BRAINARD
ESSAY ON A NEW METHOD OF TREATING
SERPENT BITE AND OTHER POISONED WOUNDS

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A NEW METHOD

OF

TREATING SERPENT BITE

AND

OTHER POISONED WOUNDS,

BEING THE ANNUAL ADDRESS DELIVERED BEFORE THE ILLINOIS STATE MEDICAL SOCIETY, JUNE 7TH, 1854.

BY

DANIEL BRAINARD, M. D.,

PROFESSOR OF SURGERY IN THE MEDICAL COLLEGE AT CHICAGO, CORRESPONDING MEMBER OF THE SOCIETE DE CHIRURGIE DE PARIS, ETC., ETC.

With Two Copperplate Engravings.

CHICAGO:

J. F. BALLANTYNE, PUBLISHER AND PRINTER.

NEW POST-OFFICE BUILDINGS, COR. OF CLARK AND RANDOLPH-STS., OPPOSITE THE SHERMAN HOUSE.

1854.

EXPLANATION OF PLATE I.

All the figures in this plate are magnified six hundred and twenty diameters.

FIGURE 1. Natural appearance of the blood corpuscles of a healthy pigeon Some are seen edgewise.

FIG. 2. Blood treated with a solution of iodine 10 grs., potass iodide 30 grs aquæ, 13. The globules are nearly natural, though a little more round, and the color is brought out.

FIG. 3. Blood on which a little infusion woorara was dropped, and at the same time some of the solution of iodine and iodide potass. Some of the globules appear preserved, though they are very much reduced in quantity, the debris of the corpuscles being the small spots, appearing like nuclei.

FIG. 4. Blood treated with a solution of woorara.

FIG. 5. Blood taken half an hour after death, from the pectoral muscle of a pigeon which had been injected with eight drops of a solution of woorara—taken from the side opposite to that injected.

FIG. 6. Blood taken from the heart of a pigeon which died in five minutes after woorara was injected. The corpuscles have all lost their natural shape, and have a tendency to run into one another.

FIG. 7. Blood taken from the medulla oblongata of a pigeon two hours after he died from an injection of eighteen drops of a solution of woorara.

Fig. 1.

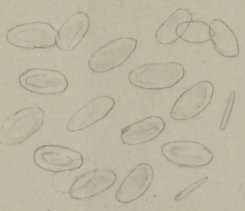


Fig. 2.

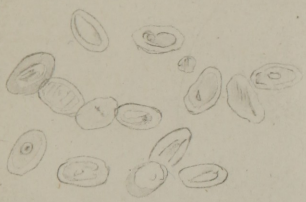


Fig. 3.

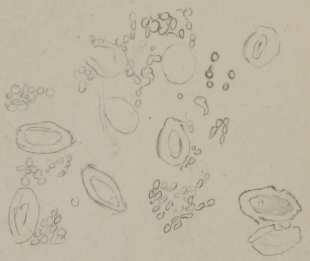


Fig. 4.

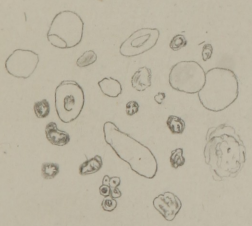


Fig. 5.

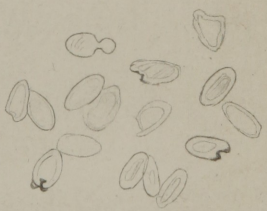


Fig. 6.

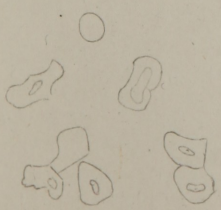


Fig. 7.

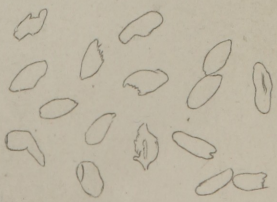
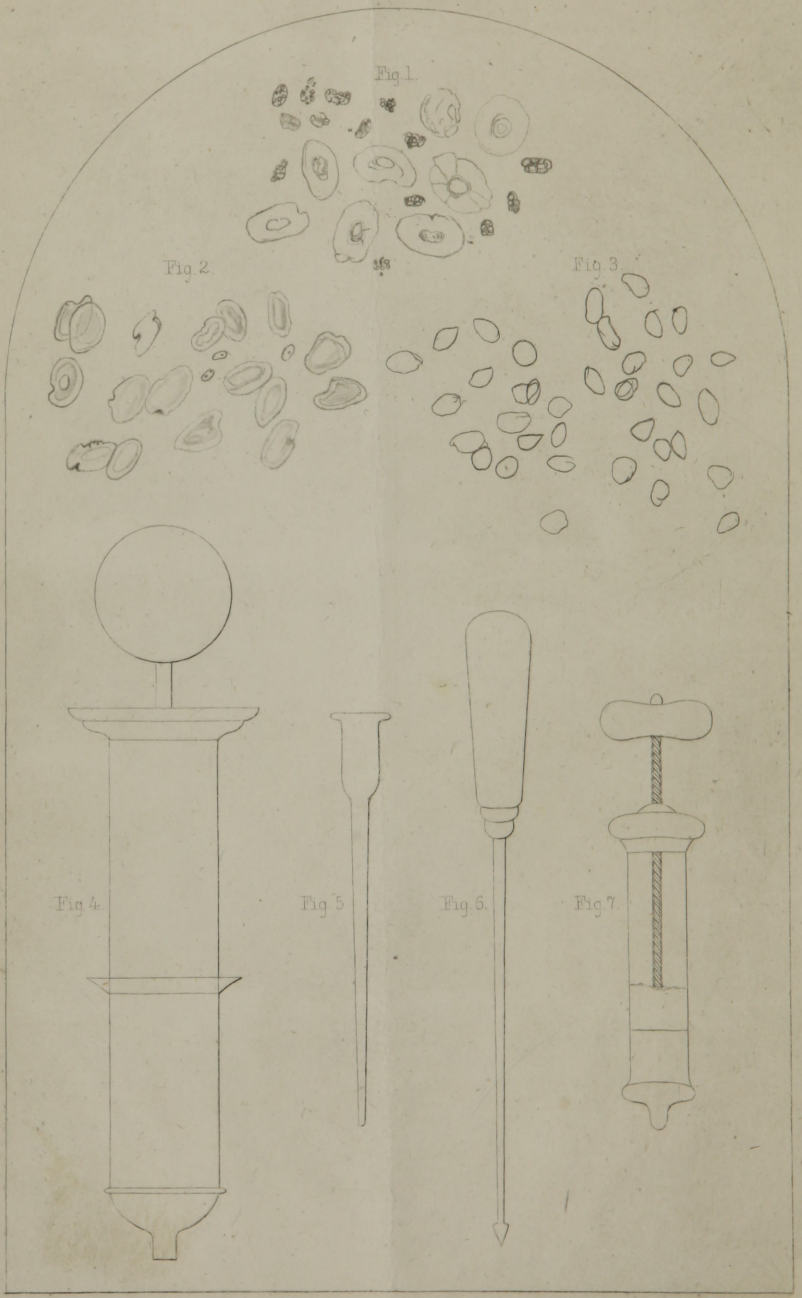


PLATE 1



PLATE, 2.

EXPLANATION OF PLATE II.

Magnified six hundred and twenty diameters.

Figure 1. Frog's blood treated with solution of woorara. Globules not all taken from one field as they were broken down.

Fig. 2. Blood from head of pigeon dead from bite of rattlesnake, taken fifteen hours after death.

Fig. 3. Pigeons' blood to which the venom of a rattlesnake had been added

Fig. 4. Syringe for infiltration—natural size.

Fig. 5. Syringe for measuring the poison by drops—natural size.

Fig. 6. Canula of trochar to which the two syringes are adapted—natural size.

Fig. 7. Stylet of trochar—natural size.

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Gentlemen of the Society,—

It is customary, on occasions like the present, to select as a topic for discourse some subject connected with the general interests of the profession, such as its history, its wants, its claims, or its duties. I hope to be pardoned for departing in some degree from this practice, and presenting before you a simple essay on a surgical subject. The reason for adopting this course is, a firm conviction that the first want, and greatest interest of the medical profession, is the improvement of medical science, and because I have made poisoned wounds, to which your attention is asked today, the subject of especial study, and entertain views concerning their treatment, which I believe to be both new and important.

The class of poisons to be considered is that, denominated by Orfila, septic, or putrid poisons. It embraces, among other substances, the venom of serpents, the woorara or American poison used on arrows, putrid animal matter, as that inoculated in dissecting wounds, etc.

These substances possess the property, in common, of being

innocuous, or little active when taken into the stomach; but causing the tissues to run rapidly into gangrene when they are placed on the surface of recent wounds, and of being more rapidly fatal when thrown into the blood vessels.

Christison and other toxicologists have not admitted the existence of septic poisons, but I think no one accustomed to witness the effects of the venom of serpents on a wound, could doubt the propriety of admitting such a division.

All rational views of the treatment of poisoning, date from the period when poisons were found to exist physically in the different organs of the body, and exert their influence on the solids and fluids by virtue of their peculiar properties. This discovery is due, mainly, to Orfila, and it is upon it that the practice is founded of using such means of treatment as are capable of neutralizing or diluting the poison, or causing it to be eliminated from the system in the excretions. In the case of mineral and vegetable poisons, chemical antidotes are useful, but in a limited degree, and only when the substance to be neutralized is still retained in the stomach. As soon as it has been absorbed, dilution and elimination are the only means of obviating its dangerous effects.

With regard to animal poisons, neither neutralization by chemical agents, nor dilution, nor elimination, has hitherto been successfully attempted. The means resorted to at the present time, are the excision or destruction, by caustic, of the part on which the poison has been inoculated, and the use of such means as are supposed to be capable of counteracting its effects.

My object in this address is, to show that the venom of serpents and the woorara may be neutralized after being introduced into the tissues; to show the manner in which this may be effected, and to prove the efficacy of the treatment by experiment before you.

Before proceeding to speak of this treatment, it may be useful to cast a glance at some of the means reputed to possess efficiency against the bite of serpents, in order to show how slight are their claims to confidence.

Washing and sucking the wound, inasmuch as they have a tendency to remove the venom from its surface, are to some extent

serviceable. Yet Fontana found them insufficient to prevent death, in birds bitten by the viper.* Sugar and common salt mentioned by Humboldt as the antidotes to the woorara used by the natives of South America, are without any effect, as Magendie has shown by experiment.

The strong mineral acids and aqua ammonia did not, in the experiments of Fontana, prevent the action of the venom of the viper when mixed with it before inoculation. Making incisions about the wound was found by Fontana to hasten death, after the bite of the viper. Nitrate of silver mixed with a solution of woorara, does not prevent its fatal effects. Mixing the venom of serpents, or the woorara, with alcohol or oil of turpentine, preserves them, and makes them more active than when they are mixed with water. In cases where excision of the part, or its destruction by caustic, or the actual cautery have been resorted to, the result has usually been fatal. The use of cups upon the part, and ligatures about the member, are the only means known, whose efficiency against the venom of serpents has been proved by experiment.

Their beneficial action results from their power of retarding absorption, thus causing the poison to enter the circulation slowly. Pennock has shown that this is not produced by the removal of the pressure of the atmosphere, as Barry supposed, but by the pressure of the edge of the cup, which interrupts the circulation in the vessels of the part.†

Alcohol taken to intoxication has at the present time the reputation of counteracting the effects of the venom of several species of serpents. The evidence in its favor is scarcely sufficient to justify the confidence reposed in it, as the following facts will show:

1. When mixed with alcohol the venom is rapidly fatal, if inoculated.

2. Alcohol injected into the tissues, or introduced into the stomach of birds, or of small animals which have been bitten hastens death. This circumstance is not conclusive, as alcohol is of itself a poison for them.

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* Traite sur le Venin de la Vipere, etc. Florence, 1771, vol. 1, p. 106.

† American Journal of the Medical Science, vol. ii, 1828.

3. Persons bitten by rattle-snakes when in a state of intoxication by alcohol are not, on that account, secure. I have authentic information of four cases in which the bite of that snake proved rapidly fatal on intoxicated persons. Another may be found related in the American Journal of the Medical Sciences, Vol, 8, 1831.

As not more than one in ten of the wounds made by the most venomous serpents proves fatal, a case of failure of a remedy is sufficient to counterbalance many cases of its supposed success.

As the woorara is one of the poisons with which I have experimented, and the one which I propose to use to-day, it may be well, before going further, to say a few words on the subject of the nature of this substance. As usually met with, the kind which is brought from South America is contained in small gourds over the internal surface of which it is spread. On being detached it presents a dark color, has a resinous fracture, a bitter taste, is readily mixed with water, but imperfectly dissolved by it. Its appearance is the same when mixed with alcohol; but both these fluids dissolve the active principle of it. The solution is neither acid nor alkaline. If the quantity of water used be small, the mixture has a ropy, tenacious consistence. The solution is coagulated by the nitrate of silver, and by the solution of iodine and iodide of potash in distilled water, and, when treated with the latter solution, neither the part coagulated nor the fluid expressed from it retains its poisonous quality. It does not effervesce with acids. Its aqueous solution is not coagulated by heat, and boiling does not impair its activity.

The active principle has generally been considered as analagous to strychnine,* and Pereira states that the strychnos toxifera yields the basis of it.

Nearly all recent authors have copied the account of its manufacture given by Humboldt,† who enters into detail, and says it is made from the bark of the root of a species of *liane*, called by the natives of the banks of the Amazon, Bejuco de Mavacure.

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* Element of Materia Medica, Vol. II., p. 364.

† Voyage to the Equinoxial Region of of the New Continent. Vol. II., pp. 547 to 556.

"The chemical analysis of the woorara has been performed yb Boussingault and Roulin, (Annales de Chimie, Sept. 1828,) who found in it a bitter principle, *very different from the strychnia* acetic acid, gum, red coloring matter, salts, etc.*

De la Condamine states that it is an extract made by heat from the juice of divers plants, about thirty in number, and that the *liane* is one of them.

Such was the state of our knowledge on this subject, when in 1850 Messrs. Pelouze and Bernard read a note at the Academy of Sciences on the subject.

Mr. Goudot, who furnished them with a specimen of the poison, confirms in general the account of Humboldt, as to the manner of its preparation from the juice of the *liane;* but he adds the important statement that "before the extract is quite dry they drop into it some drops of the venom of serpents collected from the vesicles of the most venomous species." Messrs. Pelouze and Bernard conclude that "the woorara acts upon animals in the manner of a venom."‡

From the discrepancy of these different accounts, it might be inferred that the various poisons prepared by the Indians of the Amazon and the Orinoco differ essentially in their properties; and Humboldt states that such is the case. There are, however, two facts stated by Humboldt himself which go to favor the opinion of Bernard and Pelouze. The first is that the juice of the *liane* before concentration is innocuous. The other is that "the Indians who have been wounded by poisoned arrows in war described to us the symptoms as entirely like those which are observed from the bite of serpents."

It is not probable that a juice from which a poison of such extraordinary activity is manufactured would be itself without power; and it is impossible to confound the effects of strychnia and those of the venom of serpents when applied to a wound on the human subject. For myself, having made more than a hundred experiments with the woorara, I entertain but little doubt

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* Dict. de Medicin, Tome IX., p 483

‡ Comptes Rendus de l'Academie des Sciences, Seance Du October 14, 1850.

that the active principle of the specimens which I have made use of is the poison of serpents preserved in extractive and gummy matter. Those specimens were two. The first I believe to be a part of the same as that furnished to Messrs. Bernard and Pelouze by M. Goudot, as it was procured for Dr. J. W. Green and myself from M. Flourens at the Garden of Plants, by the Prince Charles Bonaparte. The other, which came from the Amazon, was furnished me by Dr. David Green, of New York. Their appearance and action were identical in every respect.

My reasons for believing its active principle to be the venom of serpents are these:

1. Its effects on birds and animals are strikingly like those preduced by the venom of the rattlesnake; and in many cases no difference can be perceived between them.

2. These effects are entirely unlike those produced by the vegetable alkaloids.

3. Iodine neutralizes it as it does the venom of serpents, but has no such effect on vegetable alkaloids.

4. It is, like the venom of serpents, innocuous when taken into the stomach, except, perhaps, when used in very large quantities, or in circumstances very peculiar. This is not the case with any known vegetable poison.

5. It is well known that the poison used by the *North* American Indians for their arrows is that of the rattlesnake. I have learned this from such varied sources as not to leave any doubt on the subject. My inquiries have related to the Indians of California, New Mexico, and Texas, and been directed to medical officers of the army and intelligent travellers. The answers have never varied. The art of poisoning weapons is no longer a secret among them, but is often employed by those whites who adopt their customs. Dr. George Johnson, of St. Louis, who has traveled extensively on the Rio Grande, gave most accurate and valuable information concerning the habits of several Indian tribes in this respect. He states that there is a variety of rattlesnake on the Rio Grande, whose poison vesicle is much developed, and forms a prominent projection. This species is much sought for, on account of the quantity of virus contained in the sac.

I am, therefore, justified in stating that the poison used for arrows is, *in some instances*, the virus of serpents. There is great reason for believing that the process of preparing it is, as far as possible, kept a secret, except in what relates to the preparation of the juice of the plants destined to serve as a vehicle for the preservation of the venom.

If I am mistaken in this point, and the woorara should be found to contain some poisonous vegetable principle hitherto unknown, it will not invalidate my conclusion in regard to the effect of iodine upon it. It would only extend the application of this substance to the treatment of two kinds of poisoned wounds instead of restricting it to but one.

Having disposed of this point, I come now to the method of treatment which I propose for wounds poisoned by the woorara.

1st. It consists in the application of cups upon the part, or of ligatures around the member wounded, so as to arrest absorption.

2d. In injecting or infiltrating into the subcutaneous tissue the solution used as an antidote.

The cups should be applied for a short time before the infiltration is employed, so as to fill the tissues with fluids, and prevent the injected liquid from producing abscess by mechanical injury. They should be allowed to remain on from five to ten minutes after the infiltration has been effected, in order to allow time for the antidote to come in contact with the poison before the latter has entered the circulation. In case much swelling and effusion have taken place before treatment can be applied, the application of cups would be unnecessary, as the fluid injected would in that case pass freely through the tissues without it. The strength of the solution should depend on the state of the parts, and the extent to which it is desired to disseminate it in the tissues. For a recent wound ten grains of iodine, and thrice that quantity of iodide of potassium to the ounce of distilled water should be employed. It should be put upon the wound, and the tissues filled with it for an inch around. When the swelling is already extensive, one-half or one-fourth the above strength will suffice; and the solution should, in that case, be disseminated as extensively as possible through the part affected, by introducing it, if neces-

sary, at several different points. In a recent case I would advise one drachm of the solution to be injected.

In order to perform the injection or the infiltration perfectly, it is requisite to have cups to fit the inequalities of surface of the different parts of the trunk and members. Although ligatures can be made to arrest the circulation, and consequently the absorption, and fill the tissues with fluids, they do this less rapidly and less perfectly than cupping glasses. To perform the infiltration, small trochars like the exploring trochar are required, or they may be made still finer, (see plate 2, fig. 5 and 6). To the canula of the trochar a small syringe, like that called Anel's, should be adapted. (Plate 2, fig 4.) After the trochar has been introduced, and the stylet withdrawn, the syringe should be adapted to the canula; while the injection is gently pressed in, the cupping glass should be gradually exhausted. This is the method I advise on the human subject. When it is desired to employ it for experiment, a small syringe, the piston of which moves with a screw of which half a turn presses out a drop, and of which the point is also adapted to the canula, should be employed to insert the poison in the tissues. (See plate 2, fig. 7.)

I was led to the belief that iodine is the proper application to the snake bite, by experiment. Selecting salts which had not been used by others, I found the selection I have recommended, to be the only one which prevented the fatal effects of the poison, without producing an eschar. The solution of the iodide of potassium alone, has no effect as an antidote.

I am aware that the infiltration of the solution into the tissues is the part of the treatment which will be longest in receiving the assent of physicians, and the most difficult to introduce into general practice. Nevertheless, it is easy to understand, a priori, the reason and the necessity for so doing. In order to neutralize a poison once introduced into the system, it is essential that the antidote should be also introduced, and placed there where the poison exists, and in contact with it. Now, in case of an inoculated poison, any application which is confined to the external surface of the skin, is necessarily insufficient, as it cannot pass through the cuticle. Antidotes taken internally cannot reach the poison in more

than the slightest quantities. If they pass into the circulation, they are quickly eliminated by the kidneys. In inoculated poisoning, the antidote can only be successfully applied by inoculation, or, what is the same thing on a large scale, infiltration. Experiment proves this to be true. A quantity of the venom of serpents, or of woorara, once introduced under the skin, neither medicines swallowed, nor those applied externally, will prevent the death of the animal, unless these latter are caustics and instantly destroy the part. But the introduction of the antidote into the tissues is capable of neutralizing it. It happens fortunately, in this instance, that the antidote is a substance whose effects, when introduced into the tissues of the human subject, are well known not to be injurious. The chemical relations of iodine are similar to those of chlorine, but its actions are slower and less energetic, and it is probably from these that it derives its virtues as an antidote to septic poisons. It is certain that it prevents the discoloration and gangrene, which are always noticed on the surface of poisoned wounds when left to themselves.

My experiments were commenced with the venom of the rattlesnake, and made principally on pigeons, dogs and cats. Birds die from it much sooner than quadrupeds, and are therefore much more difficult to save by treatment. The way of using the serpent is, to have it confined in a groove, with only his head projecting. Denude the breast of the pigeon of its feathers, and when the fangs are raised in anger, press it against them. I prefer this method to that of extracting the venom and inoculating it, for two reasons:

1. The poison, when extracted, is uncertain in its operation, being often composed in part of saliva, and sometimes wholly of that fluid. Fontana constantly found that the wounds made by inoculating the venom were less fatal than the bite of the viper.

2. The bite is the wound we are called upon to treat, and is placed in circumstances less favorable than a wound by inoculation.

Of the pigeons thus bitten, and treated by iodine in the manner I have described, not more than one half die, and these are cases where it is impossible to bring the antidote in contact with the venom in time to prevent its action.

The serpent which I employed was the species called crotalophorus tergeminus, or prairie rattlesnake, and I have at the present time performed fifty experiments with the iodine on its bite.*

My experiments with the woorara were conducted in the following manner:

1. In order to test the strength of the poison, six drops of a solution, containing one fifth of a grain of woorara, was thrown under the skin of a pigeon.—It died in five minutes.

2. I mixed the same quantity with twenty drops of a solution of iodine, of the same strength before given, and injected it under the skin of a pigeon.—No symptom of poisoning.

3. Threw the same quantity under the skin of a pigeon, and applied a cup lightly over the point, twenty drops of the solution of iodine were injected through the same canula.—No effect.

4. Covered a deep wound in the muscles of a pigeon with a paste of woorara, in a few drops of water.—Bird died in five minutes.

5. Same experiment.—After the application of the paste, the wound was washed with the solution of iodine.—No effect produced.†

These experiments have been repeated by myself alone, and in connection with others, over one hundred times, with the same results; and I feel confident, therefore, that their accuracy cannot be called in question, and that in regard to the woorara, it is quite safe to affirm that the solution of iodine neutralizes its action.

In making this statement, I would by no means be understood as asserting that it is so in all circumstances and in all proportions. The circumstances which prevent its being so are, the introduction of the poison in such a situation that the solution cannot reach it, or so directly into the circulation that it has not time to act upon it. In most cases of wound neither of these conditions is likely to occur.

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* For a fuller account of these experiments, the reader may consult the annexed paper on the subject.

† These experiments were repeated before the society with the result here stated.—H. A. Johnson, Secretary.

According to the experiments which I have made, for the purpose of determining the proportion of iodine required to neutralize the poison, it appears that $\frac{1}{3}$ gr. of woorara in solution is perfectly neutralized by $\frac{1}{8}$ gr. of iodine and $\frac{3}{8}$ gr. of iodide of potassium also in solution. When the proportion of the antidote was smaller death was prevented, but the effects were severe.

It will be seen that in regard to the woorara, no possible doubt of the neutralizing power of iodine employed in the manner indicated, can exist. Although in a purely practical point of view, this knowledge might suffice, yet it is by no means sufficient to satisfy the inquiring mind, or the demands of science. It is necessary further to ask—

a. In what manner does the poison produce its fatal effects?

b. In what manner does iodine prevent them?

a. The inquiry as to the *modus operandi* of medicinal and toxical substances has generally been regarded as chimerical, at least, if carried further than to assert that they act by being received into the circulation, by producing a sedative effect, by increasing the irritability, etc. Now, however valuable may be the knowledge that a poison cannot act without entering the circulation, this fact in itself does not in the slightest degree enable us to understand in what manner it produces its effects The other explanations offered are, in general, still less satisfactory.

In regard to the venom of serpents and the woorara, an attempt will be made to explain their action in a greater degree. These two poisons produce death in a similar manner, and by two kinds of action.

1. By changing the form of the blood globules.

2. By a local action on the tissues and fluids of the part which extends itself by proximity

1. As an illustration of the former method, we may take the experiment of injecting the poison into the blood vessels. If a certain quantity of either of the substances in question be thrown into the current of the circulation, a period of time will elapse sufficient for it to reach the great nervous centres before its effect is produced. At this moment the animal dies instantly; as quickly as if the medulla oblongata had been removed, and ap-

parently in the same manner. The respiration, sensation, and voluntary motion, are abolished. The action of the heart continues in some cases for a long time.

If, after death from their effects, we take blood from different parts of the body, (if it be a frog or pigeon that has been employed,) and subject its globules to a careful examination with a microscope of accurate defining power, and capable of magnifying 640 diameters, it will be found that they are altered in form, indented on the edges, the capsule appearing to be partially detached from the nucleus. Those taken from the heart and great vessels are sometimes least affected; and it will even happen that not one can be found in the field of the microscope exhibiting the characteristic appearance produced by the poison. On changing the field, more or less of the globules will be discovered to be affected. The blood scraped from the muscular tissue is much more affected (see plate 1, fig. 5.), and that taken from the vessels of the nervous centres most of all (see plate 1, fig. 7); although in this not more than perhaps one in a hundred of these globules can be seen to be changed in form. It is probably for this reason that this change has been overlooked by some observers. The aqueous solution of the woorara destroys most of the globules of birds as soon as it is mixed with the blood, leaving only *debris* and granular matter. (See plate 1, fig. 4.) The different changes produced on this substance when mixed with iodine are shown in the plate, to which the reader is referred for more complete information on this point. I have found a similar change to take place in a case of snake bite. In a bird which died of it I found, fifteen hours after death, the characteristic appearance of the globules noticed after death from woorara. (See plate 2, fig. 2.) In mixing the venom with blood, the uncertainty of its being pure, or more or less mixed with saliva, is likely to give rise to errors In a wound from the bite of a rattlesnake Dr. Johnson found the blood globules destroyed. Dr. J. W. Burnett mixed the venom of the crotalus with blood drawn from the finger. The globules ceased to run and pile together, and remained without any special alteration of structure.*

* Proceedings of the Boston Society of Natural History, Jan 1854, p. 134.

According to my observations on birds and animals which die quickly of the serpent poison or the woorara, the blood is found coagulated The destruction of fibrine and loss of coagulability is not in the living body an instantaneous effect.

There are, doubtless, changes produced upon the blood by these poisons which the microscope cannot detect. Those we have noticed as resulting constantly from the woorara are quite sufficient to account for death. The altered globules arrested in the capillaries of the nervous centres, which they are incapable of traversing, destroy their vital actions, and arrest these organs in the performance of their functions. Hence the effect, as before stated, is the same as annihilating or removing them. Those who are not disposed to admit so mechanical an explanation of the effects of so virulent a poison may find an analogous case in the action of olive oil or mucilage of gum, which, injected into the vessels, are almost as rapidly fatal as the woorara. They act, no doubt, by arresting the circulation in the capillaries. Mixed in an emulsion, the oil may be injected with impunity.

Woorara absorbed from the surface of the stomach is as harmless as olive oil—no doubt its mixture with some other fluid preventing its action on the blood.

b. In what way does iodine neutralize the action of the woorara? As the chemical character of the poison is unknown, it is impossible to describe the reactions which take place between it and the iodine. There is every reason to believe that iodine acts chemically upon the active principle, and neutralizes it. At the same time, it preserves the red color of the blood and tissues, and prevents the tendency to gangrene which poisoned wounds generally manifest.

Iodine coagulates the solution of woorara; but neither the part coagulated nor the fluid expressed from it preserves its activity. Other substances, as the nitrate of silver, which coagulate it, do not neutralize it.

2. Of the local effect of the poison.

For a long time the most active poisons were supposed to kill from their action on the nerves.

When it came to be established, as is said, by the experiments of

Blake, (the same thing had long before been shown by the experiments of Fontana,) that they enter the circulation, and that, so long as they are prevented from doing so, they produce no effect immediately, their local action, and that which they exert through the nerves, was neglected and overlooked. Many medicines and poisons have, nevertheless, the most decided local effects, independent of corroding or irritating properties. Thus belladonna dilates the pupil, rhus radicans produces numbness of the hands. Many anesthetics have a local action, etc.

In regard to the poison of the serpent, it is most commonly its local action which kills. The part bitten becomes discolored; rapid gangrene occurs, which spreads upon the neighboring parts. *The muscular fibres of the part are the first affected with spasmodic action.* During the time when this action is taking place the pain is excessively severe, and the impression conveyed by the nerves is like that resulting from a shock, or crushing a part of the animal body, such as coldness, syncope, etc.

This local action is the cause of that dark discoloration noticed upon members bitten, and sometimes upon other parts. It does not result from inflammation, for all the fibrine of the blood disappears during this action. It most resembles those actions called catalytic, and it is the interstitial fluid of the cellular tissue first affected by it. It is a peculiarity of the woorara and serpent poison that they do not produce these effects except when inoculated. When swallowed they are absorbed without dangerous symptoms resulting; when thrown into the vessels they kill quickly, without any other perceptible change than that produced on the blood.

In stating that the woorara is absorbed from the mucous surface of the stomach or intestines, and passes into the circulation, without producing fatal or dangerous effects, I am well aware that I am stating an opinion in opposition to one which has received the sanction of the highest scientific authority. Messrs. Bernard and Pelouze, in their note already referred to, advance the opinion that the reason why woorara does not act when introduced into the stomach is, that this organ is incapable of absorbing it; and they relate some experiments going to show that the

membranes of the stomach are incapable of absorbing it when in solution out of the body. This paper received a prize from the Academy of Sciences for the year 1850. Although well aware of the high authority of such a sanction, and of the skill of M. Bernard as an experimental physiologist, I have not been able, in this respect, to make the results of my experiments accord with his.

The following experiment, which I have repeated three times with every precaution, seems to me to disprove his views :

Take two drachms of a solution containing five grains of woorara, and introduce it through a small gum-elastic tube into the stomach of a pigeon which has been kept twenty-four hours without food or drink. Let the pigeon remain twenty-four hours longer without food or drink ; kill it at the end of that time, and no fluid will be found in the intestinal canal. Wash the stomach and intestines with one drachm of distilled water, and inject this under the skin of another pigeon, and no effect will be produced. As the quantity introduced into the stomach was sufficient to kill twenty-five birds in five minutes, it seems impossible to avoid the conclusion that it is absorbed without injuring the pigeon, unless, indeed, we adopt the view that the poison is first digested. This view Bernard combats by experiments ; but they cannot be considered as conclusive under all circumstances. They only prove that it may remain for a certain length of time mixed with the gastric juice in the stomach of a dog, and possess all its activity when taken out. I admit that the gastric juice has no power of decomposing the poison—at least, that there is no evidence of its possessing such a power, and that all the facts that we are acquainted with go to disprove it.

Lest it be supposed that I claim to be the first to propose the iodine as a remedy for the bite of the rattlesnake, I beg to state here that it was first proposed by Dr. Whitmire, of Illinois, who states that the idea was suggested to his mind by reading Guthrie's remarks on its effects in removing engorgements. But, as recommended by Dr. Whitmire, it may have the effect of hastening the absorption of effused serum or fibrine—but that is all. Before my experiments no one had proposed it as an antidote to the

venom, or proved it to be so by experiment, or discovered a method of using it by which the effects of the venom could be counteracted. It stood on a par with the innumerable other applications which have been recommended, but of whose true value nothing positive is known.

The conclusions which I think may legitimately be deduced from the preceding facts are these:—

1. The woorara, in many cases at least, owes its activity to the venom of serpents mixed with it, and thus preserved.

2. Iodine, properly used, is an antidote for it, and, mixed with it before or after inoculation, or applied on a wound poisoned by it, is capable of preventing its dangerous effects.

3. The woorara produces its effects by changing the form of the blood globules, and by a local action, which consists in gangrene and decomposition of the tissues and fluids of the part affected.

4. The iodine acts by neutralizing the poison, and preventing the tendency to gangrene.

5. The woorara may be taken into the stomach, and absorbed without any ill effects.

APPENDIX.

Experimental Researches on the Venom of the Rattle snake showing certain of its effects not before noticed, and the means of preventing its absorption and neutralizing its effects. By DANIEL BRAINARD, M. D., Prof. of Surgery in the Medical College at Chicago, Ill. (Being an abstract of a paper presented to the Academy of Sciences, Paris, November 28, 1853.)

The experiments, the results of which are herein reported, were undertaken with the view of finding the antidote to the venom of the crotalus; and of testing the effect of such antidote, when thrown into the tissues of the animal body where the venom has been inoculated. They have furnished results, not before noticed by other observers, which are deemed of sufficient importance to be placed first in order.

The new facts observed are—

1. A spasmodic action of the whole muscular system, but more particularly of the larynx.

2. A certain change of the blood globules.

The antidote recommended is, the solution of iodine and iodide of potassium in water, applied upon the wound, and infiltrated into the tissues of the part affected.

As a means of preventing absorption, and rendering the action of the antidote more effectual, the use of cupping-glasses is recommended.

The serpent employed in these experiments was the massasagua, or prairie rattlesnake, the bite of which is deemed less dangerous than that of some other varieties. This probably does not arise from a difference in the venom, but from the snake being smaller and not sufficiently strong to make a deep wound. That such is the case, is proved by the fact that animals and persons bitten on the cutaneous surface, rarely die of the wound; but when bitten on the mucous surface, death is generally and speedily the result. In birds, also, whose skin is tender, the bite is uniformly and quickly fatal.

My experiments were mostly made on the domestic pigeon. The rapidity with which the poison affects it, and the size and form of its blood globules, render it peculiarly adapted for this purpose. When freely bitten, the birds generally live from five minutes to two and a half hours, according to the extent of the wound and the degree of concentration of the poison. There is great difficulty in experiments with this venom, in arriving at the degree of accuracy required in all such cases. This difficulty arises from the impossibility of measuring accurately the quantity used, the strength of each specimen being liable to vary from that of others. Not only those procured from different species, but even specimens procured from the same species, and the same serpent at different periods, differ in strength. The season, the temperature, the food of the serpent, the frequency of discharge, and other causes difficult to appreciate, render the bite of any serpent most uncertain in its effects.

In order to obviate, as far as possible, the causes of uncertainty, a serpent was not allowed to bite more than three times the same

day. One of the pigeons bitten was left without treatment, and if this did not die, all experiments with that serpent on that day were left out of consideration.

Effects of the Poison.—As an example of the effects of the poison, I transcribe from the record of experiments the following case, in which, from death occurring slowly, the changes could be carefully noted :

Friday, September 1, 1853.—A pigeon plucked under the wing was bitten at that point by a serpent. In fifteen minutes the wound and skin for half an inch around it were of a blue color. Effusion of serum had raised the skin, and separated it from the tissues beneath. At this time, slight spasmodic twitching of the fasciculi of the pectoral muscle beneath the bite was observed.

In twenty-two minutes this spasmodic action was greatly increased, and all the muscles, those of respiration especially, were affected with a tremulous movement, which passed off and recurred in paroxysms.

At this time the movements of the larynx in expanding and contracting were found to be much restrained. This organ being in full view in the pigeon when the mouth is opened, may be seen expanding during each inspiration, contracting after each expiration, and closing instantly and perfectly if it be touched, or if an effort be made to swallow.

In this case these movements were restrained, becoming more so as the effects of the poison increased. In thirty minutes there was difficulty of standing, the bird was gasping for breath, the mouth open, the eyes closed, the respiration spasmodic. At this time, the larynx was still more contracted, and the inspirations were at times accompanied by a sibilant sound.

In forty minutes, the bird was unable to stand, the respiration more irregular, the larynx more contracted. On being handled, this bird still moved its wings, but the legs were paralyzed.

It died at sixty-one minutes, the larynx being almost entirely closed for ten minutes before death. Observations on twelve birds which died, did not in any case show symptoms essentially varying from these, except in the greater rapidity or slowness of their

occurrence. In some the spasm of the larynx was less, in others more decided. In one the larynx was found to dilate fully and spasmodically several times in succession, and then close perfectly so as apparently to cause the death of the bird.

The vision and the hearing were apparently unaffected until an advanced stage of the action of the venom.

The birds uniformly lose the use of the posterior extremities first, and one which recovered did not regain the power of using them for two days.

Effects noticed in the parts bitten.—Almost instantly, in rapid cases, the wound turns blue. This discoloration spreads rapidly, principally in the direction of the vessels leading to the heart. On laying open the wound, the tissues are found discolored, brown, infiltrated with serum, presenting all the appearances of a wound in approaching gangrene. If the wound be on an extremity gangrene actually occurs.

State of the blood.—When death is delayed, the blood found in the cavities of the heart and in the great vessels, is of a dark color, and not coagulated. When death occurs rapidly, the blood is found coagulated, but less firmly than in the natural state.

Felix Fontana states that the venom of the viper causes the blood to coagulate in the vessels and the cavities of the heart. Much as I admire the genius and patience of Fontana, who, notwithstanding his profession (he was an ecclesiastic), devoted himself to researches concerning a subject so repulsive as that of experimenting with vipers, and made over six thousand experiments with them, I think it is still permitted to doubt whether in this respect he is not mistaken. The viper is nearly allied to the crotalophorus, as this species of serpent is to the crotalus, and there is every reason to believe that in regard to the venom of these serpents, there exists only the difference which results from quantity and various degrees of activity. I should desire a new series of observations directed to the subject, before admitting that the venom of the viper produces effects on the blood directly the reverse of those resulting from the venom of the rattlesnake.

There is, probably, no disease or state of the system in which the fibrin of the blood is reduced to as small a quantity as it is in persons or animals bitten by these serpents.

As a consequence probably of this, ecchymosis occurs, and the member bitten, and sometimes the whole cutaneous surface, is covered with spots like those which are observed in petechiæ hemorrhagicæ. If death does not result in a few hours, hemorrhage often takes place. It may occur from the mucous surfaces, from ulcers, slight wounds, and from the bite itself. In the case of a patient admitted into the Illinois General Hospital on account of a bite, Dr. Johnson was unable to detect any appearances of fibrin in the blood which came from the mouth. In a dog bitten on the abdomen, a hemorrhage occurred, the next day from a slight punctured wound, which was near proving fatal.

Microscopic examination of the blood.—I have already stated that in extreme cases, the fibrin is entirely wanting, or at least is in so small quantity as not to be perceived by the microscope. The globules, the only other part of the blood subject to microscopic examinations, are in the pigeon more or less altered.

The venom having been extracted from a serpent and mixed with a few drops of distilled water, the mixture was added to the blood of a pigeon, under the focus of the microscope. As fast as the globules were reached by the venom they changed their form and assumed the appearance, shown in plate ii, fig. 3, of the accompanying paper.

A pigeon which had died from the bite of a rattlesnake, was examined fifteen hours after death. There was no appearance of putrefaction. Fig. 2, plate ii represents the appearance of the globules of blood taken from the vessels of the head.

I have examined them in numerous other instances, with the aid of my friends, Drs. H. A. Johnson and J. C. Morfit. In some of them we found, immediately after death, the blood of the great vessels much altered. It was not coagulated. Some of the globules were indented, others flattened on the side so as to be shield-shaped, others assumed a dumb bell form. In these cases many granules, resembling the nuclei of the globules, were noticed.

In the blood taken from the wound of a bird dead of the bite, Dr. Johnson found much granular matter and few globules. In that taken from the cellular tissue, at a certain distance from the bite, the globules were found thickened in their transverse, and

shortened in their longest diameter. This latter change resembles that produced by a solution of sugar, and it did not result probably from the direct action of the poison, but from the globules having been macerated for some time in the effused serum.

When some hours had elapsed after the bite, before death, and the local effect was considerable, the blood taken from the vicinity generally showed an unusual number of white globules, which manifested a tendency to aggregation.

Treatment of the bite.—These is no point of practice in surgery which is less settled than the treatment of the bite of serpents. For reasons already alluded to, the wound inflicted even by the most poisonous species, such as the cobra de capello and the crotalus, are not commonly fatal. Hence, many inert remedies and others calculated to injure, have received the credit of curing, and come into popular use. Without, at the present time, going into this subject, it may suffice to state that the efficiency of no method has heretofore been established by direct experiment, if we except the application of cupping glasses. These, made use of as soon as the bite is inflicted, and continued for some time, have the effect of retarding the action of the poison. In cases where the dose is barely sufficient to kill, delaying its action neutralizes its effect, by causing it to be taken into the system in small doses.

Tracheotomy.—Bearing in mind the experiments of Dr. Marshal Hall, on dogs poisoned by strychnia, one of which was saved by tracheotomy, I no sooner observed that spasm of the larynx was one of the effects of the poison of the serpent than the operation presented itself as a possible means of relief. It was performed upon pigeons six times, in each case the effects were so far advanced as to show an undoubted tendency to a fatal termination. In no case did it prevent death, yet it must be admitted that in some of them it rendered the respiration regular and easy and evidently prolonged life.

Treatment with the solution of iodine.— In experimenting with different medicinal solutions, while searching an antidote to the effects of the bite of the rattlesnake, I was led to the belief that the solution of iodine and iodide of potassium in water, exer-

cises a much greater influence over it than any other substance, excepting some of the most powerful caustics.

I extracted the virus from the vesicle of a serpent; it stood in a drop on the surface of a spoon. Having made superficial wounds on the breast of the two pigeons, I put the venom on them, dividing it between them, as nearly as possible, equally. On one of the wounds a few drops of solution of iodine was placed. It was of the strength of ten grains of iodine and thirty grains of iodide of potassium to the ounce of distilled water.

These birds were not closely watched, but at the end of six hours the one treated with the iodine was quite well, and the other was dead.

I repeated this experiment with much care, and having a larger quantity of poison used four pigeons. Of the two not treated, one lived two and the other three hours, those to which the solution of iodine was applied lived, and did not appear to be affected.

It is well known that wounds thus inoculated are much less rapidly fatal than the bite itself of the serpent. I therefore applied the solution upon the breast of a pigeon where a bite had been inflicted, but it did not prevent death from taking place in the usual time.

When we consider that the fangs of this serpent are capable of penetrating the tender skin and tissues of a pigeon at least half an inch, and are so constructed as to deposit the venom there, that the part of it which is left upon the surface is without effect. that an application to the surface can but slightly penetrate the wound, it becomes obvious that an antidote applied in that manner cannot reach the virus, and must of necessity remain without effect upon it. So far as the virus is concerned, it is the same as if the solution had remained in the bottle.

Under these circumstances, I thought of a method of treatment which I had made use of with success in some cases of erysipelas and œdema, viz: infiltrating the solution into the tissues. This operation is performed as follows:

A pigeon being prepared, and bitten as before directed, a cupping glass is immediately applied over the wound. A fine trochar being then passed beneath it and under the skin to the seat of

the wound, the stylet is withdrawn and the solution of iodine injected through the canula into the tissues. The cup is then continued upon the part for from five to ten minutes.

Of ten pigeons treated in this manner, there died five, recovered five. Average time of death, two hours and fifty-two minutes. Of ten birds bitten, without treatment, all died, average time of death, eighty-eight minutes. Of those which died after being treated with iodine, two had the wound so situated as not to be covered by the cupping-glass, and in all of them the solution used was too weak, being of but half the strength required and of that before directed to be used.

I also tried cupping alone, and the injection of a solution of the lact ferri, eight grains to the ounce of distilled water, and distilled water alone. Dr. Morfit, who was kind enough to assist me in my experiments, tried liquor potassa, a solution of bi carb. soda, tr. arnica, and a solution of ammonia in water.

The cupping alone has the uniform effect of retarding the action of the poison and prolonging life. In cases where the dose of poison is barely sufficient to kill without any treatment, this of itself is capable of preventing death. This was the result obtained by Magendie, and it is not a little surprising that a means of treatment of such certain efficiency should be so seldom resorted to in practice.

On the other hand, birds treated with the aqua ammonia died quickly. Fontana found that aqua ammonia, applied to a viper bite, hastened death. Yet this is the most popular application for serpent bite.

In regard to the other fluids tried, it is sufficient to say, in general, that none of them had an effect, except those capable of producing an eschar. Soda and potass do this, unless very weak. Fontana, who tried the mineral acids, and almost every imaginable solution in his experiments with the viper, found the caustic potash alone capable of preventing its effects.

The result of my experiments, taken in connection with those made by others, is, that up to the present time, no substance or solution has been found capable of preventing the fatal effects of the rattlesnake bite (unless destroying by caustic or excising the

tissues of the part) excepting the solution of iodine. This, within certain limits, is capable of neutralizing it.

In order to guard against error, it should be stated that, in experimenting with birds, the separation of the skin by injecting even distilled water and applying cupping-glasses, is liable to cause the skin to fall off in scales. When the skin is not extensively separated, the solution recommended does not produce an eschar. The effects of iodine solutions on the tissues, since the publication of Velpeau's work on the subject, are so well understood that it is unnecessary to dwell further on this point.*

The effect of solutions of iodine, infiltrated into the tissues around the bite of the rattlesnake, is to prevent their discoloration and preserve the natural texture and color of the parts. Even when it does not prevent death from occurring, it still has this effect in a great degree.

The deductions which I think may legitimately be made from the foregoing facts, are—

1. The venom of the crotalus produces spasm of all the muscles —most marked in the muscles of respiration.

2. This venom produces a peculiar change of the blood globules, which consists of alteration of form and disintegration.

3. If death is delayed, it deprives the blood of its fibrine.

4. The solution of iodine and iodide of potassium. in the proportion of ten grains of the former and thirty of the latter to the ounce of distilled water, is, within certain limits, an antidote to the venom of the rattlesnake.

5. When the venom is deeply inserted, or when it has been absorbed, the antidote, to be effectual, must be infiltrated into the tissues.

6. This infiltration can be performed without causing loss of substance, or producing either eschar or suppuration.

NOTE.—I am under great obligation to Drs. H. A. Johnson and J. C. Morfit, of Chicago, for aid in conducting experiments with serpents, making the microscopic observations and drawing the figures of the plates.

I am also deeply indebted to my young friend, Robert Kennicott, for procuring for me as many serpents as I needed for my experiments, and for many valuable facts in relation to the effects of the poison.

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* Des Injections Medicamenteuses dans les cavites closes. Par A. A. Velpeau. Paris, 1846.