

BENZOIC ACID can be inhaled with the vapour of water. If six grains be put into half an ounce of water, the patient will inhale about half of it, and should leave off before the water is quite dried up, to avoid the pungent fumes which would otherwise arise. For the next inhalation, some water and about three grains more of benzoic acid can be added to that which remained. I have not seen sufficient of its employment to speak of its effects.

CREASOTE may be best inhaled in the same manner. If not more than about four drops be put into the half ounce of water, all of it will be inhaled. I have generally given creasote, however, with the inhaler marked number 2 in the engraving. Several patients have inhaled it at the Brompton Hospital, generally using three or four drops twice a-day. The benefit from its use has not been very great, but might

probably have been greater, if it had been inhaled with vapour of water, which itself is serviceable.

II. INHALATION OF MEDICINES AT THE ORDINARY TEMPERATURE.

The smaller inhaler, shewn in the engraving, was contrived for the inhalation of chloroform in medical and obstetric cases. It is made of brass tube, rather less than an inch in diameter, and is lined with bibulous paper to absorb what is put in, and afterwards yield it up in the form of vapour as the patient inhales. It is adapted by a screw to a face-piece similar to that employed with the other inhaler. It is not my intention to speak of chloroform on the present occasion. Amongst the other medicines which have been inhaled with it, are hydrocyanic acid and conia; and it is adapted for the inhalation of almost any agent that does not require the application of heat.

HYDROCYANIC ACID has been inhaled by several patients at the Brompton Hospital, but it has not seemed to produce any good effects which would not have resulted from its use by deglutition. The quantity inhaled was generally twice as much as one would give by the stomach, and it was somewhat diluted with water, to diminish the pungency of the vapour, and enable the nurse to measure the quantity more easily in the minim glass.

CONIA, the volatile alkaloid of spotted hemlock, has been inhaled by several patients. Some of this active principle having been kindly given to me by Mr. Morson, I first tried small doses on myself, and found that a minim of it could be inhaled without inconvenience. This was the quantity usually administered, although two minims were inhaled in a few cases. Dizziness was caused by it in many instances, especially when the larger dose was employed, but this effect subsided in less than an hour. The cough was usually relieved by it, and in two or three cases of asthma, the breathing was also relieved. The conia was diluted with nine parts of spirit, both for convenience in giving the right dose, and in order that it might be better diffused over the paper in the inhaler, and offer a larger surface for evaporation.

The following experiment, performed in 1848, on the inhalation of conia, may not be uninteresting, as shewing that this is one of the agents which might be employed for the prevention of pain in operations.

A chaffinch was placed in a covered glass jar, holding 100 cubic inches, and one grain of conia was put in. The bird seemed unaffected for ten minutes, and the jar was opened with the intention of trying a larger dose; a minute afterwards, however, it fell on its side and lay, not relaxed, but like a stuffed bird, as its head did not droop. It moved its legs, now and then, by convulsive starts. It was insensible to pricking and pinching, although, from the appearance and motion of its eyes, it seemed to be conscious all the time. It recovered its sensibility in about two minutes, but was not able to stand for ten minutes. It afterwards appeared well.

In a guinea-pig, in which the inhalation was continued till a fatal effect was produced, violent convulsions occurred before death, and the heart remained irritable afterwards.

AMMONIA has been inhaled with great relief in a few cases, in which more or less bronchitis, with difficulty of expectoration, existed.

The inhaler employed was similar to that described by Mr. Smee in the *Medical Gazette* for 1843, except that an elastic tube and face-piece were attached to it. It consists of a Woulfe's bottle with wide apertures, and a tube for the entrance of air, descending a certain way, but *not* dipping into the solution employed. The ammonia was given weaker than by Mr. Smee. Two ounces or so of cold water remained constantly in the bottle; and when it was about to be used, twenty minims of strong solution of ammonia were added, and the patient inhaled for half an hour, or as long as ammonia continued to be given off. The inhalation was repeated twice or three times a day.

It may be remarked, that either ammonia or hydrocyanic acid might be inhaled, along with vapour of water, in the opium-inhaler first described; so that a person provided with it might apply it in almost every kind of inhalation.

CHLORINE has been inhaled by a few patients, in different stages of phthisis, but with no advantage, although it was continued by some of them for a few weeks. To obtain it, some chloride of lime was put into the Woulfe's bottle-inhaler, just mentioned, and moistened with a little water. When it was wished to increase the quantity of chlorine beyond the small amount spontaneously given off, the inspiratory valve of the face-piece was prevented from closing completely, and a little of the expired air being thus allowed to get into the bottle, the carbonic acid it contained acted on the lime, and caused chlorine to be liberated.

It will be observed, that the medicines mentioned above have all been recommended to be inhaled, either alone, or with the vapour of water: and, as a general rule, it is better for medicines to be inhaled singly; since, no two being equally volatile, they could not be inhaled, if combined, in the proportions in which they might be mixed. The method of administering medicines by inhalation also being yet as it were, in its infancy, the exhibition of one at a time is better adapted for the collection of correct observations respecting their effects.

54, Frith-street, Soho, January 2, 1851.

REMARKS ON CONTINUED FEVER, AND MORE ESPECIALLY ON THE CONDITION OF THE BRAIN IN FEVER.

By HUMPHRY SANDWICH, M.D., Physician to the Hull General Infirmary.
(*Read before the Hull Medical Society, Oct. 26th, 1850.*)

As Englishmen we must honestly admit, in spite of our proud recollections of what English observation has achieved from the days of Sydenham downwards, that the French have won imperishable laurels in the important field of Febrile Pathology. It is due, indeed, to the memory of Sir John Pringle to assert, that, even a hundred years ago, he caught a glimpse of the doctrine that, when fever proves fatal, it mostly or often does so by the production of certain specific organic lesions. This truth, though crudely stated, is embodied in the assertion, that "he examined ten patients who died of typhus, and came to the conclusion, that, when it proves fatal, it generally terminates