S. R. W. Dunbar 1828 3

OBSERVATIONS AND EXPERIMENTS

ON THE

Philadelphia

EFFICACY AND MODUS OPERANDI

OF

CUPPING-GLASSES,

IN

PREVENTING AND ARRESTING THE EFFECTS

OF

POISONED WOUNDS.

BY CASPAR WISTAR PENNOCK, M. D.

[Extracted from the American Journal of the Medical Sciences, for May, 1828.]

PHILADELPHIA:
PRINTED BY J. R. A. SKERRETT.

1828.

To

John R. W. Dunbar M.D.

with the Respects of his fellow

graduate, Thos Anthon

3

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THE occurrence of poisoned wounds being comparatively unfrequent, the opportunities presented of witnessing their effects, are very limited. Under these circumstances, it is not surprising that the medical world should be still divided in their opinions respecting the modus operandi, and the treatment of external poisons.

All the other departments of medical and surgical science have been cultivated with a zeal proportioned to their importance; and the accumulated experience of centuries, has rendered the enlightened practice of medicine and surgery, in many respects, certain.

That branch, however, to which I have alluded, has, from unavoidable circumstances, not attained correspondent elevation. Our practice in the treatment of such injuries, must be considered tentative and experimental—too frequently, indeed, it is altogether empirical. The numerous physiological investigations, however, which at present are conducted with so much ardour, warrant the belief, that this neglected subject will be more fully elucidated, and that a more determinate and scientific practice will happily result from such inquiries.

Among the authors who have recently written on the external application of poisons, Dr. Barry, an English physician formerly resident at Paris, has presented some very interesting views on the treatment of such injuries, which he has illustrated by a series of well-conducted and instructive experiments. Although the physiological inferences which he has derived from these experiments are not entirely satis-

factory, yet I presume the profession of medicine will derive from his inquiries some suggestions which will be found practically useful.

This gentleman, in studying the phenomena of the venous circulation, "was astonished that the pressure of the atmosphere was either entirely left out in the enumeration of its causes, or considered merely as a secondary agent." In pursuing his investigations, he was led to observe, that by the act of inspiration, a vacuum is formed within the chest, when it tends to dilate its capacity; and that all liquids in communication with the interior of the thorax must be attracted thither, being forced towards it by atmospheric pressure. By this physical action, he explains the fact of the swelling of the jugular veins during expiration; their collapse at the moment of inspiration; the cessation of certain hæmorrhagies, by means of forced inspiration; the absorption of air by the veins, and the accidents which have resulted from it, when any of the vessels near the heart have been opened or divided.*

With the view of proving the agency of atmospheric pressure in the circulation of the veins, he instituted a series of experiments: these were repeated by Dr. Barry in the presence of the Baron Cuvier and M. Dumeril, a committee appointed by the Institute of France, to investigate his views. The report of this committee was decidedly favourable to the correctness of Barry's positions, which they state were satisfactorily elucidated and demonstrated by his experiments, "executed with the greatest address, and with such satisfactory precautions as would obviate all objections which might be opposed to them."

Dr. Barry's view of absorption is also peculiar. He does not consider it as a vital function, but as a physical effect dependant on the same cause as the venous circulation: i. e. atmospheric pressure. It is thus defined by him: "absorption, as exercised by living animals, in its physical acceptation, and with reference to matter external to those animals, is the transport of that matter from their surface towards their centre." This is effected by "atmospheric pressure," and two causes or circumstances are considered as indispensable to its accomplishment.

First. "A free communication between the matter to be absorbed, and the thoracic cavities."

Second. "Atmospheric pressure, modified by the expansion of these cavities around one end of the communicating tubes, (the sanguiferous

* See note at the end of this essay.

or lymphatic veins,) while the same pressure is free and undisturbed around the other."

Assuming these data, and taking for granted that sanguiferous or lymphatic veins, or both, are the organs of absorption, and that death from poisoned wounds is caused by the absorption of the poison, Dr. Barry arrived at the conclusion, that the deleterious effects could be prevented by arresting this function; which could be effected, provided "the points of contact of the absorbing surface and the substance to be absorbed were placed under the influence of a vacuum." In applying this theory to practice, Dr. Barry removed the atmospheric pressure from the poisoned surface by means of cupping-glasses. He instituted a series of experiments with poisons, the fatal activity of which had been well ascertained; such as concentrated hydrocyanic acid, strychnine, upas tiéute, and white oxide of arsenic.

Considering the results of these experiments as very interesting in a physiological, as well as in a practical point of view, I repeated a similar series during the month of August, 1827. The results which I obtained were very much in accordance with those of the original experiments, and most of the important facts were fully verified. The articles employed, were the strychnine, hydrocyanic acid, and the arsenous acid. I did not consider it necessary to employ many different poisons, as my object was, not so much to ascertain their specific effects as to establish general principles respecting the influence of a vacuum on poisoned surfaces.

As a preliminary experiment, I ascertained the effects of the different poisons. I was satisfied by my trials, that a grain of strychnine, deposited in the cellular tissue of the thigh of an adult rabbit, would produce death, in from eighteen to twenty-five minutes. That six drops of the usual medicinal hydrocyanic acid, of the London Pharmacopœia, would, under similar circumstances, destroy life in eight or ten minutes; and that ten grains of the white oxide of arsenic, required seven hours to effect the same purpose.

The poisons used by Dr. Barry must have been more powerful than those employed by me. He found the fatal effect of strychnine on rabbits, to take place in five to seven minutes—of hydrocyanic acid in two minutes; and ten grains of arsenic killed a dog in six hours. The latter poison I found much slower in its operation; upwards of thirty-six hours being required to kill a dog, by the insertion of thirty grains beneath the integuments of the thigh. The articles I used were from the most respectable sources. The arsenic was procured in crystalline form, and the strychnine was from MM. Robiquet and Pelletier of Paris. The animals employed in the pursuit of these

investigations were principally rabbits and dogs, and two animals were subjected to each experiment. The poison was applied to each under corresponding circumstances, as regards the depth of the wound, the place of insertion, and the quantity of the substance employed. The "piston cupping-glass" was applied to one, whilst the other was abandoned to his fate. The animal on which the cup was used did not manifest any symptoms of poisoning, although the poisonous matter remained in contact with the cellular or muscular surface frequently for hours; in one instance, for upwards of forty hours. The experiments were performed at the Philadelphia Anatomical Rooms, and I was indebted to the politeness of Dr. J. Webster, for that privilege.

The conclusions derived from the experiments are as follow, viz:—

First. The usual effects of poisoned wounds cannot take place during the absence of the atmospheric pressure procured by the application of cupping-glasses.

Second. Such application does not arrest the deleterious action of the poison by withdrawing it from the exposed surface; on the contrary, the fatal effects are wholly prevented, though not a particle of the substance employed has been abstracted. In proof of this, if a poison, in powder, (strychnine or arsenic for instance,) be conveyed by a tube through a narrow wound, in an oblique direction under the integuments, to some distance from the opening by which it is introduced, and there deposited—and under these circumstances the glass be applied over this spot, where the skin is sound and unbroken, the wound being without the bounds of the glass, none of the poisonous substance will be removed, and yet no indication of its action will be presented during the time of the application of the glass.

Third. The constitutional symptoms, such as tetanic convulsions, etc. are arrested by the establishment of a vacuum on the poisoned surface; then by removing the poison by an incision through the integuments, the life of the animal is preserved.

Fourth. When the cupping-glass is applied over the opening made in the integuments for the purpose of introducing the tube containing the poison, and this is deposited under the skin beyond the circumference of the glass, none of the effects are manifested during the continuance of the vacuum, but as soon as the cup is removed, the action of the deleterious article commences.

Fifth. If during the application of the cupping-glass, placed as just stated, an incision be made between its edge and the place at which the poison has been lodged, death will ensue as speedily as though the atmospheric pressure had not been removed.

Sixth. If after the application of a glass for a given time, to the sound skin over the spot where the poison has been deposited, the glass be removed, death will then ensue as soon as if no such application had been made.

This last position is entirely at variance with the observations of Dr. Barry. He expressly says, that "after the glass had been taken off, the animal continued for one or two hours to carry imbedded in his cellular tissue a dose which would infallibly have destroyed him in a few minutes, had the cupping-glasses not been previously applied.

I have repeatedly observed, however, that if the animal was abandoned to his fate after the glass had been removed, after an application of it for an hour or more, that death took place as soon afterwards as it ordinarily did when no vacuum had been formed. Experiment fifth is in confirmation of this fact.

Experiment 1st.—I introduced into the left thigh of a remarkably large and strong adult rabbit, between the skin and cellular tissue, one grain of strychnine. The wound was closed by suture and adhesive plaster. The animal soon showed symptoms of great uneasiness, attended by difficult respiration. In thirteen minutes after the insertion of the poison, slight convulsive movements were manifested, which at seventeen minutes increased greatly. At twenty minutes, violent convulsions of a decided tetanic character ensued, which threw the whole frame of the animal into violent agitation. At twenty-three minutes after the introduction of the poison, opisthotonos came on: every muscle was rigid, and death quickly ensued.

Experiment 2d.—I inserted into the thigh of a rabbit, smaller, and less vigorous than the subject of the first experiment, one grain of strychnine under circumstances precisely similar. The wound was closed by suture, and covered by a strip of adhesive plaster. Two minutes afterward, the cupping-glass was applied, and the atmospheric pressure removed; this was continued an hour and fifteen minutes, and no symptom of the action of the poison was exhibited. The poison was now cut out, and the wound being carefully washed, it was closed by suture and adhesive plaster. The animal being placed at liberty, ate, appeared lively, and regardless of the pain to which he had been exposed; in a few days he recovered from the injury.

Experiment 3d.—One grain of strychnine was introduced through the barrel of a quill, some distance beneath the skin, and into the cellular tissue of the thigh of a rabbit. The orifice was closed by suture and adhesive plaster, and the animal abandoned to his fate. He became extremely uneasy and restless; walking with agitation about the room,

and with irregular and difficult respiration. In twelve minutes, spasm came on, which was soon succeeded by opisthotonos, and life was destroyed in four minutes afterwards: sixteen after the insertion of the poison.

Experiment 4th.—One grain of strychnine was introduced through the barrel of a quill to the distance of an inch between the muscles and skin of an adult rabbit.

The small orifice through which the tube was introduced, was covered with a strip of adhesive plaster, and the cupping-glass immediately applied to the sound skin, over the spot at which the poison was deposited, leaving the wound without the bounds of the glass. No symptom appeared during the time of the application of the cup, which was fixed on the spot for more than an hour. Upon the removal of the glass, the poison was cut out, the part carefully washed, the wound closed with the interrupted suture, and the rabbit lived and did well.

Experiment 5th.—One grain of strychnine was introduced into the thigh of a full grown rabbit, as in the preceding experiment, and the cupping-glass applied on the sound skin over the poison. No tetanic symptoms having been manifested at the expiration of one hour and eleven minutes, I removed the cup; and wishing to ascertain at what period after the removal of the cupping-glass, the poison would prove fatal, the rabbit was released from the board to which he had been bound, and placed at liberty on the floor. In sixteen minutes afterwards he was seized with violent tetanic symptoms, opisthotonos supervened, and he died in two minutes afterwards.

From this experiment it is evident that although the peculiar effects of the poison are prevented during the application of the cupping-glass, yet the symptoms of poisoning recur immediately after its removal, and death results, as soon as if no such application had been used.

This fact being of great practical importance, and being directly the reverse of a position laid down by Dr. Barry, I should have stated it with great hesitation, had I not verified it by repeated experiments, in the performance of which I was kindly assisted by my friends, Dr. Comstock, and Messrs. George Spackman and H. Levret, students of medicine.

I am therefore decidedly of the opinion, that the cupping-glasses do not so affect the texture of the parts to which they are applied, as to induce any functional alteration in the poisoned surface, which will in any degree arrest the effects of the poison after their removal.

Experiment 6th.—Two very small and feeble rabbits were the sub-

jects of this experiment. Into the thigh of the first, one grain of strychnine was deposited beneath the cutaneous tissue. He was abandoned to his fate.

Tetanic symptoms came on in nine minutes—in eleven, death.

Into the left thigh of the other rabbit, one grain of strychnine was introduced through the barrel of a quill to the distance of an inch and a quarter, between the skin and muscles. Almost the whole of it was deposited at the end of the quill, but a small portion accidently adhered near the orifice of the wound. The small incision was closed by suture and adhesive plaster. The cupping-glass was applied on the sound skin over the poison, leaving the orifice of the wound outside of the circumference of the glass. The animal remained perfectly quiet, and did not manifest any symptom of poisoning during one hour. The cupping-glass dropped off at this time, but was immediately re-applied. After a further lapse of ten minutes, no symptoms having occurred, it was removed, and the rabbit placed at liberty. Violent spasms came on in two minutes. The cup being immediately applied, the convulsions ceased in five minutes.

The animal appearing entirely relieved from pain, the glass was again removed, at one hour and thirty-five minutes from the commencement of the experiment. The poison was apparently all cut out, and the wound washed, and closed by the interrupted suture and adhesive plaster. Eighteen minutes afterward the rabbit became again violently convulsed, and true opisthotonos was exhibited. This was succeeded by symptoms of an opposite character. All the muscles of the body became extremely flaccid, respiration was suspended, and the only sign of life remaining was a tremulous motion almost imperceptible at the nostril.

So completely prostrated were the vital powers, that several gentleman who were present pronounced the animal dead. The cupping-glass was now applied, the atmospheric pressure removed as much as possible by the constant employment of the exhausting pump; relief was afforded in eleven minutes. The effects of this application were very peculiar: at each motion of the piston, the animal appeared invigorated, and at the expiration of the time stated, he rose on his feet and attempted to walk. At this time I left the animal in care of an assistant, directing him occasionally to apply the exhausting pump, in order to maintain the absence of the atmospheric pressure. Upon my return, one hour and twelve minutes after the second re-application, the animal being placed at liberty, rose, and walked across the room.

The glass was removed at four hours and thirty-two minutes from

the insertion of the poison, and two hours and thirty-nine minutes after the second re-application. The suture was cut out, and in order to remove any remaining portion of poison which had escaped the first excision, a portion of the muscular part was removed—the wound, which was of a very severe character, was dressed by suture and adhesive plaster.

The animal died on the second day after the experiment: not from the effects of the poison, as no symptoms of poisoning were exhibited, but from the extent of the wound and the intense heat of the weather.

Experiment 7th.—With the view of ascertaining whether the cupping-glasses would have any effect in preventing the action of poison when it was entirely without the circumference of the glass, we introduced one grain of strychnine through a tube to the distance of one-third of an inch beyond the space which the cup would occupy. The poison was deposited in advance of the cup, and nearer the source of the circulation, (the heart.) The orifice was closed by suture and adhesive plaster, and the cup applied over it: the glass remained on sixty-three minutes, during which time no symptoms of poisoning appeared. The poison was cut out a few minutes previous to the removal of the cup. In eleven minutes after its removal, spasm came on: which was relieved in five minutes by the cup. It was then removed, and the wound dressed as usual. The rabbit was free from spasm for two hours and thirteen minutes: violent tetanic convulsions and opisthotonos then ensued, but they were immediately relieved by the cupping-glass. The glass was applied at intervals during the succeeding hour. The rabbit then ate, and appeared well and lively. He died however in a few days, whether from the effect of poison, or the extent of the wounded and denuded surface, (as he had been the subject of a former experiment,) I cannot determine. The second day after this experiment, however, I observed no tetanic symptoms: on the contrary, he ate, and appeared lively.

Experiment 8th.—This was a repetition of the preceding experiment, except a difference in the mode of introducing the poison. With the view of diffusing it over the sub-cutaneous texture, and removing it beyond the space covered by the glass, I introduced a quill attached to a large syringe, and forcibly impelled and diffused the poison one inch from the orifice, which was then closed, and the cupping-glass applied over it, no symptoms of poisoning ensued. In fifty-five minutes the glass was removed. The wound was dilated, and the strychnine found diffused over the surface: almost the whole quantity being one-fourth of an inch beyond the boundary of the glass, The poison was removed, and the wound dressed. No morbid symp-

tom appeared. The animal, immediately upon being released, ate, was lively, and, with the exception of the wound, was apparently as well and vigorous as before the experiment. He lived for ten days, and then became the subject of another experiment.

Experiment 9th.—This was the introducing of one grain of strychnine through a valvular opening in the skin of the left thigh of a rabbit, and the depositing of it by means of a tube at the distance of one inch and a quarter from the orifice. The cupping-glass was not applied until constitutional symptoms, such as the difficulty of respiration, spasmodic movements of the lower jaw, and tetanic twitchings were manifested. These took place in nine minutes from the insertion of the poison. All the symptoms yielded instantly to the application of the cup over the poison. The glass remained on for one hour and a quarter: the poison was then extracted through an incision in the skin; the wound was dressed, and the animal recovered.

Experiment 10th.—Six drops of the medicinal hydrocyanic acid, prepared by Farr and Kunzi of this city, were injected by means of a syringe into the cellular tissue of the thigh of a rabbit. In five minutes convulsive movements were manifested, accompanied by difficulty of respiration, prostration of strength, and a comatose state. In ten minutes death ensued.

Experiment 11th.—The same quantity of hydrocyanic acid was inserted as in the preceding experiment. The cupping-glass was immediately applied on the sound skin over the poison, leaving the orifice without the bounds of the cup. No ill effects during one hour and twenty minutes. The wound was then dilated and carefully washed. The animal being released, appeared free from pain and in perfect health. In a few days the wound healed.

Experiment 12th.—A small incision was made in the thigh of an adult rabbit, and one grain of strychnine deposited by means of a tube between the muscles and skin an inch and an half from the wound, and nearer the heart. The orifice was closed as usual, and the cupping-glass applied over it, leaving the poison nearly half an inch without the boundary of the glass. The glass was taken off at intervals during one hour, upon which, tetanic symptoms invariably appeared, which were always arrested by the re-application of the cup. Finally, when the animal was perfectly at rest, and free from all morbid symptoms, I made an incision through the skin, between the edge of the glass and the spot where the poison was deposited: the glass still remaining on the part. The rabbit was then affected precisely as if no cupping-glass had been applied, and death took place twenty-two minutes after the incision.

Experiment 13*th.*—In order to ascertain whether the cupping-glass, placed elsewhere, than over the poisoned wound, or its immediate neighbourhood, would, by acting as a counter-irritant, prevent the action of the poison, or relieve the symptoms caused by it, the following experiment was instituted.

One grain of strychnine was introduced in the manner previously mentioned, under the skin of the right thigh of an adult rabbit; the cupping-glass having been previously applied on the thigh of the left side. In sixteen minutes spasms appeared—in nineteen, violent tetanic convulsions, and in twenty, death. Hence, the counter-irritant produced no effect, either by allaying, retarding, or preventing the poisonous symptoms.

Experiment 14*th.*—Two dogs were selected for the purpose of ascertaining the efficacy of the application of cupping-glasses, in arresting the action of the slower poisons.

One of the dogs was large, full grown, and strong: the other was a small animal, under the middle size, and of less than half the weight of the first.

On the 16*th of August*, at nine o'clock, A. M. I introduced ten grains of the pulverized white oxide of arsenic, some distance beneath the skin and into the cellular substance of the thigh of the large dog. The edges of the wound were firmly united by suture over the poison, and the orifice covered by adhesive plaster. The animal was then muzzled, and abandoned to his fate.

The same quantity of arsenic was inserted into the thigh of the smaller dog: it was introduced through a glass tube of a large caliber, and deposited as in the first instance, and the wound closed with the same precautions.

Forty minutes after the insertion of the poison into the thigh of this dog, he began to whine, manifested some symptoms of pain, attended by a considerable discharge of saliva. The cupping-glass was applied a few minutes afterward on the sound skin over the poison, leaving the orifice of the wound without the boundary of the glass. The vacuum was maintained during the day, and an assistant left in charge to watch the animals and persevere in the application of the cupping-glass during the night.

August 17*th.*—No symptom decidedly indicative of poisoning having occurred in the larger dog, although twenty-four hours had elapsed since the insertion of the arsenic, I determined to introduce a large additional portion of the poison. Accordingly, opening the original wound of the large dog, and making a fresh incision in the thigh of the other, I inserted into the respective openings, in imme-

diate contact with the first portions, thirty grains more of the arsenious acid. Every precaution was taken to secure the orifices of the wounds. The dogs were fed and supplied with water, of which they drank large quantities. They were then muzzled as before.

In the course of a few hours afterward, the large dog exhibited symptoms of pain, restlessness, intense thirst, and great muscular debility, particularly of the hinder legs. The pain became more and more intense, and nausea, vomiting, and purging continued during the night. On the morning of the eighteenth he died—twenty-three hours after the insertion of the additional portion of arsenic, and forty-eight from the commencement of the experiment.

The other dog was subjected to the application of the cupping-glass during the whole of the 17th, and at eleven and a half o'clock, P. M. he was lashed down by rope and bandages, and his mouth secured; hoping, by this expedient, to retain the cup on him during the night. He however severed the cords, and the cup fell off, the assistant supposed, between four and five o'clock, on the morning of the 18th. On the 18th, at nine o'clock, A. M. whilst the large dog was dying, I excised the poison from the smaller animal, washed the wound, closed it by suture and adhesive plaster. The dog lived and did well; seven days afterwards he became the subject of another experiment.

Upon examining the dog which was killed, the mucous coat of the stomach was found highly inflamed, the sub-serous tissue of that organ, as well as that of the intestines generally, was congested with blood. In both ventricles of the heart was contained very dark-coloured blood. In the examination of a portion of blood from the heart and vena cava, I was assisted by my friend Mr. J. P. Wetherill; but we did not detect the presence of the arsenious acid.

Being desirous of rendering more generally useful, the method of preventing the fatal effects of poison by the exhaustion of cupping-glasses, I resolved to institute a series of experiments on the bite of the rattlesnake.

Messrs. T. and F. Peale, with their accustomed liberality granted me the use of a very fine snake, *(Crotalus horridus, banded rattlesnake,)* nearly five feet in length, whose bite on the smaller animals they had observed to be almost uniformly fatal. My first experiments were performed on the 20th of August; two rabbits, whose hinder extremities had been previously shaved, were presented for the bite. The first rabbit was bitten twice; on the back and hind leg. The second was bitten, an hour afterwards, on the thigh.

The first soon manifested signs of great muscular debility, and lay

on the unbitten side: he remained motionless and comatose, showing no symptom of uneasiness for six hours, except when laid on the wounded part: he then struggled violently. He died without presenting any of the appearances of swelling and petechiæ which are usually mentioned as concomitant with death produced by the venom of the rattlesnake.

The second rabbit was affected during the day with severe rigors: these were the only symptoms observed. They had entirely subsided before the ensuing morning, and the animal was then perfectly well.

On the day succeeding the last experiment, another rabbit was bitten by the same snake: the snake bit twice with violence: one of the wounds was on the upper part of the thigh, the other lower down. The incisions were marked by a minute effusion of blood. This animal exhibited no morbid symptoms, but continued from the first as lively as though nothing had occurred to him.

The rattlesnake was now suffered to remain undisturbed for three days, in the hope that by this expedient the poison would accumulate in sufficient quantity to produce death. A small dog, from whose hinder limbs the hair had been previously shaved, was then placed within the cage. He appeared panic struck at the sight of the snake, and lay as though deprived of the power of motion. The snake struck at him with great reluctance, and not until he became exceedingly irritated by being pushed and teazed by sticks passed beneath the dog's body. The dog received two wounds; one on the upper anterior part of the thigh, the other on the lower part of the leg. Upon his removal from the cage, he recovered from the torpor caused by the snake's presence, soon resumed his usual sprightliness, and did not subsequently manifest any morbid symptoms.

The result of the preceding experiments having proved to me that the fatal consequences from the bite of the rattlesnake were altogether uncertain, I determined to adopt a different plan, which gave greater promise of certainty.

Supposing that the poison might not always have been fairly inserted beneath the skin by the bite of the snake, I determined to procure one, decapitate it, and making an incision through the skin, insert the venom beneath it. By the aid of a distinguished naturalist, I selected one of the finest snakes from a large collection then exhibiting in this city. The animal remained undisturbed for some days, in order that the secretion of poison might accumulate. His head was then struck off by a single stroke of a chisel, and as soon as the convulsive motions of the jaw had ceased, Dr. Harlan inserted the venom found in the bag around the fang, into two rabbits and a dog.

One of the rabbits died several days afterward, but under circumstances which rendered the cause of his death very doubtful. The other rabbit and dog did not exhibit any signs of poisoning.

Not willing to abandon the research on the effects of the poison, and hoping to succeed in procuring it possessing a fatal power, I purchased another snake. This was decapitated: about ten drops of a viscid fluid of a yellowish-green tinge, was found in the poison bag. This was injected through a glass tube, with a capillary extremity beneath the skin and integuments, and to the depth of one-eighth of an inch into the muscles of the thighs of three rabbits. None of these animals died in consequence. From these experiments it is evident, that the fluid existing in the sac and secreting organs of these snakes was entirely destitute of active poisonous properties.

The difference of the habits of the animal whilst in captivity, from those of a state of nature, and the want of a proper subsistence for several preceding months, are doubtless among the causes producing the inertness of the secretion. These results furnish additional evidence that the supposed specifics for the bite of a rattlesnake owe their reputation to their having been used in cases wherein no fatal effects would have resulted.

The want of success in obtaining an animal whose bite would infallibly produce dangerous consequences, compelled me to defer any further investigation of the subject. To this postponement I have consented with reluctance. I hope, however, to renew the experiments under more favourable auspices, and I am sanguine in the belief that the results of the application of cupping-glasses will be precisely analogous with those, mentioned in the preceding details of experiments on other poisons.

Such were the effects observed by Dr. Barry, in his investigations on the bite of the viper. He made experiments on rabbits and dogs, and found that "the animals bitten by one, two, and sometimes three vipers, when the cupping-glass was applied for half an hour, suffered none of the effects whatever of constitutional poisoning; whilst those that were left to nature were invariably attacked with convulsions, stupor, and the dogs by vomiting." That "the local action of the viper's venom, so marked and rapid in its effects, seems to be concentrated by the cupping-glass within its own bounds—that the vacuum sucks a reddish serum in considerable quantities through the skin of animals in which it is thin, and almost invariably in these cases the poison appeared to have been removed from the wound."

We now proceed to offer some remarks on Dr. Barry's theory of the modus operandi of the cupping-glasses, etc.

Agreeably to Dr. Barry's view, external absorption is not a vital function, but it, as well as the circulation in the absorbing vessels, is a physical effect caused by atmospheric pressure, the fluids passing through the absorbents precisely as a liquid is forced into, and rises into a Torricellian vacuum.

Dr. Barry, in support of his opinions, appeals to the series of experiments: the truth of the results of which, as stated by him, I have had the pleasure to confirm. His view, however, of the modus operandi of the cupping-glasses in preventing the effects of external poisons are, I am induced to believe, entirely erroneous.

The results of some experiments which I instituted with a view of testing the principle, whether their efficacy *depends merely on the abstraction of atmospheric pressure*, have convinced me that such is not the fact.

It is true that the exhaustion of air from within the bounds of the glass, relieves that portion of the body inclosed within its periphery from the usual atmospheric pressure: but the parts *beneath* the *circumference* of the cup, suffer an increase of pressure proportionate to the diameter of the glass. Thus the glass which I used, being one inch and a quarter in diameter, the animal suffered an increase of pressure on the parts just indicated of at least fifteen pounds.

Convinced of the truth of this position, and supposing that increased pressure, rather than a diminution of it, was the cause of the arrest of the poisonous action, I instituted the following experiments:—

Experiment A.—I inserted one grain of strychnine into the cellular tissue of the thigh of a small and feeble rabbit: the poison was introduced through a quill to some distance from the incision in the skin, and there deposited. Pressure equivalant to fifteen pounds was immediately made over the poisoned surface, by applying to it the leg of a chair loaded with the abovementioned weight. No symptoms of poisoning occurred during the first forty-five minutes, and supposing it possible that the strychnine had not its usual poisonous character, we determined to test it on another rabbit of about the same size and vigour. One grain of the poison having been inserted into the thigh of this animal, and he left to his fate, he died in five minutes. It was thus determined that the strychnine now used, was more virulent and energetic than any previously employed.

No symptom of poisoning having been evinced by the first rabbit during fifty-two minutes after the application of the poison, the pres-

sure was discontinued, and we removed all the strychnine that was visible. A small portion probably remained, as tetanic spasms occurred in seven minutes after the removal of the pressure. By the re-application of the weight, these convulsive movements were immediately arrested, and no morbid symptoms were presented during the continuance of the pressure, which was maintained for thirty minutes. Releasing the rabbit, spasms again ensued in eight minutes: the tetanic action was violent; he appeared soon after to be dead, and life could scarcely have been recovered had not pressure been immediately applied. This, however, instantly revived him, and he remained free from spasm during the ensuing forty-five minutes. Two hours and twelve minutes having elapsed since the first exhibition of the strychnine, it was determined to remove the pressure and abandon the animal to his fate. He died in four minutes afterwards.

It is due to my friend Dr. Comstock to acknowledge that I am indebted to him for the suggestion of this experiment.

Experiment B.—A modification of the preceding experiment was effected by applying pressure on the surface poisoned with strychnine, by means of a cupping glass unexhausted, and loaded with a weight of fifteen or eighteen pounds. The pressure was continued for one hour, during which no morbid symptoms were discovered.

Experiment C.—One grain of strychnine was inserted as before. Pressure was made on the poisoned surface by means of a small screw press acting upon a cupping-glass applied over the poison, and continued for an hour and ten minutes, during which time no evidence of poisoning was exhibited. The poison was then removed: the animal appeared perfectly well, and I observed him healthful and lively three weeks afterwards.

The results of these experiments are strikingly analogous to those produced by the application of exhausted cupping-glasses, and they induce me to suppose that it is an increased pressure upon, or in immediate proximity to the poisoned surface, which produces most of the beneficial effects which have been ascribed by Dr. Barry to the mere abstraction of atmospheric pressure.

The experiments of Dr. Barry do not therefore appear to militate against the position, that absorption is a vital function—that the contents of the absorbents are propelled by some power inherent in the vessels themselves, or by some mechanism immediately connected with them.

Poisons externally applied appear to act upon the general system, and produce constitutional effects, either by the influence of sympathy or by absorption. Admitting these causes, it appears to me, that

we have a solution of the problem of the mode of action of the cupping-glasses by attributing it to pressure; which produces either suspension of nervous action of the part, or compression of the capillaries.

Of these two causes, the first, or that of the paralysis, or suspension of the nervous influence, is probably the most efficient. Many of the most active vegetable poisons act probably altogether by producing their specific effects on the nerves. This point is uniformly conceded as regards prussic acid: and it appears more than probable that such is the fact as regards strychnine. This is in accordance with the opinion of Drs. Lawrence, Harlan, and Coates,* and I am compelled to adopt the same views from my own observation of its effects. Did it act otherwise, and if the poison entered the venous and absorbent systems, how would it be possible to arrest the violent tetanic action, as evidenced so repeatedly in Dr. Barry's researches, and as exemplified in the present series, in experiments *6th*, *7th*, and *A*.

Hence, considering the fact as established, that some poisons do act on the general system entirely through nervous agency, I would infer, that if the function or action of the nerves communicating with the brain and spinal marrow, with the surface that has been poisoned, could be suspended, the deleterious effects of the poison would not be exhibited. Now this arresting of the poisonous effect is observed when the cupping-glass, or other pressure is applied; and is, I presume, dependant upon the condition just indicated. On the other hand, in the case of those poisons which produce death by entering the absorbents, a similar hypothesis may be adduced.

Every part of the animal system appears to be under the influence of the ganglionic or cerebral system of nerves: if therefore the nerves of a part be paralyzed, or have their functions suspended, may not absorption be interrupted? In the circulatory system we have an analogical illustration, which I would suppose satisfactory. I allude to the absence of hæmorrhage in severe lacerated wounds: here although great injury may be done to the parts, and in some instances, limbs may be torn from the body, and arteries of the largest class be divided, yet little or no blood escapes. Is not this effect owing to the paralysis of those nerves, upon which the circulatory action of the blood-vessels depends? If this be the fact, is it not fairly deducible from analogical reasoning, that by the same agency the circulation of the absorbents may be interrupted? And have we not good reason

* See their experiments. Philadelphia Journal of the Medical and Physical Sciences, Vol. II.

to believe that this state of the nerves may be induced by *pressure?* —whether applied directly by weight, by ligature, or by the exhausted cupping-glass?

The application of the foregoing principles and experiments to practice in the treatment of poisoned wounds, has been detailed with so much precision by Dr. Barry, that it would be superfluous for me to say any thing on that subject. But, during the investigations herein detailed, my attention has been forcibly directed to the astonishing effects which are produced by the application of the cupping-glasses, in arresting tetanic symptoms:—even where decided opisthotonos has been exhibited, we have witnessed a subsidence of the symptoms, by means of pressure thus applied. I therefore venture to propose it, as one of the means of combating that terrific disease, traumatic tetanus. This variety of tetanus appears to be occasioned by the injury sustained by the sentient extremities of the nerves of the part wounded. It has occurred to me that if these wounded and irritated nervous extremities could be paralyzed, the general spasmodic action, which is produced by the local irritation, would be arrested. *Would not pressure by weights, or ligatures, or the application of exhausted cups over the wound, or in its immediate vicinity, paralyze the sentient extremities of the wounded nerves, and thus suspend, and perhaps remedy, the general spasmodic action?*

If the constitutional symptoms should be arrested; as a security against their return, *before the cup over the wound* is removed, an incision so extensive as effectually to remove the wounded portion of the nerves ought to be made.

Thus have been detailed the results of an investigation, which I hope will not be considered altogether profitless or uninteresting. The inquiry has been directed entirely to the attainment of a knowledge of physiological facts without reference to any preconceived theory, and the results have been stated with candour and truth.

Note.—In the course of my investigations, I have had occasion to observe several of the phenomena cited in page 4. In one instance, having divided the internal jugular vein of a dog, for the purpose of introducing a tube, jets of blood were observed to issue from the lower portion of the divided vein, at intervals which were synchronous with the expiration from the lungs. After this phenomenon had continued for nearly two minutes, the animal experienced great difficulty of respiration, and died very shortly afterwards, manifesting all the symptoms of strangulation. Upon dissec-

tion, the right ventricle of the heart was filled with blood, unlike that usually found in that cavity; being red, spumous, and apparently arterialized. The cause of the animal's death was now sufficiently obvious: the atmospheric air had entered the cavity of the heart through the divided vessel.

Another circumstance connected with the venous circulation, is also worthy of being mentioned. In an unsuccessful attempt to repeat the celebrated experiment of M. Magendie, on venous absorption, one of the platina tubes by which it was intended to form the channel of communication in the femoral vein, was forced so far upwards within it, as to be beyond our reach. Upon searching for the tube, it was found as high as the right auricle of the heart!! This tube was two and one-eighth inches in length, and weighed thirty-two grains.

Assisted by Mr. Chew, student of medicine, I afterward introduced into the right femoral vein of a sheep, a platina tube, one inch and one-fifth in length and weighing nineteen grains. The animal did not subsequently manifest any symptom of pain or uneasiness. He was killed about thirty minutes after the insertion of the tube: upon examination, the tube was not discovered in the entire tract of the iliac vein, nor in the ascending cava, nor even in the right auricle of the heart. It was finally discovered, however, in the larger lobe of the left lung.

Philadelphia, November, 1827.


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