the first place, into its origin and cause. As is well known—in two bands, one to the north and the other to the south of the equator—the north-east and south-east trade-winds, reduced to meridional directions by the eastward frictional impulse of the earth's rotation, drive before them a magnificent surface-current of hot water 4,000 miles long by 450 miles broad, at an average rate of thirty miles a day. Off the coast of Africa, near its starting-point, to the south of the islands of St. Thomas and Anna Bon, this equatorial current has a speed of forty miles in the twenty-four hours, and a temperature of 23 deg. C. (73 F.).

"Increasing quickly in bulk, and spreading out more and more on both sides of the equator, it flows rapidly due west towards the coast of America. Towards the eastern point of South America, Cape St. Roque, the equatorial current splits into two, and one portion trends southwards to deflect the isotherms of 21 deg. C. (70 Fahr.), 15.5 deg. C. (60 Fahr.), 10 deg. and 4.5 deg. C. (50 deg. and 40 Fahr.), into loops upon our maps, thus carrying a scrap of comfort to the Falkland Islands and Cape Horn, while the northern portion follows the north-east coast of South America, gaining continually in temperature under the influence of the tropical sun. Its speed has now increased to sixty-eight miles in twenty-four hours, and, by the union with it of the waters of the River Amazon, it rises to one hundred miles (6.5 feet in a second); but it soon falls off again when it gets into the Caribbean Sea. Flowing slowly through the whole length of this sea, it reaches the Gulf of Mexico through the Straits of Yucatan, when a part of it sweeps immediately round Cuba; but the main stream, having made the circuit of the Gulf of Mexico, passes through the Strait of Florida; thence it issues as the Gulf-Stream in a majestic current upwards of 30 miles broad, 2,200 feet deep, with an average velocity of four miles an hour, and a temperature of 86 deg. F. (30 deg. C.) The hot water pours from the strait with a decided though slight north-easterly impulse, on account of its great initial velocity."

It follows the line of the American coast, and abuts on the cold Labrador current, the two streams being so distinct that a vessel may have her bows in one and her stern in the other, the thermometer registering a difference between them of 30 deg. Fahr. Continuing to ascend, the current passes Sandy Hook, near New York, and reaches Cape Cod, latitude 41 deg., and thence spreads chiefly eastward, the velocity having greatly diminished.

According to Professor Buff, a great part of the warm water is carried, partly by its own motion, but chiefly by the prevailing west and north-west winds, towards our own coasts and those of Norway and Spitzbergen. This water can be traced across the Atlantic, skirting the coasts of France, Great Britain, Scandinavia, rounding the North Cape, and passing the White Sea and the Sea of Kari, along the western shores of Nova Zemla and Spitzbergen; and, after coursing round the coast of Siberia, a trace of it may be found in Behring's Straits entering the North Pacific.

One proof that a current takes this direction is the fact that drift-wood and tropical products from the Gulf of Florida have been washed on the western shores of Ireland, Great Britain, the Hebrides, Orkney, Shetland, and Faroe Isles, Norway, and even Spitzbergen; but a stronger proof still lies in the direction of the isothermal lines of the North Atlantic, for these attribute a far higher degree of warmth to the European shores than to those in the same latitude on the American continent.

It is thus seen that those physicists who do not accept the theory of the Gulf-Stream reaching our coasts, hold that a considerable portion of this warmth may be assigned to the westerly winds which follow its course, and, deriving heat from it, carry this onwards to us.

The broad fact with which we have to deal, as medical men, in considering our climate is, that a warming influence reaches its shores from the Atlantic, traceable somehow to a reversed equatorial current—a current most apparent in the Straits of Florida and off the American coast; but whether this warming influence be conveyed by the Gulf-Stream itself or by a drift current, as the cautious Admiralty chart indicates, is immaterial. We know that, though the waters of the Gulf-Stream may lose their heat after the thirtieth meridian is passed, the said heat has been absorbed by the air, and is brought to us as warm south-west winds; and not only this, but all the heat received by the current in the tropics above 86 deg. Fahr. becomes latent, and is given back in temperate latitudes as free atmospheric heat. It is sufficient to recognise the original source of all this warmth; and to acknowledge that full exposure to it, as is seen on the west coast of Ireland, in Devonshire, and Cornwall, implies considerable advantages in mean and winter temperatures, as well as a larger rainfall and greater equability of climate.

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.

THE early effects are those of excitement in most cases. The patient speaks incoherently, and often loudly, and may struggle much. The degree of this excitement and its continuance vary greatly in different persons. No doubt temperament may affect it; but the state of previous nervousness and the condition of the bowels influence it considerably; while intemperate habits, or the inordinate use of tobacco or opium, most markedly augment it. It is always a dangerous condition. The respiration is often much obstructed, and the terrible strain to which the heart and the vessels of the brain are subjected is full of anxiety. Occasionally, patients become very rigid, and, clenching the teeth and setting the muscles, seem almost in a tetanic seizure. The cloth should be withdrawn, and close attention given while such unpleasant effects last. Usually, this state passes off quickly; but, if not, do not increase the supply of chloroform on the towel, as a very rapid and deep induction is not uncommon after such struggling. It is always to be remembered, however, that this stage of excitement may not occur at all, or be very transient; as otherwise, in watching for it, the full state of anæsthesia may be reached before we are aware of it.

When the patient is struggling, there is a right and a wrong way of holding him. If you try to restrain him by sheer force, you will only augment his struggles. When he meets with resistance, he tries hard to overcome it; but if you guide his hand clear of the cloth, which it is usually his object to seize, you will occupy his attention, and prevent him from doing any harm. A good way to fix his body, if that be required, is for an assistant standing on each side to face the patient, and place a hand in front of each shoulder, and so press him firmly down on the bed. There is no better or more effective way of fixing him than this. The patient is generally much concerned to get rid of the saliva which the chloroform causes to be secreted in augmented quantities. Some keep constantly swallowing, while others eject it. In the latter case, they appear to concentrate their whole energy in collecting and throwing it out, and this so occupies them that the inhalation is retarded. You should always have a soft cloth beside you to wipe the sputum quickly out of the mouth, and the same plan should be adopted to get rid of any vomited matter which may be brought up. To twist the neck towards a basin is a troublesome and even dangerous method of management. Till the vomiting has passed off, no more chloroform should be given. As the patient becomes more deeply affected, the respiration gets regular and natural; the pulse, probably hitherto excited, comes down to the natural standard, and frequently assumes a regularity it had not at first. The anæsthetic, in turn, acts on the brain and spinal cord, and so abolishes intelligence, together with voluntary motion and sensation. This stage is all that I have usually seen operators abroad seek for. They do not, as a rule, wait for the disappearance of reflex action as we do, and, consequently, the movements of the patient commonly continue during an operation. An English authority has told us to seek no more than the abolition of feeling, and says we are to keep the patient quiet by force during the operation. This is wrong. At the stage alluded to, the danger to the heart during an operation is, if possible, augmented. It is requisite for safety that we go on till reflex action is asleep, and this we know by the lids not closing when the eyeball is touched. This is a very good and useful test of the condition of complete anæsthesia having been attained; and no operation should be performed till that state has been reached. If we interfere sooner, no protection to life is secured by the use of the chloroform. Another test, but a much less efficient one, is to handle the diseased or injured part, and observe if it be withdrawn from us. I have not been able to discover any change in the pupil which is so constant or decided as to be of any practical value as a guide in administering chloroform, so that I will not occupy your time by any reference to that point.

* Concluded from page 7 of last number. In the first part of this paper, at page 5, column 1, line 5 from bottom, for "individual", read "undivided"; and in column 2, line 26 from bottom, for "meat, soup, and bread", read "meat-soup and bread".

What we wish, then, is to annul intelligence, voluntary motion, sensation, and reflex action. We do *not* wish to interfere with the vital functions of the lungs and heart, which go on so long as their regulating ganglia are not involved. If obstruction to the breathing arise, and the blood become supercharged with the anæsthetic, then danger to the functions referred to very quickly comes on. Asphyxia will show itself by the dark lips and face, and more or less embarrassment in breathing, while syncope too surely proclaims itself by the death-like pallor which overspreads the countenance. It is as showing a tendency to these dangerous conditions that any lividity or paleness of the lips during administration demands instant attention. A slight degree of either state may be present (and, in fact, in most cases is present), but it should never be trifled with, but always be carefully watched. Lividity, with loud breathing, you will now and again see; but I trust you may never have any experience of the deadly pallor, the opaline whiteness of the features, which marks the most fatal of all accidents from chloroform. I have seen it twice, and can never forget it. Both patients were rescued by lowering the head and shoulders in the way afterwards related. Whether this syncope is always preceded by such obstruction to the respiration as should attract attention, is not by any means clearly established. For my own part, I think that it usually is; but careful observers who have had to deplore the fatal consequences of such an occurrence, have strenuously maintained that no preliminary embarrassment to the breathing was present. The first time I saw it was in the Royal Infirmary, and I was standing close to the patient at the moment. I cannot say that I saw any evidence of obstruction before the establishment of the syncope, but, as I was not in immediate charge of the administration, I cannot be certain. On the second occasion, the patient unquestionably did present signs of obstructed respiration, but not in a violent or intense degree. The embarrassment did not appear worse than it often is when it passes off without harm; but in a moment, as if a flash of light passed over the face, every capillary was emptied of blood, and the whole expression became that of a dead man. What was done in these cases was what I recommend you to do in like circumstances. The tongue was well drawn out, the head and shoulders were lowered over the side of the bed till the head touched the floor, and cold water was dashed on the face and chest. In the one case, almost immediate reaction took place, the heart resumed its function, and the patient is not aware to this hour that he was in any danger, nor did he suffer any after-harm from the chloroform. In the other, recovery was more slow; but it was, I think, fairly attributable to the means employed. I sat down on a chair, and pulled his head down from the high hospital table into my lap. An assistant held the tongue out, another dashed water, and I was able to apply Silvester's method of artificial respiration. A terrible moment or two passed before life was rekindled. The most curious and instructive circumstance, however, was, that twice over the pallor returned when the patient was replaced on the table, to disappear again when the head was lowered as before. Nélaton explains the condition to which I have referred as being due to anæmia of the brain; hence the mode of dealing with it described, which emanated from him. Whatever be the true cause of the symptoms, I am fully convinced of the efficacy of the remedy. It is said that in these cases the heart ceases to beat before the respiration is arrested; but, in truth, the whole affair takes so short a time, the invasion of the danger is so rapid, that it is not easy to declare what is the succession of events.

The electric or galvanic battery is capable of doing good service in the circumstances I have described. The poles can either be applied to the nape and præcordium, or to the phrenic nerve at the point where the omo-hyoid passes below the sterno-hyoid in the neck, and the side of the chest near the heart. The proper management of either the continuous or the interrupted current for the purpose held in view is not so simple as many represent; and as a machine is seldom at hand when wanted (never, I may say, in private practice), you need hardly count on any aid from it. A rapid and very good plan of rousing the heart is to saturate the sponge I advised you to have prepared before hand, with very hot water, stuff the bowl of which I spoke with it, and evert it over the heart. This acts rapidly and with energy. For the relief of mere asphyxia it is manifestly wrong to lower the head, though the record of fatal cases would show that this has been frequently done. When the obstruction to the breathing is due to the falling back of the tongue and its mechanically impeding the breathing, then it can be easily removed by drawing the tongue itself forward, or seizing the beard or the lower jaw, as Mr. Clover has proposed, and drawing the whole forward; but when the difficulty is lower down ("laryngeal"), then nothing short of pulling the tongue firmly and decidedly out of the mouth, well beyond the line of the teeth, will give relief. The finger is quite inadequate to accomplish this. The artery-forceps should be used, and a good firm hold taken of the organ, and so strong a pull made that it is very firmly put

on the stretch. Mr. Lister has stated his conviction that this does more than act mechanically; he supposes that it acts through the nervous system in re-establishing the dormant function. Be this as it may, the effect is markedly good. Cold water, slapping the face and chest smartly, and artificial respiration, are the other remedies called for. A current of cold air from window or door should at once be allowed to play on the face and chest. Turning the head to the left side will, in an uncertain and feeble way, replace the drawing out of the tongue if it has fallen back. It may be true that the tongue is occasionally drawn out and lacerated unnecessarily when we use the forceps (though you will admit that it is not often that we have here to interfere with it); yet it is better that it should occasionally be pulled out without cause, than that by neglecting this important measure we should risk losing our patient. I have seen no case in which opening the larynx or trachea was called for; but if artificial respiration could be better conducted by so doing in cases of danger, then such an operation would be legitimately performed. The artificial respiration should be continued for a considerable time, and not desisted from in fatal cases till all possible hope is abandoned. Smelling salts to the nose, and the injection into the rectum of aromatic spirit of ammonia (a drachm in an ounce of water), might help to rouse the patient. In no case should a stimulant be given by the mouth unless the patient can distinctly swallow. If brandy be forced into his throat when deglutition is gone, only harm can follow. It is always to be remembered that the chest may heave as if respiration were going on, and yet no air may be entering the lungs.

I have been thus induced to speak to you of the dangers which may attend the administration of chloroform, but in point of fact these dangers very rarely appear. Usually the patient sinks into a gentle and undisturbed sleep, and awakens to express his pleasure and astonishment that the operation is completed. When we wish him to recover, the chloroform-cloth should be put far away from him, never left on the pillow; he should be made warm by blanket and hot pan; a plentiful supply of fresh air admitted, and, if necessary, some smart slaps given to his face to rouse him. So soon as he can swallow, some strong warm tea should be given, and in a quiet dark room he may be left to sleep. I know nothing like tea for removing all traces of the chloroform; and if a short sleep be obtained, no further trouble need be feared. Sickness depends, I think, more than anything else on the prolonged use of chloroform, when care has not been taken so to manage it that as small a quantity as possible is used in keeping up the effect. When the stomach is quite empty and the system has been drenched with chloroform, the recovery is less rapid and satisfactory. Do not give any opiate afterwards either by the mouth or otherwise: it only tends to derange the stomach and cause sickness and headache. Iced champagne, chips of ice, darkness, rest, light food, and heat over the abdomen, have always appeared to me to act most beneficially in removing chloroform sickness; but of this, I am glad to say, my experience has been very limited.

There seems some reason to suppose that chloroform accumulates, to some extent, in the system. Certain it is, that no patient should be left alone till he is entirely and completely recovered from its influence. A partial restoration should never be deemed a condition of secured safety. The sooner the patient returns to the use of solid food the better. Constipation is a common consequent of chloroform action. On the second or third day a saline purgative should be used to relieve this, and any remains of headache are best got rid of by such means.

Gentlemen, in bringing these remarks to a close, I regret that my time will not allow me to dwell on many collateral points of great interest. I have tried to follow out the narrative of chloroform administration as clearly as possible. I am, as I before said, very conscious that a change may any day come in the success which has hitherto attended my own practice as regards chloroform; but I can conscientiously say that hitherto I have never refused to administer it to any patient who had an operation to undergo, and that I have never been baffled in securing the required effect, nor has any accident followed when the rules I have tried to lay down have been attended to. If you are to secure safety, it can only be by constant and sedulous attention. An accident can usually be traced to an error on the part of the administrator. Do not believe in idiosyncrasies, but have faith in the power of care and caution on your part when you administer this useful and very powerful agent. (Silvester's method of artificial respiration was then demonstrated on a patient.)

[I regret to say that, since the above lecture was delivered, a death from chloroform has occurred in the out-door department of the Royal Infirmary. It was administered for the removal of a finger. The patient was a very weakly and particularly anæmic patient, on whose pale face the whiteness of the fatal syncope produced very little change.

The head and shoulders were not drawn over the table, but the pillow was removed, and artificial respiration, drawing out of the tongue, and cold water dashed on the face, were tried without effect.]

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

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

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I WISH now to direct attention to some of the physical results of an impeded return of blood through the systemic veins. In order that the blood may maintain its normal composition and its physical properties, it must move freely through the vessels. Dr. Polli (*op. cit.*, p. 306), by a series of experiments, clearly proved that the blood is rendered more dense by inducing an artificial stagnation or engorgement by means of the fillet applied for some time previously to opening the vein; and his conclusion is, that "venous blood, when it is prevented by any obstacle from circulating freely in its veins, becomes more dense, or loses a certain portion of its watery principle". And he asks: "Does not this fact constitute a principal pivot of the doctrine which explains œdemas, cellular dropsies, and other infiltrations, by considering them as exudations induced by obstructed circulation?" Without doubt, the œdematous swelling of a limb, whose principal veins are obstructed, is the counterpart of the blood-thickening which results from the transudation of the watery constituents. The force which drives the water through the walls of the vessels is derived from the left ventricle of the heart. The blood is driven through the capillaries into the veins, and its passage through the venous channels being impeded, a portion of its water is forced through the capillary walls into the tissues outside. The result is an œdematous dropsical swelling of the limb, and an increased thickness and consistency of the blood within the veins. This simple experiment explains some forms of blood-thickening which have perplexed pathologists.

It explains the blood-thickening of apnoea. It is a well known fact that a great impediment to the aëration of the blood is always associated as one of its consequences with an impeded circulation through the lungs, and a consequent engorgement of the right side of the heart and of the whole systemic venous system. One result of this impeded venous circulation is a puffy œdematous condition of the subcutaneous tissue, especially of the face and neck; and another result is, that the blood becomes dark, thick, and treacly, and coagula often form in the right cavities of the heart and in the pulmonary artery.

Dr. George Buchanan, in one of his papers on tracheotomy in croup and diphtheria, read before the Medico-Chirurgical Society of Glasgow, in giving the history of a case in which he opened the wind-pipe in an advanced stage of laryngeal diphtheria, states that, "as soon as the wound was made, a quantity of dark tarry-looking blood flowed from the edges, and was with difficulty cleared away by firm and repeated applications of a moist sponge". Dr. Buchanan, again referring to the state of the blood, says "it was quite evident that that fluid was in a dark and viscid state. The darkness might be accounted for (he says) by the impeded respiration; but the tarry consistency struck me as a condition which might be one of the pathological elements of the disease (diphtheria) in an advanced stage." The tarry consistency of the blood is, in fact, one of the usual results of extreme and prolonged apnoea. Not long since, during the operation for tracheotomy on account of laryngeal obstruction of long standing, I saw a decolorised fibrinous coagulum coughed out of one of the cut veins in the neck. When I say it was coughed out, I mean that it was thrust out of the vein during the expiratory effort of coughing, which, as we continually see, always forcibly drives the blood into the superficial cervical veins.

There is also chemical evidence of the blood-thickening which results from apnoeal conditions. Thus the late Dr. Dundas Thomson, who published an elaborate paper on the Chemistry of the Blood in Cholera (*Medico-Chirurgical Transactions*, vol. xxxiii), states that one specimen of blood "from a patient who laboured under an affection of the mucous membrane of the air-tubes contained a greater excess of solids in proportion to water than he had found even in cholera blood".

I now come to one of the main objects of this communication, which is to suggest a more complete explanation than has hitherto been given of the increased density and viscosity of the blood during the collapse

stage of cholera. In order to explain the phenomena, we must have the facts clearly set forth.

The main facts, then, are these. The blood-thickening is a phenomenon which is present only during the stage of collapse; it does not occur during the diarrhoeal stage, and it quickly passes away when reaction occurs. We have already seen that mere diarrhoea, however profuse, does not thicken the blood; the reason being that, so long as the circulation of the blood is unimpeded, water passes from the tissues into the blood as rapidly as it escapes from the blood into the bowels. Dr. Garrod, many years ago, made careful analyses of the blood in cases of cholera, and he states that "the amount of intestinal evacuations in any case is by no means an indication of the extent to which the blood has become altered". (*London Journal of Medicine*, vol. i, p. 409.)

The blood-thickening, as a rule, bears a direct relation to the degree and the duration of the collapse. Now, there is one condition which is common to cases of apnoea and of choleraic collapse; and that is an impeded flow of blood through the lungs. This impeded circulation, with the consequent engorgement of the systemic venous system, is the main cause of the blood-thickening, which is also common to the two pathological states. The blood is thickened partly in consequence of its slow movement and partial stasis within the veins; but mainly, perhaps, by the passage of its watery portion through the walls of the capillaries. In the choleraic cases, it is probable that the passage of water from the distended venous system into the tissues is facilitated and much increased by the previous partial dehydration of the tissues during the diarrhoeal stage. The less water the tissues contain, the more readily would water pass into them through the walls of one of the distended capillaries.

There is another condition, common to cases of apnoea and choleraic collapse, which must tend to lessen the stream of water which naturally sets from the tissues into the blood. The impeded circulation through the lungs during the stage of collapse involves, as a necessary consequence, a diminished supply of oxygen, and, therefore, a diminished oxidation of the tissues. Many of the products of oxidation are crystalloids; for example, urea, uric acid, creatin, and the bile acids. These crystalloids, when formed in the tissues, pass into the blood, and with them they carry, or are carried by, a current of water. The crystalloid products of oxidation may be said normally to have an interstitial diuretic influence similar to that which urea and other urinary crystalloids exert upon the kidneys. During the collapse stage of cholera, the main products of oxidation—carbonic acid, urinary and biliary constituents—are simultaneously and greatly diminished. We see, then, that, at the same time that the distension of the systemic veins tends to force water from the blood into the tissues, the formation of crystalloids is much lessened; and, in a corresponding degree, the flux of liquid which, under their influence, normally passes from the tissues into the blood, is impeded. It is obvious that, during the stage of collapse, with the physical conditions already described favouring the passage of water from blood to tissues, and retarding the flow from tissues to blood, a continued escape of water through the alimentary canal would have much more influence on the composition of the blood than an equal drain of liquid at a time when the circulation of the blood, and the chemical and physiological changes resulting therefrom, are unimpeded.

I shall, perhaps, render my doctrine more intelligible if I recapitulate now the main phenomena of cholera upon which the blood-changes depend. In the diarrhoea stage, the discharge of water from the bowels draws an equal amount of water from the tissues, but does not thicken the blood. In the stage of collapse, the impeded circulation through the lungs involves, as a necessary consequence, venous distension, a limited supply of oxygen to the blood and the tissues, and hence a lessened formation of crystalloids in the tissues. It consequently happens that two influences tend simultaneously to deprive the blood of water: (1) the arrest or diminution of the current of water-borne crystalloids from the tissues; and (2) the passage of water from the distended veins into the more or less dehydrated tissues. If, at the same time, there be a continuance of the intestinal discharges, the blood-thickening is yet further increased.

Before I conclude, I wish to direct attention to the general conditions under which the circulation of the blood is arrested or much retarded by the influence of the minute blood-vessels. The phenomena to which I refer may be observed especially in cases of apnoea, cholera-collapse, and chronic renal disease.

The first effect of paralysing the respiratory muscles by curara is to increase the blood-pressure in the systemic arteries. Then, after a time, the pressure falls; and, after death, a large accumulation of blood is found in the right cavities of the heart, while the left are comparatively empty. The explanation of the phenomena appears to be

* Concluded from page 8 of last number.