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.,

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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

to 800.7 of water. After the loss of about ten ounces of blood, the proportion of solids in 1,000 parts was reduced to 187, while the water had increased to 813. A horse suffering from tetanus had his carotid artery opened: 1,000 parts of the serum of the blood which first flowed contained 106 parts of solids; while, after fifteen pounds of blood had flowed, the proportion of solids in the serum was reduced to 100.5 in 1,000. (Heller's *Archiv für Chemie und Mikroskopie*, 1847, p. 385.)

The explanation of the rapid passage of water from the tissues into the blood appears sufficiently obvious. Normally, there is an equilibrium of pressure within the blood-vessels and in the surrounding tissues. A partial emptying of the vessels by an escape of blood tends to lessen the pressure within them, and the equilibrium is restored by water being pressed from the tissues through the capillary walls. Thus the fullness of the blood-vessels is maintained, while the blood is diluted with water, and its proportion of solids is lessened. We have illustrations of the same hydraulic principles in some morbid phenomena and in the practice of therapeutics. Thus, a dropsical patient has his blood-vessels overfull, and his tissues flooded with excess of water. A dose of elaterium excites copious watery discharges from the bowel; this escape of liquid tends directly to deprive the blood of its water. Then the drain of water from the blood, and the consequent diminution of pressure within the vessels, cause an absorption of the dropsical fluid, which is now pressed from the tissues through the capillary walls; and thus, by a copious purging, a dropsical accumulation may be removed. Sir Thomas Watson mentions the case of a man in whom a profuse purging, excited by intoxicating doses of rack punch, led to the disappearance of a large hydrocele in the course of one night. Here it is clear, as Sir Thomas remarks, "that the expenditure of serous fluid from one part led to its absorption into the blood from another". In other words, the pressure within the blood-vessels having been lessened by a copious drain of liquid, the equilibrium was restored by water from the hydrocele being pressed through the walls of the capillaries into the blood.

Now let us consider the physical effects of copious watery purging upon a subject not dropsical, but previously in a normal condition. Mere diarrhoea, however copious, has no appreciable influence in thickening the blood or increasing its specific gravity, and the explanation of this is sufficiently obvious. As venesection causes a rapid dilution of the blood by water passing from the tissues through the walls of the vessels, and as the operation of a hydragogue purgative often results in the removal of a dropsical accumulation, so profuse choleraic purging first tends to lessen the contents of the blood-vessels, and then, to fill the vacuum and restore the equilibrium, water passes from the soft tissues into the blood, which thus maintains its fluidity notwithstanding the copious discharge of liquid through the bowels. When the watery discharges from the bowels have ceased, the hydraulic currents are reversed. During the stage of diarrhoea, absorption of water through the mucous membrane of the alimentary canal is prevented by the outward flux of liquid; the current is entirely outwards; but, when the discharges have ceased, water taken into the stomach rapidly enters the blood-vessels, and is thence transferred to the tissues, which have before given up a large portion of their water to the blood. So great is now the demand for water by the tissues, and so strong is the current towards them, that for a period, varying in different cases from a few hours to several days, little or no urine is secreted, the main stream of water being into the dehydrated tissues: a direct reversal of the tide of liquid which sets from the tissues through the blood-vessels, towards the alimentary canal, during the diarrhoeal stage. The stream of liquid from the blood into the tissues may carry with it urea and other excreta, and thus may contaminate and poison the tissues. This tissue-poisoning is probably in part the cause of the consecutive fever of choleraic attacks. On the other hand, we have evidence that, when, in consequence of degeneration of the kidneys, the blood and the tissues are contaminated with urine, a hydragogue purgative removes not only water, but also some urinary excreta from the blood, and thus counteracts the tendency to uræmic poisoning. We know from experience that the surest way to restore the secretion of urine after a copious watery diarrhoea is to supply an abundance of water to the blood and the tissues through the stomach and through the skin by an occasional immersion in a tepid bath. If frequent vomiting interfere with the introduction of liquid through the stomach, tepid water may be injected into the rectum.

[To be concluded.]

NAVAL MEDICAL PROMOTIONS.—The undermentioned surgeons have been promoted to the rank of staff-surgeon in Her Majesty's fleet, with seniority from November 20th; Edward Mulcahy, George Curtis, Ingham Hanbury, Alexander Scott, William Jabez Inman, George Robertson, M.D., John Richard Burke, M.D.

ON A CASE OF DIABÈTES INSIPIDUS TREATED BY (1) BELLADONNA AND (2) ERGOT.

By WILLIAM MURRELL, L.R.C.P.

RESPECTING the treatment of a large number of diseases, it must be confessed that our knowledge is almost *nil*. In this number may be included that group of symptoms to which we apply the term diabetes insipidus. It is only by the study of pathology and of the physiological action of drugs, combined with careful clinical observation, that we can hope to attain success in the treatment of disease, and to establish the science of therapeutics upon a firm scientific basis. In the following case of polyuria, the remedies employed—belladonna and ergot—were administered on purely theoretical grounds. That their exhibition not only modified the excessive urinary secretion, but also removed some of the most distressing accompanying symptoms, will be seen by the record of the case.

The patient (Isaac C.) was on several occasions under the care of Dr. Ringer, and, at the time at which the belladonna treatment was commenced, was an inmate of the Children's Wards in University College Hospital. He was at that time between 13 and 14 years of age. There was no history of the disease being hereditary. The father was in the enjoyment of good health, and was in constant and active employment as the proprietor of a dairy. The mother was a strong healthy-looking woman, suffering from nothing but a little chronic bronchitis in winter. She had spat blood, but never more than in streaks, which had occasionally followed a paroxysm of cough. There was no suspicion of her being phthisical. She had seven children, three girls and four boys, all of whom, with the exception of the patient, were perfectly healthy. Of the paternal grandparents nothing was known. The patient's maternal grandfather was an asthmatic, and his maternal grandmother was still living and in good health. The parents were apparently temperate in their habits. There was no history of consumption in the family, and none of neurotic disturbance, such as apoplexy, chorea, or paralysis. The history of the patient's illness obtained from the parents was as follows. When six months old, he had the measles, and, four or five months later, it was noticed that he drank much more than is usual with children of his age. When about fifteen months old, he fell and cut his head against the stairs, leaving a scar still visible on the margin of the right orbit. The mother attached but little importance to the accident, and appeared not in any way to have associated it with the subsequent illness. Since that time, he had suffered greatly from thirst. He was "always thirsty"; was drinking all day long; and they had "almost to drag him away from it". They had tried to keep him from drinking so much, but it "always made him sick and bad". He occasionally had half a glass of beer, but it had no particular effect on him. He was fairly intelligent and good tempered; but his mother stated that he was "not so sharp as his brothers"; that "he took his learning badly". His appetite had never been good; he lived chiefly on milk, of which he took between five and six quarts daily. He never cared for butcher's meat or vegetables, but liked pork and German sausages. His skin had always been very dry and harsh. His mother said that no amount of exercise ever made him perspire, and she did not believe "he ever sweated more than once in his life". He suffered greatly from cold; always seemed chilly; "was shrivelled up by it"; and was over the kitchen fire all day long, even in summer, "just like an old man". He suffered a great deal from cramps in his hands and in the calves of his legs; the pain in the hands came on whenever he attempted to write, but that in the legs was almost constant. He was sick every morning, sometimes more than once, and nearly always after eating. The motions were thick and dry, and were often passed in lumps. There was occasionally oozing of blood from the gums. The mouth and lips were usually dry and parched. He was not subject to boils. During the time he was under observation at the hospital, he was always well nourished, fairly healthy-looking, and rosy cheeked. There was an absence of the emaciation frequently associated with excessive diuresis. He was carefully examined upon several occasions, but, with the exception of the state of the skin and the passage of the large quantity of urine, he appeared to be perfectly healthy. The urine was repeatedly examined. It was clear, almost colourless, acid, ranging in specific gravity from 1005 to 1008, free from albumen and sugar. His temperature was taken twice daily, and varied between 98 deg. and 99 deg. Fahr.

For eight days after his admission, he took no medicine, and the average daily quantity of urine was 2819 cubic centimètres (about five pints). There was no diminution in the urine during this time, the quantity being as great on the eighth as on the former days. He then took five drops of the tincture of belladonna for four days, the daily average