AN EXPERIMENTAL INVESTIGATION

OF

THE EFFECTS

OF

LOSS OF BLOOD;

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AFTER paying considerable attention to the effects of loss of blood as manifested by the human subject under the influence of blood-letting or hemorrhagy, I still felt that there were so many questions left in obscurity, that the investigation of them, in the way of experiment, was one, the object of which was at once legitimate and most important.

1. It was highly important to ascertain the effects of loss of blood, in circumstances entirely free from the complication of disease or other unusual condition of the system.

2. It was highly important to estimate the difference in the effects of loss of blood in the different ages.

3. It was also highly important to fill up a blank left in my former investigations by ascertaining more accurately and distinctly than before, the various organic changes induced by loss of blood.

4. And as blood-letting constitutes the most powerful of our remedies, and hemorrhagy one of the most formidable of diseases, it became of the utmost moment to fix the rules and limits of the employment of the former, and to ascertain the most efficacious mode of restoration in the latter.

The present paper is devoted to the inquiry into the effects of loss of blood in animals of adult age. They may be divided into: I. Syncope; II. Excessive reaction; III. Gradual sinking; IV. Immediate dissolution; and V. The organic changes.

The other parts of this inquiry, and especially that which relates to the effects of loss of blood in the young animal, are necessarily postponed to a future opportunity.

In all the experiments I had the advantage of the co-operation of Dr. Hope and of Mr. Field, so that their accuracy cannot be called into question. Indeed

the results were observed too frequently, and noted at the moment with too great care, to admit of error.

I shall first state the general deductions and principles which have flowed from the experiments, and then detail the experiments themselves. The experiments will be arranged in the order in which they appear best to illustrate the subject; but they will be dated in that in which they were actually performed. In this manner the facts detailed, even in the experiments themselves, will be given in the order of the phenomena; whilst some apparent discrepancies in regard to the periods at which they were observed, will be explained.

I. OF SYNCOPE.

Syncope may be considered as the first of the decided effects of loss of blood. In order to induce this condition several precautions are necessary. First, there must be a certain degree of strength in the animal; secondly, the blood must be drawn with a due degree of promptitude; and thirdly, the position must be more or less raised. If one or more of these circumstances be wanting, we shall, instead of syncope, induce a state bordering on dissolution, and very different from syncope.

In syncope, the whole of the phenomena appear to be dependent on the sudden abstraction of blood

from the *brain*. The languor of the eye and of the expression; the panting, or sighing, observed in the breathing; the cessation or extreme diminution of the frequency and force of the action of the heart and of the arteries; the loss of appetite; the nausea and vomiting; the debility of the voluntary muscles and the relaxation of the sphincters of the bladder and rectum, all appear to have this origin.

The truth of this remark, in regard to some of these phenomena, is obvious from the influence and effects of posture. The most remarkable of the phenomena of syncope may be renewed, after they have disappeared, by placing the animal in such a posture that the head shall be as much elevated, and the other parts of the body as much depressed, as possible: the countenance and the eye languish, and the head droops; the mouth then opens and the respiration becomes panting; if at this moment the ear be applied over the region of the heart, its action, distinctly perceived before, is found to be either suspended or so feeble as scarcely to be heard. On reversing the position, the animal is immediately relieved, it raises its head and looks about, the respiration, although impeded by so constrained a position, is greatly restored, and the beat of the heart becomes instantly perceptible, and in a short time loud and strong.

The influence of position upon the action of the heart, in cases of syncope, is one of the most interesting facts, ascertained, and repeatedly verified,

in the course of the subsequent experiments. It was at once marked and decided. The erect position subdued the action of the heart; the inverted position restored it, even still more promptly. Commensurable and coincident with the subdued action were the falling of the lip and panting; so that he who saw the animal knew distinctly what the other heard, who applied his ear to listen to the beat of the heart. If there were no pantings, the action of the heart continued; as the mouth opened and the animal panted, the pulsation of the heart ceased to be heard or felt.

From these facts it seems to be manifest that syncope depends chiefly upon the condition of the brain, and only in a secondary manner upon that of the heart itself.

It is further observable that in syncope all the functions are affected: the respiration and the power of the voluntary muscles first; then the action of the heart; then that of the stomach; then that of the bowels; and then that of the sphincters.

The degree in which these functions are affected varies. The drooping state of the head and eye-lid; the staggering walk; the panting and sighing; the feeble beat of the heart and pulse; the repugnance to food, are observed in the milder forms of syncope. In the severer, the breathing is laboured and performed principally by the diaphragm; there are nausea and vomiting; and the bowels are not only

moved, but the sphincter relaxed. Such a state of syncope is not without danger to life.

In the chain of phenomena in syncope a sigh constitutes the first link, and actual vomiting and relaxation of the sphincter the last. If there be more serious affection still there is the danger of dissolution. Vomiting itself only occurs in the most decided syncope; but there is repugnance to food in syncope in its slightest form.

If the appetite do not speedily return, if the respiration continue deep, or laborious, there is a danger of dissolution, although the beat of the heart and of the pulse appears somewhat restored. The condition of the *appetite* and of the *respiration* may be taken as the principal index of safety or of danger.

It is important to observe that syncope from a second blood-letting, and especially a third, in the same animal, is far less distinct than that from the first. The animal is more subdued; but the symptoms of syncope are less marked.

II. OF EXCESSIVE REACTION.

From the milder forms of syncope induced by the abstraction of blood, the animal soon recovers, the heart and arteries regaining and not surpassing their usual beat. The principle on which this recovery takes place may be denominated reaction. It appears

to be inherent in the animal constitution and not to admit of being referred to any more simple law of vitality.

From a first syncope, and even from a second if not too severe, the animal recovers to a condition not to be distinguished from that of health. But if the detraction of blood be repeated at such intervals and in such quantities as not to endanger life, the reaction passes beyond the limit of healthy action, and becomes excessive, presenting a peculiar and highly interesting series of phenomena.

As syncope appears to consist primarily, in a peculiar condition of the brain, so excessive reaction is as obviously an affection of the *heart*.

There is also this further distinction. The affection of the brain in syncope is immediately followed by an impaired condition of the respiration, of the circulation, and of the functions of the stomach and bowels, &c. In excessive reaction the function of the heart and arteries alone is affected. The respiration may be accelerated, but the eye is bright, the countenance and the manner lively, the appetite good.

That excessive reaction is independent of the brain, and dependent on the heart itself alone, seems to be proved by the total absence of any effect from change of position. When there is any tendency to syncope, the reaction of the heart is, as has been already

stated, subdued by the upright and restored by the inverted position. When there is full reaction, on the contrary, no such changes are observed; though the animal be long suspended in the erect position, there is neither panting nor cessation of the action of the heart or of the arteries.

I believe it may be stated that in all the effects of loss of blood, except syncope, the frequency of the beat of the heart is augmented. In syncope alone it is diminished.

The action of the heart and of the arteries in excessive reaction is characterized by a peculiar throb; that of the heart is accompanied by a peculiar noise resembling that of the saw or of the file, termed by the French 'bruissement,' and very discernible on applying the ear to the chest. The pulsation of the minuter branches of the arterial system, not to be felt in health, becomes quite perceptible.

In extreme cases not only the heart and the carotid and femoral arteries are observed to beat forcibly, but even the head is seen and felt to throb. Otherwise the brain does not appear to be at all affected.

It has been stated already that, during excessive reaction, the appetite and the other functions of the stomach and of the bowels remained unimpaired.

Even the process of assimilation goes on uninterruptedly within certain limits. One of the dogs subjected to the loss of blood gained half a pound in weight, instead of losing, although he had been bled seven times, and lost 35 ounces of blood, in the space of seven days.

The immediate effect of syncope is to lower the temperature; that of a first reaction to raise it. In the former condition the temperature sometimes fell below 96° Fahr.; in the latter it frequently rose to 101°, the natural temperature being 99°. The thermometer was placed far back between the teeth and cheek.

During the state of excessive reaction a little further detraction of blood affects the respiration, inducing panting, but it is better borne, within certain limits, than would have been expected. The animal soon recovers from its drooping state and does not lose its appetite for food.

Unless syncope be induced, the beat of the heart becomes more frequent; the peculiar sawing sound ceases for a very short time, but quickly returns, and the other sounds are very distinct.

In excessive reaction, not only the augmented impulse, but the 'bruissement' observed in the action of the heart, might lead to the erroneous conclusion that there was disease in this organ and its valves.

III. OF SINKING.

It is easy to induce the state of syncope. We have only, in a first blood-letting, whilst the animal's powers are undiminished, to take blood enough. The experiment is attended with no danger. Reaction follows, and does not generally pass the limit of health.

It is not more difficult to induce the fullest reaction. A moderate quantity of blood, taken each second day, will, if the animal be strong, soon issue in the singular series of phenomena which constitute this condition of the system. But I have found it extremely difficult to induce the state of sinking. If but moderate quantities of blood be taken, the animal soon rallies; if a larger quantity, dissolution and not gradual sinking follows; the animal dies during the night.

The phenomena manifested in experiments II. and IV., were the nearest to those of the sinking state; yet they consisted rather in an impaired and failing condition of the functions of the respiration, than of those of the *nervous system*, as observed in the pure and gradual sinking, which I have repeatedly had occasion to watch in the human subject. Still, these phenomena are of a most interesting character, and, even as they occurred in those experiments, border on those of sinking. Not the least so was the state of the cornea in several of the experiments.

With the peculiar full, deep, sighing respiration, the heart lost its diffused and throbbing beat, and the pulse its size and power; and the stomach was so affected as to lead to total loss of appetite, a symptom, which, if continued, I always found to be fatal.

The state of the respiration and of the appetite afforded the clearest indications of approaching dissolution. Whenever the animal continued to refuse food for several hours, it invariably died. The slight spasmodic twitchings observed in the ears and in one of the legs in Experiment VI., was also obviously of fatal omen. The louder state of the breathing during life, and the effusion into the bronchia, and the slight degree of œdema of the cellular membrane of the lungs after death, clearly denote the continuance, for a short period at least, of the true sinking state or failing nervous energy.

IV. OF DISSOLUTION.

Dissolution is probably, like syncope, principally an affection of the *brain*. In one animal, when the experiment of the erect and inverted positions was tried, a convulsive movement of the eyes was observed, and symptoms of dissolution, instead of mere syncope, were induced in the first of these postures, and there was no restoration of the action of the heart in the second, although no previous symptoms had occurred to indicate such immediate danger.

Approaching dissolution, yet not immediate dissolution, is denoted by a deep thoracic respiration, loud to the ear applied to the chest. Dissolution is more imminent when the respiration is laborious, performed principally by the diaphragm and abdominal muscles, and sighing and irregular. It is more imminent still when there is moaning; this usually leads to a peculiar whine, and perhaps to barking. Lastly, there is, in the act of dying, gasping, the gasps being repeated at longer or shorter intervals.

The condition of the respiration is thus, as we have already stated, an index of approaching or impending dissolution. The beat of the heart and of the pulse is sometimes performed with strength and regularity in the midst of a state of dissolution. As death approaches there are restlessness and various convulsive affections; the eye, the angles of the mouth, the head, and the fore legs are drawn spasmodically, and convulsed, and the limbs become stiff.

In the midst of this scene the sphincter ani is frequently relaxed, and the contents of the bowels discharged. After the last gasp, after the last convulsive movement, the heart can be seen, felt, and heard beating with force, and the pulse of the femoral artery is quite distinct. We observed this in several instances, and in one for many minutes.

This series of phenomena plainly shew that the functions of the brain are first impaired in the act of

dissolution, as in the state of syncope. When the brain has ceased its influence, the breathing is suspended, the action of the heart and arteries still continuing. Their functions cease in their turn, and with them doubtless those of the capillaries; in syncope, but especially in the act of dissolution, the ears, lips, and feet lose their temperature.

In cases in which the animal would doubtless recover if left in the horizontal posture, the vertical position may issue in immediate dissolution. This position, which leads to syncope in one instance, may induce convulsions and death in another. This fact was exemplified in Experiment III. How much practical information is involved in it! It is well known that a similar sudden dissolution has been the unexpected result of effort or of the upright posture, in the human subject reduced by hæmorrhagy or other loss of blood.

V. OF THE ORGANIC CHANGES.

The Brain.—If an animal die from the effects of one, two, or three abstractions of blood, the brain and the other viscera do not appear to be remarkably blanched. In the dogs which were the subjects of Experiments I. and III., in which thirty-two ounces and eighteen ounces of blood were lost respectively, the brain, lungs, and abdominal viscera appeared to contain pretty nearly their wonted quantity of blood. The appearance of the brain was perfectly natural;

its membranes and substance had their natural degree of injection; and the ventricles were free from effusion. Nor were the lungs or the stomach and bowels remarkably pale. In Experiment IV., in which twenty-eight ounces and a half of blood were abstracted, the brain was slightly paler than natural.

But if, on the contrary, the animal has survived a longer time under the influence of loss of blood, the brain, the lungs, and the stomach and bowels, are alike found blanched and drained of their blood. This was remarkable in the subject of Experiment V.: the brain was as pale as any other organ, and that without any effusion into the ventricles or about its surfaces. The conjecture of Dr. Kellie*, that there would, in such a case, be an effusion of a considerable quantity of serum, does not, therefore, appear to be well founded. Twenty-nine ounces of blood had been taken within four days; the dog was a young slim spaniel.

In Experiment II., fifty-six ounces of blood were taken in the course of seventeen days. For many days there were the most marked symptoms of reaction. The animal died immediately on being bled the last time, so that there was at no period the true sinking state. The brain was found less blanched than in Experiment V., but there was considerable effusion between the dura mater and pia mater, and

* Ed. Med. Chir. Trans., Vol. I. p. 116.

into the ventricles. The effusion was apparently connected with the long continued state of *reaction*.

In Experiments VI. and VII., in which sixty-seven and forty-eight ounces were taken respectively, there was less of the state of reaction, my object being continually to subdue such a state into that of sinking. There was accordingly no effusion; but the brain was blanched.

The Lungs.—The lungs were found natural in the subject of Experiment IV.; in that of Experiments II. and VI. a little frothy serum issued from the divided bronchia. It was only in Experiments VI. and VII. that any marked disorganization was observed: in these there were traces of emphysema and spots of congestion, or hepatization; and the bronchia and air cells both exuded fluid on being divided with the scalpel. These were distinctly the effects of the *sinking state*, though this was not long continued.

The Heart.—The right side of the heart generally contained blood. In Experiments II. and III., in which the examination was made immediately after death, the left ventricle was found perfectly empty. In Experiment IV., however, although the examination was also made immediately, the left ventricle contained abundance of blood.

The spleen in general appeared small.

The *other viscera*, except the liver, were blanched whenever large quantities of blood had been taken.

VI. OF THE CIRCULATION.

1. *Of the Blood*.—The blood having separated into serum and crassamentum, the proportion of the latter at first exceeded that of the former; but this proportion was gradually inverted, the quantity of serum augmenting, whilst that of the crassamentum diminished.

In several cases, but by no means in all, a creamy substance floated upon the serum. A specimen of this kind of blood was sent to Dr. Prout for examination. The cream-like substance was found to consist of oily matter, soluble in æther. It was readily taken up by silver paper, leaving a permanent oily transparency when the paper was dry. I think this appearance is to be associated with emaciation, and probably depends upon fat absorbed and carried into the circulation. In one instance only was there an appearance of buff. This was observed in Experiment VII., and it is remarkable that in this very case the crassamentum bore the greatest proportion to the serum throughout, whilst it was least firm under pressure.

2. *Of the Pulse*.—The pulse was sometimes made slower, sometimes more frequent, by the loss of blood. The former event was observed whenever, the pulse being but of moderate frequency previously, the effect was syncope; and whenever the pulse was of ex-

treme frequency previously to the blood letting. The latter was observed in all other cases.

3. *Of the Capillary Circulation.*—The effect of syncope is very obvious in the capillary circulation. The conjunctiva is blanched, and the ears and feet become cold. The thermometer was usually applied in these experiments far back between the cheek and gums. In this situation it was generally found to have fallen under the influence of syncope. It is probable that this would not have been equally observed in the axilla.

The condition of the capillary circulation observed in the web of the frog which has lost blood, is very peculiar. Instead of red vessels, transparent lines are seen pursuing the usual course of these vessels, and an occasional globule is observed running along them.

VII. PRACTICAL APPLICATIONS.

We may deduce from the foregoing experiments the extreme difficulty of ascertaining the state of immediate danger arising from loss of blood, whilst the animal retains the horizontal position. There is no phenomenon which clearly indicates such danger.

In the prosecution of these experiments I had continually to regret the want of a criterion for the extent to which I might allow the blood to flow,—a criterion which is afforded to the veterinarian by the position of the horse, and of which the physician may avail himself by directing his patient to be placed

upright. The dog is apt to pass from the sitting to the prone position, and then more blood may be withdrawn than he can bear to loose, before any distinct criterion of the sufficient quantity was apparent.

This difficulty was particularly felt when we attempted to induce the slowly sinking state. If we took too little blood, the animal rallied perhaps completely; if too much, it sank immediately. In another position the signs of an incipient syncope would have afforded us the guide and the warning which were wanted.

From observations made on the human subject, and in the course of these experiments, I am alike persuaded that blood-letting ought never to be employed in the horizontal position. The quantity of blood taken, although apparently moderate, may be beyond the powers of the system to bear. But if the erect position be adopted, the occurrence of syncope limits the flow of blood, and the change to the horizontal position affords a prompt refuge from danger.

We learn from these experiments that during the state of excessive reaction there is danger of effusion into the brain. That state must therefore be watched with peculiar anxiety in the cases of our patients.

We learn also that there is great danger of mistaking the state of excessive reaction for diseases of the heart and its valves. A correct diagnosis is, of course, of the utmost moment.

EXPERIMENT I.

Nov. 2d, 1830. The first experiment was performed on a terrier dog, aged 18 months, weighing 17 pounds, lively and muscular. It was bled to syncope; nearly 16 ounces of blood were taken.

As the blood flowed the eye became languid, the eye-lids partially closed, the head drooped, and the dog sank down upon its chest; it drew a deep sigh, the respiration was accelerated, and it drew a deeper sigh. Being placed on the floor it staggered, became sick and vomited, and evacuated the rectum.

Being now held up by the fore leg, the respiration became loud and hurried, the eyes closed, the head drooped, and there was a more complete state of syncope than before. Being then suspended by the hinder legs, the syncope was immediately relieved, and it looked about in a lively manner.

In subsequent experiments it was found that the beat of the heart ceased to be perceptible to the ears applied to the chest, during the state of syncope induced by suspending the animal by the fore legs, but that it was immediately audible on inverting this position. The effect of change of posture was repeated with a similar but far less marked result.

About a quarter of an hour after the blood-letting the action of the heart was barely audible, beating

80 times in a minute. It refused milk. At eleven o'clock, p. m., four hours after the blood-letting, it still refused milk.

At nine o'clock on the following morning it took a little milk, and then a little bread, and again a little milk; but it lay still and spiritless. At noon it took a little bread and drank milk more readily. At five o'clock, p. m., it was lively and leaped on seeing the milk and bread, which it took with avidity, and afterwards gnawed a bone.

At seven o'clock, p. m., the pulse being 140, the sounds of the heart loud and clear, the temperature between the lips and teeth and under the tongue, 98° Fahr., the ears warm, and the tongue rather furred and white, this dog was again bled to incipient syncope. Eight ounces of blood were drawn.

The animal soon opened its mouth, panted and sighed; the eye became dull and the eye-lids drooped. The respiration then became noisy in the nostrils, irregular, laboured, and performed principally by the diaphragm. The beat of the heart was imperceptible to the ear applied to the chest; that of the femoral artery 98. The fæces were discharged. The pupils were dilated and incontractile, the walk feeble and staggering.

There was less appearance of fainting, but more of

debility than the day before ; the ears became slowly cool ; the tunica conjunctiva was blanched ; milk was refused.

At half past eight o'clock, one hour and a half after the detraction of blood, the dog still refused milk, and seemed feeble and spiritless. Its ears were cool. In three hours more the same observations were made ; it breathed twenty-two times in a minute, and the pulse was 132.

On the succeeding morning, Nov. 4th, at nine o'clock, this dog still refused milk, which he lapped once only ; there was a little moaning. The pulse was 144 ; the respiration 24 ; the temperature far back between the cheek and gums, 100° Fahr. ; the tongue was whitish and furred. At five o'clock it lapped milk and took a little bread ; the pulse was 132.

At seven o'clock, p. m., the pulse was 130, the respiration 24, the temperature 99° Fahr., the ears cool. The external jugular was again opened ; eight ounces of blood flowed, which was thin ; it separated afterwards into equal parts of serum and crassamentum.

During the flow of the blood the respiration became sighing and panting, the head drooping, the mouth open, the eye-lids partially closed ; the animal then lay down, resting its head on the table, and assuming the posture on the side. Soon after the abstraction of

blood it evacuated the fæces, and in ten minutes more, the urine. The pupils were dilated; the pulse sank to 93, the temperature to 94° Fahr.; the respiration was first quick for three times and then followed by a full inspiration, and this by a full expiration; completed by a strong action of the abdominal muscles. The heart before the blood-letting beat loudly and clearly,—afterwards feebly; in half an hour, again loudly.

At one o'clock, a. m., the dog refused milk, and bread thickly buttered, and appeared dull. The temperature was 85° Fahr., the pulse 120, the respiration 24, and slightly snoring. The ears were cool; the bowels very relaxed.

At nine o'clock, a. m., of Nov. 5th, this dog was found dead, the limbs having been obviously drawn by convulsive action.

The cavities and viscera were examined at eight o'clock, p. m. The brain was absolutely blanched, the longitudinal sinus empty, the ventricles free from effusion. The lungs were blanched and free from oedema; a little mucus was observed in the bronchia.

The right side of the heart, the large veins, and the vena portæ were all distended with dark-coloured blood; the left side of the heart contained a little florid blood. The stomach and intestines were blanched.

This dog lost 32 ounces of blood; viz. 16, 8, and 8 ounces on successive days.

Even after the last blood-letting there were no phenomena to lead to the idea that the animal would not recover. We were therefore forcibly struck with the difficulty of judging of the degree of danger in cases of loss of blood.

EXPERIMENT II.

Nov. 6th, 1830. The subject of this experiment was a terrier, two years old, 16 pounds in weight, thin and lively, its pulse 120, respiration 30, and temperature 99° Fahr.

Eleven ounces of blood were drawn from the external jugular vein. During its flow the eyes became dull and partially closed; the dog slowly sank upon its chest and looked sluggish and drowsy; it staggered on attempting to walk and stood wide; it refused milk. There was no further approximation to syncope. These symptoms were mild and supervened tardily. We bled it cautiously, having lost the former dog somewhat unexpectedly.

On the following morning this dog remained dull. We did not, therefore, venture to bleed it.

On the succeeding morning (Nov. the 8th) it became lively, and in the evening presented the following phe-

nomena: the pulse was 160, the respiration 30, the temperature 101° Fahr.: the beat of the heart was attended with a whizzing noise.

The external jugular vein was now opened, and five ounces and a half of blood were withdrawn. This afterwards separated into three ounces of serum, and two ounces and a half of crassamentum. It gushed out at first. In half a minute the dog drooped, closed the eye-lids, hung down the head, sank upon his chest, and lay passive, and sighed. There was no sickness. The pulse fell to 108, the respiration to 20, the temperature to 98½° Fahr.: the beat of the heart could not be felt. In two minutes the pulse rose to 116, the respiration to 22. The impression made by the abstraction of blood on this day, was much greater than on the day before, though the quantity taken was but one half.

At half past eleven, p. m., the respiration was 22, the pulse 128, the temperature 98° Fahr. The heart and arteries had a throbbing beat. The dog would scarcely lap milk, and it refused bread.

At ten o'clock, a. m., Nov. 9th, the temperature was still 98° Fahr. the respiration 22, and the pulse 140.

At seven o'clock, p. m., the pulse had risen to 160, it indeed varied from 160 to 180; it was accelerated by the slightest excitement. The beat of the heart

was a throb, accompanied by a whizzing sound. The arteries partook of the same throbbing character ; the pulse was felt in many branches, as the maxillary and labial, in which it cannot be perceived under ordinary circumstances ; the carotid and femoral arteries throbbed exceedingly ; and if the head were held between the two hands a general beat and throb were communicated to them.

The effect of a varied position in suspending or renewing the beat of the heart in a state approaching to syncope having been ascertained in intermediate experiments, the dog was now suspended by the fore feet, the head being kept upright ; the beat of the heart continued, however, as before : it was then suspended by the hinder feet, the head hanging down ; but no difference in the action of the heart was discernible. The beat of the heart in the case of reaction appears, therefore, to be uninfluenced by position.

On the succeeding day, Nov. 10th, at eight o'clock, p. m., the phenomena were the same. The temperature was 101° Fahr. We still postponed, until another day, the abstraction of blood.

On Nov. 11th, at seven, p. m., the pulse and the beat of the heart were nearly the same as the two days before. The heart beat 144 times in a minute, with throbbing, and the same "bruit de lime." The temperature was 100½° Fahr. The sound of the heart was examined in the upright and reversed, per-

pendicular, positions; and little difference was observed.

The external jugular was now opened; the blood flowed well in a small stream; it was allowed to flow until the dog drew a sigh; the vein was then immediately closed. The quantity was found to be nearly three ounces and a quarter, of which one ounce and three-quarters, after twenty-four hours, were serum, and one ounce and three-eighths crassamentum.

After the blood-letting the pulse varied from 96 to 108; the temperature became 99° Fahr.; the respiration about 28, but various; the whizzing sound of the heart was lost. In twenty minutes the pulse rose to 160 and the whizzing sound of the heart became as loud as ever.

At this moment the influence of the upright and inverted positions, was again tried; in the former, the sound of the heart became very feeble, with other symptoms of syncope; in the latter, it was immediately restored, but it shortly afterwards again became feeble, apparently from fatigue, or the impeded state of respiration. These phenomena were by no means so marked as in other experiments, in which a state of more perfect syncope was induced. It was, however, perfectly obvious.

The animal being laid on the table, its eyes were ob-

served to be bright, the pupils contractile. The animal appeared subdued, and the head drooped. The ears were cold. The temperature 98° Fahr. The respiration occasionally sighing. Relaxation of the sphincter ani, with escape of flatus.

By this detraction of blood the previous reaction was merely subdued, without any appearance of syncope, except when the animal was suspended by the fore feet. The reaction speedily returned, and the throb in the heart and arteries became very remarkable.

Nov. 12th. The dog has been very lively and does not appear in the least indisposed. The pulse is from 150 to 160; the temperature 99° Fahr. The action of the arteries is even still more throbbing, and the whizzing noise in that of the heart, if possible, more marked. The ears and feet are cool. The appetite good. Indeed there is no morbid phenomenon except the throb of the heart and arteries.

Nov. 13th. The pulse is 132, the respiration 32, the temperature 100° Fahr.; the tips of the ears rather cool. The pulse has rather less throb; the whizzing sound of the heart is as distinct as ever, but the impulse less.

Four ounces and three-quarters of blood were drawn from the external jugular vein, which again separated, in 24 hours, into three ounces and a

quarter of serum, and one ounce and a half of crassamentum. The dog sank down. The heart lost its whizzing sound; and the first and second sounds became distinct. The pulse fell to 108; the respiration was 24, the temperature $99\frac{1}{2}^{\circ}$ Fahr. He was languid and subdued, and refused meat.

At eleven o'clock, p. m., he was again quite lively; he took meat and milk, and did not refuse bread soaked in milk. The respiration was 28, the pulse 150, the temperature 96° Fahr.

• On Nov. 14th, at seven o'clock, p. m., the pulse was 152, the respiration 30, the temperature 100° Fahr.; he was quite lively and had taken food eagerly. He was therefore again bled to four ounces, which separated into two ounces and three-quarters of serum, and one ounce and a quarter of crassamentum. He panted, sighed, sank down, and lay listless with the eyes half closed. The respiration was 26, the pulse 108, the sounds of the heart very feeble.—In five minutes he rallied and took meat with avidity.

On Nov. 15th, at seven o'clock, p. m., the pulse was 160 and thrilling, the sawing sound of the heart unabated, the respiration 24, the temperature 99° Fahr. Four ounces and a quarter of blood were drawn; it separated into three ounces of serum, and one ounce and a quarter of crassamentum.

The respiration became 28, the pulse was slow but grew gradually quicker, and the sawing sound of the heart, which had disappeared, gradually returned. It took meat.

In this experiment the dog sighed and sank promptly, but the other signs of syncope were less marked even than in the former blood-lettings.

On Nov. 16th, at seven, p. m., the pulse varied from 152 to 160 and 168; the respiration from 24 to 28; the temperature was 99° Fahr.; the tips of the ears were cool, the beat of the heart had the "bruit de scie," and that of the artery its thrill. Two ounces and three-quarters of blood were taken away which separated into two ounces and three-quarters of serum, and one ounce of crassamentum.

In five minutes the animal was lively and took meat eagerly. The pulse was 156, the respiration 30, and the temperature 99° Fahr. On weighing him, he had actually gained half a pound!

On Nov. 17th, at seven o'clock, p. m., the pulse was 158, the respiration 24, the temperature 99° Fahr.; the "bruit" of the heart was the same, the ears were cool. Blood was taken until he sighed thrice. It was found that three ounces and a quarter had flowed, and this separated into two ounces and a quarter of serum, and one ounce of crassamentum.

The pulse fell to 100, the respiration to 20, and the temperature to 96° Fahr. ; the "bruit" continued. At ten o'clock, p. m., the pulse was extremely frequent, the animal more subdued than before ; he took food, but less greedily than usual.

On Nov. 18th, at seven, p. m., the pulse was 160, and jerking, the respiration 24, the temperature 99° Fahr. ; the sound of the heart as before, the dog more languid and dull. Two ounces and a half of blood were taken ; it separated into one ounce and three-quarters of serum, and three-quarters of an ounce of crassamentum.

The dog drooped, and sank down without sighing. It remained still and prone for some time. The pulse was 132 ; the sound of the heart was weaker.

On the 19th it appeared more subdued than usual ; the pulse was 168, the sound of the heart continued, the respiration was 24, the temperature 99° Fahr. It lost two ounces one dram and a half of blood, which separated into one ounce five drams and a half of serum, and half a dram of crassamentum.

It sighed and the respiration became slightly laborious, the pulse 132 and feeble, the temperature 98° Fahr., the respiration 20 and deeper, the "bruit" continued.

On weighing the dog to-day, it was found to

have lost, since the 16th, two pounds. The signs of reaction were less marked, and there was a state more bordering on sinking.

On Nov. 20th, the pulse was nearly 180, and thrilling; the sound of the heart still more remarkable than before; the respiration twenty-two, the temperature $99\frac{1}{2}^{\circ}$ Fahr.; the carotids were felt to beat. The head drooped; there was an unwillingness to sit up or move. The tunicae conjunctivæ were observed to be a little inflamed. The appetite good.

The animal was now bled to six ounces and three-quarters, of which four ounces and five drams were serum, and two ounces and one dram were firm crassamentum without buff.

The pulse became fuller during the flow of the blood, and the animal sighed. Shortly afterwards the pulse was counted and found to be 120 in a minute; the respiration was 22, deep and diaphragmatic, the temperature 96° . The palpebræ were partially closed, the pupils unusually contracted.

At midnight, five hours after the blood-letting, the pulse had risen in number, and varied between the rates of 160 and 216 in different twelfth parts of a minute; the respiration was 22, deep and regular; the temperature 96° Fahr. The eyes were plainly intolerant of light, the pupils much contracted; a

film of mucus was spread over the corneæ, especially the right one, which was a little cloudy. The pulse had still a remarkable thrill or throb; the heart its 'bruissement'; the head itself seemed moved by the pulsation. A little nice meat was taken; but what had been taken eagerly enough before was now refused. There was a little tottering in walking. The hair had started and appeared shaggy and rough, especially on the forehead.

In the morning of the 21st, this dog remained dull and in his corner. The eyes were generally closed; when opened the cornea was observed to be slightly opake, and covered with mucus, especially that of the right eye; the pupils were contracted, and the eyes turned from the light.

The pulse was 180, the respiration 24, the temperature 98°; the end of the nose warm and dry. The animal was feeble and emaciated; he took nice mutton, but reluctantly. In the evening he was weighed and found to have lost ten ounces. We did not venture to take blood. It appeared plain that symptoms of sinking, the state we wished now to watch, were coming on.

On Nov. 22nd, at seven o'clock, p. m., the pulse was 190, the respiration 24, the temperature 99°; the right cornea was still more cloudy.

The animal was bled to six ounces five drams,

of which four ounces and a half were serum, and two ounces and one dram crassamentum, firm but free from buff. During the flow of the blood the symptoms were but the same as on the previous occasions of blood-letting. The pulse sank to 128; the respiration became deep and sighing, and remained at 24; the temperature sank to 96° Fahr.

The animal now lay subdued and prostrate. The beat of the heart was visible. There was no relaxation of the bowels nor sickness. Shortly, however, the bowels were evacuated and the respiration became laboured, and it was doubtful whether he would recover.

From this time he sank,—with the following phenomena in the order in which they are detailed. The under lip fell; there was a peculiar moan; the angle of the mouth was convulsed; one leg was convulsively drawn; it was difficult to separate the teeth; and there was stiffness of the limbs. The respiration became deeper and more laborious, inspiration being performed by a strong contraction of the diaphragm and expiration by that of the abdominal muscles; the respiration then became gasping, and the gasps occurred at longer and longer intervals. There was once a loud whine. At another time the dog lay still and as if dozing. The expired air was cold. There was no sickness. The rectum was evacuated.

At length, after a few more gasps at distant in-

tervals, the respiration ceased. Still the heart could be heard beating with varying frequency for many minutes, so that all the three gentlemen present were severally satisfied on this point more than once.

We immediately proceeded to the examination. The brain was, in its external appearance, blanched, but not so much so as in the subject of Experiment the VIth. Fluid was found effused rather abundantly between the dura and pia mater and into the ventricles. The longitudinal sinus contained a little blood, and the choroid plexus and other vessels displayed a degree of colour from florid blood. The substance of the brain was pale and entirely free from red points in the parts divided by the scalpel.

The right ventricle of the heart was full of venous-coloured blood; the left ventricle was perfectly empty. The aorta contained plenty of blood. The lungs were extremely pale. A little fluid exuded apparently from the air passages, on making incisions through their substance. The stomach and intestines were pale; the mesentery was crossed by vessels of a florid colour. The spleen was small, compact, and paler than natural. The cornea of the right eye rather opaque; the conjunctiva entire.

This little dog lost in all $56\frac{3}{4}$ oz. of blood: on Nov. the 6th, 11 oz.; 8th, $5\frac{1}{2}$ oz.; 11th, $3\frac{1}{4}$ oz.; 13th, $4\frac{3}{4}$ oz.; 14th, 4 oz.; 15th, $4\frac{1}{4}$ oz.; 16th, $2\frac{3}{4}$ oz.; 17th, $3\frac{1}{4}$ oz.; 18th, $2\frac{1}{2}$ oz.; 19th, $2\frac{1}{4}$ oz.; 20th, $6\frac{3}{4}$ oz.; and the 22nd, $6\frac{1}{2}$ oz.

We were all again impressed by this experiment, with the extreme difficulty of judging with accuracy of the quantity of blood which we may safely withdraw, unless we have some criterion which we did not possess in this instance. Such a criterion is afforded us in the human subject and even in the horse, by the influence of posture in denoting the effects of loss of blood. Dogs always sink down, and their position, therefore, becomes nearly horizontal; otherwise earlier syncope would have warned us to take less blood. The horse, on the contrary, retains his posture, with his head raised, and that of the human subject may be controlled, so that we have a guide in such cases which we had not in this.

As in the first experiment we had the marked symptoms of syncope, so in this we had those of reaction and of the act of dying. It still remained for us to watch the symptoms of the slow failure of the powers of life. It will be seen that we again and again failed in our object of inducing this condition. But the experiments afford additional confirmation of some of the phenomena we had witnessed before, and some additional observations.

EXPERIMENT III.

Nov. 9th, 1830. A mongrel dog, weighing seventeen pounds, aged two years, fat and of a dull and heavy disposition; was bled from the external jugular vein. Eight ounces of blood flowed, and he began to sigh; he looked subdued, the eyes were half-closed,

he sank upon his chest, and the respiration became accelerated and laboured.

At this moment he was suspended by the fore legs, the head being raised. He began to pant in two minutes, opening the mouth and half-closing the eyes; the pupils dilated, and the head fell. The ear was then applied over the heart, the beat of which could not be perceived. The position was then reversed, and he was suspended by the hinder legs. The beat of the heart became instantly distinct, and the signs of syncope disappeared.

This change of position was repeated twice, with the same results, but in a less and less marked form. During the second and third accessions of syncope, the beat of the heart could still be perceived; but the change, on reversing the position, was still very marked.

After the experiment, this dog remained dull and languid, and could scarcely be coaxed to take bread soaked in milk.

On the succeeding day this dog was again bled to incipient syncope. Ten ounces of blood were drawn. He sighed as the blood flowed, drooped his head, and sank on the chest, and the respiration became laborious.

On being held erect, suspended by the fore legs,

he panted and laboured in breathing, the eyes were moved convulsively, the mouth opened, and the lips fell; the beat of the heart was perceptible. On being suspended by the hinder legs, he scarcely revived, but the beats of the heart became distinct; they, however, remained feeble, unequal, and intermittent. It became plain that it would not recover.

Being laid on the table, the limbs and trunk were convulsed; the respiration became gasping; the beat of the heart continued quite perceptible to the ear for several minutes after the last act of respiration.

On inspection the brain was found perfectly natural, neither blanched nor suffused; the ventricles free from effusion. The right side of the heart contained abundance of dark-coloured blood; the left side was perfectly empty, not containing even a drop. The lungs, and the stomach and intestines, were by no means remarkably blanched. The examination was made immediately after death.

This dog lost eighteen ounces of blood, eight on the 9th, and ten on the 10th day of November. It presented the important phenomenon of dissolution, induced by mere position!

EXPERIMENT IV.

Nov. 13th, 1830. A mongrel dog, aged one year

and a half, well fed, strong and lively, weighing twenty pounds, was bled until he began to sigh. Ten ounces and a half of blood were drawn, which separated, in twenty-four hours, into four ounces of serum, and six ounces and a half of crassamentum.

Before the blood-letting, the respiration was 23, the pulse from 116 to 120, the temperature 100.

During the flow of the blood, he first sighed, and then turned restless. The respiration then became quicker, with a little noise in the nostrils, and there were increased restlessness, struggles, a little whining, and a relaxed state of the sphincter ani, and discharge of flatus and fæces. The pulse was 120, the breathing 46, and the temperature 94° Fahr., and he refused meat.

At eleven o'clock, p. m., four hours after the abstraction of blood, this dog appeared quite well.

On the succeeding day, Nov. 14th, at seven o'clock, p. m., he was again bled to nine ounces, of which, after twenty hours, four were serum, and five crassamentum.

During the flow of the blood, he sighed and struggled, as on the day before. Afterwards he drooped, sank down, panted, and refused meat. At night he appeared quite recovered.

Nov. 15th, seven o'clock, p. m., this dog has been lively, and eager for food all the day. The pulse is now 156, the temperature 98° Fahr.

He was bled again to nine ounces, which separated into five ounces of milky serum, and four of crassamentum.

During the flow of blood he began to whine and struggle, sank, sighed, and panted. Afterwards, he lay prostrate, evacuated the rectum, refused meat; the heart beat with the "sawing" sound. In ten minutes more he appeared to have sunk rather than to have rallied; he suddenly became affected with opisthotonic spasm of the neck, and spasm of the fore legs, and appeared dying. A little alcohol and water was given. Shortly afterwards, he began to moan, then to whine, and then to bark, and then he became sick, vomited, and seemed relieved. This was repeated in half an hour, and he again appeared easier, having vomited some portions of bone.

From this time he was obviously sinking. At length the respiration ceased; but the pulsation of the heart was seen between the ribs, and felt and heard on applying the ear, and the pulse was perceptible in the femoral artery for several minutes.

The viscera were immediately examined. The brain was a little paler than natural. Many blood-vessels

were seen containing a florid blood. The longitudinal sinus was nearly empty, the plexus choroides a little faded, the ventricles without effusion.

The right side of the heart contained a little blood ; the left, abundance. The lungs were perfectly natural. The stomach and bowels rather pale, much filled with food. There was a good deal of fat.

This dog lost twenty-eight ounces and a half of blood ; ten ounces and a half on the first day, nine on the second, and nine on the third. The proportions of serum and crassamentum were 4 : 6 $\frac{1}{2}$; 4 : 5 ; and 5 : 4, respectively.

EXPERIMENT V. Nov. 24th, 1830.

DATE.	OUNCES.	SERUM.	CRASSAMENTUM.
Nov. 24	12 $\frac{1}{2}$	4 $\frac{1}{2}$	8
26	7 $\frac{1}{4}$	3 $\frac{3}{4}$	3 $\frac{1}{2}$
27	9 $\frac{1}{2}$	5 $\frac{1}{4}$	4 $\frac{1}{4}$
	<hr/> 29 $\frac{1}{4}$		

This experiment was performed on a slim spaniel, about fifteen months old, nineteen pounds in weight ; the temperature 99 $\frac{1}{2}$ ° Fahr. Twelve ounces and a half of blood were taken slowly, and separated in twenty-four hours into four ounces and a half of serum, and eight ounces of crassamentum. The dog sank down and panted.

Being suspended by the fore legs, with the head

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erect, the beat of the heart became inaudible, with panting; on inverting his position, the sounds of the heart became accurately distinct, and the panting ceased.

On Nov. the 26th, the pulse was 120, the temperature 99° Fahr. Seven ounces and a quarter of blood were taken, which separated into three ounces and three quarters of serum, and three ounces and a half of crassamentum. The respiration became accelerated and sighing, and performed chiefly by the diaphragm. The animal was restless. The pulse sank to 96 and then rose to 88. The blood flowing freely, the symptoms of syncope were more manifest than on the 24th.

On the next day, Nov. 27th, the pulse was 150 and a little throbbing; the impulse of the heart considerable and the sound loud; the temperature 99½°.

Nine ounces and a half of blood were taken, which separated into five ounces and a quarter of serum, and four ounces and a quarter of crassamentum.

The animal first sank; then the respiration was observed to be accelerated, but it was not audible in the nostrils. The pulse fell to 88, and shortly afterwards to 72. There was then a degree of sighing but no deep sigh.

The pulse in a little time rose to 80 and had a slightly throbbing beat. The action of the heart was loud and with a considerable impulse. The respiration remained sighing or deep. The animal lay subdued, voided the bladder but not the rectum, and refused nice meat.

After this the limbs became cold. A cup of hot milk was poured down the throat and retained on the stomach. The extremities and the body were rubbed.

At eleven o'clock, p. m., three hours after the blood-letting, this dog remained in a state of extreme languor, and the ears and feet were very cold. The pulse was 144, and as well as the beat of the heart, slightly throbbing. The respirations were from 12 to 14, and deep, and loud to the ear applied to the chest. The temperature far back between the lips and gums was 87°, and in the axilla 89°. He staggered excessively and could scarcely guide or sustain himself when made to walk.

Two tea-cupsful of hot broth were given and retained; he was rubbed well for an hour, until the ears and feet were quite warm; he was then laid before a moderately warm fire upon a warm rug.

When left at one o'clock, a. m., the pulse was rather less frequent; its beat and that of the heart, not without strength; the respiration was deep,

thoracic, regular, and without much labour, and loud to the ear applied to the thorax,—very different from that of syncope mild or severe. The eye was bright. He once or twice raised his head. In the morning this dog was found dead.

Examination.—The brain was perfectly blanched. Not a vestige of fluid was found either between the membranes or in the ventricles. A very few large vessels were seen containing blood. The plexus choroides was pale. The tuber annulare alone manifested a few red dots on being divided.

The left side of the heart contained much blood; the right, a little. On cutting and pressing the lungs, a little frothy mucus exuded from the divided bronchia in several parts. The stomach and bowels were blanched. The spleen was small and dense.

EXPERIMENT VI.

The subject of this experiment was a black terrier, aged about 18 months; two and a half pounds in weight; the temperature between the gums and back teeth $99\frac{1}{2}^{\circ}$ Fahr. The quantities of blood taken, and of the serum and crassamentum into which it afterwards separated, are shewn in the following table:

DATE.	BLOOD.		SERUM.		CRASSAMENTUM.	
	OZ.	DR.	OZ.	DR.	OZ.	DR.
Nov. 23	11	0	4	4	6	4
24	3	6	2	0	1	6
29	8	3	4	5	3	6
Dec. 2	5	2	3	0	2	2
4	4	3	2	4	1	7
6	5	1	3	2	1	7
8	4	2	2	4	1	6
9	5	5	3	3	2	2
11	6	1	4	0	2	1
15	6	2	4	1	2	1
18	9	5	7	0	2	5
Days 26	69	6				

The effects of the various blood-lettings were so similar to those observed in the experiments already detailed that I purposely avoid making any distinct report of them until Dec. the 4th. On this day it was reported, before the blood-letting, that the cornea of the left eye was opaque and the conjunctiva vascular, with an increased secretion of mucus; the pulse was 132, and throbbing, the heart throbbing with considerable 'bruissement' on applying the ear: immediately after the blood-letting the pulse rose to 180, and from throbbing became small; the beat of the heart lost its throb and its 'bruissement' whilst its two sounds were heard *distinctly*; the respirations were sixteen in a minute, and deep, but without labour, and there were one or two sighs; the animal walked pretty well, then lay down and refused meat; in a very short time he raised his head and took food, and the heart was found to have regained its 'bruit.'

It was thought proper to keep the animal, at this

moment, in the perfectly erect position : the beat of the heart became feeble, and still more frequent, and again lost its 'bruit'; but it remained distinct; there was no panting.

On Dec. the 12th, the pulse varied from 160 to 180; the respiration was deep and sighing; the temperature 96° Fahr.

On the morning of Dec. the 13th, the pulse was 132 and small; the respiration deep, sighing, and frequent, considering its character, that is varying from 20 to 24, and audible in the nostrils. At eight o'clock, p. m., the pulse was 160 and larger; the temperature 99° Fahr. At midnight, the pulse was 150 without throb; the respiration 18, very deep, loud to the ear applied to the chest, and in the nostrils during expiration; the beat of the heart was without 'bruit,' without throb, and heard only in the cardiac region, not diffusely over the chest as in circumstances of reaction; the end of the nose was dry and warm, the ears cool; yet the eye was bright, and the appetite good.

On the 15th, the pulse was 156 and had recovered its throb; the heart was heard extensively over the chest, with much 'bruit'; the carotid was *seen* beating in the neck, the respiration was 20 and had lost its deep and sighing character; the temperature was 98½° Fahr. The animal was quite lively. The eye recovered.

After the blood-letting on the 15th, the pulse im-

mediately rose to 192; the flow of blood was immediately arrested on observing one sigh; the pulse and heart retained their throb; the appetite remained, and there was neither drooping nor lassitude.

On the 16th, the heart was heard to beat with 'bruit,' and extensively over the chest, the pulse was 132; the emaciation extreme, the weight eleven pounds and a half. After blood-letting to nine ounces and five drams on the 18th, the pulse was 168, and there was great prostration of the strength and of the appetite.

I watched the animal until one o'clock in the morning. It did not lie prostrate; but its breathing had the peculiar deep and sighing character observed on the 13th, being loud to the ear, and in the nostrils, with a very slight degree of moaning; the beat of the heart was 144 and without throb, and confined to its own region. The ears and mouth were cold; the nose dry; there was a spasmodic movement of the ears and of one leg. Nothing could induce the animal to take food; but a little water, and warm broth, were poured down the throat.

At this period I supported it in the erect position. Little change was observed. Its heart beat as before. In about ten minutes, however, it began to suffer from fatigue and I laid it down on soft hay. The pulse sank from 120 to 108, and it did not recover its former frequency or beat. Having covered it with

flannel, I left it for the night. In the morning it was found dead.

On examination, the brain was blanched, but there was no effusion, a few red points were seen on the divided surfaces. The tips of the lungs were slightly emphysematous, and in one place solid and apparently hepatized. Much fluid issued on making a few incisions; and the bronchia were found, on a careful examination, to contain much frothy fluid. The stomach and bowels were pale; not distended. The spleen was small.

EXPERIMENT VII.

This experiment was performed upon a white terrier, 15 months old, and ten pounds and a half in weight; its temperature was $99\frac{1}{2}^{\circ}$ Fahr. The quantities of blood taken are given in the following table:

DATE.	BLOOD.		SERUM.		CRASSAMENTUM.	
	OZ.	DR.	OZ.	DR.	OZ.	DR.
Nov. 30	5	4	1	5	3	7
Dec. 1	7	2	2	2	5	0
3	3	3	2	1	1	2
4	2	4	1	6	0	6
6	3	2	1	6	1	4
8	3	0*				
9	4	4	2	4	2	0
11	3	4	2	0	1	4
15	5	4	3	0	2	4
16	5	0	3	4	1	4
18	4	6	2	1	2	5
<hr/>						
Days 19	48		1			

* This blood was sent undisturbed to Dr. Prout for his examination. See p. 265.

Nothing remarkable was observed in this animal until Dec. 4th, when the symptoms of reaction were fully established: the pulse was 160 and throbbing; the heart beat with impulse and 'bruit' extensively over the chest; the eyes were bright: during the flow of the blood the respiration was first sighing and then diaphragmatic, and the heart lost its impulse, 'bruit', and diffused beat; the eyes became languid; he, however, took food.

On the 10th the pulse was 180, and the 'bruit' quite extraordinary: after the blood-letting the pulse was 144, and a little later 120, and there was sighing and panting.

On the 11th the pulse was again 180, the temperature 100° Fahr. and the 'bruit' as on the previous day. The coagulum was, for the first time in these experiments, observed to be covered with a thin layer of buff, which extended down its sides, so as to encircle it.

At midnight, on the 13th, the pulse was 150, with scarcely any throb in its beat; the respiration was 18, deep, sighing, loud to the ear, inaudible in the nostrils, and slightly moaning; the beat of the heart, from being diffused, became confined to the cardiac region, without throb, but with 'bruit'; the end of the nose was dry and warm, the ears slightly cool; the animal appeared dull and languid, and sought re-

pose, but its eye was bright, and its appetite for food remained.

On Dec. the 15th, the recovery was complete, the pulse was 160 and throbbing, the heart beat with much 'bruit' and impulse, extensively over the chest, the throb of the carotid was *visible* in the neck; the respiration was 24, expiration loud; the temperature 100° Fahr.; the dog was lively, the eye bright, the nose damp and cool, the appetite good; the ears were cool, the hair stood on end, and the emaciation was extreme. After the blood-letting, the pulse was only 144, there was slight sighing, but food was not refused.

On the 16th the pulse sank from the loss of blood, from 172 to 144, the respirations from 24 to 12, assuming the sighing character. The weight was nine pounds and a half.

On the 18th, the pulse before the blood-letting was 180, after it 128; the respiration sank from 18 to 12, and was full and slow.

At midnight the dog still refused food; the pulse was 144 and small; the beat of the heart neither throbbing nor diffused; the respiration was deep, loud to the ear, heard in the nostrils, and attended by slight moaning; the ears and internal mouth were cold; the animal supported itself in the position on the belly. In the morning it was found dead.

On examination the brain was found blanched, without red points, and without effusion. The lungs were slightly, yet distinctly, emphysematous, and on making free incisions, a little serum exuded; the tip of one lobe was hepatized; the bronchia contained much frothy mucus. The stomach and bowels were pale but not distended. The spleen small.

There still remains an important part of this inquiry. It is that of establishing a comparison between the effects of loss of blood in the adult and the young animal. I have already made several experiments, and hope, on some future day, to present the results to the Society. They will be of the utmost importance in guiding us in the use of blood-letting in infancy.