presented by each case and the effect desired, rather than that a stated amount should be administered in the usual dogmatic way. In view of the augmented action of morphine in the presence of ether or chloroform, satisfactory effects are usually produced by the exhibition of much smaller doses than those commonly employed, and it will be found that from gr. $\frac{1}{10}$ to gr. $\frac{1}{6}$ is usually sufficient. Chloral has also been used before anæsthesia on the same principle as that governing the use of morphine, but the results have not been favorable; danger of collapse being rather increased in the case of chloroform and the after-effects being exaggerated in the case of ether. Other hypnotics have been tried in this way with some success, but the results have not been pronounced enough to lead to their general adoption.

The administration of oxygen during anæsthesia has received much attention, especially its use in conjunction with nitrous oxide, the administration of which in a pure state is complicated by asphyxia resulting from deprivation of oxygen. The investigations of Bert, Hellischer, Hewitt, and others have demonstrated that this asphyxia may be eliminated by combining oxygen with nitrous oxide, without interfering with the production of narcosis. In 1878 Bert produced perfect and long-continued anæsthesia in dogs with a mixture of about eighty three per cent. nitrous oxide and seventeen per cent. oxygen administered under an atmospheric pressure increased by one fifth. The year following, the method was successfully employed in human subjects and attracted much attention. Bert later succeeded in narcotizing animals with gas and oxygen at the normal atmospheric pressure. Hillischer made use of the combination with great success in over fifteen thousand dental cases. Hewitt has made a particular study of this subject, and has demonstrated that although no definite mixture of these gases will produce anæsthesia without asphyxia in all cases, one containing ten or twelve and one-half per cent. of oxygen proved quite satisfactory in average cases. The best results, however, were obtained by using a regulating apparatus by means of which the gases could be administered in proportions to suit the case in hand and the conditions as they arose during the narcosis. Oxygen has been recommended in conjunction with ether and chloroform by numerous observers (Neudorfer, Foy, Kreutzmann, Northrop, Cole, Buxton, and others), and while it is probable that oxygen is not an antidote to these agents and will not prevent their fatal effects when administered in an overdose, there is no doubt that its use will obviate the asphyxia which frequently complicates their administration, thereby removing an unpleasant and occasionally dangerous element of the narcosis.

Experience has demonstrated that chloroform and ether may be administered in such a manner that the patient does not suffer from lack of oxygen, and it is therefore evident that the routine use of this agent during anæsthesia is uncalled for. Buxton calls attention to a possible danger in its use as follows: "The supply of oxygen keeps the patient of a cherry-red color, and chloroform is pumped on until the respirations stop through poisoning of the medulla. No peripheral duskiness or gradual failure of respiration appears, as the tissues remain red until circulation and respiration cease." It has been suggested that a small proportion of amyl nitrite added to chloroform might offset the dangerous effects of the latter, and this combination has been highly spoken of by Sanford, Balliet, Sir B. W. Richardson, and others. The anæsthesia is said to be characterized by greater circulatory stimulation than when chloroform is used alone. Sanford employed a mixture of two drachms of amyl nitrite to a pound of chloroform, Balliet a mixture containing sixteen drops to the ounce.

In view of the physiological action of amyl nitrite, it would seem that while its use in this way with chloroform might be very satisfactory for brief administrations, the powerful primary stimulation of the former counteracting the not infrequent primary depression of the latter, its prolonged use would be hazardous on account of its later paralyzing action on the vessel walls and its depressing effect upon the heart.

Physiological Action.—Before taking up the action of anæsthetics in the production of narcosis, it may be of interest and significance to consider other instances of their power. The luminous oxidation of phosphorus in air is suspended in an atmosphere slightly impregnated with chloroform or ether, and in like manner the flame of a candle may be extinguished by the addition of chloroform vapor to the surrounding air. In the presence of anæsthetic substances fermentation does not occur, certain chemical reactions are prevented, movement of the leaves and respiration in plants are arrested, and the germination of seeds and the hatching of eggs are checked. These effects are transient if the exposure has not been too long continued or the strength of the vapor too great. In the latter event the life of organic matter of any kind may be destroyed.

The effect of anæsthetics upon isolated tissues of the animal economy demonstrates that they have the power of arresting the functional activity of all its parts. The nature of this action is not clearly understood, but it apparently consists in paralysis or immobilization of the ultimate cellular elements. Claude Bernard demonstrated that the posterior extremities of the frog can be completely paralyzed by their immersion in a weak chloroform solution, and that if means are employed to exclude these parts from the general circulation the anterior portions of the body remain unaffected. Experiments by Simpson, Nunnely, and others on earthworms, leeches, centipedes, rabbits, and other animals prove that entire members or segments of their bodies may be completely anæsthetized apart from the remainder. Gaskell and Shore produced fatal cessation of respiration by the application of a small amount of chloroform to the fourth ventricle. Waller's experiments relative to the action of anæsthetics on nerves are of great interest. Isolated nerves were exposed, in a moist chamber, to intermittent electrical excitation, the responses being recorded by the galvanometer. Under normal conditions the nerves responded with remarkable regularity and endurance, but when exposed to anæsthetic vapors of various strengths the responses to excitation failed more or less completely. The nerves were now said to be "anæsthetized or temporarily immobilized." After brief exposure to air their electromobility was restored, unless the strength of the vapor had been too great, in which event there was no recovery, the nerve being "permanently immobilized or killed."

Coats has demonstrated that "the heart of the frog is very sensitive to chloroform vapor. When the heart is exposed, under a bell jar, to air charged with chloroform, the heart became rapidly weaker, till it ceased beating; to recover when the chloroform atmosphere was removed. In this respect chloroform contrasted with ether."

The inhalation of anæsthetic vapors brings them in intimate contact with the blood through the enormous surface of the pulmonary air cells. Here they are absorbed by the liquor sanguinis and by the blood corpuscles, and are carried to every part of the body, affecting each in proportion to its susceptibility or to its special affinity for these substances. While it is thus evident that all of the tissues must be influenced to some extent, the phenomena of anæsthesia, as induced by inhalation, are due almost entirely to the action of the narcotic upon the nervous system, which exhibits striking susceptibility to the action of all of this class of drugs. This susceptibility is no doubt to be explained by the selective action of anæsthetics upon the tissues of the nervous system according to the principle of a chemical affinity between certain drugs and certain organs, as pointed out by Ehrlich and confirmed in the present instance by the observations of Lallemand, Perrin, and Duroy, that the brain and spinal cord of persons killed by chloroform contain a larger proportion of it than other tissues.

In the production of narcosis it is evident from the

progressive manner in which the signs appear, that the different parts of the nervous system possess different degrees of resistance to this influence, and according to the observations of Flourens, Snow, and others they are overcome in the following order: 1. The cerebrum. 2. The cerebellum. 3. The sensory centres of the cord. 4. The motor centres of the cord. 5. The medulla. According to Anstie, certain signs point to an early involvement of the sympathetic nervous system.

While the ultimate effect of anæsthetics upon the nervous system is to paralyze its various parts, it is a conspicuous clinical fact that this is usually preceded by some degree of excitement and functional perversion. This is due to the fact that all anæsthetics act as stimulants in less than narcotic doses; and since it is necessary, in view of safety, that certain of these, as chloroform and ether, should be administered gradually in a diluted form, a period of excitation and partial narcotism is frequently observed. With nitrous oxide—which is administered pure and the action of which is rapid—such a period is exceedingly rare, and when it occurs, is usually due to the admission of a considerable percentage of air with the gas.

The period of complete narcosis as required for surgical purposes is characterized, so far as the nervous system is concerned, by loss of consciousness and by paralysis of the centres governing sensation and motion, while those which control circulation and respiration are but slightly affected. Mere loss of consciousness is a prominent factor in ordinary surgical anæsthesia, and many operations may be satisfactorily performed with only enough of the anæsthetic to produce this condition, which is one of the earliest manifestations of their action. Painless operations during the unconsciousness of "primary anæsthesia" and of fainting are examples of this fact.

Sensory paralysis is also one of the earliest and most potent factors in general anæsthesia, and occurs, according to Anstie, as follows: "It will be found, in the great majority of cases, that it commences in the posterior extremities (at least in vertebrated animals), and advances slowly, engaging successively the parts supplied by nerves more and more from the anterior portions of the spinal cord." As showing the relation of loss of consciousness to sensory paralysis the following observation of Anstie is pertinent: "The main difficulty of tracing accurately the comparative course of the sensory paralysis produced by different narcotics is, that, in the case of those which affect the brain powerfully, unconsciousness arrives so early as to vitiate the investigation, unless the circumstances of the experiment are particularly favorable."

It is probable that in the usual depth of surgical narcosis, quiescence of the motor apparatus is for the most part dependent upon these two conditions: loss of consciousness and sensory paralysis. Numerous facts are observed during operations under general anæsthesia which show that the motor parts of the nervous system are not incapable of response to direct stimulation at that time; in fact, from the vigor of the action thus caused, it would seem that they are but slightly affected. Of these facts the following are the more common: In deeply anæsthetized subjects, violent muscular action is evoked by irritation or section of the motor nerves. Examples of this are found in the twitching of the muscles of the face which not infrequently occurs in mastoid operations from irritation or injury of the facial nerve in the Fallopian canal, and in similar movements of the muscles of the back and arm from injury of their nerves during extensive breast operations. Electrical excitation of the phrenic nerves results in powerful movements of the diaphragm, even in the most alarming depths of narcosis. The various motor centres of the brain are capable of causing movements in the parts they control upon proper excitation during deep anæsthesia, and all of the phenomena of epileptic seizures may be induced in certain epileptic subjects (particularly in cases of traumatic origin) by such irritation of the area corresponding to the part in which the motor manifestations of a paroxysm begin. Ankle clonus and many similar motor reflexes frequently occur from certain positions of the parts in completely anæsthetized subjects. These and other examples of the non-paralyzed condition of the motor nervous apparatus, in complete and even deep anæsthesia, would seem to confirm the opinion that the action of the narcotic is chiefly upon the sensory parts and those governing consciousness.

As has been seen, the last portion of the nervous system to be overcome by the paralyzing influence of anæsthetics is the medulla, and it follows that respiration and circulation are thus maintained after practically all other body functions have been abolished. Joseph Coats has clearly stated that: "The object of an anæsthetic is to suspend the action of the nerve centres which have to do with sensation and motion while leaving the respiratory and cardiac centres intact. It is not surprising that these latter centres, which continue under all circumstances throughout life their rhythmic action, should be more resistant than others, and that they should persist in their function after other centres have succumbed. We may expect, however, that any agent which suspends the function of the centres of sensation and motion will have some effect on those of the respiratory and cardiac centres, and there is abundant evidence to show that all anæsthetics which produce their action by being introduced by some method into the blood are capable of affecting both the respiratory and the cardiac centres."

It is now a proper time to consider the action of anæsthetics upon the respiration and circulation.

Action on the Respiration.—In the early stages of the induction of anæsthesia the respiration takes part in the general stimulation or excitation which is usually present at this time. We therefore observe an increase in the rate, depth, and vigor of the respiratory movements. As narcosis appears these subside, becoming progressively shallower and shallower as the action of the anæsthetic increases, and finally ceasing altogether after a period of irregularity as the medulla is paralyzed. These statements refer to the simple action of anæsthetics upon the function of respiration, and do not take into account the complications which arise from certain states of the circulation and from alterations in the supply of oxygen, as met in actual practice.

The effect of these factors will be considered in the following paragraph, and later under the heading, Phenomena of Anæsthesia.

Action on the Circulation.—The maintenance of the circulation depends upon the integrity of a number of factors: the action of the heart, its nervous control, intrinsic and central, the tone of the vaso-motor mechanism, and the continuance of the respiration. Anæsthetics are apparently capable of affecting the circulation through each of these, and the matter is consequently a complex one. An administration so conducted as to produce uncomplicated narcotism, gradually increased till death, would cause the following changes in the circulation: After a period of stimulation, in which the heart's action was increased in rate and force, it would subside to normal and below; the blood pressure, at first elevated, would fall from vaso-motor paralysis and cardiac enfeeblement, and with stoppage of the respiration the heart would suffer from the withdrawal of this effective aid in maintaining the circulation, from the resistance due to stoppage of the circulation in the lungs and from non-aeration of the blood. Already influenced by the increasing paralysis of the medulla and its own intrinsic ganglia, the heart's action would now become more and more inefficient, and would cease after a period of irregularity.

Such, in brief, would seem to be the mode of action of anæsthetics on the respiration and circulation, but clinical experience has furnished an abundance of facts indicating that under certain conditions this sequence of events may be strikingly altered. Deaths have occurred at all periods of the narcosis, in many instances before loss of consciousness and from but a few "whiffs" of the anæsthetic. Some of these cases have presented primary

failure of the respiration, but in others the circulation has distinctly failed first. In the hope of clearing up these points, numerous experimental investigations have been undertaken, notably those of the Royal Medical and Chirurgical Society of London, the Glasgow committee of the British Medical Association, the Hyderabad Chloroform Commissions, as well as those of Reichert, Wood, MacWilliam, Gaskell, Shore, Hare, Hill, and others. These investigations all relate to the action of anæsthetics, particularly of chloroform, on the circulation and respiration; and while on many points they are in perfect accord, there is great difference of opinion as to whether deaths from anæsthetics are due primarily to action on one or the other of these functions, some contending that the respiration invariably fails first, others that the heart may be directly paralyzed and fail before the respiration. The conclusions of the Hyderabad Chloroform Commissions on this point are thus clearly expressed:

"The inhalation of chloroform vapor, no matter in what doses or in what manner carried out, cannot kill a dog by acting directly upon its heart. We must invariably affect the nervous mechanism of respiration before involving the cardiac centres of the medulla oblongata or affecting the contractions of the ventricles and auricles to any extent. The commission further consider that chloroform vapor administered to dogs never kills by acting on the intracardiac ganglia either primarily or secondarily. It is impossible to produce syncope from chloroform in dogs. The commission are of the opinion that in the dog the danger to life from chloroform inhalation arises only when the cells of the respiratory centres (both respiratory and expiratory) of the medulla oblongata have their functions interfered with."

These positive assertions of the first Hyderabad Chloroform Commission were the outcome of carefully and ably conducted experiments on one hundred and forty-one dogs in the year 1888. They were so opposed to clinical evidence and to the results of the experiments of the Glasgow Committee and others, that their deductions were not generally accepted as applicable to man. A second Hyderabad Chloroform Commission was held in the following year. The experiments numbered five hundred and eighty-eight. They were conducted chiefly upon dogs and monkeys on thoroughly scientific principles and "were designed to show the effect upon the blood pressure, heart, and respiration of the inhalation of chloroform, ether, and the A. C. E. mixture, administered in various ways and under varying conditions." The results of this commission were the same as those of the first, and the following conclusions relative to the action of anæsthetics upon the respiration and circulation are sufficient for the present purpose:

"Chloroform, when given continuously by any means which insures its free dilution with air, causes a gradual fall in the mean blood pressure, provided the animal's respiration is not impeded in any way, and it continues to breathe quietly without struggling or involuntary holding of the breath, as almost always happens when the chloroform is sufficiently diluted. As this fall continues, the animal first becomes insensible, then the respiration gradually ceases, and lastly the heart stops beating. If the chloroform is less diluted the fall is more rapid, but is always gradual, so long as the other conditions are maintained; and however concentrated the chloroform may be, it never causes sudden death from stoppage of the heart. The greater the degree of dilution the less rapid is the fall, until a degree of dilution is reached which no longer appreciably lowers the blood pressure or produces anæsthesia. If the administration of the chloroform is stopped at an early stage, the pressure very soon begins to rise again, and gradually becomes normal; but if the chloroform is pushed further, there comes a time, not easy to define, when the blood pressure and respiration will no longer be restored spontaneously, although the heart continues to beat after the inhalation is stopped. . . . Complete stoppage of respiration always means that an overdose has been administered."

The experiments of this commission with ether were few and unsatisfactory.

Laurie, who was a member of both Hyderabad chloroform commissions, has very concisely stated his views on the action of chloroform relative to the respiration and circulation as follows:

"1. During the first stage (from the commencement of the inhalation to the point where anæsthesia is complete) chloroform narcosis affects primarily and immediately the vaso-motor centre. This dilates the arterioles, and the blood pressure falls continuously throughout, and as the narcotic action of the chloroform increases, consciousness is abolished, the reflex functions of the brain and spinal cord, other than those necessary to sustain life, are also abolished, and the period terminates with complete anæsthesia, with or without some narcosis of the respiratory centre. We all know that sometimes before anæsthesia is complete, stertorous breathing is set up.

"2. During the second stage (between the point of complete anæsthesia and stoppage of the respiration), while the narcosis of the vaso-motor centre continues and becomes fully developed, the respiratory centre is gradually completely narcotized. During this stage, the fall of the blood pressure is due in the first instance to the completion of vaso-motor narcosis, and in the second to weakening of the heart from narcosis of the respiratory centre and failure of the respiration. It is not possible to say exactly when the vaso-motor fall ends and the cardiac fall begins; a great deal will depend on the strength of the heart at the beginning of the period at which narcosis of the respiratory centre sets in.

"3. During the third period (from the point of stoppage of the respiration to death from failure and stoppage of the heart), the respiration having ceased, the nutrition of the heart fails, and with completion of cardiac failure the blood pressure falls too, and terminates in death at zero. Death is not due to asphyxia or to syncope, but to failure of the nutrition of the heart after stoppage of the respiration just as it is in bullet wounds of the brain."

Brunton, who was a member of the second Hyderabad Chloroform Commission, has thus expressed his opinion on the points under consideration: "I have stopped the pulsations of an animal's heart by blowing chloroform vapor directly into the lungs. But what I wish to maintain is, that notwithstanding all this, when chloroform vapor is inhaled in the usual way by inspiratory efforts of the patient himself it does not stop the heart, but first acts upon the respiratory centre, and, by stopping the breathing, prevents a quantity of chloroform sufficient to stop the heart from reaching that organ."

The elaborate experiments of MacWilliam followed closely those of the Hyderabad Chloroform Commission, and his conclusions, from experiments performed mostly on cats, are at considerable variance with theirs. A number of the more important ones are as follows: "During chloroform anæsthesia the blood pressure is lowered and the heart's action is weakened. Dilatation of the heart occurs to an appreciable extent, even when chloroform is administered gently, mixed with abundance of air (under four per cent. of chloroform vapor in the air). Dilatation may occur even before the conjunctival reflex is abolished. The dilatation affects all parts of the heart, more or less—the left side as well as the right. It is not due to changes in the pulmonary circuit. The dilatation is not due to the accompanying fall of pressure, to the diminished resistance to the ventricular systole, or to the diminished blood supply through the coronary arteries. Dilatation does not result from a similar fall of pressure brought about by means other than chloroform—for example, arterial relaxation caused by section of vaso-motor nerves. Dilatation under chloroform often occurs very quickly, before there is any fall of pressure. Moreover, when the dilatation has followed a fall of pressure, it is not removed by artificially raising the pressure—for example, by compression of the abdominal aorta. There is no distinct change in the rate of the heart's

action when dilatation occurs. A sudden and complete cessation of the cardiac rhythm is never caused by the inhalation of chloroform. Cardiac failure occurs by a more or less sudden enfeeblement and dilatation of the organ, not by a sudden complete cessation of rhythm. The tone of the heart muscle is depressed, the cardiac walls become relaxed, and the functional efficiency of the organ is impaired. When the heart becomes greatly dilated it fails to be an effective force in keeping up the circulation, while its rhythmic movement still continues —though so feebly as to be inefficient. Cardiac failure sometimes occurs in this way a considerable time before the respiration stops, though generally the respiration stops before the heart has become incapacitated. The depressing influence of chloroform on the heart—leading to dilatation of its cavities—is not exerted through the vagus nerves, but is a direct effect of the drug upon the cardiac mechanism. Section of both vagi does not obviate the weakening and dilating influence of chloroform upon the heart. The weakening and dilating effects of chloroform are sometimes manifested in tolerably equal degrees on both auricles and ventricles; but sometimes more readily upon the auricles, and at other times upon the ventricles.

"The contrast between the relation to the heart's action of chloroform and ether in anæsthetic doses is very marked. With chloroform, cardiac dilatation frequently occurs—and often, indeed, a very marked dilatation—before the conjunctival reflex is abolished. With ether, the induction of anæsthesia with complete abolition of the conjunctival reflex has not been attended by any noteworthy dilatation; indeed, effects of a stimulating character have sometimes been observed, and the peculiar periodic ventricular depression sometimes following chloroform has been seen to be removed. The occurrence of fibrillar contraction (delirium cordis) does not appear to be a primary mode of cardiac failure from the inhalation of chloroform in the healthy animal, though it may sometimes supervene when the heart has become distended and incapacitated by chloroform. The fall of blood pressure under chloroform is in its earlier stages due mainly to the depressing effect of the anæsthetic on the vaso-motor centre, preceded often by a slight stimulation; the later stages are associated with failure of the heart as well as of the vaso-motor centre. The relative occurrence of cardiac dilatation and vaso-motor depression varies. Sometimes the heart begins to dilate early—before there is any fall of pressure; at other times a large fall of pressure may occur before cardiac dilatation becomes marked. In certain circumstances, when chloroform is very suddenly taken in, a dangerous dose may be absorbed, and the heart may become seriously affected *before* the vaso-motor centre has had time to be much depressed."

H. C. Wood has taught for years: "First, that although ether in moderate doses acts as a stimulant to the circulation, yet, in overwhelming amount, it is capable of depressing the heart; but that such depression of the heart is always less than the depression of the respiration, and therefore ether kills always through the respiration. Secondly, that chloroform may produce death by paralysis of the respiratory centre, or by a simultaneous arrest of respiration and circulation, but that primary paralysis of the heart may occur, and is especially prone to do so when the chloroform vapor has been given in concentrated form."

Reichert, Wood, and Hare agreed that "chloroform is a cardiac paralysant and often does kill dogs by a direct action upon the heart or its contained ganglia." The conclusions of the Hyderabad Chloroform Commissions induced the two last named to restudy the subject, with the result that they "definitely proved that in the dog chloroform has a distinct, direct, paralyzing influence on both respiration and circulation; that the respiration may cease before the heart-beat, or the two functions be simultaneously abolished; but that in some cases the heart is arrested before respiration. We have several times seen the respiration continue as long as one, and even two minutes after the blood pressure has fallen to zero, and the pulse has completely disappeared from the carotid artery. . . . In a series of experiments I have recently made myself [Wood] to determine the changes in the circulation produced when ether anæsthesia is carried on to death, I have found that in the first periods of anæsthesia the blood pressure is usually elevated, and that it is usually quite high at the time when the respirations are very shallow and imperfect, and the dark color of the blood shows that it is heavily charged with carbonic acid. It is not, however, very rare for the blood pressure to remain near the normal, and I have seen the blood pressure begin to fall in the very first stages of ether anæsthesia; moreover, in at least two experiments, death occurred from syncope, the respiration continuing for one or two minutes after the complete cessation of the respiration. . . . So far, then, as concerns the method in which ether and chloroform kill, I claim most urgently that there is no contradiction between the results as obtained by the bedside and in the physiological laboratories, and that a complete, broad study of the clinical and experimental evidence leads to one conclusion, namely, that chloroform and ether are capable of paralyzing the respiration and the circulation; that in some cases one function, in other cases the other function, is primarily arrested; but that ether is less prone to produce a primary arrest of the heart than chloroform."

Leonard Hill has made a large number of valuable experiments and observations on the action of anæsthetics with reference to the respiration and circulation, the result of which is indicated by the following conclusions:

"Chloroform acts upon three parts of the economy: (1) the heart, (2) the respiratory centre, (3) the arterioles. By its action on the arterioles, chloroform does not produce directly fatal results, but inasmuch as it dilates these, it lowers the blood pressure and produces anæmia of the respiratory centre. This is a most important factor in regard to the stoppage of respiration. . . . The action of chloroform upon the respiratory centre is twofold. It is partly indirect, as we have just stated, and partly a direct action of the chloroform itself upon the centre. Arrest of respiration will be most easily produced when both these conditions of anæmia and chloroform act together on the centre. If the centre be much damaged by anæmia, far less chloroform will arrest its action than when it is well supplied with blood. And both these conditions are present during prolonged anæsthesia. This is the explanation of death from respiratory failure after chloroform has been administered for some time. Partly from the shock of operation, partly from the prolonged action of chloroform on the heart and arterioles, the circulation through the respiratory centre has been ebbing and ebbing until the centre is no longer able to bear up under the degree of anæmia so produced, combined with the depressing effects of the amount of chloroform which happens at that moment to be administered. Thus the respiration ceases. . . .

"But the action of chloroform upon the heart is a much more serious matter. When chloroform dilates the cavities of the heart, the power required to empty them increases as the cube of their radius, yet at the same time the power of the poisoned muscle is directly diminished. There are thus two factors acting in the arrest of the heart: (1) the distention of its cavities and (2) the direct weakening of its muscle."

In the cross-circulation experiments of Gaskell and Shore, in which the brain of one animal was supplied with blood from another, whereby "chloroform could be sent to the vaso-motor centre without being sent to the heart, or to the heart without reaching the vaso-motor centre, it was shown that the vaso-motor centre was not, at any rate at first, depressed by chloroform, while the heart was primarily affected, and that this weakening was the cause of the fall of blood pressure." Kirk has advanced a theory, accounting for "primary chloroform syncope," of which he has given this brief description: "The way to produce the primary syncope with certain anæsthetic vapors, more especially with such chlorine compounds as bichloride of methylene and chloroform, is to charge