Hyoscyamine may be dissolved in water and glycerin, as follows:

℞ Hyoscyaminæ (cryst.), gr. ij; glycerini, aquæ, āā ♏ c (100 minims). M. Sig.: Each minim contains $\frac{1}{100}$ of a grain.

Strychnina—*Strychnine.* ℞ Strychninæ sulphat., gr. j; aquæ, ℥j. M. Sig.: Ten (10) minims contain $\frac{1}{48}$ of a grain.

Conina, *Coniine.* ℞ Coninæ hydrobromat., gr. j; aquæ, ℥j. M. Sig.: Ten (10) minims contain $\frac{1}{48}$ of a grain.

The hydriodate and the tartrate are also now made, and can be used in the same strength.

Curara—or *Woorara.* ℞ Curaræ, gr. j; acid. acetic., ♏ v; aquæ, *ad* ♏ c (to 100 minims). M. Filter. Sig.: Ten (10) minims contain $\frac{1}{10}$ of a grain.

As the active constituents of curara are soluble in water, an aqueous solution will contain them—the residue being woody fiber, starch-granules, etc. As, however, the specimens vary greatly in strength, the character of any new specimen should be ascertained by trial on animals before giving it to man.

Any salt of the alkaloid, *curarine*, will, however, be more exact in its effects.

℞ Curarinæ sulphat., gr. j; aquæ, ℥ ss. M. Sig.: Four (4) minims contain $\frac{1}{60}$ of a grain.

Tabacum—*Tobacco.* Nicotiana—*Nicotine.* ℞ Nicotianæ, ♏j; acid. acetic., ♏ v; aquæ, ʒiv. M. Sig.: Four (4) minims contain $\frac{1}{60}$ of a grain.

Acidum Hydrocyanicum Dilutum. ℞ Acid. hydrocyanic. dil., q. s. Sig.: Four minims is the maximum single dose.

Physostigma—*Calabar-Bean.* Eserina, *Eserine.* The extract of Calabar-bean dissolved in sufficient water, and filtered, is used hypodermatically, sometimes; but the alkaloid *eserine* is to be preferred.

℞ Eserinæ sulph. vel muriat., gr. j; aquæ, ʒiv. M. Sig.: Four (4) minims contain $\frac{1}{60}$ of a grain.

Pilocarpina—*Pilocarpine.* ℞ Pilocarpinæ nitrat., gr. xvj; aquæ, ℥j. M. Sig.: Five (5) minims contain ($\frac{1}{6}$) one sixth of a grain.

Amyli Nitritum—*Nitrite of Amyl.* From three (3) to five (5) minims of amyl nitrite can be injected subcutaneously at a time. The repetition of the dose will depend on the effect, but the injection may be practiced every half-hour for a time.

Chloroformum Purificatum—*Purified Chloroform.* From five (5) to fifteen (15) minims can be used at one injection. This agent is employed by the "deep method"—i. e., the chloroform is thrown by the syringe deeply and in the neighborhood of the nerve-trunk, the seat of pain.

The official *spiritus chloroformi* has also been used successfully in the same group of cases.

Alcohol and Ether are also injected subcutaneously—alcohol in the diluted form, as whisky or brandy, and pure ether.

Chloral Hydrate. ℞ Chloral. hydrat., ℥ ss.; aquæ, ℥j. M. Sig.: Thirty (30) minims contain fifteen (15) grains of chloral.

Sometimes it is advantageous to give chloral and morphine together.

Caffeina—*Caffeine.* ℞ Caffeinæ citratis, gr. xxiv; aquæ, ℥j. M. Sig.: Twenty minims contain one grain.

Apomorphina—*Apomorphine.* ℞ Apomorphinæ, gr. j. Ft. pulv. No. xvi. Sig.: One or more may be dissolved in sufficient water as required.

Apomorphine undergoes a change in the presence of moisture, especially when kept in solution for some time; hence the solution for hypodermatic injection should be prepared when required. The dose ranges from $\frac{1}{16}$ of a grain to $\frac{1}{6}$ of a grain.

Ergota—*Ergot.* ℞ Ext. ergotæ, ʒj; aquæ, ℥j. M. Sig.: Twenty minims contain two (2) grains.

Quinina—*Quinine.* "℞ Quininæ disulphat., gr. l (50); acid. sulphuric. dil., ♏ c (100); aquæ font. ℥j; acid. carbolic. liq., ♏ v (5). Solve.

"Place the quinine and water in a porcelain dish over a spirit-lamp; heat to the boiling-point, and add the sulphuric acid, stirring with a wooden spatula. Filter at once into a bottle, and add the carbolic acid. This gives six grains to the drachm."

The above is the formula of Dr. Lente as given by himself. All solutions containing sulphuric acid are very irritating. Hence, those which can be prepared without acid are much to be preferred. The hydrobromate of quinia is soluble in a degree sufficient for hypodermatic use: thus,

℞ Quininæ hydrobromat., gr. xlviii; aquæ destil., ʒiv. M. Dissolve, and by heat if necessary. Sig.: Twenty (20) minims contain 4 grains.

Quinina bimuriatica carbamidata, a combination of quinine and urea, is freely soluble—in equal parts of water, in fact—and therefore a most useful preparation for hypodermatic use.

Acidum Carbolicum—*Carbolic Acid.* ℞ Acid. carbolic. purif., gr. x; aquæ, ℥j. M. Sig.: Eight minims contain $\frac{1}{6}$ of a grain.

The quantity administered will range from one sixth of a grain to two or three grains.

Hydrargyrum—*Mercury.* The solutions of mercury now chiefly used are those of the corrosive chloride and the albuminate. Formulæ for both are subjoined:

℞ Hydrarg. chlor. cor., gr. j; aquæ, ℥j. M. Sig.: Ten (10) minims contain $\frac{1}{48}$ of a grain.

Various albuminous solutions of mercury have been proposed: the chlorides of mercury, ammonium, and sodium, mixed with albumen.

Arsenicum—*Arsenic.* The preparations of arsenic used hypodermatically are Fowler's and Pearson's solutions; the former in doses from two (2) to ten (10) drops, and the latter in twice the quantity.

Aquapuncture.—By *aquapuncture* is meant the injection of pure water beneath the skin. A special instrument has been invented to effect this; but ordinarily a hypodermatic syringe will suffice for this purpose. From a half-drachm to a drachm is thrown under the skin over the organ or part on which it is intended to act.

Irritant Injections.—Injections intended to excite local inflammation are also employed in various morbid states. The materials so used, and the conditions requiring them, will be set forth hereafter.

IV.

BY THE VEINS.

The injection into the veins of medicinal agents is too dangerous a procedure to be lightly undertaken, and is admissible only in emergencies. Formerly, before the introduction of the hypodermatic method, the injection of medicines directly into the blood was suggested and

occasionally practiced in cases of asphyxia, in the collapse of cholera, in the insensibility due to narcotic poisons, etc. At present this method is restricted within narrower limits. Some remarkable results have been obtained by the injection of a saline solution in the veins in cases of the *collapse of cholera.* Unfortunately, the appearances of improvement, which are very remarkable, are not usually sustained, although Little reports five recoveries out of twenty apparently hopeless cases treated in this way. Dr. Hilton Fagge has recently reported a case of *diabetic coma*, in which the injection of twenty-six ounces of a warm solution of salines (phosphate and chloride of soda) produced an astonishing improvement in the condition of the patient. A suitable saline solution for intra-venous injection may be made of phosphate, carbonate, and chloride of sodium, dissolved in water at the temperature of 100° Fahr. until the specific gravity of 1020 is attained. The instruments employed for transfusion of blood may be used for the intra-venous injection of salines, especially the apparatus of Dr. Aveling for immediate transfusion, or the *aspirateur* modified according to the plan of Dr. Howe, of New York, when used for transfusion mediate or immediate. In the absence of these, an ordinary Davidson's syringe may be used for this purpose by attaching to it suitable canulæ.

Halford, of Australia, has recently practiced the *injection of ammonia* into the veins, in the treatment of the bite of venomous snakes. He employs one part of the stronger *aqua ammoniæ* to two parts of distilled water, the injection being made with an ordinary hypodermatic syringe. A vein in a convenient situation is selected, the needle is inserted into it, and the solution of ammonia is thrown in gradually. The operation may be repeated, as necessary, the guide to the repetition of the injection being the state of the circulation. Fayrer shows that this practice is not successful in the systemic condition caused by the bite of the venomous snakes of India, and the special committee of the Medical Society of Victoria, appointed to investigate the subject of the intra-venous injection of ammonia, report adversely to the claims of Halford. The proposer of this expedient has, at least, demonstrated the safety of the intra-venous injection of ammonia; and, although his first claim has been shown to be incorrect, the method itself has been utilized in other maladies: for example, in *chloroform asphyxia*, *opium narcosis*, *hydrocyanic-acid poisoning*, etc. It has been used, not with encouraging success, however, in septic states with a tendency to the coagulation of the blood in the larger venous trunks. Failure of the heart's action and *thrombosis of the pulmonary artery, post partum*, are also indications for the intra-venous injection of ammonia.

Transfusion.—This consists in an operation for substituting healthy blood for the abnormal fluid occurring in certain diseases, and for supplying blood in cases in which a deficiency exists by reason of hæmorrhage. Ordinarily the blood of a healthy adult is used in transfusion, because ever since the time of Blundell it was supposed the blood of an animal would not functionate properly in the arterial system. This notion is now, however, fully exploded, and Gesellius has especially shown, in his elaborate monograph on transfusion, that lamb's blood will answer the same purpose in the human system as human blood.

As the red globule is the vivifying constituent of the blood, and as the fibrin is non-essential to the most important office, at least of the circulating fluid, it is obvious that defibrinated blood may be used for transfusion. According to the statistics collected by Gesellius, of one hundred and forty-six cases of transfusion with blood without defibrination, seventy-nine, or 54·11 per cent, were successful, and, of one hundred and fifteen cases in which defibrinated blood was used, seventy-nine, or 68·70 per cent, proved fatal. Mr. Higginson, of Liverpool, reports thirteen cases occurring under his own observation, in which mediate transfusion with pure blood was employed, with the result of six successful. The injection of defibrinated blood is free from one source of danger—the introduction of clots into the circulation—which, as Panum has shown, will be followed by the disastrous result of multiple embolisms, or thrombus of the pulmonary artery. Separating the fibrin, however, renders the blood much less capable of performing its office. The necessary agitation in order to coagulate the fibrin injures the blood-globules, and the fibrin itself is necessary to prevent transudations and the recurrence of hæmorrhage. With the improved instruments now used for the operation, and with the exercise of the necessary care, there need be no formation of clots, the chief danger in the use of blood containing its fibrin.

Transfusion may be *mediate* or *immediate.* Mediate transfusion consists in the reception of the blood in a suitable vessel, and its transference by means of an injecting apparatus into the veins of the patient. Immediate transfusion consists in an apparatus for making direct communication, from the vein of the person or animal furnishing the blood, with the vein of the patient receiving it. A number of appliances have been invented for mediate transfusion. Martin, of Berlin, has used in his operations a glass syringe provided with a suitable canula for insertion into the vein. Belina invented an apparatus consisting of a receiver for the blood, a hand-ball like that of the spray-douche, and a flexible tube provided with a stop-cock and canula. Belina, who has treated at great length of the operative procedure, decides that all forms of syringes are objectionable. Higginson proposed and has used successfully an instrument similar to the enema-syringe invented by him. This apparatus can, however, only be used for mediate transfusion. As immediate transfusion is to be preferred, as a rule, it were better to be provided with a suitable instrument for this operation. The instrument invented by Dr. Aveling, and presented to the

Obstetrical Society of London in 1864, is at the same time the simplest and most effective. This consists of a hand-ball and flexible tubes like a Davidson syringe, but without valves. There are two canulæ attached to either extremity of the flexible tubes—one for insertion into the vein furnishing the blood, and the other for insertion into the vein receiving it. The small-sized Davidson syringe will answer perfectly well by removing the valves, the action of which tends to separate the fibrin, and fitting to the flexible tubes suitable perforated needles or canulæ. In using Aveling's instrument it must be first put into water at the temperature of 100° Fahr., and it must be filled with warm water, or better, a warm solution of phosphate and chloride of sodium of a specific gravity of 1020. The object of this is to exclude the air from the apparatus. The next step consists in inserting the canula in a vein—usually of the forearm—of the person or animal furnishing the blood, and in a position so that the blood-current will be in the direction of the current in the patient receiving it. Should the veins of the patient be collapsed, the skin overlying those at the elbow may be transfixed and raised, which will bring into view a vein into which the canula may be inserted—care being used here that the direction of the current shall be toward the heart. The canulæ can be held in position by the fingers of assistants. The operator compresses the bulb gently, pressing at the same time the supply-tube between the thumb and finger of the other hand, in order to prevent a reflux of the fluid. When the bulb is emptied, the delivery-tube is pressed between the thumb and finger shifted from the supply-tube, and the bulb is allowed to fill with blood from the source of supply. In this way, successive charges of fresh blood can be delivered without difficulty into the patient's vein. The *aspirateur* may be used in the same way for immediate transfusion, as has been suggested by Dr. J. W. Howe, of New York, who has used it successfully. He advises the substitution of smaller tubes than those which accompany this instrument, and he has devised suitable canulæ for the veins.

The quantity of blood which it is advisable to introduce varies from four to eight ounces. The smaller amount is generally more successful. Too large an amount will seriously embarrass the heart. A further precaution is necessary as to the manner of injection; force is never necessary, and may be very injurious; the blood should be delivered into the vein slowly and gently.

Besides the danger arising from coagulation of the blood and the formation of thrombi, immediate bad symptoms or fatal syncope may come on from the introduction of air into the veins. The utmost care is necessary to exclude air from the apparatus. Phlebitis may also ensue from the injury done to the vein, and the patient's life be put in jeopardy from this cause, but this is a danger much more remote than the introduction of air and clots into the circulation.

As a number of successful cases of transfusion (Gesellius, Hasse, and others) have been reported in which lamb's blood was used, the practitioner is now justified in its employment, notwithstanding Landois has shown by experiment that transfusion of mixed blood does injury to the red blood-globules. If lamb's blood is to be used, the animal should be sufficiently anæsthetized to keep it quiet, and it should be securely tied. A vein may be selected, and immediate transfusion performed with Aveling's instrument or with the *aspirateur* in the mode already described.

Transfusion is especially indicated in cases in which life is put in imminent jeopardy by *hæmorrhage*. According to Belina, it is in hæmorrhage from *abortion*, and during the first months of pregnancy, that transfusion is most successful. Of thirteen cases of hæmorrhage from abortion thus treated, according to this author, eleven had a fortunate issue. Of the cases of *post-partum hæmorrhage*—eighty-five in number—in which this expedient was adopted, fifty-six resulted favorably. Routh, Soden, Hicks, McDonnell, Mudge, Howe, and others, have reported successful cases, not included in the statistics of Belina. In other forms of hæmorrhage, *hæmatemesis*, *intestinal hæmorrhage*, *epistaxis*, etc., in which death by exhaustion is imminent, the operation of transfusion is proper. Belina has collected twenty-six cases of *traumatic hæmorrhage*, of which twelve resulted favorably, in two the result was doubtful, and twelve terminated fatally.

Transfusion has also been employed in certain morbid states of the blood, but not with encouraging results. Thus, Belina has collected a number of cases belonging to this category, of which nineteen terminated favorably, in two the result was equivocal, in three temporarily beneficial, and thirty-nine died. Two very interesting cases of the *hæmorrhagic diathesis* successfully treated by transfusion have been reported by Dr. Joseph Buchser, of New York. This form of constitutional cachexia is especially an indication for transfusion. In the treatment of *anæmia* this operation has not been successful. Thus, three cases treated by Stohr, of Würzburg, terminated fatally. Cases have also been reported by Concato, Cavaleri, and others. Transfusion has been used very successfully in cases of carbonic-oxide poisoning (Uterhart, Prof. König, Prof. Martin), and in phosphorus-poisoning (Prof. Jürgensen).

Eulenburg and Landois advise transfusion in cases of danger to life from poisons for which there are no antidotes. It has been recommended, in such cases, to abstract blood and to suppy fresh blood to the suffering organism. Nussbaum has employed transfusion with complete success in *epilepsy*, and it has also been used with favorable results in *eclampsia* due to *uræmic poisoning*.

Arterial Transfusion.—Prof. Albanese has proposed injection of defibrinated blood into an artery, either the radial or posterior tibi-

al, as a substitute for the intra-venous injection. The artery is exposed, punctured, and the blood thrown into it, in the same way as in the operation on the vein. It is claimed for this method that thrombosis is less apt to occur, and that the danger arising from the introduction of air is obviated. When a large amount of blood is necessary, it is more safely introduced by the arterial system, because, having to traverse the capillaries before reaching the right side of the heart, sudden distention of this organ is avoided. Prof. Hüter, who has especially advocated this method, reports a number of cases successfully performed in this way, and Aschè has collected a number of others.

Transfusion of Milk.—The experiments of Donné on animals demonstrated the harmlessness of the intra-venous injection of milk. Hodder, of Canada, was the first to employ this expedient on man; and, of three cases of *cholera collapse* which he thus treated, two recovered. Thomas, of New York, has also transfused milk with success in *post-partum hæmorrhage;* and Wagstaff has failed twice with the same method in *traumatic hæmorrhage.* Within the present year (1880) Mr. Arthur Meldon has published an account of three cases in which the transfusion of milk was performed with success.

When milk is used for transfusion, it should be fresh and directly from the cow if practicable, and its temperature should be that of the blood itself—100° Fahr. Not more than four to six ounces should be injected at one time, lest the heart be paralyzed by over-distention. The effects which follow the intra-venous injection of milk are very much the same as those produced by blood, except that they are probably less permanent, and that albuminuria is a frequent result. That this expedient is as useful as blood transfusion by the immediate method has been strongly maintained, but the most recent experience does not justify this opinion. Indeed, it is probable that the chief value of blood transfusion, in functional diseases, is to gain time for the operation of other and more permanent measures (Pepper). We also agree in the estimate of Dr. Pepper that transfusion in any of its forms is without utility in important organic diseases.

In an experimental inquiry into the methods of transfusion, Schafer has examined anew the question of the substitution of some other fluid for blood, deciding with Landois, of Germany, and Howe and Dupuy, of America, that the introduction of any other fluid does injury to the corpuscles, and that a fluid without hæmoglobin can not functionate as blood. As respects the substitution of the blood of some other animal—lamb's blood, for example—the conclusion of Schafer is in accord with the previously expressed judgment of Landois, that only human blood should be used in transfusion on man. Schafer has also made some important observations on the best mode of performing the operation. He finds that the best results are obtained on animals

by arterial transfusion, and recommends that the dorsal artery of the foot be used for receiving and furnishing the blood in the operation on man. When the artery is used the blood is received into that part of the vascular system where it is most needed, and only an elastic rubber tube and glass canula are required, the force of the donor's circulation being sufficient to propel the blood. There is no danger of the supply from the donor becoming excessive, as the pressure in the arterial systems of the donor and of the recipient soon acquires the same force. Usually, and indeed unless the circulation in the donor is feeble, no other medium of communication is necessary besides the flexible tube and glass canula, as the elastic pump of Aveling's instrument does not contribute to the force of the flow. The tube and canulæ should be filled with carbonate-of-soda solution, both to exclude air and to prevent clots forming. It is not necessary to measure the quantity of blood, as the condition of the recipient furnishes the true indications to be followed.

Peritoneal Transfusion.—To the various kinds of transfusion must now be added this form, originally proposed by Ponfick. With antiseptic precautions, a trocar with canula is passed through the abdominal walls in the linea alba. A flexible tube, with a glass funnel attached, is then connected with the canula—the trocar being withdrawn—and defibrinated blood is poured into the cavity. Excellent results follow this practice, which the researches of Bizzozero and Golgi have shown to be based on sound physiology. This method has been used successfully by Von Kaczorowski and others in the various maladies in which the other modes of transfusion have been employed. Some adverse reports have, however, been made. Peritonitis has been caused by the procedure, but in these cases the subjects operated on may have been unsuitable ones. On the whole, peritoneal transfusion, which at one time promised to be a valuable measure, must be regarded as still *sub judice*—if, indeed, its utility is not questionable.

Dr. Joseph W. Howe, of New York, who has made many valuable observations on transfusion, in a recent issue of the "New York Medical Journal" (February 3, 1883), announces that no other expedient can be properly substituted for the intra-venous injection of blood. When life is endangered by hæmorrhage, Dr. Howe holds that it is not advisable to wait for intestinal or peritoneal absorption, but that intra-venous transfusion should be practiced without delay.

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PART II.

THE ACTIONS AND USES OF REMEDIAL AGENTS.

THOSE USED TO PROMOTE CONSTRUCTIVE METAMORPHOSIS.

ALIMENTS.

This extensive subject can, in this work, be considered briefly only, and from the point of view of therapeutics. The various aliments are of the first importance as remedial agents. No satisfactory repair of diseased or wasting tissues can take place without a suitable supply of healthy blood, and healthy blood is the product of proper food and normal digestion and assimilation.

The Physiological Relations of Food.—The food of man is derived from the three great kingdoms of nature: mineral, vegetable, animal. It may be conveniently classified into three principal groups: 1. Mineral constituents—incombustible or unoxidizable: water, phosphate of lime, chloride of sodium, etc.; 2. Oxidizable—heat-producing and force-forming—carbon compounds: fat, sugar, starch, gum, etc. Nitrogenous — flesh-forming: albumen, fibrin, casein, etc.; 3. Food adjuncts—alcohol, acids (citric, tartaric, etc.), alkaloids (caffeine, theine, etc.).

The members of the first group will be discussed hereafter, under the head of "agents promoting constructive metamorphosis"; the second group, the most important, will be considered in this relation, with the foods; and the third will have separate treatment under appropriate heads.

The classification of foods, originally formulated by Liebig, if not too strictly adhered to, is of much utility, as indicating the general purposes of these substances in the economy—viz.: carbonaceous or force-producers; nitrogenous or flesh-formers. Under the first division are comprehended fat, starch, sugar, etc.; under the second, substances containing nitrogen, as albumen, casein, etc. There is not, however, a rigid line of separation between these two classes, for both