made for the crucible furnace stand, as a rule, exceedingly well; but with alterations in form great difficulties are introduced, more especially with muffles, which, as at present made, will not stand any sudden heat, nor will they hold their shape at any temperature approaching whiteness. The burner alone will be useful in heating many substances in the open, but, owing to the broad and diffused flame, it is of little practical value for blow-pipe work.

The special advantages of the apparatus are that it is entirely self-acting, requires no attendance, and that it greatly increases the range of temperatures which can be obtained by any simple apparatus. The largest size at present made takes crucibles not exceeding three inches high.—*Nature*.

THE ACTION OF MEDICINE.

By E. M. McPHERON, M.D.

A KNOWLEDGE of the *modus operandi* of medicine when introduced into the organism is the most essential element of therapeutics. In order that the physician may make a rational application of remedial agents for the cure of disease or alleviation of pain, it is necessary that he be possessed of a knowledge, to some degree, of the method of action, when introduced into the body, of the agents which he is using; and the more he knows of such action, the more rational will be their application and the more successful will be his practice.

We will admit that the manner of action of many therapeutic agents in the organism is obscure, and in some instances impossible of detection and apparently inconsistent, as is instanced in the action of carbo-veg. It is an admitted fact, among those who have specially experimented with this agent, that it is incapable of absorption when introduced into the organism in the natural way, regardless of the amount introduced or the high degree of subdivision; still it is a well-known fact that this is an agent used extensively by the best physicians of our school and of other schools to overcome passive hemorrhagic conditions of organs of the body remote from the alimentary canal, prominent among which is the uterus.

In Scudder's "Diseases of Women," page 461, in treating of menorrhagia, the author says: "In passive uterine hemorrhage I have placed more dependence upon carbo-veg., 2d dec. trituration, than upon any other remedy, though of course it is not adapted to all cases. I give it in grain doses, every one to four hours, and usually follow it with the tincture of cuprum as a blood maker."

There are other agents which are almost insoluble, such as subnitrate of bismuth, sulphur, calomel, etc., but it is probable that these substances undergo decomposition in some of the fluids of the body, being rendered partially soluble thereby. According to Headland, calomel is rendered soluble, to some degree, by the action of the biliary secretion upon it; and, aside from this, that it is absolutely insoluble and incapable of absorption in the animal organism; but no experimenter has ever discovered a solvent for carbo-veg., hence we cannot account for its probable action in such a manner. A number of propositions, as formulated by Headland, will serve as a basis of what we shall say upon this subject.

The first proposition affirms that "the great majority of medicines must obtain entry into the blood or internal fluids of the body before their action can be manifested;" that mechanical contact with the parietes of the stomach is not sufficient, in general, to produce a systemic effect. The only exceptions to this rule may be cited those agents having a mere local action on the mucous membrane, simple contact being necessary, such as irritant emetics, irritant cathartics, superficial stimulants, sedatives, astringents, etc. Medicines do not have to enter the blood directly to reach distant parts. For example, when chloroform, cocaine, aconite, or opium—fluid preparations—are rubbed upon the skin or mucous membranes, they are directly absorbed by the intestinal fluids, acting upon the minute nervous ramifications in the superficial tissues before being taken into the blood. Such is the action of belladonna, atropine, and eserine when dropped into the eye of an animal. They are directly absorbed by the intestinal fluids of the cornea, sclerotics, and iris, and exert their action upon the tissues of the parts before entry into the blood. From the foregoing, it might be inferred that these medicines may never reach the blood, but this is pretty conclusively disproved by the fact that a drop of hydrocyanic acid, dropped into the eye of a dog, has been known to produce speedy death; and the more conclusive does this seem to be, since it has been positively demonstrated that nervous connection alone is wholly insufficient for the transmission of the action of medicines in the organism. To substantiate our proposition, we will make the following affirmations:

1st. That a medicine introduced into the organism elsewhere acts in the same way as when introduced into the stomach. Many proofs of this may be shown. Tartar emetic, ipecac, apomorphia, etc., injected into the tissues, will produce emesis, and even more rapidly than when taken into the stomach. A moistened leaf of tobacco, placed over the radial artery at the wrist, has been known to provoke vomiting. Sulphate of magnesia, when injected into the veins, will act on the bowels; and, in like manner, rhubarb or senna, injected into the thorax, will produce purging. Croton oil, liquid jalap, rhubarb or gamboge, rubbed upon the abdomen sufficiently long, will produce purging. Injections of nux are rapidly followed by toxic symptoms, similar to those following its internal administration, etc.

2d. The continuity of nerve is not necessary for the propagation of remedial effects; but vascular connection is necessary. This affirmation is proved by the experiments of Magendie. He introduced some urari poison into the limb of a dog, which was only connected to the trunk by means of quills uniting the divided ends to the main vessels. It rapidly took effect. Having divided all the nerves and lymphatics in the intestine of another dog, he introduced into it some nuxvom. beyond the division. It quickly acted, and must have done so through the vessels. Sir B. Brodie cut all the nerves of the anterior extremity of a rabbit near the axilla, and introduced urari into the foot. It quickly acted. Sufficiently tight ligaturing of an extremity will prevent systemic toxic influence. Sir B. Brodie also ex-

perimented upon parts connected with the body only by nerve continuity carefully dissected out, and found nervous structure incapable of transmitting toxic action. Other experimenters, as Emmer, Robinson, etc., have confirmed this latter experiment with the most violent of poisons, prominent among which is prussic acid.

3d. The circulation of the blood is sufficiently quick to account even for the operation of those poisons which act most rapidly by influencing the nerve centers. Experiments have proved that a substance will traverse the whole circulation of a dog in nine seconds, and of a horse in twenty seconds, while in an adult man the time required is 65.76 seconds. This is sufficient to account for the mode of action of that most rapid and fatal of all poisons, viz., prussic acid. Besides, if a medicine acted by nervous transmission, it would act as soon as it touched the stomach or injected into the tissues. Animals will sometimes live for thirty minutes after being poisoned with cyanide of potassium.

4th. The great majority of medicines have been detected in the blood or the secretions formed from it. We have proved that poisons act when introduced into the organism at any point; that vascular connection is required for this action; that nervous connection is wholly insufficient; and that the circulation is sufficiently rapid to account for the action of the most rapid of poisons. Now, if our last affirmation can be proved, we will have carried our first proposition close to certainty. In 1847, Mr. Allen detected daturia in the urine of a man poisoned by stramonium. In 1824, M. Runge discovered the principles of henbane and belladonna in urine. Kletinsky finds that if the throat be gargled for five minutes with a solution of any soluble mineral salt, its presence may be detected in the urine next evacuated. Chloroform has often been detected in the blood. Indigo, logwood, and many other substances have been found in the urine. Alcohol, prussic acid, etc., have been found in the blood of persons dying shortly after the ingestion of such substances. Sulphur has been detected in the perspiration, and mercury in the saliva of persons who have taken these substances. Arsenic, mercury, antimony, and other poisons may be detected in various parts of the body after death. Blood passing from the veins of a poisoned animal into the circulation of another animal causes its death. Flesh of poisoned animals is poisonous to those who eat it.

Thus, from these four considerations, we seem to be justified in concluding that a medicine must pass from the stomach into the blood before its distinct action can be manifested.

Some exceptions may be taken to this as follows: Suppose a cantharides plaster be applied to the surface of the chest, in a case of pericarditis, so as to blister the skin, absorption of the fluid in the pericardium may follow the application. In our proposition, we have reference to the special or peculiar action of a remedy. In this last case, any irritant would have done the same thing; so we cannot attribute the absorption to the special or peculiar action of the cantharides.

Some medicines have a marked local action on the mucous surfaces of the stomach and bowels. These may, without entry into the blood, produce an effect in parts of the organisms remote from the alimentary canal, by counter-irritation or revulsion. Thus we use irritant emetics or cathartics to arrest incipient inflammatory action, as in disease of the eye, ear, brain, etc. This action may be carried to that extent that it will produce death, as when powerful corrosive poisons are taken into the stomach; but, as before stated, this is not the special action of such agents, and does not invalidate our proposition.

Our second proposition is as follows: That the great majority of medicines are capable of solution in the gastric or intestinal secretions, and pass without material change, by a process of absorption, through the coats of the stomach and intestines, to enter the capillaries of the portal system of veins.

In order that the substances may gain entrance into the blood after ingestion, it is necessary that they pass through the coats of the stomach and intestines, and also penetrate the capillary coat.

This process is called absorption or endosmosis. The basement membrane, supporting all mucous membranes, is a structureless or homogeneous tissue; hence no substance can pass through this membrane except it be in a state of solution. Outside the mucous membrane, and in juxtaposition to it, is a network of very small veins with thin walls, and the same forces which cause the fluids to penetrate the mucous membrane also cause the same to pass through the walls of the capillaries and smaller veins.

We will consider this subject in three parts: 1st. What is the nature and function of the gastric juice? 2d. The laws of the process of endosmosis. 3d. The mode by which medicines are reduced to a state of solution.

Stomach digestion is pretty thoroughly understood at the present time. We will not attempt a treatise on gastric digestion, but will recount some of the more salient points having a relation to the thought we are pressing. Whenever a substance is introduced into the stomach there is a copious outpouring of the gastric juice, the secretion of the glandular apparatus of the mucous membrane of the stomach. The amount of this secretion depends, to some extent, on the kind and mode of introduction of substances introduced into the stomach. This secretion is highly acid, owing to its admixture with hydrochloric or lactic acid, and contains, as one of its essential constituents, an organic principle known as pepsine, or *gasterase*. The result of this secretion is the solution of those substances soluble in a fluid of this chemical nature, reducing them to a thin, watery pulp capable of being absorbed. Medicinal substances which are soluble in the gastric secretion are directly taken up by the coats of the stomach and passed into the blood, and from thence to that part or parts of the organism upon which they have an affinity for action; while those that are insoluble in this *menstruum* are passed on into the intestines; and if non-soluble in the intestinal fluid, are excreted in the form in which they were ingested, without producing any special or peculiar effect on any part of the organism remote from the alimentary canal. The intestinal and buccal fluids are alkaline in reaction, from the presence of carbonate of soda, and the gastric juice, as before stated, is acid; so that if any substance is insoluble in the one, it will likely be reduced to solution

in the other. We need say nothing about the possibility of stomacic and intestinal absorption, as that fact is well established. The mucous membrane of the small intestines is covered by small projections, called villi, the function of which is the absorption of fatty substances which have been taken into the alimentary canal and reduced to a state of emulsion by the action of the pancreatic juice. According to Bernard, and others, the villi of the small intestines never absorb medicinal substances not of an oily or fatty nature, but that substances reduced to solution in the intestines are absorbed directly into the blood. Magendie demonstrated that a ligature placed around the thoracic duct will not affect or prevent the toxic influence of poisons introduced into the body. Experiments have been made to discover the presence of medicinal substances in the chyle ducts, but so far they have failed; so that we may reasonably conclude that medicines are not absorbed in this way.

The process by which fluids pass and repass through animal membranes is known as *endosmosis* and *exosmosis*, according as the current tends inward or outward. There are fluids on both sides of the membrane, so the following laws regulate the direction of its passage: 1st. The densities of the liquids. The lighter of the two tends to pass through the heavier, other things being equal. 2d. Their attraction for the intervening membrane. The one passing the more rapidly having the greater affinity for the membrane. 3d. The affinity of the fluids for each other. That one passing through more rapidly which is readily taken up and dissolved by that on the opposite side. 4th. The motion of the fluid on one side prevents the passage from the other. 5th. Pressure of the fluid on one side tends to hasten its passage to the other.

All soluble mineral substances are absorbed in the stomach and intestines. Precipitations and re-solutions occur between some of the minerals and the salts of the digestive fluids, but in no case is there absolute fixation of the foreign agent, from its chemical incompatibility with animal fluids. Mineral acids, salts of metals, alum, and the tannic principles of vegetables must be precipitated to some extent by the albumen and pepsine of the gastric juice, but are redissolved by the intestinal fluids, which are alkaline. The inorganic alkaline salts are not precipitated by any of the animal fluids, but tend to render them more solvent. Some have thought that the soluble salts of mercury, silver, and lead might be precipitated by the chloride of soda in the gastric juice; but this can hardly be, since this fluid only contains 25 per cent. of the salt; besides, a small dose is more efficient than a large one of these salts, which could not be if precipitation took place. The intestinal secretions contain alkaline carbonates, which would precipitate the oxides of many metals, from solution of their salts; but if the metallic salt is not absorbed in the stomach, it descends into the intestines as an albuminate, and, instead of being precipitated, is rendered more soluble by the alkaline secretion.

Thus it appears that all soluble substances, organic or inorganic, given either as food or medicine, and in whatever way rendered soluble, whether by acids or alkalis or by digestion, are absorbed by the stomach or intestines. All, except fatty matters, pass directly into the blood, through the portal vein into the liver, to the heart, and thence to the various parts of the body. They are mostly absorbed without change. Some, however, may be absorbed as an albuminate. The stomach acid is too weak to displace mineral acids. It does displace a few vegetable acids, prominent among which is prussic acid. When cyanide of potassium is administered, the acid of the gastric juice, being a stronger base than that of hydrocyanic acid, immediately displaces the latter, setting free the prussic acid in the stomach; hence the rapidity of its action.—*Amer. Med. Jour.*

ON THE USE OF STEAM IN SPECTRUM ANALYSIS.

By JOHN TROWBRIDGE and W. C. SABINE.

AMONG the difficulties with which the investigator in spectrum analysis must contend is that of obtaining a source of light which is free from constituents other than those which are under examination, and at the same time sufficiently powerful to enable him to photograph the spectra of the latter. The voltaic arc gives a sufficiently strong light to enable one to photograph throughout the visible spectrum; the electric carbons, however, are full of impurities, and it is difficult to interpret the spectra obtained by these means. Moreover, it is not easy to employ the arc spectrum for researches in the ultra-violet portion of the spectrum. On the other hand, the spark from a Ruhmkorff coil taken between terminals of metals, the spectrum of which we wish to examine, gives us in general spectra comparatively free from impurities, but its light is very feeble compared with that of the electric arc, and even when the spark is obtained by means of a powerful coil which is excited by an alternating dynamo machine an hour is necessary to obtain with a concave grating of 21 feet radius of curvature, on the most sensitive dry plate, a photograph of the ultra-violet spectra of copper at the wave length 2100.

It becomes an important question then to ascertain whether the time of exposure of the sensitive plate can be shortened by any process; for the outlay in obtaining one photograph in the ultra-violet by the means hitherto at our command is very large, involving as we have said the running of an engine of at least two horse power for an hour. In our experiments with a jet of steam we find that the time of exposure of the sensitive plate can be shortened to at least one-third.

We were led to employ steam for the purpose of obtaining the spectra of oxygen and hydrogen with a more powerful electrical excitation than is possible in Geissler tubes. During the winter of 1886, when engaged upon the subject of oxygen in the sun, one of us in connection with Mr. C. C. Hutchins tried to obtain a powerful electric spark in an atmosphere of steam, but the experiments were unsatisfactory. The difficulties were chiefly in the way of proper insulation. Experiments showed that no containing vessel could be employed for the sides of the vessel conducting the electricity from one terminal of the Ruhmkorff coil to the other. No spark could be obtained, and the experiments were abandoned. During the present winter the experiments were renewed. The containing vessel was abandoned, and the jet of steam was allowed to