

are produced in the course of the putrefactive decomposition of the human body, and as *alkaloids*, closely related to those formed in the tissues of plants, are developed in the course of infectious diseases, there can be no doubt of the importance of this class of remedies. We are, however, yet in the infancy of our knowledge, but sufficient has been acquired to amply justify the construction of such a class of remedies.

A large group of remedial agents is used not to influence the metamorphosis of tissue, but simply to modify the functions of the nervous system, of which morphine and strychnine may be taken as types. It is true that probably no medicinal agent modifying function does so without affecting structure; but, in the present state of our knowledge, we are, in respect to some of them at least, unable to designate the tissue-changes which they induce.

To the class of evacuants belong emetics, cathartics, anthelmintics, and diuretics. These remedies are either so irritant as to excite speedy action for their expulsion, or they are eliminated by the organs on which they appear to have a selective effect. When the movement for their expulsion or elimination terminates, as a rule their action ceases. Some of these irritant emetics and cathartics, acting locally merely, might be classed with topical remedies, but such an arrangement would destroy the continuity of the subject.

Topical remedies act upon the part to which they are applied. Absorption is not necessary to, and indeed hinders the local effect; hence, any systemic impression produced by them is accomplished through the agency of the nervous system. Some of the most important of their therapeutical effects are due to the influence of the peripheral excitation on the nervous centers in anatomical connection therewith. A superficial neuritis may excite extensive secondary lesions in the spinal cord. The vaso-motor and trophic systems are peculiarly impressionable to peripheric irritation, and hence, through the intermediation of this nervous apparatus, important changes may be wrought by slight counter-irritation.

PART I.

ROUTES BY WHICH MEDICINES ARE INTRODUCED INTO THE ORGANISM.

I.

THROUGH THE EXTERNAL INTEGUMENT.

By this tissue medicines are applied in the following modes:

- Enepidermatic.
- Epidermatic.
- Endermatic.

ENEPIDERMATIC.—In this method, the medicament is placed in contact, only, with the epidermis, and friction, to hasten absorption, is not employed. Although the epidermis opposes a strong obstacle to absorption, it does not entirely prevent diffusion into the blood, as numerous facts show. The skin may be considered a colloidal septum. The rate and degree of absorption of any medicine will depend, in large part, on its power of diffusion. Various circumstances influence this—for example, the chemical position of the agent to be diffused. On one side of the colloidal septum—the skin—lie the blood-vessels, containing an alkaline fluid. An acid fluid on one side of the dialysing membrane, and an alkaline fluid on the other, are conditions most favorable to diffusion. Experiments are wanting on this point, but it is a reasonable presumption that solutions of medicinal substances, acid in reaction, will find their way most readily into the blood.

Besides the epidermis, the sebaceous matter of the skin offers more or less positive obstruction to cutaneous absorption. Medicinal substances in solution in water, therefore, very slowly permeate the skin to enter the vessels. Waller, who has made very careful experiments, has ascertained that alkaloids dissolved in chloroform are readily transferred through the skin into the blood, and produce characteristic phenomena, while “alcoholic and aqueous solutions are either not at all, or very slowly, absorbed.”

His observations were made with chloroformic solutions of aconitine, atropine, strychnine, and morphine. Waller further ascertained that alcohol mixed with chloroform did not retard absorption, but alcohol alone caused an outward osmotic flow. It follows from these facts that, if, in the application of a medicinal agent to the skin by the endermatic method, the object be to promote absorption, the remedy should be dissolved in chloroform, or in a mixture of alcohol and chloroform, and not in alcohol alone, or in water.

EPIDERMATIC.—This method differs from the enepidermatic in that friction is employed to promote absorption by forcing the medicament between the cells of the epidermatic layer. Many agents are used in this way, as mercurial ointment in syphilis, cod-liver oil, and other fats, in wasting diseases, and ointments of various kinds for the relief of local lesions, etc. The evidence is conclusive that by this mode systemic effects are produced.

ENDERMATIC.—As the epidermis is the chief obstacle to cutaneous absorption, it is sometimes removed by blistering, so that the medicament may come into immediate contact with the derma. The mode of proceeding by the endermatic method is as follows: a piece of flannel, patent lint, or cotton cloth, is moistened with *aqua ammoniacæ*, and when placed on the skin is covered with oiled silk to prevent evaporation. When the blister is raised, the epidermis is removed with scissors. A less painful, but slower method, is the application of a cantharides-plaster, followed by a poultice to raise the blister. The medicinal agent, in a finely-powdered state, is sprinkled over the raw surface, and is rapidly absorbed. Morphine, atropine, strychnine, and quinine, are the most important agents used in this way.

The endermatic method is a useful resource to the therapist, but the opinion of Brown-Séguard is hardly admissible, that the extensive use of the hypodermatic method has caused the endermatic to be unwisely neglected. There are decided objections to the endermatic method: it is painful; absorption is somewhat uncertain; ulceration of an intractable character may occur. It has these advantages in its favor: it may be used in cases of irritable stomach; it may be conjoined with counter-irritation; it is sometimes quite effective.

II.

THROUGH THE INTERNAL INTEGUMENT.

APPLICATIONS TO THE BRONCHO-PULMONARY MUCOUS MEMBRANE.—By the method of *insufflation* solid medicinal agents in a finely-divided state are applied to various parts of the respiratory tract. Insufflation-tubes with a rubber air-bag attached are now found at the instrument-makers. The powder, contained in a chamber intended for its reception, is forced by the compression of the air-bag

through the straight or curved delivery-tube of the instrument. Powders may be projected by such an apparatus into fauces, larynx, and anterior and posterior nares. In the absence of an insufflator, a simple glass tube or goose-quill may be used for the purpose—the powder being blown in by the operator, or drawn in by a forcible inspiration by the patient.

The method of insufflation is a useful mode of making local applications to the nares, fauces, epiglottis, and the aryteno-epiglottidean folds, but it is of little utility as a means of reaching the larynx and trachea, for, as is well known, the glottis is exceedingly intolerant of foreign bodies whether solid or gaseous. By this method we can use tannin, the zinc salts, nitrate of silver, alum, morphine, etc. Any remedy thus applied should be in small quantity, should be minutely subdivided and mixed with some unirritating, impalpable powder, so as to insure uniform distribution over the surface to be acted upon.

The *nasal douche* is a mode of applying remedies to the nasal passages now much practiced. This consists of a bottle or funnel-shaped reservoir to contain the medicated fluid, and a flexible rubber tube to which is attached a hard-rubber or glass nose-piece. The reservoir being placed on a higher level than the head, the nose-piece adjusted and the mouth being kept open, the fluid is permitted to flow. As when the mouth is open, the patient breathing quietly, the palate applies itself closely to the posterior wall of the pharynx, it is obvious that the fluid will be conducted from the one to the other nostril and thus make its exit. Not every patient can succeed perfectly in the performance of this feat. In some persons, even when breathing quietly through the open mouth, the veil of the palate does not apply itself perfectly to the posterior fauces and the fluid flows into the œsophagus. Other persons can not refrain from attempts at swallowing when the fluid reaches the posterior nares. In such instances the use of the nasal douche may be attended with ill results. As has been shown by Moos, Roosa, and others, and as I have myself observed, the fluid may pass through the Eustachian tube into the middle ear, giving rise to destructive inflammation and suppuration. If pain in the ears follows its use, it is quite certain that mischief will result if the douche be persisted in. The following rules should be adhered to in making applications by this method:

The fluid used must be tepid.

The first applications must be bland and unirritating.

The applications, if strong enough to excite irritation, must not be used frequently.

Under the most favorable circumstances this mode of treating diseases of the nasal passages has very limited utility, for the fluid reaches but a part of the Schneiderian mucous membrane. It is a useful means for cleansing the nares, and for applying deodorizing agents to correct

fetor. Chlorides of sodium, potassium, and ammonium, permanganate of potassa, carbolic acid, iodine, and many other agents of the same kind, are applied by means of the nasal douche.

An ordinary Davidson's syringe, made to act as a siphon, may be used in the same way as the Weber's or Thudichum's nasal douche. The mode of proceeding with this instrument is as follows: the vessel containing the medicated fluid is placed on a higher level than the patient's head; the syringe is filled by compressing the bulb to expel the air, and then inserting the suction-pipe in the fluid; the nozzle of the delivery-pipe is put into the nose, when a steady stream will discharge into the nostril and escape by the other.

The method of *inhalation* is more generally applicable to the treatment of diseases of the broncho-pulmonary mucous membrane. Carbolic acid, iodine in vapor, iodoform, sal-ammoniac, bromine, and other volatilizable solids and gases, may be readily and advantageously applied in this way. A convenient mode of using iodine is the following: make a cone of stiff paper, so that the smaller extremity shall fit the mouth or nose, or both; drop some tincture of iodine into a cup of hot water, so placed that the vapors will ascend through the funnel, the larger mouth of which is in position to intercept them. Iodoform vaporized on a warm plate or saucer may be similarly conducted into the mouth or nose. Some drops of bromine may be put into a warm vial, and the vapor be cautiously inhaled. Several forms of inhalers are now made for applying muriate of ammonia vapor, as it is formed by the combination of ammoniacal gas and the fumes of hydrochloric acid.

The inhalation of carbolic acid alone or in combination with iodine, is especially useful in chronic bronchitis and phthisis. If the method of inhalation is pursued as above advised, the vapors pass into the lungs with the inspired air. The effect is very different when solutions of the medicaments are applied by means of *pulverization* or *atomization* of medicated fluids. Air or steam is the motive power in the various forms of apparatus used for reducing solutions of medicinal agents into spray. Of those now in use, the hand-ball apparatus for air, and Siegle's apparatus for steam, are the principal. Whether air or steam be used for pulverizing the medicated fluid, the essential parts of an atomizing apparatus consist of a cup for containing the solution to be pulverized, a vertical tube terminating in a fine capillary extremity and dipping into the medicine-cup, and a tube communicating with the steam-boiler or air-bulb, and placed at right angles to the vertical tube. When air or steam is forced through the horizontal tube, over the capillary orifice of the vertical tube, the air in the latter is rarefied and the fluid rises into it, until, reaching the top of the tube, it is broken up into fine spray by the impact of the horizontal column of air. It is obvious that, provided with suitable tubes, spray may be

applied to the nares, anterior and posterior, to the pharynx, epiglottis, and larynx. The utility of applications made in this way to these parts is now conclusively established. Although it has been a question whether any quantity of medicated spray passes the chink of the glottis, it has been proved experimentally that a minute quantity does actually enter the trachea. The efficacy of inhalations of subsulphate of iron in pulmonary hæmorrhage is a clinical fact confirmatory of the experimental demonstrations. The inhalations of substances in a state of vapor, and atomized, in affections of the parts beyond the larynx, have thus far been rather disappointing, except, it may be, the treatment of pulmonary hæmorrhage by iron inhalations.

In using the various inhalations, some precautions must be taken to avoid harm. Strong applications should not be made in the beginning of the treatment. The mucous membranes should be accustomed to the impact of such unirritating substances as warm water and tepid solutions of common salt and chloride of ammonium, before commencing the use of tannin, the zinc, copper, and silver salts, etc. For cleansing the mucous membrane and removing fetor, common salt, carbolic acid, iodine, and the sulphides are useful, and as astringents and deodorizers, the sulpho-carbolates of zinc, soda, etc. The most effective application for the cure of diseased states is nitrate of silver, but it should be kept in mind, in using this agent, that the handkerchiefs and linen of the patient will be soiled. Solutions of nitrate of silver are best applied by means of the hand-ball atomizer, tubes of various shapes, according to the locality, being inserted into the anterior and posterior nares, pharynx, or glottis, as the case may be. Should the steam atomizer be used for making application of the various salts named above, the face of the patient should be protected by a shield.

Applications to the broncho-pulmonary mucous membrane are also made use of to procure absorption of the materials applied, and thus to produce systemic effects. Anodynes for the relief of cough, difficult breathing, painful affections of the heart, etc., are applied to the fauces and larynx by means of the steam atomizer. Various preparations of opium, cannabis Indica, belladonna, and nitrite of amyl, are employed in this way. The most effective method of treating an asthmatic paroxysm is by means of a cigarette containing various narcotic substances.

APPLICATION TO THE GASTRO-INTESTINAL MUCOUS MEMBRANE.—The stomach is the organ most usually selected for procuring absorption of remedial agents. Diffusion through the walls of the stomach into the blood is by no means definite in rate, or in the quantity passed even with the same medicament and in the same individual. The presence of fluid or food, the chemical reactions which may ensue, the state of the mucous membrane, the blood-pressure in the veins, and the

condition of annexed organs, are circumstances modifying the rate and degree of absorption. The stomach empty, the mucous membrane in a healthy state, veins not turgid, are the conditions most favorable for rapid and perfect absorption. Crystalloidal substances in solution, which pass by simple osmosis into the vessels, are taken up more rapidly and perfectly than colloidal substances which require preliminary digestion and solution. It follows, therefore, that medicines in solutions not intended for a merely local action on the stomach mucous membrane, and not irritant in character, as salines, alkaloids, etc., should be administered when the stomach is empty. Substances that are irritant, or that require digestion and solution, or that, like iron, are intended to supply a material to the blood in which it is deficient, are best administered during the process of digestion. On the other hand, many of the metallic salts precipitate pepsin and thus derange digestion, whence it follows that they should not be given after food, if unimpaired digestion be essential to the safety of the patient.

Although it is true that medicines in solution are more readily taken up than solids, yet many of the latter are absorbed with great facility, as metallic iron, calomel, etc., which are rendered soluble by the gastric fluids. The chemical changes induced in medicines by the gastric juice are by no means well understood. How individual agents are affected is a subject to be considered hereafter.

The following are the chief forms in which medicines are administered by the stomach :

Powders are medicines reduced by mechanical subdivision, or by precipitation, to various degrees of fineness. The Pharmacopœia of 1880 advises several grades ; a *very fine* powder is one triturated to that degree that it should pass through a sieve having eighty or more meshes to the linear inch ; a *fine* powder is one which should pass through a sieve having sixty meshes to the linear inch ; a *moderately fine* powder is one which should pass through fifty meshes ; a *moderately coarse* powder through one having forty meshes, and a *coarse* powder through one having twenty meshes to the linear inch. These powders are designated respectively No. 80, No. 60, No. 50, No. 40 and No. 20. Those soluble in water are usually administered in that menstruum. If insoluble, they may be suspended in water by means of sugar, sirup, solution of gum, glycerin, or they may be rubbed up with some innocuous powder, as sugar, sugar of milk, liquorice-powder, etc.

Triturationes are made by triturating 10 parts of the drug with 90 parts of sugar of milk.

Pills are small masses of medicine made into a globular shape, by means of an extract, conserve of roses, sirup, or glycerin. A pill should not exceed five grains in weight, including the excipient, and, as a rule, it should be smaller than this. To cover the taste, pills may

be coated with sugar, gum, gelatin, silver or gold foil. It should not be overlooked that pills too long kept, especially when sugar-coated, become very hard and insoluble, and therefore without activity. Extemporaneously, pills may be covered with fine tissue-paper, or enveloped in a raisin, to cover the taste of the ingredients.

A *Mixture* is a suspension of one or more insoluble substances in the vehicle, by means of sugar, gum, glycerin, treacle, albumen, etc. The term *emulsion* is restricted in application to the mixture of oil and water, in which the oily particles are suspended mechanically by rubbing them up with water and gum.

Extracts are solid and fluid. The solid extract may be aqueous or alcoholic ; in the one case water, in the other alcohol, being the menstruum employed to extract the active and soluble principles. An extract is *solid* when evaporation is carried far enough to produce a soft paste or a dry mass ; it is *fluid* when sufficient alcohol and water are retained to give the proper fluidity. The strength of the fluid extract (Pharmacopœia, 1880) is as follows : "One hundred avoirdupois ounces of drug make ninety-six fluid ounces," or nearly one minim to one grain. The strength of the fluid extract prepared according to the Pharmacopœia of 1870 is five per cent greater.

Abstracta are dry, powdered extracts, having about twice the strength of the official fluid extract. The mode of preparation is as follows : An alcoholic tincture is first prepared, the alcohol is then evaporated, and the residue is thoroughly triturated with sugar of milk.

Infusions are such solutions of active and soluble principles as can be extracted by digesting the crude drug in water, cold or at a temperature short of boiling. When water at the boiling temperature is used, the resulting solution is termed a *decoction*. Cold infusions are, when practicable, to be preferred to decoctions, for, at the temperature of boiling water, many active principles are decomposed or volatilized.

Infusa are prepared by taking 10 parts of the drug coarsely comminuted, and 100 parts of boiling water, which is poured on ; allowed to stand for two hours in a suitable covered vessel, and is then strained, and sufficient cold water is added to make 100 parts.

Decocta are prepared of the same strength as infusions—10 parts to 100—but the medicament, coarsely powdered, is put into 100 parts of cold water, and boiled for fifteen minutes. It is then allowed to cool to 113° Fahr., when sufficient cold water is added to make 100 parts.

Aceta consist of 10 parts of drug to 100 parts of diluted acetic acid. Acidum aceticum dilutum consists of 17 parts of acid and 83 parts of water, and therefore contains six per cent of absolute acetic acid.

Vina are preparations made with vinum album fortius, but differ

in strength. The official *vinum album fortius* is prepared by adding 1 part of alcohol to 7 parts of white wine.

Capsules are hollow cylinders or cones of gelatin, to contain offensively-tasting substances, as copaiba, oil of sandal-wood, etc. In the stomach the gelatin is dissolved and the medicament liberated.

Lozenges or Troches, button-shaped masses, are sometimes introduced into the stomach, but usually these bodies are intended to be dissolved slowly in the mouth, to exert a local action on the fauces.

Wafers are circular disks with a central cavity for holding the medicine. They are made of isinglass.

A *Suppository* is a conical mass of cacao-butter, or wax and cacao-butter, with which is incorporated a medicament, and should not weigh more than fifteen grains. They are applied to the rectum, vagina, and urethra.

Clyster, Enema, Lavement, are medicated solutions to be thrown into the rectum.

Although the rectum as an absorbing surface is inferior to the stomach, medicines are frequently introduced by this organ with great advantage. Some medicines enter the blood more quickly by the rectum than by the stomach, but, as a general rule, absorption is slower by the former organ. If the mucous membrane of the rectum be irritable, or if the substances introduced be irritating or bulky, they will not be retained. As the contents of the rectum are alkaline, solids requiring an acid for their solution will be slowly or not at all taken up. Acid solutions of medicinal agents, on the other hand, are readily enough absorbed, provided the quantity of acid present be sufficient to maintain solution. As a general rule the mineral salts act chiefly locally on the mucous membrane of the rectum, and enter the blood in small quantity. The salts of the alkaloids, on the other hand, are absorbed with facility. Alkaloids insoluble unless in presence of an acid are not absorbed with the same rapidity and completeness by the rectum as by the stomach, unless they are administered in acid solution. The salts of morphine, atropine, and strychnine, in solution, are absorbed as quickly, and the last named more quickly by the rectum than by the stomach.

Remedies administered by the rectum may be in solution suspended in some menstruum, or incorporated with a soap or fat in the form of suppository. The solution used should have the temperature of the rectum (about 100° Fahr.). The quantity administered should not exceed two fluid-ounces of solution. Before introducing a medicated solution or clyster into the rectum, this organ should be emptied of fecal matter by an ordinary enema.

Administration of remedies by the rectum is an important resource to the therapist in cases of inability to swallow, irritable stomach, and in children's maladies. Unfortunately, this organ soon becomes

intolerant, the mucous membrane irritable, and the medicament is either at once rejected or absorption delayed.

APPLICATIONS TO THE GENITO-URINARY MUCOUS MEMBRANE.—Brown-Séquard has proposed to utilize the bladder for securing absorption of remedial agents in cases of great intestinal disorder, as in cholera. Experiment has shown that morphine, for example, is taken up with considerable rapidity by this viscus.

Topical applications to the urethra and vagina are very frequently made, usually in the form of astringent injections. Suppositories, variously medicated, are also occasionally used in the treatment of affections of these parts.

III.

BY THE SUBCUTANEOUS AREOLAR TISSUE—THE HYPODERMATIC OR HYPODERMIC METHOD.

The term *hypodermatic* is used in conformity with the nomenclature already existing—as “epidermic,” “endermic,” etc.—but the termination of the word is now altered in deference to the opinions of the best philologists. The term *hypodermic*, which has been universally adopted, is known to be formed on wrong principles, and hence, in accordance with the rules of construction, the word *hypodermatic* is substituted. As the term indicates, by this method the medicine is applied to the subcutaneous areolar tissue. This does not include the method of “inoculation,” introduced by Lafargue, nor that proposed by Luton and Bertin, which consists in the injection of irritants into diseased tissues. It is obvious that by the hypodermatic method medicines can be introduced only in the state of solution. To introduce the solution under the skin, a special instrument is necessary. This is the now well-known hypodermatic syringe—a small syringe having a capacity not to exceed a drachm—the nozzle being a hollow needle having a lancet-shaped extremity for easily transfixing the skin. These instruments are various in form and construction, and are made of gold, silver, glass, or hard rubber. The most efficient instrument for ordinary use is the silver hypodermatic syringe described by the author. The piston-rod of this instrument should be semi-cylindrical and should be graduated for minims on its flat side, to indicate the quantity of solution contained in the barrel. Glass hypodermatic syringes break easily, and the mountings work loose and give way. Now, however, the glass cylinder is in part inclosed in a metal sheath, for greater strength and security. A graduated hypodermatic syringe should not be used until the exact value of the divisions of the scale has been determined by comparison with a standard minim-glass.

A medicine employed for hypodermatic use should be capable of

perfect solution in the menstruum, which is usually distilled or pure water. Particles of medicine undissolved are not only not in a condition for ready absorption, but are irritant to the tissues, producing inflammation and abscess. The solution for hypodermatic use should be free from foreign matter of every description and should be neutral in reaction, or, at least, without decided acid or alkaline property. Any substance which will coagulate the blood or produce violent local irritation is unfit for hypodermatic use. A solution of even a neutral substance should not be too concentrated. Clean water, free from visible impurities, is entirely harmless, and the quantity of fluid injected is, within certain limits, a matter of indifference, provided suitable care be used in selecting the site and injecting. On the other hand, concentrated solutions are more apt to produce local irritation than dilute solutions. Moreover, a drop too much of a concentrated solution of a powerful alkaloid may produce an alarming, if not dangerous state. In ordinary syringes a few drops remain at the bottom of the barrel and in the needle—whence it follows, in using strong solutions, it is difficult to inject the precise amount desired.

Solutions of alkaloids, too long kept, become unfit for use, hypodermatically, by reason of the development in them of a *penicillium*, a minute organism which grows at the expense of the alkaloid. Fresh solutions should be made when needed. When hypodermatic injections are used infrequently, it is preferable to prepare an extempore solution, using powders of a definite strength. Filtered river, melted ice, or rain water, may be used for dissolving the powders. Solutions prepared extemporaneously from ordinary spring or rain water are found to produce less inflammation, and are less likely to be followed by abscess, than solutions prepared with pure distilled water which have been kept for several days. The author, therefore, advises the use of extemporaneous solutions, powders of suitable strength being kept for the purpose.

In practicing the hypodermatic injection it is important to avoid puncturing a vein. Serious depression of the powers of life and sudden and profound narcotism have been produced by injecting a solution of morphine directly into a vein. Fatal collapse may ensue from injecting air into a vein along with the narcotic solution. Bony prominences ought to be avoided, and also inflamed parts. It is not necessary to follow Wood, the discoverer of the hypodermatic method, who advised that the solution be inserted at those points where pain can be awakened by pressure (the painful points of Valleix). Some exceptions to this rule undoubtedly exist. The arms, the abdomen, the thighs, the calves of the legs, and the back, are suitable places. Eulenburg makes the assertion that the effect is slower when the injection is made in the back, but I have not observed this difference.

THE FOLLOWING ARE THE REMEDIES, SOLUTIONS, AND DOSES, EMPLOYED BY THE HYPODERMATIC METHOD:

MORPHINA—*Morphine*. ℞ Morphinae sulphat., gr. xvj; aqua, ℥j. M. Sig.: Two (2) minims are equal to one fifteenth of a grain.

An antiseptic solution of morphia, intended to be kept for several weeks, may be prepared according to the following formula:

℞ Morphinae sulph., gr. xvj; acid. carbolic., gtt. v; aqua, ℥j. M. Sig.: Two minims contain $\frac{1}{15}$ of a grain of sulphate of morphia.

Solutions of morphine may be readily prepared extemporaneously from powders of a definite strength, as follows:

℞ Morphinae sulphat., ℥j; atropinae sulphat., gr. ss. M. Ft. pulv. No. cxx (120). Sig.: Each powder contains $\frac{1}{6}$ of a grain of morphine and $\frac{1}{240}$ grain of atropine.

Powders of morphine containing the necessary quantity may also be used extemporaneously, dissolved in sufficient water. It is now known that a solution thus prepared is less likely to produce local irritation and induration than a prepared solution kept some days before using it. The chief cause of the irritating qualities of such a solution is the development of a *penicillium*—a minute organism, which grows in an alkaloidal solution, at the expense of the alkaloid. The author, therefore, advises the habitual use of powders of suitable strength made into extemporaneous solutions whenever practicable, rather than the permanent solutions.

There are now prepared for physicians' use, gelatin disks containing certain defined proportions of the alkaloids, and also "hypodermic tablets," so called, having a definite measure of morphine, or combined morphine and atropine, and morphine and other alkaloids. These preparations are useful, but the author is convinced, after considerable experience, that no substitute hitherto proposed will prove as satisfactory in all respects as the extemporaneous solution of the alkaloids. Experience has shown that fresh water, whether cistern (rain) or hydrant (river) water, is preferable to distilled water. Hence, a powder of morphine, dissolved at the moment it is required, in ordinary clean water, is safer in respect to local complications than the most carefully prepared solution in distilled water.

ATROPINA—*Atropine*. ℞ Atropinae sulphat., gr. ij; aqua, ℥j. M. Sig.: One minim contains $\frac{1}{240}$ of a grain. Three (3) minims contain $\frac{1}{80}$ of a grain, which is a maximum dose for many persons.

MORPHINA AND ATROPINA.—℞ Morphinae sulphat., gr. xvj; atropinae sulphat., gr. ss.; aqua, ℥j. M. Sig.: Six (6) minims contain $\frac{1}{6}$ grain of morphine and $\frac{1}{240}$ grain of atropine.

Powders prepared in conformity to this formula may be dissolved when required. "Hypodermic tablets" are also made in the same strength. A good formula for the powders is the following:

℞ Morphinae sulphat., ℥j; atropinae sulphat., gr. ss. M. Ft. pulv. No. cxx (120). Sig.: Each powder contains $\frac{1}{6}$ of a grain of morphine and $\frac{1}{240}$ of a grain of atropine.

DUBOISINA—*Duboisine*. ℞ Duboisinae sulphat., gr. j; aqua, ℥j. M. Sig.: Four (4) minims contain $\frac{1}{120}$ of a grain. Eight minims is the usual maximum dose for an adult.

HYOSCYAMINA—*Hyoscyamine*. ℞ Hyoscyaminae, gr. j; acid. sulphuric. dil., ℥j; aqua, ℥j. M. Sig.: Five (5) minims contain $\frac{1}{60}$ grain.

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 $\frac{1}{8}$ of a grain.

CONINA, *Coniine*. ℞ Coninæ hydrobromat., gr. j; aquæ, ℥j. M. Sig.: Ten (10) minims contain $\frac{1}{8}$ 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 $\frac{1}{10}$ of a grain.

TABACUM—*Tobacco*. NICOTIANA—*Nicotine*. ℞ Nicotianæ, ℥j; acid. acetic., ℥ v; aquæ, ℥ iv. M. Sig.: Four (4) minims contain $\frac{1}{10}$ 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, ℥ iv. M. Sig.: Four (4) minims contain $\frac{1}{10}$ of a grain.

PILOCARPINA—*Pilocarpine*. ℞ Pilocarpinæ nitrat., gr. xvj; aquæ, ℥j. M. Sig.: Five (5) minims contain ($\frac{1}{8}$) one sixth of a grain.

AMYL 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 in-

jection should be prepared when required. The dose ranges from $\frac{1}{8}$ of a grain to $\frac{1}{4}$ of a grain.

ERGOTA—*Ergot*. ℞ Ext. ergotæ, ℥j; 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. carbol. 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 carboic 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. xlviij; aquæ destil., ℥ iv. 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—*Carboic Acid*. ℞ Acid. carbol. purif., gr. x; aquæ, ℥j. M. Sig.: Eight minims contain $\frac{1}{8}$ 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 sub-joined:

℞ Hydrarg. chlor. cor., gr. j; aquæ, ℥j. M. Sig.: Ten (10) minims contain $\frac{1}{8}$ 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