**An account of some further experiments to determine the absorbing power of the veins and lymphatics / By J. O'B. Lawrence [sic] M. D. & B. H. Coates, M. D.**

AN

# ACCOUNT

OF

# SOME FURTHER EXPERIMENTS

TO DETERMINE

## THE ABSORBING POWER

OF THE

## VEINS AND LYMPHATICS.

BY

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ANNEX.
Cardiovascular

# AN ACCOUNT, &c.

WE had intended, ever since the experiments which were made last year, for the Academy of Medicine of this city, to take up the subject anew, and endeavor to prosecute it further. The committee, since that time, having been dissolved, we conclude to continue our inquiries in a private capacity. We have accordingly performed a number of experiments with that view.

We feel much pleasure in acknowledging the very liberal assistance which we have received from professor Chapman; who enjoys the singular praise of originating a lengthened course of inquiries, without any reference, whatever, to his previous opinions on the subject: it being his only object to discover and confirm the truth.

We have also been gratified with the company and occasional assistance of several gentlemen; among whom we may enumerate Dr. Seybert, Dr. Horner, professor Keating, Dr. S. Jackson, Is. Lukens, C. Riddle, H. Seybert and W. Dirk, jr. young man who has since been removed, in the flower of age, by death. As this young man did not live long enough to see the completion of any of his scientific undertakings, his name will not be very widely known; but as he made himself useful to us by long and persevering attention, we deem it not improper, in our short-lived paper, to mention his affectionate disposition, and his promising talents.

As we considered it of the highest importance to have several witnesses of whatever was done, we invited various gentlemen, chiefly connected with the medical profession, besides those above named: and no experiment of importance was performed in the presence of fewer than four or five persons, and scarce any even of the repetitions, before fewer than three.

We commenced by making a few further trials with coloured substances, and still with the negative result of none of them entering the vessels. Two animals were made to eat articles of this kind; a bitch the prussian blue, and a kitten, a mixture of indigo and milk. These were under somewhat different ciscumstances from the experiments of last year, in which the coloured substances were thrown into portions of exposed intestine, and secured with ligatures. They may be

considered by some as fairer trials, as the natural condition of the parts concerned were unaltered, until the animals were killed and examined. They were tried in consequence of reading the experiments published by Dr. Milnor, in his inaugural thesis. The first named animal consumed not less than nine ounces and a half of the prussian blue; nevertheless a considerable number of different solids and fluids, including the ordinary routes by which absorption has been supposed to take place, were examined, without discovering it in them. Cochineal, red saunders, anatto, turmeric and prussian blue, were thrown into the abdominal cavity of cats and kittens; and with precisely the same result; absorption of the colours not having been detected in any one route.

In one instance, decoction of cochineal, strongly coloured, was forced into the cellular substance, over the abdomen of a kitten; and with the same negative result.

Far the largest part of our experiments were made with the prussiate of potass, which has many advantages in inquiries of this kind, as being the article at once most easy of absorption and of exposure by chemical means, of all the different substances we have tried. We can present a list of thirty-four animals, in which this salt was introduced into the alimentary canal, with an account of most of the fluids in which it was chemically evinced to exist, and the intervals of time at which each examination took place. In the first twenty-one, the parts were left undisturbed, until the animal's death; in the rest ligatures were affixed, as described in the list.

| Animals. | Quantity. | Duct. Thor. | Rt. sid. hrt. | General Circulation. | Urine. | Vena portæ | Miscellaneous |
|---|---|---|---|---|---|---|---|
| Kitten. | Near 4 grains. | 49 m. no blue. | | | 45 m. no blue. | | |
| Idem. | Near 12 grains | | | | 97 m. no blue. | | |
| Idem. | 7 grains at twice, 5 hours a part. | | | 9 m. jugular, 10 m. carotid, no blue. | Bladder blue. | | |
| Dog. | Considerable quantity, probably greater part of a drachm at intervals. | 4 1-2 hours slight blue. | | Fem. art. 4 1-2 h. no blue. | 4 1-2 h. deep blue. | 4 1-2 h. slight blue. Bluer than D. thor. | Liquor pericardii perceptible blue. |
| Idem. | Idem. Idem. | 5 h. 28 m. no blue. | | | 5 h. 39 m. distinct blue. | 5 h. 10 m. strong blue. | |
| Rabbit. | Idem. Idem. | 62 m. distinct b. | 68m. strong blue. | Left side of heart 68 m. blue. | 64 m. pelvis of kidney blue. | 67 m. strong blue. | 53m. liquor pericardii faintly greenish Cellul. sub. valv. of heart, &c. blue. |
| Dog. | Nearly half a drachm of salt. | 2 h. 4 m. blue. | 2 h. 7 m. blue. | Intercostal vein 1 h. 48 m. blue. Fem. art. and vein 2 h. 22m. blue. | 1 h. 5 m. blue. | | Valves of heart blue. |
| Idem. | Nearly a drachm of the salt. | | 2 h. 2 to 12 m. blue. | Fem. art. 2h. 2m. blue. Mesent. art. bluer. | 2 h. 2 to 12 m. blue. | 2h. 2 to 12 m. no blue. | |

| Animals | Quantity. | Duct. Thor | Rt. sid. hrt | General Circulation. | Urine. | Vena portæ | Miscellaneous. |
|---|---|---|---|---|---|---|---|
| Cat.* | 2 drachms solution | 46 1-2 m. blue | | Aorta blue 38 1.2 m. venacava. 46 m. blue. | | 34 1-2 m blue. | |
| Dog. | 2 scruples salt | 40 m. no blue | 37 m. no blue | Exter. iliac. art 31 m. no blue. | 47 m. blue. | 28 m. no blue. | Liq. pericardi 34m. no blue. |
| Idem | Half a drachm of the salt, | 50 m. no blue | | Jugular 26 m. no blue, Aorta 42 m. no blue. | 55 m. no blue. Pelvis kidney, none. urine after several days blue. | 35 m. suspicious. | |
| Kitten | 2 drachms solution | | | Aorta 17 m. blue | 12m. strong blue, bladder faint blue. Pelvis kidney 34 m. blue. | 16 m. blue, equal to aorta. | Abdom. cavity no blue. Surface of stomach 31 m. blue. |
| Cat starved ten days | Idem. | 24 m. blue | 14 m. blue. | Aorta 12 m. blue | 20 m. faint blue. Pelvis kidney blue. | 10 m. blue but less so than the aorto. | Cellular substance of thigh blue. |
| Cat | Idem. | 22 m. distinct blue, but not exceeding aorta | | Aorta 11 m. faint, but distinct blue | 28 no distinct blue. | | Liquor pericardii, 13 m. blue. Outside of stomach 19 m. no blue. |

*The animals after this were starved.

| Animals | Quantity. | Duct. Thor | Rt. side of heart | General Circulation | Urine | Vena portæ | Miscellaneous |
|---|---|---|---|---|---|---|---|
| Cat | 2 drachms solution | 17 & 23 m. no blue | 12 m. no blue | | 20 m. no blue | | |
| Idem. | Idem | 12 1-2m. no blue | | Aorta 7 m. blue | 15 m. no blue | | |
| Kitten. | Idem | | 10 1-2 m. blue | Aorta 6 m. blue | 20 m. blue | | |
| Idem. | Idem | 17 m. tinged blue. | 11 m. blue | Idem 8 m. blue | | 7 m. blue | Outer surface of the stomach blue |
| Idem | Idem. | 12 1-2 m. faint blue | 8 m. not blue | Idem 6 m. blue. | | | |
| Cat | Idem | 14 m. no blue | | Idem 8 m. no blue. | More than 14 m. no blue | 7 m. faint light blue. | |
| Idem | Near 4 d achms | 16 1-2m. no blue | | | 6 1-2 m. no blue | 9 m. blue. | |
| Kitten | 1 1-2 drachm in rectum | More than 57 m. no blue | | Jugular 57 1-2 m. no blue Carotid next more than 57 1-2m. no blue | Strong blue. Pelvis kidney strong blue | More than 57 1-2 m. no blue | |

| Animals | Quantity | Duct. Thor. | Rt. side of heart | General Circulation | Urine. | Vena portæ | Miscellaneous |
|---|---|---|---|---|---|---|---|
| Kitten | 2 drachms solution | 7 1-2 m. no blue | | More than 26 m. no blue. | 26 m. strong blue | 5 m. no blue | Surface of stomach no blue |
| Rabbit | 4 drachms solution | Inner surface of the duct 34 1-2 m. no blue | 22 1-2m. no blue | Aorta 18 1-2m. no blue | 25 1-2 m. no blue | 14 1-2 m. no blue. | |
| Idem | Idem | 30 m. light blue | | Vena cava ascendens 24 1-2 m. no blue | 28 m. strong blue. Papilla of kidney 38 m. blue | 21 m. no blue | Cellular tissue 34 m. blue. Capsule of a joint 40 1-2 m. blue |
| Idem | 2 drachms solution | | More than 28 1-2 m. blue | Aorta 23 1-2 m. blue | 28 1-2 m. strong blue. Pelvis kidney more 28 1-2 m. blue | 19 1-2 m. blue | Liquor pericardii 25 1-2 m. no blue |
| Young rabbit. | Idem | | 24 1-2 m. slight blue | | 33 m. green* | 15 m. slightly blue. | |

*This indicates the prussiate, together with some cause which partially deoxygenates the test.

## WITH LIGATURES AFFIXED TO THE ŒSOPHAGUS.

| Animals | Quantity. | Duct. Thor | Rt. side of heart | General Circulation | Urine | Vena portæ | Miscellaneous |
|---|---|---|---|---|---|---|---|
| Kitten (sick) | Idem | 46 m. deep blue | | | 42 1-2 m. very deep blue. Substance of kidney more than 23 m. blue | | Liquor pericardii 44 m. light, but obvious blue. Cellul. sub. more than 48 m. blue |
| Kitten. | Idem | | 12 m. blue | Aorta 12 m. light blue | 12 m. no blue | | |
| Idem. | Idem | 40 m. light blue | | Aorta 23 m. blue | 33 m. blue | 22 m. blue | |
| Idem | 1 1-2 drachms solut. | 17 m. very faint blue | | Aorta 13 m. pretty strongly blue | 20 m. blue | 11 m. strongly blue | |
| Idem | Idem | 15 1-2 m. light blue | More than 18 m. blue | Aorta 9 1-2 m. blue, weakest | 18 m. faint blue | 8 1-2 m. blue strongest | |
| Idem | 2 dachms | 20 m. blue | 16 1-2 m. faint blue | Aorta 13 m. pretty strongly blue | 23 m. faintly blue | 11 m. pretty strongly blue | Liquor pericardii 15 m. uncertain |

The imperfections in the above table arises, in part, from the circumstance of our not being able to procure a sufficient quantity of the fluids in question to exhibit the effect of the test, or from not being able to procure them pure, and unmixed with red globules of blood, or other matters which render the results obscure and uncertain. Very frequently, however, owing to the interrupted manner in which we were obliged to perform these delicate operations, and from the circumstance of being compelled to attend to them at distant and inconvenient hours, in the midst of professional engagements, haste has produced the loss of observations which were really made. Partial as some of the statements are, in consequence of this, it was thought that a fair view of the evidence could not be obtained without giving all that could in any degree affect it; and we resolved to insert all those instances in which as many results were known as the reader may see in the more deficient ones of the table.

The experiments which are placed last in the order of enumeration were the first performed. As we feared that vomiting might occasionally ensue from the introduction of so unnatural a stimulous into the stomach, we deemed it necessary to secure the œsophagus by a ligature; when afterwards, in making comparative trials without a ligature, we found that this more simple and natural process might easily be adopted in the numerous repetitions which were made. The article was now injected through a tube, introduced into the stomach by the mouth. The great apparent irregularity of the results will sufficiently explain why so many repetitions were deemed necessary.

The general weight of evidence in these cases is strongly in favour of the principal absorption having taken place through the vena portarum. Only one case is mentioned in which the colour in the fluid from the thoracic duct was not less intense than in the serum of the vena portarum.

In this instance, the former was not taken until thirty minutes, and the latter in twenty one; during the interval of which there is every possibility for much of the absorbed substance to reach the points at which both were examined; as much greater diversity than this exists in many of the results. Hence it may be supposed that absorption would have taken place in the porta, to a greater extent, had both been examined at the same time. Another circumstance which affects the inference to be drawn in a very material degree, is, that the vena portæ conveys so much larger an amount of fluid than the thoracic duct, that an equal intensity of colour implies the presence of a much larger quantity of the chemical agent. This is also a reply to a suggestion made in the re-

port to the Academy of Medicine in favour of the thoracic duct as a route. But as this was based, as far as relates to the mucous membranes of which we are treating, upon only seven experiments, and in none had we then proceeded to examine the serum of the vena portarum, it is hardly necessary to array them in opposition.

Inferences, however, of a more decisive kind may be drawn from some of the experiments which ensue. Five are first enumerated, in which the vena portarum was secured by a ligature. In the two first, the cardia being undisturbed and the fluid introduced down the œsophagus, the œsophageal and pharyngeal veins had access to it, and their radicles or capillaries may have absorbed the salt. A degree of uncertainty also prevails whether the vena portarum was in all these instances properly secured. In the three last, however, this point was carefully ascertained by subsequent dissection, and a ligature was also passed round the cardia to prevent the regurgitation of the fluid into the œsophagus itself. The prussiate was then introduced through a wound in the upper end of the duodenum, and this part also tied. In the first case, the prussiate was detected in the heart in thirty-four minutes, in the second in thirty-nine, and in the third in thirty-five minutes. This we consider as proving directly and decidedly that there are other means of absorption besides the veins. We now proceeded to tie the thoracic duct, and endeavour to ascertain whether the prussiate could be made to enter the circulation, by passages independent of this. The three first experiments recorded are not quite definite from the cardia not being secured, as the fluid was liable to regurgitate into the lower part of the œsophagus; a circumstance which we always found to take place when that part was not artificially closed. It may also be remarked by the way, that the œsophagus was always found, when examined for that purpose after feeding, to contain a portion of the substances swallowed, whenever these retained the fluid or semifluid form.

As, however, the agent was conveyed into the systems of these animals, it certainly follows from the two first cases, that another route than the thoracic duct admitted of the passage of the salt. In the last of the three experiments both this vessel and the trunk of the lymphatics in the right side of the neck were secured: thus stopping every known outlet to the system of lacteals and lymphatics. The blue was nevertheless easily produced in the serum of blood taken from the right side of the heart, in twenty-minutes.

In tying the lymphatic outlets, great care and much time were employed. The sufficiency, however, of the ligatures

was proved by extreme turgescence of the trunks and all the visible branches immediately after the application of the ligatures, generally followed by much enlargement, and frequently by their rupture in different places.

In the next animal, after securing these parts, the cardia was also tied, thus confining the visible means of absorption to branches of the vena portarum alone. Injection of the prussiate was made through an opening below the pylorus, and the wounded part tied. In thirty-two minutes, blood was taken from the right side of the heart, the serum of which gave a strong blue. We regard it, then, as evinced, first, by the two first of these experiments, that other means of absorption than the thoracic duct exist; secondly, by the third, that other routes exist, than either that or the lymphatic trunk of the right side; thus confining them, of all visible vessels, to the sanguineous ones alone; and thirdly, by the last, that absorbed fluids are carried through the trunk of the vena portarum individually, as access was barred to the branches of any other vein.

In the four next instances, after tying both the two lymphatic trunks, and the vena portæ, injections of prussiate of potass were made down the œsophagus, without tying either the cardia or pylorus. In all these cases, the prussiate was conveyed into the circulation. In the first, it was discovered to be in the right side of the heart in thirty-six minutes, in the second, in forty-eight minutes, in the third it was found in the aorta in thirty minutes, and in the last it was exhibited more faintly in the shorter period of twenty-five minutes, in the right side of the heart.

In four cases which follow, all these vessels were first secured, and then the cardia. The upper part of the duodenum was lastly secured, after injecting the agent through it. In none of these was a distinct blue to be found in either the serum of the right side of the heart, or in the urine. In the second instance only, a *bluishness* is mentioned as having been visible in the serum of the right side of the heart. As, however, none of the others are so, as the term is so weak, and as the urine in the same case, although twenty-five minutes had elapsed, did not indicate it, it affords no very formidable exception. The intervals at which the examinations were made, for the heart, are 25, upwards of 23, 25 and 26 minutes; for the urine, 32, upwards of 23, 36 1-2 and 28 minutes.

A comparative experiment was made, by tying all the attachments of the stomach whatever, in order to ascertain the effect of simple infiltration. No prussiate was found in any of the fluids, although the stomach almost immediately after ty-

ing, gave an evident blue on applying the test to its outer surface, the animal being alive. The contents of the carotid were removed for examination in 31 minutes; of the right side of the heart, in 34; of the bladder, in 37; and then the pelvis and papilla of the kidney were examined.

We conceive we have thus established that articles taken into the stomach may escape by three outlets for absorption; namely, the vena portæ, the œsophageal veins and the thoracic duct, and if all these are closed, the absorbing matters are no longer conveyed to the circulation or to the urine. With regard to the quantity conveyed by each, we have no sufficient means of judging. As the quantity of fluid, however, contained in the vena portarum, is much greater than in the thoracic duct, it follows, that to produce a colour of equal intensity, a much larger amount of the colouring matter is requisite.

In examining the fluid of the thoracic duct, to detect prussiate of potass, if the colour was not immediately produced on applying the test, a portion of it was laid aside for several hours, generally till the next morning, and then tested again. The blood was of necessity, treated in the same way. The urine being a substance exclusively recrementitious, and without vitality, this delay was not adopted with it, except where particularly mentioned. Great rigour was observed in making the minutes of the results; nothing being set down in an unqualified manner, or as being distinct, unless it was so exhibited to the satisfaction of all the persons present, as to leave no doubt upon the statement.

Where the time of the animal's death is not mentioned in the accompanying list of experiments, it is generally to be understood as occurring about the time that fluids were obtained from the vessels in the thorax, and as a consequence of having exposed that cavity; sometimes, however, as resulting from opening the large blood-vessels.

In consequence of reading the experiments described, in the medical journals which have reached us, as having been made by professor Mayer of Gottingen, upon absorption in the lungs, we have made a few with that reference. They have the disadvantage of being made upon small animals. We regret much the misfortune under which most American physicians labour, of the extreme difficulty and sometimes almost utter impossibility of access to publications of the European continent. We are from this cause ignorant, further than the writer of medical intelligence for an English journal has informed us, of the extent of this gentleman's inquiries. Our principal results are included in the following table, in which the prussiate was thrown into the trachea.

| Animals. | Quantity. | Rt. side heart | Lt. side heart | Duct. Thor. | Urine | Miscellaneous |
|---|---|---|---|---|---|---|
| Cat | 1 1-2 drachms of solution | Doubtful | 5 m. greenish blue | 8 m. no blue | More than 8 m. no blue | More than 8 m. left pleura blue, right not. Had lain on left side. Valves of heart blue. Ligaments and periost. none. |
| Kitten. | Idem. | 5 1-2 m. blue strongest | 5 1-2m. strong blue | | More than 9 1-2m doubtful. bladder inside no blue | 9 1-2m. pleura blue. Afterwards valves and chord tendin. blue Lining memb. of heart no blue |
| Idem | 1 drachm of solution | 4 1-2m. no blue | 4 1-2 m. no blue | 7 1-2 m. no blue | More than 7 1-2 m. no blue. | More than 7 1-2m. pleura pulmon. blue. Peritoneum no blue |
| Kitten | 1 1-2 drachms of solution | More than 7 1-2m. doubtful | More than 7 1-2 m. no blue | Upper part thor. duct, contents & adjoining surface 7 1-2 m. blue | | |
| Cat | 1 drachm of solution | 7 m. weakly blue | 7 1-2m. strongly blue | 16 1-2m. no evident blue | More than 18 1-2 m. no blue | Cava descend. serum 18 1-2m. no blue |
| Cat | Idem | 4 1-2 m. no blue | 3 1-2 m. blue | 14 1-2 m. no blue | 31 1-2 m. no blue | |
| Kitten | Idem. | | | | | Lay on left side. Right lung 4 1-2 m. left lung 6m. neither blue—in 2 or 3 m. more both blue. Uncertain if now alive. |
| Id. comparative | 1 1-2 drachms of solution | | | | | Tried 6m. after death. In 21m. the liquor pericardii blue |

The animals generally died in about a minute from the injection, from suffocation, by the ligatures which we placed on the tracheas of most of them. These experiments, we think, go to favour the idea that absorption from the mucous membrane of the lungs, is performed principally by the pulmonary veins; but we do not feel prepared to give a positive opinion from such limited inquiries. We would, however, lay particular stress upon experiments 5th, and 6th of the preceding table; (Nos. 65 and 66 of the list.) In the first, the blood from the left side of the heart indicated the agent in much larger proportion than that from the right side, both being examined about the same time, viz. 7 minutes. In the second, where the examination was made in a much shorter period, viz. 3 1-2 and 4 1-2 minutes, the article was distinctly found in the left side of the heart before it had arrived in any other part of the system.

The effect of infiltration is also remarkable. The last is also probably a case of it.

The results of five trials of the prussiate in the cavity of the abdomen are here arranged for inspection.

| Animals | Quantity. | Thor. Duct | Carotid & Jugular | Urine | Miscellaneous |
|---|---|---|---|---|---|
| Kitten | 1.2 oz. of solution | 12 & 13 m. distinct blue | 6 m. distinct blue | 19 m. no blue | |
| Idem | Idem. | 4 m. blue | 2m. no blue | 10 or 15 m. no blue. 29 m. distinct blue | |
| Idem | Idem, nearly. | 3 3-4m. blue | 2m. no blue | 5 m. blue, not strongly | |
| Idem | 1-2 oz. | 3 m. blue | 4m. strongly blue | More than 4m. doubtful | |
| Cat | Uncertain | 9 1-2m. blue | 6m. no blue | More than 9 1-2m. no blue | |

The short time in which the prussiate reached the upper part of the thoracic duct in the above cases, induced us to make four other trials in order to ascertain the earliest period at which that took place. Half an ounce of solution was employed in each case.

In the first animal, a kitten, the salt first arrived at the spot of observation in four minutes, and the quantity gradually in-

creased till 7 or 8 minutes. In the second kitten, it appeared in 2 minutes. The serum of this animal gave a blue. In the third kitten, in 3 1-2 minutes. Serum of blood also blue. In the cat, it first appeared in 13 minutes.

In these cases the thoracic duct was cut off near its insertion; and the test applied there. In consequence of this interruption, previously to the prussiate arriving at the upper extremity of the duct, the discovery of the salt in the serum of the blood clearly evinces that it was conveyed there by other channels.

The next experiment with the prussiate, we postpone till we speak of those made with nux vomica.

It has long been supposed by many physiologists that the process of absorption continues after animal death; and this has been assigned by some as a reason for the small quantity of blood found in the arteries of human subjects. We do not, however, know of any published proof that this process so continues in the lymphatics. It is mentioned by Magendie that he has seen, on pressing the lacteal branches so as to discharge their contents in the direction of the trunks, that those branches would again fill themselves after the animal's death. We have witnessed these appearances ourselves; but we do not know of any similar observations made on the lymphatics, or of any evidence of the actual chemical presence of any article conveyed after death into either of these systems from without.

Four kittens were bled to what is commonly considered death. The blood ceased to flow from the divided carotid, and voluntary motion was extinct. Prussiate of potass in solution was then thrown into the abdomen. It appeared at the thoracic duct in 5 1-2, 5, 14 and 12 minutes respectively. In the two last, the great vessels originating at the heart were secured by a common ligature. The blue colour was in every instance perfectly distinct.

With a strong solution of the green sulphate of iron, we made the following trials, testing it with the prussiate of potass.

## WITH GREEN SULPHATE OF IRON.

| Animals | Place of inj. | Quantity. | Duct. Thor | General Circulation. | Urine. | Miscellaneous. |
|---|---|---|---|---|---|---|
| Kitten | Small intestines | Half ounce solution | 52m. no indication | Carotid 37 m. no blue | | Sulphate entered the stomach |
| Cat. | Œsop. and stomach | 3 drachms solution | 6 hours 46 m. no blue | | 6 h. 50m. no blue | External surface of the stomach 6 h. 53 m. no blue. Stomach and rectum contained the salt. |
| Kitten | Abdomen | 6 drachms solution | 29 m. deep blue | Carotid more than 18 m. doubtful, but probable | 31 m. strong blue | |
| Idem | Idem | Idem | 27m. strong blue. | | More than 27 m. no indication. | |
| Idem | Idem | 1 oz. and 1 drachm | 23m. strong blue | More than 23 m. no indication | More than 23 m. no indication | |
| Idem | Cellular tissue | 1 ounce | 31 m. no indic. | Carotid more than 40 m. no indication | 48 m. no indication | |
| Idem | Idem | 6 drachms | More than 10m. strong blue | More than 10 m. no blue | More than 10 m. no blue | |

In reasoning upon the subject of absorption, the question has frequently arisen whether the articles found in the living fluids exist there as chemical substances, or have their chemical nature altered and animalized by the action of the vessels through which they have entered the system. In other words, it has been inquired whether the chemical results we obtained were produced without previously causing the death of the fluid, and thus again reducing it to the influence of chemical laws, from which its vitality had previously entirely protected it. The instantaneous changes which take place in the recent chyle on applying the test, seem to forbid the idea of two successive alterations being produced, and one of them commonly so gradual in its progress as the extinction of life. It was, however, deemed a curious subject of inquiry, whether artificial chemical changes can take place in the fluids while they continue to circulate in living vessels, and the ordinary actions of life go on. We can hardly consider fluids as having undergone a change from life to death, while they continue to permeate the living organs, including the brain, and all the functions continue with no greater disturbance than naturally ensues from doing so great violence to the system, as is necessary to the experiment. We commenced by throwing prussiate of potass into the abdomen, and green sulphate of iron into the cellular tissue, in order to try whether the well known result of their admixture, the prussian blue, would be produced in the vessels. This, however, did not take place; and we resolved to repeat it, by throwing the sulphate, as the article of more difficult absorption, into the abdomen, where this process went on with more facility, and the prussiate into the cellular substance. On performing this, we were gratified by the striking result of a distinct and beautiful blue in the thoracic trunk, and its contents, and in nearly the whole substance and surface of the *lungs*. These viscera were preserved in spirits, and are now in our possession. The blood threw up a coagulum of a strong blue colour, and the lymph and chyle from the thoracic duct, threw down a blue deposit. Thus not only a foreign, but a pulverulent substance could present its unnatural stimulus, and circulate through the vessels, and could accumulate in the lungs, without preventing the actions of life from considerable exertion, and without occasioning coagulation of the blood. The animal manifested some difficulty of respiration before she was killed, but walked about without the least difficulty, and uttered no cries, nor other signs of disturbance of its powers. In another case, the urine and lungs are noted in our journal

as exhibiting a blue. The other parts similar to those above enumerated are not described as being found coloured. In a third, the fluid in the thoracic duct was blue, but not the other fluids examined, nor the lungs. Two unsuccessful trials were also made. In another case the thoracic duct was tied, and the same process repeated. A decided bluish green was here found in the urine; but neither the serum of the arterial blood nor the lymph of the ductus thoracicus manifested the blue or green. Several inferences may be drawn from this experiment, with which we shall not now trouble the reader.

We repeated the celebrated experiment of Magendie, in which he separated a limb from the body, except by the double attachment of either an artery and a vein or of their two columns of blood circulating through quills. We employed nux vomica, and succeeded entirely in one case without the quills, and in two in which they were used. In six other cases, two of which were with prussic acid, we failed. In conducting this distressing operation, we have not escaped the mortification of disappointment; it has, however, been gratifying to us as far as we went to verify the results of this enterprising physiologist. They depend, however, on *symptoms* for their evidence, chemical proof of the presence of nux vomica not being capable of exhibition. In one experiment, (No. 73,) while waiting the result of an introduction of nux vomica, made ten minutes previously, two drachms of the solution of prussiate of potass which we employed, were forced into the cellular substance of the separated limb, from a pointed syringe. This salt was afterwards detected in the body, after having passed through the quill with the column of venous blood; thus rendering visible its actual transition, and confirming the results of Magendie

## LIST OF EXPERIMENTS.

### I. CONTINUATION OF THOSE WITH COLOURED SUBSTANCES.

#### A. *In the alimentary canal.*

1. A bitch of rather a large size, was fed on meat containing prussian blue. Of this latter, she ate nine ounces and a half during twenty-two days; two ounces and a half of which were consumed during the last twenty-four hours.

Serum from the jugular vein and from the heart, two parcels of chyle and lymph from the thoracic duct, the lacteal vessels themselves, the mysentery, the outer surface of the in-

testines and stomach, sections of the os femoris, through the center of both ends, the cellular substance, the brain and upper part of the medulla spinalis, the inside of the bladder, the pleura and the heart, underwent the fullest and most satisfactory examination, and were totally free from any unusual colour. The contents of the intestinal canal were very deeply coloured, throughout its whole length, with the blue.

On the next day, the fluid of the thoracic duct and the serum of the blood, were tested with sulphate of copper, and sulphate of iron, but without detecting the presence of the prussic acid.

2. A kitten, during three hours and forty-one minutes, ate as much as she could be made to eat, of a strongly coloured mixture of indigo and milk.

On killing the animal, neither the serum of the blood, nor the urine, was coloured with the indigo; though the inside of the whole alimentary canal was found most strongly so.

B. *In the abdominal cavity.*

3. A decoction of one drachm of cochineal in two ounces of water was thrown into the abdomen of a half-grown kitten. In eight minutes she vomited. This continued one or two minutes.

In fifty-two minutes, the animal having been pithed, the heart still beating, the thoracic duct was found visibly reddish. In fifty-nine minutes, infiltration to a considerable extent, was visible on the cellular substance beneath the peritoneum. The chyle did not give a black with red sulphate of iron; but it requires a considerable proportion of cochineal to produce that effect. Serum of the blood did afford a blackness with the red sulphate.

4. An ounce and a half of saturated tincture of red saunders in diluted alcohol, was thrown into the abdomen of a cat. Almost immediately on removing the pipe, the operation having taken up several minutes, the breath smelled strongly of alcohol. The animal soon became quite insensible. The chyle was found of its natural appearance.

5. Five drachms of a strongly coloured solution of arnatto were injected into the abdomen of a kitten, In one hour and two minutes, the animal was killed and blood obtained from the carotid artery. In one hour sixteen minutes, the bladder was removed. No unusual colour was detected in any of the fluids.

6. Five drachms of a strongly coloured infusion of turmeric were thrown into the abdomen of a kitten. In 17 minutes the blood of the jugular vein; in 18, that of the carotid; in

20 1-2 the thoracic duct, and in 21, its fluid contents were exhibited to view. Neither the recent fluids, the duct, nor the serum obtained from the blood by retaining it till the next day gave any appearance of the colour.

7. About a quarter of an ounce of a deeply coloured mixture of prussian blue and water was thrown into the abdomen of a kitten. In two hours and a half, the kitten was killed. The celullar substance covering the abdomen was thought to have a bluish colour. The urine presented a natural appearance; but, on adding sulphate of iron, it became blue. The mucous surface of the bladder presented similar appearances. The serum of the blood from the neck, was not blue either with or without the addition of sulphate of iron. The papilla of the kidney was similar to the bladder in its appearances. A section of the liver afforded no indications, nor did the outer surface of the intestines. It was found that the prussiate of iron here used, contained some alkaline prussiate mixed with it.

8. Four ounces of a deeply coloured mixture of prussiate of iron were thrown into the abdomen of a kitten.

In two hours and fifty minutes, the animal was killed. The colour of the urine was natural, but it gave a blue on adding persulphate of iron, (the prussiate as before being impure.)

C. *In the cellular tissue.*

9. About an ounce of a decoction of cochineal, in the proportion of two drachms to four ounces of water, was injected into the cellular substance over the abdomen of a kitten. In an hour and eleven minutes, the animal having been previously pithed, the thoracic duct was tied. The fluid contents were perfectly white. Serum of the blood from the aorta afforded no peculiar appearance, until on adding caustic potass, when it became visibly purplish.

II. WITH PRUSSIATE OF POTASS.

A. *In the alimentary canal.*

*a.* Without disturbing the natural condition of the parts.

10. Two kittens were fed on milk containing fifteen grains of prussiate of potass, of which the present one took about one fourth.

In forty-nine minutes the thoracic duct was opened and fluid obtained, which afforded no blue with the test.

In forty-five minutes the urine—no blue.

The salt was found in the alimentary tube as far as the middle of the great intestine.

11. The remaining kitten had swallowed the rest of the mixture. In seventy-nine minutes the urine afforded no blue. Of the other fluids we have no memorandum.

12. Another kitten swallowed about seven grains of the salt in some milk. Part of this was eaten about noon, and the remainder about five hours afterwards. The fæces and urine gave a blue with the test.

In nine minutes after she had done eating, blood was obtained from the jugular vein, and in ten minutes from the carotid artery, the serum of neither of which gave a blue with the test.

The bladder, on its internal coat gave, as might be expected, a strong blue. Its external surface was then examined, with a view to discover infiltration of the prussiate, if any existed, but without exhibiting it.

13. A large dog had taken a considerable quantity of prussiate of potass dissolved in milk, at three periods of two hours apart. He was then made the subject of a trial of experiment 102, in this list, and finally bled to death, at 4 1-2 hours after the last feeding. The fluids of the thoracic duct gave a slight blue. Serum of blood from the vena portæ a blue, stronger than the last. Serum from the femoral artery, no blue. Urine a deep blue. Liquor pericardii, perceptible.

14. A small bitch swallowed a considerable quantity of prussiate of potass at two feedings, with an interval of two hours.

In five hours and ten minutes, blood was obtained from the vena portæ. The serum gave, next day, a strong blue. At five hours twenty-eight minutes, a ligature was placed upon the thoracic duct, and the fluid removed four minutes after, gave no evident blue. In five hours and thirty-nine minutes the urine gave a distinct blue.

15. A rabbit had swallowed a quantity of the prussiate in milk at three times, with intervals of three hours, and near three hours and a half. At about fifty-three minutes the liquor pericardii became faintly greenish with the test, in our judgment, but rather doubtful. Fluid of the thoracic duct at 1 hour 2 minutes, gave a distinct blue. Pelvis of kidney at 1 hour 4 minutes, afforded blue. Serum from blood of vena portarum obtained at 1 hour 7 minutes—strong blue. Serum of blood from the right side of the heart in 1 hour 8 minutes—strong blue. Same fluid from the left side of the heart, blue. Valves, distinctly so in their substance. The cellular substance of several parts of the body was examined, and gave a distinct blue. The ligaments of the knee joint, cap-

sular and lateral, gave a blue. The animal had been used, in the interval between feeding and opening, for experiment 105.

16. A middle-sized dog drank some milk containing about half a drachm of prussiate of potass, at one time. He was then employed for experiment 104.

In 1 hour 48 minutes blood was taken from an intercostal vein near the sternum; the serum of which gave a blue.

In 1 hour 54 minutes the urine afforded a blue, but not strongly. It was not visible till more than usual of the sulphate of iron was added.

In 2 hours 4 minntes the fluid of the thoracic duct gave a blue.

In 2 hours 7 minutes blood from the cava ascendens and right side of the heart, mixed, was procured. The serum afterwards gave a blue. The valves of the heart gave a blue.

In 2 hours 22 minutes blood from the femoral artery and vein. Both afforded a blue in the serum.

In 2 hours 37 minutes from the vena portarum. Of this enough was not obtained, owing to the death and exhaustion of the animal.

17. A small dog swallowed near a drachm of prussiate of potass, in milk. He then underwent experiment 100.

In 2 hours 2 minutes blood was taken from the femoral artery, the serum of which gave a blue with the test. Serum of the mesenteric artery gave a stronger blue. That from the right side of the heart, a blue. That from the vena portarum, none. The urine, a blue.

All these were removed within ten minutes from the first.

In the subsequent experiments, the animals were starved for a day or two previously to commencing the operations, unless otherwise expressed in the descriptions.

18. A cat had 2 drachms of the solution injected down her throat.

Serum of bloood taken from the vena portarum in 34 1-2 minutes gave a blue.

That of the aorta, taken in 38 1-2 minutes, a blue. The fluid of the thoracic duct in 46 1-2 minutes, blue. Serum from the vena cava, afterwards, a blue.

19. A small but full grown dog was made to drink some milk containing two scruples of the prussiate. In 28 minutes blood was obtained from the vena portarum; in 31 minutes from the external illac artery; in 34 minutes liquor pericardii; in 37 minutes blood from the right side of the heart; and in 40 minutes fluid from the thoracic duct: none of which, on

the usual treatment, afforded a blue. The last mentione dfluid was *reddish* at its upper end for about half an inch, and above a bifurcation found there. The urine in 47 minutes gave a blue.

20. A small dog was fed on milk containing half a drachm of the prussiate. This animal had eaten within five or six hours previously. The fluid of the thoracic duct and the serum of each of the parcels of blood obtained were white and chylous. He was not employed for any other experiment. In 25 minutes, blood from the jugular vein was obtained; in 42 minutes, from the aorta; in 50 minutes, the fluid of the ductus thoracicus; the urine at 55 minutes; and subsequently the pelvis of a kidney examined. None o fthese gave any blue, when examined in the usual manner. The serum of blood taken from the vena portarum in 35 minutes was considered suspicious. Urine after being kept for several days, produced a blue.

21. Two drachms of the above mentioned prussian solution were injected down the throat of a half grown kitten. A stomach tube was used in these cases.

In 16 minutes blood of the vena portarum was obtained, and in 17 of the aorta. The serum of each of these gave a blue nearly equal in intensity. The indications afforded by the fluids from the vena cava, the thoracic duct, and the right side of the heart are lost. It is most probable that a sufficient quantity of that of the thoracic duct was not obtained. The urine, in 12 minutes, a strong blue. The empty bladder, still moist, a faint blue. The cavity of the abdomen, no blue. The external surface of the stomach in 31 minutes, a blue. The pelvis of a kidney in 34 minutes, blue. The substance of the same viscus, no blue.

22. A cat had been starved ten days, in consequence of her having escaped and hid herself in a situation where she could not get food. Two drachms of the saturated solution were then injected down the animal's throat,, and water was afterwards thrown in to wash it more completely down.

The following results were found by the usual process: In the contents of the

| | |
|---|---|
| Vena portarum | in 10 min. blue, but not so much as the aorta. |
| Aorta | 12 min. blue. |
| Right ventr. of the heart | 14 min. blue. |
| Urine | 20 min. faint blue. |
| Fluid of the thoracic duct | 24 min. blue. |

Pelvis of a kidney, blue. Cellular substance of the thigh, blue.

23. Two drachms of the solution were injected through a tube down the œsophagus of a Cat.

*Results.*

In the serum from the aorta in 11 min. faint but distinct blue.
Liquor pericardii 13 min. no blue.
Outside of the stomach 19 min. no blue.
Fluid of the thoracic duct 22 min. distinct blue, but not exceeding that of the aortal serum.
Urine 28 min. no distinct blue.

24. Two drachms were injected down the œsophagus of a large cat.

The serum of the aortal blood, obtained in 9 minutes, was accidentally obscured, so as to prevent a judgment; as also that of the right side of the heart, obtained in 12 1-2 minutes. The fluid of the thoracic duct at 17 minutes, and again at 23 minutes, and the urine at 20 minutes, gave no blue, although fairly exposed and examined.

25. Two drachms of the solution were injected down the œsophagus of another cat.

*Results.*

Serum of the aorta in 7 min. blue.
Urine 15 min. no blue.
Fluid of the thoracic duct 12 1-2 min. no blue.

26. Two drachms of the same were injected down the throat of a kitten.

*Results.*

Serum of the aorta in 6 min. blue.
Serum of the right side of the heart 10 1-2 min. blue.
Urine 20 min. blue.

27. Two drachms of the same down the œsophagus of another kitten.

*Results.*

Serum of the vena portarum 7 min. blue.
Aorta 8 min. blue.
Right side of the heart 11 min. blue.
Outer surface of the stomach —blue.
Fluid of the thoracic duct 17 min. tinged blue.

28. Two drachms of the same down the œsophagus of another kitten.

*Results.*

Serum of the aorta 6 min. blue.
Serum of the right side of the heart 8 min. not blue.
Fuid of the thoracic duct 12 min. faint blue.

29. Two drachms of the same down the œsophagus of a cat.

*Results.*

| | | |
|---|---|---|
| Serum of the vena portarum | 7 min. | faint light blue. |
| of the aorta | 8 min. | no blue. |
| Fluid of the thoracic duct | 14 min. | no blue. |
| Urine | | no blue. |

30. Nearly four drachms of the solution were injected down the œsophagus of a cat.

*Results.*

| | |
|---|---|
| Urine | 6 1-2 min. not blue. |
| Serum of the vena portarum | 9 min. blue. |
| Fluid of the thoracic duct | 16 1-2 min. not blue. |

*b.* By securing it within the rectum by a ligature.

31. About a drachm and a half of the solution were injected into the rectum of a kitten. She suffered so much from securing the anus with a ligature, which was obliged to be passed through by two stitches, that she appeared to be dead when the operatoin was done. She, however, soon recovered, and exhibited great uneasiness.

*Results.*

Serum of the blood obtained from the jugular vein in 57 1-2 minutes exhibited no blue; nor did that from the carotid or the vena portarum, nor the fluid from the the thoracic duct; all of which was extracted in a very short time after, and in the order here enumerated.

The urine afforded a strong blue, as also the pelvis of a kidney.

*c.* By cutting into and securing the œsophagus in the neck.

32. Two drachms of a saturated solution of prussiate of potass were injected into the œsophagus of a pretty well grown kitten, through an opening, and secured by tying the œsophagus. The wound, when this was done, was in all instances carefully secured from the effect of the prussiate.

In 5 minutes the current of blood in the vena portarum was arrested by a ligature, and blood was then extracted, the serum of which gave no blue, with red sulphate of iron. In 7 1-2 minutes the thoracic duct was tied; its contents, when removed and examined at 24 minutes, gave no blue. About 12 minutes, or nearly so, she died, from opening the thorax.

The urine, at 26 minutes, gave a strong blue. The surface of the stomach, soon afterwards, gave no blue. Serum from the general circulation gave no blue.

33. Four drachms of a saturated solution of prussiate of potass were thrown into the stomach of a rabbit, through an opening in the œsophagus, and the opening tied.

Blood of the vena portarum, of which the serum was af-

terwards examined, was obtained in 14 1-2 minutes; that from the aorta in 18 1-2 minutes; that from the right ventricle of the heart in 22 1-2 minutes; the urine in 25 1-2; and the inside of the thoracic duct exposed to a test in 34 1-2. In none of these situations did the test afford a blue colour.

34. A young rabbit was treated in the same way, and the same quantity of fluid was employed.

In 21 minutes the serum of the vena portarum was procured, and it could produce no blue. In 24 1-2 minutes the serum of the vena cava ascendens was likewise obtained, and the same result ensued. In 28 minutes the urine gave a strong blue. In 30 minutes the fluid of the ductus thoracicus gave an evident light blue. In 34 minutes the cellular tissue, a blue. In 38 minutes a section of the papilla of a kidney, the same result; and in 40 1-2 minutes the capsule of a joint.

35. Two drachms of the saturated solution were injected into the stomach of a rabbit, through an opening made in the œsophagus, and secured by tying the orifice. The animal was languid at the time of the experiment.

*Results.*

| | | |
|---|---|---|
| Serum of the blood of the | | |
| Vena portarum | in 19 1-2 min. | blue. |
| Aorta | 23 1-2 min. | blue. |
| Liquor pericardii | 25 1-2 min. | no blue. |
| Urine | 28 1-2 min. | strong blue. |
| Serum from the right side of the heart | | a blue. |
| Pelvis of the kidneys | | a blue |

36. Two drachms of the prussiate solution were injected into the stomach of a young rabbit, and a ligature made on the œsophagus.

*Results.*

| | | |
|---|---|---|
| Serum from the vena portarum | in 15 min. | slightly blue. |
| From the right side of the heart | 24 1-2 min. | slightly blue. |
| Urine | 33 min. | green. |

37. A half grown kitten without any other visible cause than confinement and bad air, lost her health, and took no food for 10 days. Two drachms of the prussiate solution were injected down her œsophagus from an opening, and the orifice tied.

*Results.*

| | | |
|---|---|---|
| Fluid of the thoracic duct | 40 min. | deep blue. |
| Urine | 42 1-2 min. | very deep blue. |
| Liquor pericardii | 44 min. | light, but obvious blue. |
| The thoracic duct | | blue. |

The cellular substance, in more than 48 minutes, became blue; the kidneys, also, gave a blue through their substance.

38. Two drachms of the solution were in like manner

thrown into another kitten, and the orifice tied. In five minutes the animal died.

In twelve minutes, nearly, the following fluids were removed from the body; viz. urine which gave no blue; blood from the right side of the heart, the serum of which gave a blue; and blood from the aorta, a slight blue.

39. Two drachms of the solution were injected and secured in the same way, in another kitten.

*Results.*

| | |
|---|---|
| Serum from the vena portarum | in 22 min. blue. |
| Aorta | 23 min. blue. |
| Urine | 33 min. blue. |
| Fluid of the thoracic duct | 40 min. light blue. |

40. Another kitten underwent the same circumstances, with a drachm and a half of the solution.

*Results.*

| | |
|---|---|
| Serum from the vena portarum | in 11 min. strongly blue. |
| Aorta | 13 min. same, but not so much. |
| Fluid of thoracic duct | 17 min. very faint blue. |
| Urine | 20 min. blue. |

41. Another kitten underwent the same circumstances.

*Results.*

| | |
|---|---|
| Serum from the vena portarum | 8 1-2 min. blue, strongest. |
| Aorta | 9 1-2 min. blue, weakest. |
| Fluid of the thoracic duct | 15 1-2 min. light blue. |
| Urine | 18 min. faint blue. |
| Serum from the right side of the heart | blue. |

42. Another Kitten half grown underwent the same with two drachms of prussian solution.

*Results.*

| | |
|---|---|
| Serum from the vena portarum | in 11 min. pretty strongly blue. |
| Aorta | 13 min. pretty strongly blue. |
| Liquor pericardii | 15 min. uncertain. |
| Serum right side of heart | 16 1-2 min. faintly blue, but the colour confused from an accidental cause. |
| Fluid of the thoracic duct | 20 min. blue. |
| Urine | 23 min. faintly blue. |

*d.* After tying the trunk of the vena portarum alone.

43. The vena portarum of a nearly grown kitten was tied, separating it from the capsule of Glisson. Two drachms of the prussiate solution were then injected down the œsophagus.

*Results.*

| | |
|---|---|
| Urine, during life, | in 18 min. not blue. |
| External coat of the stomach | 21 min. blue. |
| Serum of the carotid artery | 27 min. deep blue. |
| Of the right side of the heart | 30 min. deep blue. |

Fluid of the thoracic duct 34 min. strong blue.
Urine, a second time, and after 34 min. not blue.
Inner coat of the bladder afforded a degree of blue.
Papilla of kidney, not blue.

44. A small dog had been used in an attempt to perform the experiment of Magendie upon the artery and vein of the thigh; but owing to the smallness of the vessels, it failed; the poison not being inserted. The vena portarum was carefully tied, and two drachms of the prussiate solution injected down the œsophagus.

In 27 minutes, blood of the carotid artery was procured, the serum of which gave no blue. This animal was so much weakened and disordered by the operation that we felt no certainty in the results obtained; although we deem it a proper attention to candour to insert it.

*e.* Tying the vena portarum, the cardia, and duodenum.

45. A drachm and a half of the prussiate solution were injected into the stomach of a half grown kitten, through the duodenum. Previously to this, the cardia and the capsule of Glisson were secured by ligatures. After the injection, the duodenum was tied, just below the pylorus.

The solution in these instances, was carefully prevented from contact with any part lower than the ligature.

Serum from the right side of the heart, obtained in 34 minutes gave a blue.

Urine, in 36 minutes, no blue.

46. The same parts of a large, vigorous cat were secured, and a drachm and a half of the solution introduced before closing the duodenum. This animal had accidentally eaten, just before commencing the operation.

*Results.*—Serum of the right side of the heart, and of the aorta had both been obtained at about 39 minutes; the first gave a blue, the second not.

The section of a kidney, no blue.

47. The same parts of a small but vigorous cat were tied, and a similar quantity of the prussiate of potass thrown into the stomach.

*Results.*—Serum of the right side of the heart, in 35 minutes, blue, decidedly and stronger than the last.

Section of a kidney, in 44 minutes, no blue.

Next day, the semilunar valves of the aorta and pulmonary artery, the mitral and tricuspid valves, the lining membrane of the left ventricle, and the inside and outside of the aorta, all gave a beautiful blue.

In this case, care was taken to cut only in the linea alba in

opening the abdomen, which succeeded perfectly in preventing excessive hemorrhage.

*f.* After tying the known outlets of the lymphatic system, without disturbing the cardia or duodenum.

48. A female cat, of uncommon strength and activity, was procured. The thoracic duct was secured with ligatures. Several lymphatics being cut, the tying of them required considerable time. Nearly two drachms of the solution were then thrown into the stomach, by a tube passed down the œsophagus, a part being lost. Water was then as in several other instances, injected after it, to wash it down more completely.

In 47 or 48 minutes, the animal having died in little more than half an hour, the section of a kidney afforded a distinct blue; the urine, having been lost, could not be examined.

49. The thoracic duct of a strong male cat was secured after a very careful dissection. The jugular and subclavian veins of the right side, and their common trunk, were next carefully secured by ligatures, so as to intercept all communication between that lymphatic trunk which enters into them, and the circulating blood. Three drachms of the prussiate solution were then thrown down the œsophagus which was uninjured.

In 35 minutes the urine was strongly blue with the test. In 49 minutes the fluid of the thoracic duct also gave a strong blue.

50. The thoracic duct and lymphatic trunk of the right side, in a cat was secured. In this animal the vena cava was tied above the renal veins, for a particular reason. Three drachms of the prussiate solution were then injected down the animal's throat. The abdomen was sewed up. In 17 minutes the animal died.

*Results.*—Serum from the right side of the heart, in 20 minutes, gave a blue.

| | |
|---|---|
| Urine | 22 min. no blue. |
| Kidney | 32 min. no blue. |
| Fluid of the thoracic duct | 37 min. no blue. |
| Same | 42 min. no blue. |
| Same | 60 min. no blue. |

*g.* After tying both the lymphatic trunks, and the cardia and duodenum.

51. The cardia and the lymphatic trunks of a cat were secured by ligatures. Two drachms of the prussiate solution were thrown into the stomach, and the duodenum tied.

In 32 minutes the blood was taken from the right side of the heart, the serum of which gave a strong blue.

*h.* After tying both the lymphatic trunks and the vena portarum, leaving the cardia and duodenum undisturbed.

52. The lymphatic trunks and the vena portarum of a cat were secured by ligatures, and three drachms of the saturated solution injected down the œsophagus. In 31 minutes the animal died.

Serum from the right side of the heart, in 36 minutes, gave, in the usual way, a deep blue. Immediately afterwards that of the left side was obtained, which also gave a deep blue. The outside of the stomach then gave a blue. The urine, none. The fluid of the thoracic duct, a blue. The serum of the vena portarum, a blue.

53. The same vessels of another cat were tied, and two drachms of the solution injected down the œsophagus.

In forty-eight minutes, and subsequently to the death of the animal, blood was obtained from the right side of the heart, which gave a blue; that from the aorta, also a blue; and the urine, which gave none. The outside of the stomach gave a blue during life.

54. The same vessels were tied in another cat, of full size. Two drachms of the prussiate solution were then injected down the throat.

*Results.*

| | |
|---|---|
| Serum from the aorta in | 30 min. blue. |
| From the right side of the heart | 36 min. blue. |
| Urine and sections of the kidneys, no blue. | |

55. The same vessels being tied in another cat, two drachms of the solution were introduced down the oesophagus. The serum of blood obtained from the right side of the heart in 25 minutes, gave a slight blue. That of the vena portarum and splenic vein, in this short interval of time gave no visible blue; nor did the urine.

*i.* After securing both the vena portarum, the lymphatic trunks, and the cardia and duodedum.

56. These parts of a half grown cat having been secured, including the whole capsule of Glisson, two drachms of the solution were injected into the stomach and retained there by tightening the ligature of the duodenum. A drop or two of the fluid fell on the peritoneal coat of the stomach.

In 25 minutes the blood of the right side of the heart was obtained, it gave no blue. In 32 minutes the inner surface of the bladder was also examined, and it gave no blue.

In 29 minutes, and after the animal had been killed, by opening the thorax and the heart; the surface of the stomach, when moistened with the sulphate of iron, gave no blue.

Forcible contractions succeeded, and in a minute and a half, the colour appeared.

57. The same parts were tied in another cat, and two drachms of the prussiate solution thrown into the stomach. The serum from the right side of the heart in upwards of 23 minutes, became *bluish* with the test. The urine underwent no change.

58. The same parts were tied in a cat not fully grown. A drachm and a half of the solution were then thrown into the stomach. The serum from the right side of the heart gave no blue. It was taken in 25 minutes. The urine gave no blue in 36 1-2 minutes.

59. The same parts were tied in a strong cat, and a drachm and a half of the prussiate solution thrown into the stomach.

Serum from the right side of the heart in 26 minutes, no blue.

Urine 28 minutes, no blue. At 29 minutes, the animal having died in consequence of opening the thorax, the external surface of the stomach became blue in one quarter of a minute.

*k.* Comparative.—The stomach being cut off by ligature from all connection with the system.

60. A kitten rather more than half grown was used for this experiment. Ligatures were placed upon the cardia, the capsule of Glisson, the duodenum three inches from the pylorus, and all other parts immediately connected with the stomach; so as to exclude this organ from all communication with the system. Two drachms of a saturated solution of the salt were injected into the stomach through the duodenum, and the wound closed by ligatures. Care was taken to prevent the contact of the fluid with other parts. The stomach soon became very dark coloured.

In 31 minutes, blood from the carotid, in 34 minutes, blood from the right side of the heart, and in 37 minutes, urine were obtained; but none of them indicated the presence of the article. Neither did the papilla of a kidney indicate it. But the test being applied to the exterior surface of the stomach, almost immediately after the injection, produced a beautiful blue.

B. *In the trachea and lungs.*

*a.* During life.

61. The urethra of a large female cat was secured. One drachm and a half of the solution of the prussiate of potass were injected from the trachea into the lungs through an incision made below the larynx. In 5 minutes a ligature was

placed upon the great vessels leading from the heart. In 8 minutes the thoracic duct was tied; its fluid was tested, but indicated no blue. Sulphate of iron being dropped in the two sides of the chest, the pleura pulmonalis and costalis of the left side became strongly blue, but no such appearance was shown on the right side. The animal had lain on the left side. The valves between the auricles and ventricles of the heart, became blue with the test. The ligaments, periosteum and urine, indicated none of the prussiate. The serum from the left side of the heart, became greenish blue. Right side appeared slightly bluish, but doubtful.

62. The same experiment was repeated upon a kitten. The same quantity of solution was used. In 5 1-2 minutes, a ligature was placed upon the great vessels of the heart, and the blood of its two sides separately obtained in 7 1-2 minutes. In 9 1-2 minutes, the exterior lining of the lungs and the pleura costalis gave a blue. The serum from each side of the heart, gave a strong blue, (the right side strongest;) as also did the mitral and tricuspid valves. The chordæ tendinæ of the left side, also gave a blue. The lining membrane of the inside of the heart gave no blue. The bladder gave no blue on its internal surface. The urine became blue; but it was doubtful whether the vessel was clean.

63. The experiment was repeated on a half-grown kitten, with the variation of throwing one drachm of the solution through a small pipe, which both made a puncture through the trachea, and afforded a passage to the fluid.

In 4 1-2 minutes, the vessels were tied, and then blood was obtained separately from both sides of the heart. Neither indicated the salt. The thoracic fluid was obtained in 7 1-2 minutes but indicated no blue. The urine remained colourless with the test. The pleura pulmonalis became blue. The peritoneum covering the bladder and intestines gave no blue.

54. The trachea of a kitten being separated from its attachments, a drachm and a half of the prussian solution were thrown in. The trachea was then tied. In one minute from the injection, death ensued.

The upper part of the thoracic duct, its contents, and all the adjoining surfaces, in 7 1-2 minutes, blue with the test. The peritoneum, no colour. Serum of the right side of the heart doubtful. That of the left side, none.

65. A stout female cat was treated in the same manner, and one drachm of the solution introduced. She died in about one minute.

*Results.*

Serum from right side of heart in 7 min. weakly blue.
Left side of heart 7 1-2 min. strongly blue.
Fluid of the thoracic duct being chyle and lymph mixed, 16 1-2 min. no evident blue.
Serum from the cava descendens 18 1-2 min. no blue.
Urine no blue.

66. Another cat was treated in the same manner, and with the same quantity of the solution.

*Results.*

Serum of the abdominal aorta in 3 1-2 min. blue.
Abdominal vena cava 4 1-2 min. no blue
Fluid of the thoracic duct 14 1-2 min. no blue.
Urine 31 1-2 min. no blue.

67. A kitten underwent the injection of one drachm of the solution into her trachea. She was laid on the left side: those previously operated on having generally been laid on their backs.

The surface of the right lung gave no blue, in 4 1-2 minutes; nor that of the left lung, in 6 minutes. In 2 or 3 minutes more both gave a blue. It was now uncertain whether the animal was still alive. The trachea had been left without a ligature, in order to prolong her life as far as possible.

*b.* Comparative. After death.

68. An animal, bled to death in exp. 2, six minutes afterwards was used for this one. A drachm and a half of the prussiate solution were thrown into the trachea.

In 21 minutes the pericardium and liquor pericardii became blue under the test. The appearances of the lungs have not been preserved.

C. *In the abdominal cavity during life.*

*c.* For comparing the different fluids.

69. Half an ounce of the saturated solution was injected with a pointed syringe into the abdominal cavity of a half grown kitten, of uncommon strength and ferocity. At 5 1-2 minutes the blood vessels of her neck were divided; and in 8 minutes she was dead.

Chylous fluid was obtained from the thoracic duct between 12 and 13 minutes; it gave a distinct blue.

The urine, in 19 minutes, no blue.

The serum of the carotid artery, mixed with that of the jugular veins, obtained in 6 minutes, gave a distinct blue.

70. Another very strong and ferocious kitten had half an ounce of the solution injected into the abdomen.

In 2 minutes the blood-vessels of the neck were cut, and blood obtained; the serum did not yield a blue.

In four minutes the thoracic duct was tied, and in 6 minutes the fluid extracted; this was chylous, and gave a blue.

In 10 or 15 minutes the urine gave no blue; in 29 minutes, a distinct one.

It should here be borne in mind that the solution lay in contact with the bladder during this period and after death.

71. A quantity nearly similar was injected into the abdomen of another kitten.

*Results.*—Blood from the vessels of the neck, in 2 minutes, no blue. Thoracic duct tied in 3 3-4 minutes, chylous fluid obtained, 6 1-2 minutes, blue. Urine removed in 5 minutes, blue, with the more delicate test. It was tried with the green sulphate, and afforded none.

72. Half an ounce was thrown into the abdominal cavity of a kitten. The thorax was immediately opened.

The thoracic duct was tied in 3 minutes, the fluid, which was chylous, being obtained in 7 minutes, gave a blue.

Serum from the vessels of the neck, in 4 minutes, strongly blue.

Urine obtained afterwards, doubtful.

73. A quantity of the solution was thrown into the abdomen of a cat.

In 6 minutes some blood was taken, the serum of which gave no blue. In 9 1-2 minutes the fluid of the thoracic duct gave a blue. The urine gave none.

*b.* To ascertain the time required for substances to pass from a serous cavity through the thoracic duct.

74. Half an ounce of the solution was thrown into the abdomen of another kitten.

In two minutes the thoracic duct was exposed and divided, and sulphate of iron applied to the wound, while the spectators watched the appearances which took place. At first, and for a short time, no effect was produced; but in 4 minutes the chylous fluid which issued began to produce a blue on coming into contact with the test, and it continued to produce an increased intensity till 7 or 8 minutes, when a very strong colour being exhibited, the experiment was discontinued. The *green* sulphate was the one here employed.

75. This process was repeated on another kitten, with the same quantity of the prussiate.

In a minute and a half an ambiguous appearance was visible; in two minutes and a half a distinct blue. The serum here gave a blue.

76. The same process was repeated upon another kitten, with the same quantity of the solution.

The vessels of the neck were then divided. In two minutes and a half no blue appeared; in three minutes and a half a strong blue was formed.

The serum of blood obtained afterwards gave a blue. Urine uncertain.

77. the same process was repeated with a cat, who happened to be pregnant.

In two minutes from the injection the thorax was opened, and as soon as it could be done, the test was applied to the orifice of the divided thoracic duct. At thirteen minutes the blue first appeared.

D. *In the cellular substance.*

78. In a large bitch, employed for exp. 100, the thigh had been separated entirely from the body, with the exception of a column of blood in the femoral artery, and another in the vein, both circulating through quills, having the vessels completely divided. Ten minutes after the application of the poison, two drachms of the saturated solution of prussiate of potass were injected by a sharp pointed syringe into the cellular substance of the separated limb.

In 59 minutes blood was extracted from the trunk of the femoral vein above the quill, where it was continuous with the animal's body; the serum of this gave a distinct blue. Of this there is no doubt, notwithstanding we were unable to detect it in any of the following substances, which were removed from the body at the periods affiixed to their names.

Blood from the femoral artery above the quill, 57 minutes; the bladder, both by an infusion, and by applying the test to its inner coat, 70 minutes; blood of the vena portarum, 75 minutes; blood of the right side of the heart, 80 minutes; fluid of the thoracic duct, 98 minutes.

E. *To ascertain whether absorption continues after animal death.*

79. A kitten was bled from the carotid artery, as long as blood would flow, and until the entire suspension of voluntary motion. Two drachms of the saturated solution of prussiate of potass were then introduced into the abdomen.

The thoracic duct being divided high in the thorax, and red sulphate of iron in solution placed in contact with it, the fluid effused continued colourless at first, but a strong blue appeared in five minutes and a half.

The serum of blood obtained afterwards gave no blue.

80. Another kitten was bled in the same manner, and to animal death. In two minutes afterwards the thoracic duct was divided near its upper extremity, and a colourless mixture of chyle and lymph issued. The test was then applied with no effect.

In three minutes two drachms and a half of the prussiate solution were thrown into the abdomen.

In five minutes from this time a blue first appeared at the orifice of division, and it became strong almost immediately.

The urine, when tested, gave a light green tinge, similar to that of exp. 93. The serum, no change.

81. Another kitten being bled to death, all the vessels attached to the heart were effectually closed by a ligature. This, and the injection of a quantity of the prussiate solution into the abdomen, were performed during two minutes. Three minutes afterwards the thoracic duct was divided, and the issuing fluids tested, no blue was produced.

In 14 minutes from the injection the blue colour began to form gradually; in 16 minutes, the whole extent of the duct, where covered with the liquid test, became blue; and at 39 minutes the colour was intense.

82. Precisely the same experiment was repeated on another kitten. A minute and a half after cutting the carotid and jugular, the vessels were tied at the heart, and in two minutes the injection was finished.

At three minutes from that period there was no blue at the wound in the duct. It appeared at twelve minutes.

### III. WITH GREEN SULPHATE OF IRON.

#### A. *In the alimentary canal.*

83. Half an ounce of a strong solution of green sulphate of iron was injected into the small intestines of a large kitten; distributing it nearly equal upwards and downwards, from a wound near their middle. Some was supposed to pass upwards into the stomach. The wounded intestine was tied, and the abdomen stiched. The kitten vomited, but the matter ejected gave no blue with prussiate of potass. Vomiting again, a green was afforded. Prussic acid was applied, at 37 minutes, to the tongue and eye; but the article not appearing to be good, and not destroying life, the carotid artery was cut, and florid blood obtained. The serum gave no blue with prussiate of potass. Fluid of the thoracic duct in 52 minutes, gave no indication of iron, either with tincture of galls or with prussiate of potass.

84. About three drachms of the solution were carefully injected into the œsophagus of a cat, being directed downwards. The œsophagus was then tied.

In 6 hours and 36 minutes afterwards, the animal was pithed.

*Results.*

| | | |
|---|---|---|
| Fluid of the thoracic duct | in 6 hours 46 min. | no blue. |
| Urine | 6 hours 50 min. | no blue. |
| External surface of the stomach | 6 hours 53 min. | no blue. |

The contents of the rectum in 6 hours 55 min gave blue in spots, and bluishness generally. In 57 min. the stomach a strong blue.

B. *In the abdominal cavity.*

85. A kitten had had camphor thrown into her rectum, which had effected her nervous system powerfully, but from which she had recovered. Two days afterwards, she had six drachms of the solution of sulphate of iron thrown into her abdomen. Almost immediately she had three stools. After violent struggles, she died, in eighteen minutes. The serum of the blood obtained from the carotid immediately after was not perfectly free from red globules, and when prussiate of potass was added, it gave a brownish tinge, such as we have often seen under similar circumstances. Fluid of the thoracic duct, in 29 minutes gave a deep blue. Urine, in 31 minutes, a strong blue.

86. Six drachms of a strong solution of sulphate of iron were injected into this cavity in a kitten. In 6 minutes she vomited; in 16 minutes was convulsed; and in 25 minutes died

The chyle in twenty-seven minutes gave a strong blue. The urine gave no colour different from its natural one.

8 7. One ounce and one drachm of the same sulphate solution were injected into the cavity of the abdomen of a kitten. In two minutes the animal vomited. In twenty minutes she died. In twenty-three minutes, or three minutes after death, the chyle was removed, and gave a strong blue with prussiate of potass, and a strong black with tincture of galls.

The urine indicated none of the article. The same was observed of the serum of the blood.

C. *In the cellular tissue.*

88. One ounce of a strong solution of the green sulphate of iron was injected into the cellular tissue covering the abdomen of a healthy half-grown kitten. In forty minutes the animal was pithed. Blood from the carotid was obtained. In fifty-one minutes the thoracic fluid was obtained. In forty-eight minutes, urine was procured. None of the fluids indicated the presence of the salt.

89. This experiment was repeated upon another kitten, and six drachms were injected. In four minutes the animal was much debilitated. In ten minutes it was pithed. The chyle gave a strong blue. The urine gave no blue, though a small drop of the ferruginous solution was sufficient to strike a visible blue. The serum, obtained after death, gave no blue.

IV. DOUBLE EXPERIMENTS WITH BOTH THESE SUBSTANCES, TO EFFECT A CHEMICAL CHANGE IN THE LIVING VESSELS.

90. Six drachms of the saturated solution of prussiate of potass, were injected into the right side of the cavity of the abdomen of a large male cat. Six drachms of the strong solution of green sulphate of iron were injected into the cellular tissue over the oppo-

site side of the abdomen. In 37 minutes from completing the last injection, blood was obtained from the jugular vein. In 40 minutes the animal was pithed. In 46 minutes, the thoracic duct, which was double, was tied.

No blue colour was observed in the fluids. But on adding sulphate of iron to the thoracic fluid and to the urine, they became blue.

The animal remained strong under the experiment.

91. This experiment was repeated on a large healthy cat with this variation, that the prussiate was first thrown into the cellular tissue over one side of the abdomen, and the sulphate next injected into the cavity of the abdomen, on the opposite side. In 35 minutes the animal was bled to death from the carotids and jugulars. The lungs felt perfectly healthy, but were of a strong blue colour throughout their whole structure, except two or three in considerable spots, where they were of their natural colour. These viscera forming a very singular preparation, were preserved, and are now in our possession. The thoracic duct in its course in the thorax, was of a strong blue before being touched. Its fluid on being received into a vessel was of a most obvious and conspicuous blue. The urine was also blue. The coagulating lymph thrown up by the blood was blue.

On the next day the chyle had thrown down a blue deposit. The liquor pericardii was clear, but became blue on adding sulphate of iron.

92. Four drachms of the saturated solution of prussiate of potass were injected into the cellular substance over the left side of the abdomen of a kitten, and four drachms of a strong solution of sulphate of iron into the cavity on the right side.

In 30 minutes the animal was much affected by the operation. In 35 minutes she was dead.

The liquor pericardii was clear, but became blue on the addition of sulphate of iron. The urine is marked as having exhibited a blue, and the lungs a blue. No memorandum has been preserved of the appearance of the thoracic duct and its contents.

93. Seven drachms of a strong solution of the bisulphate of iron were injected into the abdomen of a cat. Five minutes after, an equal quantity of the prussiate solution was forced into the cellular membrane at a distant point of the abdomen. In one hour seven minutes the fluid contents were arrested in the thoracic duct by a ligature, and immediately removed. They were already of a faint blue.

In this animal the lungs were not of an unnatural colour. The blood obtained in one hour three minutes, gave no blue in the serum until the sulphate of iron was added to it. Neither did the urine, obtained soon after. Both these fluids indicated distinctly the presence of the alkaline prussiate alone; by producing, with the sulphate of iron, the first a strong blue, the latter a light green.

Besides these three last cases we met with the following failures:

94. A kitten, in which four drachms of the feruginous solution were thrown into the peritoneal cavity, and as much of the prussian solution into the cellular substance.

95. A small Maltese dog, into which six drachms of each were introduced in the same manner, but beginning with the prussiate, and adding the other within 3 1-2 minutes.

The following experiment is somewhat dissimilar.

96. In a large strong cat, the outlets of the lymphatic trunks of both sides were carefully secured by ligatures. Three drachms of the solution of the sulphate were thrown into the abdominal cavity and within a minute and a half of this, three drachms of prussiate of potass into the cellular tissue on the other side.

Blood was obtained from the femoral artery in 44 1-2 minutes.

The animal died in 54 1-2 minutes. The thoracic duct was full and distended in 62 minutes, with a white fluid. In 2 minutes more, a considerable quantity of this chylous matter was obtained. Each of these fluids was remarkably free from blue appearance. Nevertheless, in one hour ten minutes, the urine was of a strong bluish green

All the above fluids indicated, on being tested, the alkaline prussiate.*

### V. WITH POISONOUS SUBSTANCES.

The experiment of Magendie, in which a limb was separated from the body so far as only to be connected with it by either an artery and a vein, or simply by two columns of blood, circulating through quills, was repeated several times. As this experiment, however, is well known, we shall not insert the details.

Six trials were made on dogs, by introducing quills and dividing the vessels, two (97, 98) with, and three (99, 100, 101) without success, in using nux vomica, and one (102) unsuccessful trials with prussic acid.

In one (103,) trial without quills, we succeeded in producing tetanus and death from nux vomica.

In three others, (104, 105, 106,) one on a dog, with nux vomica, one on a rabbit, with the same substance, and one on a dog, with prussic acid, we failed; and deeming the cases above enumerated sufficient, did not persevere in this painful experiment.

J. O'B. LAWRENCE,
B. H. COATES.

*We are happy to learn that our friend, Dr. I. K. Mitchell, of this city, has since made a trial, in which these two salts were injected into the thorax, and the abdomen, with the result of a fine blue appearance in the lymphatics, running over the diaphragm; also another, in which, two portions of intestine being employed the precipitate was seen to take place at the union of lacteal trunks on the mesentery.