is not alluded to in any of them, nor is the attitude of the patients— which I consider a great element in modern staphyloraphy.

Here, however, is what I contend for in support of my paper of April 4th, 1874, in bringing forward fifty-six original cases operated on, chiefly in accordance with the views therein propounded since that time, all of which, with a few exceptions above referred to, have been successful. In a considerable number of these cases, further operations have been required, and many of these were of a kind which, under former views, admitted of no remedy, excepting by artificial plates. The further interference in these cases has been such as to induce my assistant and registrar Mr. Rose to put down each as an operation; because, in each such instance, chloroform has been used, and the whole manipulative process on the hard palate has been in a manner repeated. Edges have had to be made new again, stitches introduced, and chisel applied. My reasons for stating that the circumstances of twenty or forty years back are different are that, in former times, as far as I can understand, the patients were seated upright; now, in my practice, they lie on a table; then there were neither gag nor chloroform, and in these I am of opinion that much of our modern improvement in practice consists. In my former paper, I had pleasure in according to my friend Mr. Thomas Smith, of St. Bartholomew's, the merit of introducing the use of chloroform and the gag in these operations; and I feel further bound to repeat my admiration for his forward movement in regard to these almost essential adjuncts.

Experience has led me to make some modifications in practice formerly described, which I fancy worthy of the object of this present paper. In dealing with a cleft in soft and hard palate, I still adhere to my preliminary division of the levator palati on each side; but if from the size of the gap in the hard palate it be deemed needful to introduce one, two, or more stitches, I advise that the holes for them be bored with the bradawl, and that the stitches be introduced before the chisel is applied. I think it an advantage, too, to make the edges of the gap bare before loosening the portions of the palate with the chisel. If these parts be made loose first, it is very difficult to push a bradawl or needle through, and there is great risk of one or both slipping, so as to separate periosteum from bone and endanger the occurrence of necrosis. This I believe to have been the cause of the misfortune in the two cases above referred to, when the operations signally failed. But I fancy I have further modifications and improvement to impart here. Recent experience has led me to the fact that stitches may not be necessary in many instances of cleft in the hard palate. I have found again and again that, when the edges of the gap have been pared and the chisel introduced, it answers to cause approximation of the raw margins by stopping the opening made on the hard substance by the chisel, with lint, so as to make the desired closure in the centre. The pledgets of lint keep the parts as steady as if not more so, than the stitches, whilst they obviate the necessity of the additional injury of the stitch-punctures. This practice, I am confident, is available in all instances when the opening in the bones is of brief extent, as the front stitch in the soft palate may be put in close behind the posterior margin of the bones.

In my former paper I referred to gags, and particularly to those of Mr. T. Smith and Mr. Wood. For various reasons, which need not be dwelt on here, I have set these aside in favour of a more simple apparatus, chiefly suggested by my friend Mr. Mason of St. Thomas's, and in a manner perfected by Messrs. Matthews, instrument-makers in Carey Street, which I strongly recommend as the best I have yet seen for the operation in question. In fact, I consider the gag as an essential instrument for the modern proceeding, for without it chloroform would be worthless. This sketch shows the instrument in question.

The narrow blades are introduced shut between the teeth on either side the surgeon chooses, and are opened by pressure on the handles at the will of the assistant who holds them. The power of the instrument is such that, if care be not taken, the lower jaw may actually be luxated, as I have seen more than once, although happily with no permanent evil. There is a peculiar twist in the blades of this instrument as regards the cheek and margin of the mouth, which can be better appreciated by looking at them in action, than from any description that might be given here. The length of the whole instrument is about

seven inches, and it will be useful to have two, one slighter than the other, to suit the mouths of patients from four to ten years of age. This gag will be found of much value in many operations about the mouth and tongue, and I presume to say that it will prove a valuable aid to the dentist.

On thinking over all that I know of these matters, and especially as regards my own humble work, I am impressed with the slowness with which facts and improvements have come upon my mental conception. I believe that I was the first who dissected and described the anatomy and physiology of cleft palate (cleft, be it observed), yet five years or more passed before the simple mechanical value of the information thereby obtained dawned on my mind. Neither the action of the levators in tugging upon the stitches, nor that of the superior constrictors of the palate in closing the cleft during deglutition, were thought of; but happily, when tenotomy and myotomy were in the full swing of novelty and fashion, I bethought me of my old dissection, which, having been fortunately preserved as unique, gave me the opportunity of further study and reflection. Yet, even now, after a comparative calm in my own mind, I am amazed at the slowness with which point after point has gradually come upon me in an experience of between three and four hundred operations, including old fashioned and new. These latter observations have been more impressed on my mind within the last two years than at any previous date.

CLINICAL LECTURE

ON

THE ADMINISTRATION OF CHLOROFORM.

Delivered on November 23rd, 1875.

By GEORGE H. B. MACLEOD, F.R.S.E.,

Regius Professor of Surgery in the University of Glasgow; Surgeon to and Lecturer on Clinical Surgery at the Western Infirmary; etc.

GENTLEMEN,—One of the first subjects on which I desire to give you instruction is how to administer chloroform, as in my service this duty is devolved on the dressers, and is not confined to a select body or a special individual. I cannot, of course, ask you to undertake this work till you have been carefully and minutely instructed thereon. To-day, I wish to explain the chief points which demand attention, while frequently I will have an opportunity of practically demonstrating to you the application of each rule I give you; till, in a short time, I will depute you (but always under my immediate and close supervision) to administer the anæsthetic when occasion arises. The duty to which I allude is a very delicate and anxious one to all who know the dangers which may arise; and it is because I consider it a very important part of your clinical education to be able successfully to perform it, that I take upon myself the additional anxiety and responsibility of allowing you to concern yourselves at all in the matter. It is an important privilege to be allowed to gain personal experience regarding this very potent agent; but, that it be not abused, your most careful and minute attention is demanded. When you go into practice, you must frequently have recourse to an anæsthetic, if you do not wish to divest yourselves of one of our most useful therapeutic appliances; and my object is to prepare you to use that agent which, in Scotland, we almost exclusively employ—viz., chloroform—with the freedom and boldness which is founded on a due knowledge of its power and its dangers, and not on the rashness which arises from ignorance. It is one thing to see it administered by another, and a totally different affair to be clothed with the responsibility of giving it yourselves; so that while I look on and see that nothing is omitted or done amiss, yet you will have in your own hands (after these demonstrations) the actual administration of the chloroform. It is only thus that you can come thoroughly to be prepared to use it in after-years. I beg of you clearly to understand that, when you take upon yourselves to give chloroform to a patient, you assume a very great responsibility. It is not a thing lightly to be determined on, or to be carelessly carried out. Every time it is administered, a certain menace is directed against the life of a fellow creature; and it is only by the utmost attention to certain rules that safety is secured. By the proper use of chloroform, you can accomplish very important ends. Much can be attained of comfort and safety for your patient, as well as of satisfaction and security for yourselves. But if any one proceed to use this agent without due attention and knowledge, he may in a moment meet with a catastrophe so serious as to destroy his happiness, if not also his prospects for life.

You see how constantly, and I may say lavishly, chloroform is used here. Day after day, in my own wards, one, two, or more patients are placed under its influence. It is used even to allay the pain incident to the dressing of certain wounds, and constantly for the more careful and precise investigation of accident and disease. You see the patient thrown securely under it, and kept so occasionally for prolonged periods; and you know how rarely any alarm is caused, and how seldom even after-sickness or other annoyance is occasioned. This free and unstinted use of chloroform has gone on since 1848; and yet, during these twenty-seven years, no patient has ever died in the operating theatre of either this Hospital or the Royal Infirmary from its use. True, four deaths have occurred from chloroform during that time in the latter institution; but they all took place when it was administered for comparatively trivial things in the ward. One happened shortly after the introduction of chloroform, when a boy was being sounded for stone; and an on-looker informed me that the cloth was left for a short time on the patient's face, while the administrator was engaged watching the process of investigation. In a second case, one of the assistants and a dresser gave the anæsthetic, in order to apply an escharotic to a spreading sore. The patient had been several times safely chloroformed before. He was said to have died suddenly, and apparently by syncope. The other two cases occurred to colleagues. In one case, a toe was being amputated, and in the other tracheotomy was being performed. It appears likely that, in some of these cases, the trifling nature of the operation, and the absence of that more regular preparation which a greater and more serious operation would have enjoined, might have occasioned less care in the administration than is usually employed. For it is a remarkable fact that a large proportion of the deaths have occurred when the chloroform was given for some trivial purpose; and the only explanation we can give is, that the same preparation and care were possibly not thought necessary as when a more serious operation was contemplated. All the patients died with pallid faces, and in a very short time. Drawing out the tongue, slapping the face, and artificial respiration were employed in all the cases in vain. If the huge amount of surgery we have here be considered, and the large number of serious operations performed under all circumstances and on persons of all ages and in every state of health—as we make no selection of cases, and refuse the benefits of chloroform to no patient having to undergo an operation—then the mortality I have stated must be admitted to be very small indeed, and, in fact, hardly worthy of computation, when the advantages which have been derived from its use are kept in mind. The contrast afforded by such results and those recorded elsewhere is very satisfactory. In England, it has been said that the deaths from chloroform are at the rate of one a week during the year; and from abroad we hear of such a violent opposition being inaugurated against it, on account of the mortality following its use, that it has been proposed in France to seek the aid of the legislature to put an end to its employment; and one of the leading surgeons has not scrupled to declare that “chloroform is mortal in itself, and it alone is to blame” for the deaths. Here we believe, on the contrary, that it is not the chloroform which is to blame, but the mode of administration.

I propose, in this lecture, to explain to you, as far as my experience goes, in detail, the steps to be taken in order to ensure safety in the administration of chloroform; and I earnestly ask your attention to the subject.

The very ease and safety with which you are accustomed to see chloroform used may become to you a source of danger, as you may conclude that it requires no special care. It is to divest your minds of such an erroneous idea, and yet to give you that assurance which is founded on a clear understanding of what you are about, that I thought it right to bring this subject before you. The first point I would dwell upon is this. When you are going to put a patient under chloroform, give the duty before you your individual attention. Resolutely refuse to take any other part in what is to be done but this alone. It is a duty quite sufficient to occupy your attention; and, if it be well performed, you will do the operator an essential and important service. No person should ever be charged with any other duty when he is asked to administer chloroform; and it has been, I believe, from neglecting this, and from the same person trying to fulfil the part of several assistants, that at least some of the accidents have arisen. The duty alluded to will, if rightly performed, take all your time. The state of the patient is ever changing; and, unless these alterations be watched and guided, danger may come in a moment. Under no circumstances, and after no amount of experience, is a man justified in relaxing his vigilance. The fact that the patient has been safely chloroformed before, makes no manner of difference as regards the need of care. True it is that such persons are usually much less nervous, and so more easily managed; but there is no excuse for want of caution. For my own part, I declare

frankly that, though I have never met with an accident in my own practice during over twenty years of an active surgical career, yet I never administer it without, if possible, increasing care. Very often, indeed, when, in private practice, I have to rely on the aid of practitioners whose use of chloroform is necessarily limited, I have far more anxiety with regard to the anæsthetic than connected with the operation I am called on to perform; and I feel that, though fortunate thus far, I may have an accident any day if I relax the care I wish now to enjoin.

I may at once say that all my remarks at present refer solely to chloroform. I have used sulphuric ether by itself, and variously combined with chloroform, and have seen enough to reconcile me to the use of chloroform alone. I am fully aware that the teaching of statistics is against the safety of chloroform as compared with ether. It has been said to be many times more dangerous. This position might be, I think, strongly controverted if time allowed; but let it at present pass. I assert that, by proper care, chloroform is a sufficiently manageable and safe agent for use; and that it has the advantage over ether of being quicker and more certain in its action—an important point in a hospital where many patients have to be submitted to its effects; that it is more pleasant both to patient and administrator; less irritating and suffocating, and so less apt to cause panic when used; less exciting, and so less objectionable in both public and private practice; less bulky, less wasteful, and so less costly. I say nothing of the inflammability of ether, which renders it dangerous to use under certain circumstances, though I have known at least one accident arise therefrom. The excitement caused by ether is very distressing to look at, and cannot be devoid of danger. If we follow the instructions given by a high American authority, we should exclude all atmospheric air, and “keep it” (the mask saturated with ether) “down on the patient's face relentlessly”. This contrasts very disadvantageously with the method of administering chloroform. The greater power of chloroform is at once its advantage and its danger. If we can secure the former, and obviate the latter, the problem of rapid and safe anæsthesia would be solved. After-sickness we rarely have here with chloroform, yet the greater liability of sickness to occur after the use of that agent than ether has been strongly stated. During the last two years, I have three times performed ovariotomy in the public theatre of the hospital, and everything connected with the after-state of the patient has been freely made known. These patients have rapidly recovered; and, though at least two of the operations were prolonged and complicated, there was no after-sickness to cause any disturbance. I mention these operations in particular, because some of you have seen them, and as they are those usually selected as being especially unfitted for chloroform on account of the after-sickness.

For the safe administration of chloroform, the first thing to secure is a pure spirit. I always employ Messrs. Duncan and Flockhart's of Edinburgh, which has never failed me in efficiency. It is always desirable to prepare your patient, if possible, for the inhalation. A purgative should be administered the day before. If the bowels be loaded, the stage of excitement is always prolonged and excessive. Food should not be given for three hours before the operation; but it is most desirable, especially in weakly persons, to allow them a fair quantity of meat, soup, and bread, at such an interval as I have mentioned beforehand; in private practice, strict and detailed orders are requisite on this point, as unsuitable food is very apt to be given, “to keep up the system”. If an undigested meal remain in the stomach, there may be much annoyance and considerable danger from vomiting; while, on the other hand, an exhausted condition of the system, with diminished courage, and also trouble from flatulence and retching, will arise from too long fasting. A small quantity—a teaspoonful or two—of brandy should be given, undiluted, just before the chloroform is employed. The less bulky the form in which the stimulant is given the better, as it is less apt to be rejected. I have always followed this practice, as I believe that it comforts the patient, aids the effect of the anæsthetic, and helps recovery from it. No special preliminary examination of a patient is made in reference to his getting chloroform; as, if he be fit to be operated on, he not only may have chloroform, but is thereby rendered more fitted for undergoing the operation. We recognise almost no disease as rendering a patient an unfit subject for chloroform; and to examine him beforehand would only augment his anxiety, and possibly discover conditions which the administrator would better be in ignorance of, as it might render him less decided in his actions, and so the patient might not be as completely under the influence of the anæsthetic as was requisite for his safety. No examination should be capable of augmenting the care and caution always to be employed. Heart-disease, in place of being a counter-indication to the use of chloroform, is often greatly alleviated by its employment; and that fatty change of the organ which is supposed to render it pecu-

liably liable to "paralysis", is the very form of disease in which chloroform, if properly administered, interposes the most effectual barrier between it and the fatal shock which an operation is apt to occasion. To obtain this good, however, the patient must be completely anæsthetised. If the action be incomplete, the danger is, if anything, augmented. I have frequently had to perform operations of severity when undoubted heart-disease was present, and no cases seemed to me to do better with it. A good many of the deaths under chloroform have apparently been due to patients suffering from heart-disease not being completely insensible when the operation was performed, and the shock killing them. The chloroform is blamed; whereas what was really wrong was that it was not sufficiently pushed. There are positively no cases which can be submitted to operation in which chloroform is inadmissible. Even in operations about the mouth and throat of the most formidable kind, you will here see it in use. In lithotomy and tracheotomy, also, it is nearly always employed. In some operations, the patient's help is required for a moment to effect some end; but in general this can be secured before the chloroform is given.

Various things should be placed ready to the hand before you begin to give chloroform to the patient. Here you always see an artery-forceps made fast to the corner of the pillow. I constantly have one in my waistcoat-pocket, and would never give chloroform without having this instrument at hand. Cold water, and a kettle of very hot water; a bowl with a sponge large enough, when saturated, to fill it full; aromatic spirit of ammonia and a syringe; brandy; and a chair for sitting on, should be at hand. The use of these, I will afterwards explain. Make sure, also, that the window can be opened, and a current of air got.

I prefer giving chloroform early in the day. I have supposed that this renders it less apt to disagree. The patient is to be placed in the recumbent position, with a somewhat low head. Never be induced to administer chloroform in any other posture. Many accidents have arisen from neglect of this. Cover the patient comfortably, but not heavily, and never put any instruments or apparatus on the chest or abdomen. Let there be no crowding of bystanders round his head, so as to obstruct the air. The dress should be loose, especially about the throat; and females should always put off their corsets, and loosen all constricting bands. Any false teeth which may get loose should be removed. A source of great annoyance, and, I am convinced, of danger, is extreme nervousness on the part of the patient. Many, from ignorance, dread the period of insensibility very greatly, and will excite themselves to a great pitch at the anticipation. This is very difficult to allay. They frequently tell you that they know perfectly they will "never come out of it"; and this fear is very often caused by the reading of cases of recent accident from chloroform in the newspapers. Persons who have to undergo operation not uncommonly seek out and store up such knowledge; and I am sure that, if editors of newspapers knew the harm which these otherwise useless records do in increasing the anxiety of both patients and surgeons, they would be more chary of communicating such information to the public. Hysterical anæmic women are most apt thus to cause embarrassment. We all know that excessive fear may of itself kill by syncope; and that it must act most prejudicially on the action of the heart under the circumstances we are now considering, must be conceded. Doubtless, some of the deaths attributed to anæsthetics have been solely due to this mental shock. It is remarkable how completely this alarm disappears after even one experience of the action of chloroform, and how quickly the most nervous resign themselves afterwards to its action. A nervous person, though expressing great courage, is generally "a bad breather". He either respires in a shallow ineffective way, or inhales too deeply. Either mode of breathing is objectionable. We wish the patients to respire naturally, as if nothing was being done. We desire, in short, that they think as little as possible about it. Those who breathe faintly are long in being affected, and take so much of the vapour that they are very apt to suffer from after-sickness; while those who breathe too deeply, will take it more quickly into their system than we may wish. It is well in such cases to withdraw the towel, and quietly show them how to breathe; nay, in persons who are very nervous, it may be desirable to give them this instruction, even some time before they are to be operated on. This may be done in a cheerful encouraging way; they may be even accustomed to the smell of the chloroform if great dread of it be evinced, or a little eau-de-Cologne may be mixed with it to diminish its pungency. It is occasionally necessary, all for the same object, not to inform the patient exactly when the operation is to be performed; and you observe that, in this institution, we generally administer the chloroform to females and nervous subjects in the side room outside of the theatre, so as to avoid the trial of bringing them in before so many. Here, we always use a towel in giving chloroform. No other form of inhaler has ever been employed, unless it be

Skinner's simple appliance, which, many years ago, I tried without deriving such benefits from its use as to make me abandon the towel, which is so simple, so ready, and so efficient a vehicle. This is Skinner's (shown), and for children it is admirable. This drop-bottle, which allows the easy addition of small quantities, is, however, an essential part of it, and without it the real advantage of the apparatus is not secured. There is, to say the least of it, a mystery about all machines, and they are calculated to produce an apprehension which is undesirable. I have elsewhere seen various forms of inhalers used, and I have imbibed a strong objection to them. The advantage they are supposed to possess is, that they accurately measure the strength of the vapour inhaled, and prevent it from being too concentrated. In order that they should accomplish this, a certain mechanism is necessary which is liable to derangement, and which, I think, does not secure any better supply of atmospheric air than the way in which you see the towel used here. In private practice, an inhaler is troublesome to carry about, and it is expensive; but, above all, many more deaths have occurred where some form of inhaler is used than in Scotland, where a towel is the only agent employed. Do not take a towel with a fringe, as, if it fall over the patient's face, it annoys him and retards his progress. In texture, the cloth should not be too thin, and, when folded, the side without free edges—that is, the one formed by the combined doubling of the whole—should be that on which the chloroform is poured. The administrator's hand is apt to lose hold of one or more of the free edges, if they be placed in front, and these fall down close to the patient's face, and may prove troublesome. These are trifles which, however, in their sum, count towards the result. We put no oiled silk between the folds of the cloth. The chloroform is to be liberally poured near the edge of the towel, and the cloth so held (all these points were here demonstrated on a patient) that a hand is placed on each side of the head to steady it and keep the neck straight. The towel is then pushed from each side towards the centre, so as to form a gutter in front of the mouth and nose. To do all this satisfactorily, the patient should lie on a narrow bed, where he can be approached on all sides, and the administrator stands directly above his head, looking towards the feet. At least two other assistants are required; one to stand on each side. They attend to the pulse, and are ready to command the patient's movements. There is less anxiety in the use of chloroform in hospital practice than in private life, as there are more assistants and better accommodation in every respect to be had in public institutions. The patient should be made to close his eyes and breathe slowly. Do not at first place the cloth close to the face, but hold it at such a distance as will allow the free inhalation of atmospheric air, so as to give the patient confidence; and then, after a little, it can be approximated. It may be necessary to remove it altogether time after time, so as to allow you to encourage the patient and prevent panic. Nothing is worse than to force the process. Violent struggling and fainting may be expected if any such dangerous method be pursued. If a child cry, this is a good opportunity to get the vapour inhaled. If the patient be a male, it is useful to expose the pit of the stomach, as the movements of respiration, and frequently the action of the heart, are easily seen in this way; but too great reliance must not be placed in the movements of the abdomen and chest, irrespective of other evidence of the breathing going on. The administrator must, however, watch these movements intently, and it is not difficult for him at the same time to feel the temporal artery with the fingers which are below the towel. He must constantly, as the patient is become affected by the anæsthetic, look at the face and lips; it is there that he will at once detect any abnormal condition. Whenever the respiratory function is becoming embarrassed, the dark colour of the lips will at once give evidence of it; while, if the heart's action threaten to fail, the blanching of the lips will at once attract his attention. In old and weak people, and those who are anæmic from any cause, special attention is called for. It is always to be borne in mind that both the breathing and the pulse demand attention; for, although I very strongly incline to the belief that obstruction to the respiration always precedes the syncope of which we have heard so much, still the observation of competent and careful administrators has not so entirely confirmed that view as to entitle us to concentrate all our attention on the breathing alone. The sound of the respiration should, if possible, be constantly noticed, and all snoring or difficulty at once looked to. It is true that ordinary snoring may occur; but stertor or the snorting of obstructed breathing is a warning never to be for a moment neglected. It seems likely, from the observations of Mr. Lister, that stertor may have both a palatine and a laryngeal origin; but, whenever it occurs, it is a warning-note of approaching danger.

I should have said before that we never measure the amount of chloroform poured on the cloth. We do not believe that it matters much what quantity is used, so long as the effects are watched. More deaths,

I fear, are due to too little than to too much chloroform being given. By this I mean that in very many cases the fatal result has been due to imperfect narcotism, and the shock of the operation having full or even augmented force on the patient. Never trust for safety to the smallness of the quantity employed. Drops may kill when drachms might save. No more erroneous proof of the efficiency of the method of administration used can be than an appeal to the small quantity which has been expended; and yet, in fatal cases, how often is that advanced as evidence of the great care which was exercised!

When renewing the chloroform, do not remove the towel, but pour it on the outside, and turn the cloth. In this way, much time is saved, and less chloroform is, on the whole, administered, as the patient is not allowed half to recover each time that more chloroform is required. Never, under any circumstances, lay the towel down on the patient's face without your hand being below it.

To keep up the effects, the administrator must carefully watch for any evidence of returning motion; and, by the reapplication of the cloth, a mere sniff of the vapour may be enough to retain command of the condition in which we wish him to remain. The less chloroform that is used to accomplish this, the better.

Perfect quietness should be maintained while the administration is proceeding. The patient's attention is excited by any talking or other noise, and he often strains to hear what is said (supposing, if he be at all nervous, that it is sure to be about himself); and in this way the influence of the vapour is delayed.

[To be continued.]

ON CERTAIN PHYSICAL PHENOMENA CONNECTED WITH THE CIRCULATION, RESPIRATION, SECRETION, AND NUTRITION.

By GEORGE JOHNSON, M.D., F.R.S.,

Professor of Medicine in King's College; Physician to King's College Hospital.

IN the body of a living animal there is an incessant movement of liquids. Not only is the blood constantly propelled through the vessels, but there is a continual passage of fluids from the blood to the tissues, and from the tissues into the blood. The phenomena of the circulation, respiration, secretion, and nutrition, are most intimately correlated with each other and with an unceasing movement of the interstitial fluids. Life implies motion; stagnation involves death, either local or general. The movement of the blood is dependent on obvious mechanical processes. The contractions of the heart, the elastic resiliency of the large arteries, the regulating power of the muscular walled arterioles, the pressure of contracting muscles on the veins, and the movements of the chest in respiration, these forces, regulated and controlled by the nervous system, are the main influences concerned in maintaining the circulation of the blood. The proofs and the explanation of the constant and rapid interchange of fluids between the blood and the tissues are less obvious, but the phenomena will well repay an attentive study.

The quick and powerful action of morphia and other narcotics, when injected beneath the skin, affords a familiar illustration of the fact that a current of liquid is constantly passing from the tissues into the blood; the blood being, of course, the vehicle by which the absorbed morphia reaches and acts upon the nervous centres.

The late Dr. Bence Jones made a number of interesting experiments to demonstrate the rapid passage of crystalloids into and out of the vascular and non-vascular textures of the body. (*Proceedings of the Royal Society*, June 15th, 1865; and *Croonian Lectures on Matter and Force*, Appendix III.) The experiments were made with the salts of lithium, which are readily detected by spectrum-analysis. It was found that in guinea-pigs, within a quarter of an hour after three grains of chloride of lithium have been taken by the stomach, the lithium may be found not only in all the vascular textures, but even in the cartilage of the hip-joint and in the humours of the eye. In half an hour, it may be detected in the crystalline lens. When the same quantity is injected beneath the skin, even in four minutes it may be detected everywhere except in the lens, and in ten minutes it has passed into the lens.

In the human subject, lithium may be detected in the urine in from five to ten minutes after a ten-grain dose of the carbonate has been swallowed; and it continues to pass out by the urine for six or

seven days. Carbonate of lithium was administered to patients at variable intervals before the operation for cataract. After a twenty-grain dose, it was found in small quantity in the lens in two hours and a half; and it was found in every part of the lens in three and a half, five, and seven hours. No trace was detected in the lens when twenty grains of the carbonate of lithium had been taken seven days before the extraction of the cataract. Within that period, the whole of the lithium had passed out of the tissue of the lens, and had ceased to be excreted by the kidneys. This rapid passage of substances into and out of the tissues belongs to the class of phenomena which come under the designation of diffusion of liquids. Most liquids exert a molecular attraction upon each other, as a result of which they mingle with and diffuse into each other. This diffusion, by a process of endosmose and exosmose, takes place through membranes; but the interposition of a membrane has this important influence, that, while it allows the ready passage of liquids containing in solution substances which the late Professor Graham has designated "crystalloids", it arrests, or greatly retards, the passage of "colloids" or gum-like substances. A membranous septum, therefore, serves as a means by which crystalloids may be separated from colloids. Place albuminous urine on a dialyser immersed in distilled water, and in the course of a few hours the crystalloids of the urine—the urea and the salts—will have passed out of the dialyser, while the greater part of the colloid albumen is retained within. The molecular attraction between the dissolved crystalloids and the membranous septum acts as a motor force, which gradually carries the materials of the crystalloid into the liquid outside the dialyser. The fact that some albumen always diffuses through a dead membrane proves that such a membrane differs from the walls of healthy Malpighian capillaries, which, in the normal state, permit no escape of albumen. The passage of albumen through the Malpighian capillaries is a result of an abnormal condition of the blood or of the walls of the vessels, or, it may be, of abnormal blood-pressure.

The same physical forces are concerned in the production of renal dropsy. When, in consequence of acute inflammatory disease of the kidney, the urinary crystalloids and water accumulate in the blood, they pass thence, by an exosmotic process, through the walls of the capillaries into the subcutaneous areolar tissue and into one or more of the serous cavities. On the other hand, when the kidney has reverted to its normal condition and recovered its functional activity, the blood being first freed from excess of urinary solids and water, a current of dissolved urinary crystalloids sets in from the tissues into the blood, and out by the kidneys. Thus, by a copious flow of urine, the dropsical accumulation is soon swept away.

We have an illustration of the result of an excess of a crystalloid in the blood when the kidneys are healthy, in the phenomena of diabetes. The dissolved crystalloid sugar finds a ready outlet through the kidneys, and carries with it so much water that, notwithstanding the copious imbibition of liquid which is prompted by the urgent thirst, the tissues of the body become more or less dehydrated.

The diffusion of a soluble crystalloid through the blood and tissues, and its final elimination, occur probably in this manner. Whether introduced by the stomach or beneath the skin, the crystalloid enters the blood, and, mingling with that fluid, is rapidly and equally diffused into all the tissues. In a few minutes, as we have seen, the salts of lithium begin to pass off by the kidneys. The elimination by the kidneys lessens the amount in the blood, and the distribution through the system is equalised by the return of a portion of the crystalloid from the tissues to the blood. This sequence of events continues: escape by the kidneys; passage back of a portion of the salt from tissues to blood; the blood and the tissues at each round of the circulation retaining less and less of the unassimilated salt, until, in the course of a few days, the whole of the crystalloid has passed out, mainly through the kidneys, but partly, perhaps, by some other channels.

As overfulness of the blood-vessels results often in a transudation of water from the blood into the tissues, so depletion of the blood-vessels determines the rapid passage of water from the tissues into the blood. The soft tissues, be it remembered, contain four-fifths by weight of easily separable water. Dr. Polli, an Italian physician, in the course of an elaborate series of experiments on human blood, ascertained that the specific gravity of the blood was rapidly lowered, not only by successive bleedings, but by a single bleeding. He found, for instance, that at the end of a single bleeding, taking the mean of forty experiments, the blood had a lower density than that drawn at the commencement of the venesection, in the proportion of 5.96 to 6.127. (*Medico-Chirurgical Review*, 1847, p. 306.) This result is in entire agreement with the experiments of Zimmermann on the blood of animals. For instance, Zimmermann found that the blood which first flowed from the crural artery of a dog contained 199.3 parts of solids