preliminary surgical measures such as excision or scraping, followed as soon after as possible by the x rays and again by the Finsen light if necessary, would considerably reduce the duration of treatment and give better results than those obtained from the x rays or the Finsen light alone.

5. In *lupus of mucous membranes* great initial improvement follows the use of the x rays, but relapses are frequent. In the upper parts of the nasal fossæ radium might be of use. I have had very little or no experience of this agent. Galvano-cautery is of service in such cases.

To sum up, the combination of Finsen's methods with the x rays, reinforced when necessary by the use of pyrogallol, salicylic, or carbolic acid or other caustic applications, has in my experience given good results in cases of lupus in which the disease is not very extensive and does not spread too rapidly to be overtaken by treatment. Vigilant supervision is necessary to detect any appearance and to destroy fresh nodules in the earliest stage of their development.

Tuberculin.—Like everyone else, when tuberculin was introduced to the world I gave it an eager trial. Notwithstanding the great immediate improvement which it produced the effect was not lasting; hence the agent which had at first been hailed as a specific was after a time discarded. Further experience, however, led one to the conclusion that it has a distinct, though limited, field of usefulness in the treatment of lupus vulgaris. Although it does not of itself cure the disease it modifies the process so as to make it more amenable to local treatment. Cases in which recurrence followed the use of the old tuberculin were permanently cured by the subsequent employment of surgical methods and caustics.⁶ A course of tuberculin injections may therefore advantageously precede the treatment of lupus by local methods.

Constitutional treatment.—I have never seen any benefit follow the internal administration of arsenic, iodoform, or iodide of potassium, each of which has found distinguished advocates. On the other hand, I am sure that certain cases of the general infective type are much benefited by the internal administration of thyroid extract. Urea has been given in a series of 15 cases over a period of six months without any result whatever. But although no drug in my experience has any specific effect on lupus vulgaris, there are, as already said, cases in which properly directed constitutional treatment does much good. In persons with a tendency to tuberculous toxæmia, as when the process begins in a suppurating gland, constitutional treatment is indicated. Lupus of the general infective form which resists all other methods sometimes markedly improves under the influence of open-air treatment in the country. By this I mean the modern treatment of lung tuberculosis. In such cases the remedial effect is doubtless due to the improvement of the appetite and health generally. In certain cases a diet of lightly cooked or raw pounded meat combined with copious drinking of hot water has yielded excellent results. I certainly do not wish to be understood as holding that such methods are applicable to the treatment of all cases of lupus vulgaris. As already explained there are cases in which local treatment fails or even does harm and in which the progress of the disease appears to be stayed by constitutional treatment. This is a clinical fact which has forced itself on my attention as my experience has ripened and which affords encouragement in dealing with cases which are the mere despair of surgery.

CONCLUSIONS.

I have now treated more than 1000 cases of lupus vulgaris by various methods. I have not attempted to give exact statistics because in the large majority of cases the treatment has been so mixed that it would be impossible to say how much of the result was due to one and how much to another agent. The general conclusions to which my experience has led me may be summed up in the following propositions:—

1. It must be confessed that after every kind of treatment, whether used alone or in combination with others, recurrence is still very common.

2. As a general statement it may be laid down that small superficial quiescent patches are curable.

3. When the disease is of moderate extent and situated on the face Finsen's method, either alone or combined with the application of the x rays and supplemented by the use of caustics, is the most efficient method in regard to cosmetic effect and probably also in regard to permanency of result. The treatment, however, requires so much time that it is

practically incompatible with the pursuit of any avocation needing close personal attention and directly or indirectly it entails considerable expense.

4. If a rapid effect is desired reliance must still be placed on gentle cautery if the disease is on the face and excision if it is on the limbs or the trunk, supplemented in the former case by pyrogallol, salicylic acid, nitrate of silver, or other caustics.

5. Very extensive and severe cases in which the health is affected must be dealt with by the general measures (open-air treatment, feeding, exercise, &c.) used at the present day in the treatment of pulmonary tuberculosis.

POINTS FOR CONSIDERATION.

A few points still remain which may probably be considered by this Congress. I will put these as briefly as possible.

1. Do we, with the superior equipment now at our disposal, cure more cases than we did 25 years ago? My own answer to this question is that this depends on the type of the disease. We certainly cure more curable cases and we cure them with less pain to the patient and, thanks mainly to Finsen, with much less disfigurement. Our differential diagnosis is more accurate and this helps us in adapting the various methods of treatment to the individual case. But incurable cases are still incurable and I fear it must be admitted that little more can be done for them than was effected by the older methods. We still meet with intractable cases that, so to speak, resent any interference. But fortunately these cases are rarer than they used to be 25 years ago.

2. A question meets us here to which different replies will be given by different persons according to their mental temperament. In the case of lupus vulgaris, what is to be looked upon as a cure? Most of us would doubtless reply: Removal or destruction of the disease, without recurrence. There is not, however, a definite time limit as in the case of cancer; would it not be well if some standard of permanency were adopted? As an aid to the solution of the question of cure I would suggest that the later history of cases in which the disease appears to have been checked should, whenever the patients can be traced, be recorded from time to time.

THE PHYSIOLOGICAL ACTION OF ETHYL ALCOHOL CONSIDERED AS A FOOD: A RESEARCH.

BY W. H. GODDARD, M.D., B.A. CANTAB.

MUCH discussion has arisen over the important and still unsettled question concerning the action of ordinary (ethyl) alcohol when introduced into the alimentary canal of a living animal as to whether—like the compound from which it is derived (i.e., grape sugar)—it is carried to the tissues and there oxidised, supporting life, giving off heat and energy the while—whether, in short, it acts as a food or, on the contrary, it has no such action in this respect, but is simply excreted from the animal system in an unchanged condition, and so can in no way lay claim to that title.

Liebig classed alcohol (ethyl) among the carbohydrate foods and the correctness of his classification remained undoubted until the year 1860, when Lallemand, Perrin, and Duroy (of Paris) announced, as the outcome of a series of experiments, that alcohol was eliminated from the system in an entirely unchanged form and could therefore in no way be considered a food. As may be supposed, this conclusion was strongly combated and among others by Binz and Baudot who, carefully experimenting, arrived at an almost opposite result—i.e., that a small portion only of the alcohol was excreted by the lung and kidney. Later Anstey, Thudicum, Dupré, and Schulinus, separately working at the same subject, confirmed the results of Binz and Baudot. Now, the experiments of Lallemand, Perrin, and Duroy are open to certain objections, since they administered alcohol in large doses, and we know that even grape sugar (which stands in the first rank among foods) when given in excess will give rise to sugar in the urine. Therefore, reasoning by analogy, we may expect that alcohol also when given in large doses will appear in the urine, for while the organism may be able to deal with

⁶ Brit. Med. Jour., vol. i., 1893, p. 1154.

a limited portion at a time it will resent an excess and eliminate it. These observers used for the detection of the alcohol a sensitive reagent, i.e., a solution of potassium bichromate in sulphuric acid, by which the alcohol and other substances were converted into acetic acid. They therefore trusted to what is at best a colour test and not altogether reliable in estimating quantities. Moreover, they were unable to state the amount of alcohol which they recovered. Hence, their conclusion was in no way warranted by the result of their work. Binz and his followers, on the other hand, experimented with only small quantities of alcohol, and using the same testing reagents, supplemented possibly by others, were able to state exactly the amount of alcohol excreted by the lung and kidney, i.e., from 2 to 4 per cent., also to note the absence, or in some cases the presence, of certain different carbon compounds into which the alcohol might have been transformed, and to conclude that the difference between the amount of alcohol administered and the quantity recovered is retained by, and oxidised in, the system and therefore, with the small exception stated, is, without doubt, a food. This conclusion is supported by the researches of Hammond (who, while taking an insufficient diet and, in consequence, daily losing weight, found that the addition of alcohol to his food not only prevented loss but even caused him to gain in weight) and also by cases collected by Anstey and many others, of persons who have lived for a considerable period upon alcohol alone.

Among the physiologists and physicians of to-day there is still a difference of opinion as to the food-supplying power of alcohol, some agreeing with Binz and Baudot that, given in small quantities, it will act as a food; others with Lallemand, Perrin, and Duroy that, independently of quantity, it never acts but as a drug and in contradistinction to food. Now, if alcohol serves as a food for the animal body it can do so only by the process of oxidation. Mixing with the digestive juices, and in some unknown way modified by them, it passes into the blood, by which it is carried to the tissues, where it is finally oxidised (if the process be complete) into carbon dioxide and water. Whilst it is in itself thus oxidised, however, it interferes with the metabolism or oxidation of other substances, for on the administration of alcohol to animals it has been found that less oxygen is absorbed, the body temperature falls, and the albuminous tissues, whilst they do not waste, degenerate into fat, the amount of urea, uric acid, carbon dioxide, and salts being diminished. From all of which we may, perhaps, fairly infer that interference with the oxygenating function of the red corpuscles is one cause, at least, of the impaired metabolism and that the readiness of the alcohol to seize upon the oxygen in the tissues, and thus to rob the fixed elements of their proper share, arrests decomposition at the stage of fat formation and so, as a whole, prevents tissue waste.

Laboratory experiments (apart from the animal body) on alcohol, tell us that it can be oxidised in successive stages into acetic aldehyde, acetic acid, and finally into carbon dioxide and water. This suggests that these may be the exact gradations which actually do take place in the animal body. Indeed, the results of experiments which are to follow prove it to be so, excepting that, since citrates and tartrates when administered to animals give rise to carbonates in the urine, we may suppose that the closely allied acetates will also produce carbonates, and therefore we shall find that in the animal body alcohol is oxidised into the following substances: acetic aldehyde, alkaline acetates, alkaline carbonates, carbon dioxide, and water. It is, however, possible to suppose that, in addition to these compounds mentioned, other carbon compounds, volatile in their nature, might be met with, derived from the alcohol administered, i.e., the higher alcohols, certain ethers, ethereal salts, and possibly other carbon compounds also of a non-volatile order. Should either or both of these latter exist, however, they will be shown to be present in such small amounts as to be undetectable by the chemical means we have employed.

From the diametrically opposite views expressed by the French experimenters and their followers on the one hand, and Binz and his adherents on the other, it would appear that the whole subject requires further investigation. Also, that since the amount of alcohol administered in the experiments of both sets of observers seems to play an important part in the different conclusions arrived at, experiments ought to be undertaken in which alcohol should be administered in progressively increasing quantities with a view to find the exact point at which it begins to be eliminated as

such from the animal body and to discover where possible the precise amount of the substances into which it is transformed in the body, i.e., what the exact rôle is which alcohol plays there. The following experiments were therefore performed, but before stating their exact results we must discuss the methods by which they were obtained.

A dog weighing about 12 kilogrammes is purged in order to clear the alimentary canal, and subsequently starved for 24 hours, when a small quantity (16 grammes) of alcohol is administered to it. The animal is then placed in a respiration chamber—the capacity of which is accurately known—and the expired air is collected during the whole time it exhibits properties other than those of ordinary expired air. The urine is also collected and examined during the time the animal is incarcerated. It is next killed and its body (a separate examination being made of its blood and its liver) is examined for all the carbon compounds, with the exception of the carbonates previously enumerated as derived from alcohol. Another dog of similar weight is then obtained and the amount of alcohol given is doubled, the experiment being repeated and the excreted products examined precisely as stated above. This animal, also, is killed and examined. Lastly, double the quantity of alcohol to that in the last instance is given, and the same methods are pursued. These processes are repeated several times in order to obtain averages of results. Under this class we take advantage of the fact that, as larger quantities of alcohol and its derivatives will be met with, we can therefore the more easily prove their presence—i.e., their qualitative determination. The expired air from the dog will now contain oxygen, nitrogen, carbon dioxide, water vapour, and, it may be, alcohol and acetic aldehyde, besides, possibly, other volatile carbon compounds (but not alkaline acetates or carbonates, since they are not volatile). The expired air is now passed through lime, which abstracts its water vapour and carbon dioxide, a previous check experiment having indicated that alcohol and aldehyde vapour are unaltered by dry lime. Now, the quantitative determination of mixed carbon compounds is always a difficult, if not an impossible, matter, more especially when they are so closely allied in their chemical composition as in the present instance of alcohol and acetic aldehyde. In the first place, therefore, in order to effect their separation we have recourse to the combustion furnace, whereby we accurately determine the weights of oxygen, hydrogen, and carbon present. Moreover, the carbon of the mixture so obtained will represent the total carbon resulting from the alcohol administered which has been given off by the lung.

We now proceed to separate directly the aldehyde from the mixture by three different methods: 1. The whole of the expired air of a dog, after having been passed through lime, is put through a refrigerator (which operates by means of liquid air, its temperature ranging between -25° and -30° C.) by which the alcohol and aldehyde are condensed. To them is added dry calcium chloride. The whole is then weighed, the aldehyde is drawn off with an air pump, and the resulting difference in weight will be that of the aldehyde. 2. Another collection of expired air is again frozen, and to the resulting liquid a trace of dry hydrochloric acid is added, by which the aldehyde of the mixture is converted into its polymer, paraldehyde— $3(\text{C}_2\text{H}_4\text{O})$. In this process we take advantage of the fact that at the temperature stated the vapour pressure of paraldehyde is almost *nil*, and in consequence it is directly frozen out and can be separated from the alcohol. 3. Another portion of air, similarly treated by lime and subjected to a low temperature, is fractionally distilled under reduced pressure, and the resulting alcohol and aldehyde are weighed. This process can be used only when we are dealing with comparatively large quantities. Experiments with known weights of alcohol and aldehyde vapour show that these bodies are recoverable by the three methods just mentioned within an error of 1 per cent.

Since, then, by the last three processes we obtain the amount of aldehyde, the average quantity deducted from the results obtained by the combustion of the mixed vapours, &c., enables us to estimate the amount of alcohol present. The residue from the process by which paraldehyde resulted is passed into strong sulphuric acid largely diluted with water and is then distilled with lime. The vapour density of the resulting gas is taken, also its boiling point; any aromatic smell is noted, and conclusions are drawn therefrom as to its nature, whether any further volatile carbon compounds be present or not.

We now come to the urine of the animal, which is

collected and subjected to decrease of pressure; the resulting gases are passed through lime, and the amounts of alcohol, aldehyde, and possibly other volatile carbon compounds are estimated in the manner before mentioned in the examination of the expired air. The liquid now remaining contains, besides its normal substances, acetates and carbonates and perhaps also other non-volatile carbon compounds resulting from the alcohol administered. The acetates are removed by the following method: (1) Distillation with phosphoric acid so long as the distillate comes over acid. (2) Neutralisation of distillate with sodium carbonate, evaporation to dryness, and extraction of the residue *several times* with warm absolute alcohol. (The sodium acetate is taken up by the alcohol.) (3) Evaporation of the alcoholic extract to dryness, and solution of the residue in a little water. Distillation with sulphuric acid. The distillate from (3) now contains any acetic acid there may be, as also other acids (if any) of the acetic series, and can be tested and weighed as ordinarily. The carbonates are estimated by the amount of carbon dioxide into which they are in part converted. From another collection of urine from an alcoholised dog we pump off any volatile matter, then acidify with sulphuric acid, and collect the liberated carbon dioxide. The carbon dioxide will now be mixed with air and water, which may be eliminated by being passed through calcium chloride and potassium hydrate tubes respectively. The potassium hydrate tube should be supplemented by another calcium chloride tube to catch any water the potassium hydrate may lose.

In order to ascertain whether any other non-volatile carbon compounds be present or not we proceed as follows:—1. To insure an average result the normal urine of a dog is collected during a period of 24 hours *on three separate occasions*. The liquid portion is pumped off and the remaining solids are combusted, by which process we obtain the total amount of carbon contained in the carbon-holding compounds of the urine, which are urea, uric acid, hippuric acid, kreatinin, also the pigment, and other substances appertaining to it. 2. During a similar period of 24 hours the urine of an alcoholised dog is secured and treated in precisely the same way as was that of the normal dog. From the total carbon thus obtained the carbon due to both acetates and carbonates contained in it is deducted; hence, any difference between this resulting quantity and that obtained from the urine of the normal dog must obviously be due to some new carbon compound.

The next thing to be considered is the examination of the blood, and, in order to obtain a sufficiently large quantity, that of two dogs is taken. This is secured just immediately before their death and surrounded by a cooling mixture so that it may retain its fluidity. The gases of the blood are obtained by a modified Sprengel air pump, the carbon dioxide is removed by passing them through lime, and the remainder is treated as in the case of those of the expired air, with the exception that in consequence of the small quantities of gas or gases (alcohol or acetic aldehyde) obtained no differentiation is attempted. The rest of the blood is now examined for acetates, as in the method previously given when the urine was examined. For obvious reasons no attempt is made to ascertain the amount of the carbonates. The animal is killed, the body finely minced, mixed with powdered glass, and shaken in an air-tight vessel. Its gases are drawn off and treated, as previously stated, for the detection of the alcohol, acetic aldehyde, &c. The remaining solid portion of the body is, after the addition of pure water, raised to a temperature of 100° C. and filtered, the filtrate also being examined for acetates by the methods already given as used in the examination of the urine. The carbonates existing in the body of the animal are not sought. Considering the great metabolic changes which ordinarily take place in the liver it is deemed advisable to search this organ separately. The liver of an alcoholised dog is therefore taken, minced, and placed under diminished pressure of the air pump, and its resulting gases are examined for alcohol, acetic aldehyde, &c., as in the case of the expired air. Next the livers of two alcoholised dogs are secured immediately at the point of death, plunged into boiling water, and retained there some little time in order to fix the glycogen present. They are then minced, mixed with powdered glass, macerated with water, put under hydraulic pressure, and filtered, the filtrate being examined for acetates by the method previously given. The carbonates are not sought for. We will now proceed to the actual experiments.

CLASS A.

Experiment 1.—The dog weighed 12·4 kilogrammes. After having been purged and fasted for 24 hours, its temperature being normal, 16 grammes of absolute ethyl alcohol, mixed with a similar quantity of pure water, were administered to it. The animal was now placed in a respiration chamber and the expired air collected during a period of five and a quarter hours. It was then examined and proved to be normal. The whole of the collected gases, which amounted to 637·5 litres, were passed through lime and subsequently sent on to the combustion furnace, when, combustion being completed, the amount of carbon, hydrogen, and oxygen together was found to equal 2·14 per cent. of the alcohol administered. The temperature of the animal on examination was found to have fallen 0·5° F.

Experiment 2.—After three days this experiment was repeated and the resulting carbon, hydrogen, and oxygen then showed 2·16 per cent.

Experiment 3.—The dog was similarly treated again (after two or three days) and the same quantity of alcohol was given in the same way, when the amount of carbon, hydrogen, and oxygen recovered equalled 2·15 per cent. Hence the average amount of carbon, hydrogen, and oxygen was equal to 2·15 per cent. of that of the alcohol administered.

Experiment 4.—Another quantity of expired air, after having been passed through lime, was sent on to the refrigerator; the resulting liquid (0·39 gramme) was volatilised by heat; one cubic centimetre was collected and its vapour density was taken, which was found to be 22·9 and its boiling-point 78·2° C., hence it was alcohol.

Experiment 5.—Another quantity of expired air having been passed through lime was put through the refrigerator: the temperature was - 28° C. To the resulting liquid, which amounted to 0·89 gramme in weight, were added 20 grammes of dry calcium chloride. The air pump was now applied to the mixture and on being drawn off the gas showed no appreciable amount of aldehyde to be present.

Experiment 6.—This experiment was again repeated with the same result, therefore no further experiments by the other methods were performed for the detection of the aldehyde.

Experiment 7.—The urine passed, together with that drawn off by catheter, had the gases pumped off. After repetition of the experiment three times the average percentage quantity of alcohol (proved to be alcohol by the methods employed in Experiment 4) was found to be 2·89 per cent., while the acetic aldehyde was found to be inappreciable.

Experiment 8.—No new carbon compound was found in the body after death.

Experiment 9.—No new carbon compound was found in the blood after death.

Experiment 10.—No new carbon compound was found in the liver after death.

CLASS B.

Experiment 1.—A dog, weighing 12·1 kilogrammes, and of normal temperature, had 32 grammes of alcohol, mixed with a similar quantity of water, given to it. The expired gases after nine hours and ten minutes amounted to 1141·5 litres. They were now passed through lime, sent on to the combustion furnace, and the average total amount of carbon, hydrogen, and oxygen after three experiments was found to be 4·44 per cent. The temperature of the dog was found to have fallen 0·9° F.

Experiment 2.—Another lot of air from the dog having been passed through lime was sent on to the refrigerator. The resulting liquid was collected and by the calcium chloride process the aldehyde was found to be 2·2 per cent.

Experiment 3.—Another quantity of expired air was passed through lime and sent on to the refrigerator. The resulting liquid, on being treated by the paraldehyde process, was found to be 2·22 per cent. Hence, by difference between it and the whole of the expired air—i.e., 4·44 per cent.—we had 2·23 per cent. due to the alcohol. The presence of these bodies (alcohol and acetic aldehyde) was proved in this instance, as in the similar case under Class C, as also the absence of any other volatile carbon compound in the expired air.

Experiment 4.—The urine of the animal was collected; its gases were drawn off by the air pump, passed through lime, and sent on to the combustion furnace. The average percentage quantity of carbon, hydrogen, and oxygen after three experiments was found to be 2·21 per cent.

Experiment 5.—Another quantity of urine was collected;

its gases were drawn off, passed through lime, and sent on to the refrigerator. On the calcium chloride process being applied the amount of aldehyde was found to be inappreciable. Hence 2·21 per cent. (in the above) was due to the alcohol. The presence of the alcohol was proved as in the method under Class C.

Experiment 6.—Another collection of urine, after having its gases separated from it, was treated by the method given for the detection of the acetates and carbonates, with a negative result.

Experiment 7.—A trace of alcohol only was found in the animal's body after death.

Experiment 8.—No new carbon compound was found in the blood after death.

Experiment 9.—No new carbon compound was found in the liver after death, but an amount of acetic acid (or one of the acetic acid series, see Class C, Experiment 14) equal to 2·1 grammes.

CLASS C.

Experiment 1.—To a dog of normal temperature, weighing 12·2 kilogrammes, 64 grammes of absolute alcohol mixed with 80 grammes of pure water were administered. The expired air, which after the expiration of 14 hours and ten minutes amounted to 1785·3 litres, was collected and passed through lime, then conveyed to the combustion furnace, at the end of which process the amount of carbon, hydrogen, and oxygen was found to be 6·9 per cent. The temperature of the dog was found to have fallen 1·8° F.

Experiment 2.—The experiment was repeated and the amount of carbon, hydrogen, and oxygen was found to be 7·1 per cent.

Experiment 3.—The experiment was again repeated and the amount of carbon, hydrogen, and oxygen was found to be 7·66 per cent. The average amount, therefore, of carbon, hydrogen, and oxygen was equal to 7·22 per cent. of the alcohol given.

Experiment 4.—Another quantity of expired air, after having been passed through lime, had its resulting gas sent on to the refrigerator. No. 1 (the calcium chloride process) showed that the amount of aldehyde was equal in weight to 3·6 per cent.; in No. 2 process (the paraldehyde) it was found to be 3·3 per cent.; and similarly, by the fractional distillation process, 3·9 per cent. The average, therefore, was 3·9 per cent. and by difference between it and the amount of the mixed gases (alcohol and aldehyde) we have 3·32 per cent. as due to the alcohol.

Experiment 5.—The gas resulting in the calcium chloride process (i.e., after the absorption of the alcohol by the calcium chloride) was found to have the vapour density of 21·8 and a boiling point of 21° C. Another quantity of the same gas on being bubbled through a solution of silver nitrate reduced the silver, while another quantity gave a crystalline compound with acid sodium sulphite. Hence it was undoubtedly aldehyde.

Experiment 6.—The substance resulting from the paraldehyde method was found to have the vapour density of 4·57 and a boiling point of 123° C. On being heated to 100° it was found to give all the tests previously tried for aldehyde, therefore the substance was without doubt paraldehyde.

Experiment 7.—In the fractional distillation process one resulting fluid gave the vapour density of 22·9 and a boiling point of 79° C., also a substance found to be iodoform on the addition of iodine and caustic potash; the fluid, therefore, must be alcohol. The aldehyde obtained in the paraldehyde process was passed into strong sulphuric acid and water, and then distilled with lime; no aromatic smell was given off, while the vapour density and boiling point on being tested were found to be those of alcohol. Hence little, if any, other volatile carbon compound could be present.

Experiment 8.—The urine, which amounted to 192 grammes, was collected as previously and the air pump was applied, the gases being collected and passed through lime, and then sent on to the combustion furnace. On combustion being completed it was found that the amounts of carbon, hydrogen, and oxygen were 43·7 per cent.

Experiment 9.—The experiment was repeated. The amounts of carbon, hydrogen, and oxygen were found to be 43·8 per cent.; and on a second experiment they were 43·9 per cent.; hence the average amounts of carbon, hydrogen, and oxygen equalled 43·8 per cent.

Experiment 10.—Another collection of the gases having been drawn from the urine and passed through lime, the amount of aldehyde was found to be (by the calcium chloride process) 2·9 per cent.; by the paraldehyde process, 2·8 per

cent.; and by the fractional distillation process, 2·4 per cent. The average amount of aldehyde, therefore, was 2·7 per cent., and so by difference the alcohol was equal to 41·1 per cent. of the alcohol administered.

Experiment 11.—The gas resulting in the calcium chloride process (i.e., after the absorption of the alcohol by the calcium chloride) was found to give all the tests previously enumerated for aldehyde, and therefore was aldehyde. The same results were obtained with the paraldehyde and the alcohol.

Experiment 12.—The fluid obtained in the paraldehyde process was passed into strong sulphuric acid and water and distilled with lime. No aromatic smell was given off; the vapour density and boiling point, on being tested, were found to be those of alcohol; hence little, if any, other volatile carbon compound could be present.

Experiment 13.—Another collection of urine (drawn from two alcoholised dogs in order to obtain a greater quantity) after having its gases separated from it, was treated in the way previously described for the detection of the acetates. The resulting liquid was found to weigh 4·8 grammes, or 2·4 grammes (equalling 0·96 gramme of carbon) for one lot of urine.

Experiment 14.—The liquid from the last experiment after having been re-distilled was found to boil at 117·5° C. It exhibited an acid smell. Fractional distillation failed to resolve this substance into any other substance or substances; hence it was acetic acid only.

Experiment 15.—The urine of a dog (192 grammes) in its normal condition—i.e., not treated by alcohol—after having its gases drawn off was tested for carbonates in the way previously given; the amount of carbon dioxide given off amounted to a few cubic centimetres only, therefore we might assume the carbonates contained in the urine of a normal dog to be scarcely anything.

Experiment 16.—Two collections of urine drawn off from the alcoholised dog after having the gases pumped off were tested for the carbonates. The amount of carbon dioxide given off was found to be 4·382 litres, or 2·191 litres for one dog (equalling 4·304 grammes).

Experiment 17.—The normal urine of a dog was now taken, the fluid portion pumped off, and the total solids combusted. The amount of carbon was then found to be 2·606 grammes.

Experiment 18.—This last experiment was repeated and the total carbon found to be 2·600 grammes.

Experiment 19.—This experiment was again repeated when the amount of carbon was found to be 2·612 grammes. The average amount of carbon was therefore 2·606 grammes.

Experiment 20.—The urine of an alcoholised dog was next taken, and on combustion the total amount of carbon was found to be 7·890 grammes.

Experiment 21.—This experiment was repeated and the amount of carbon found to be 7·900 grammes.

Experiment 22.—The same experiment was again repeated, when the amount of carbon was found to be 7·809 grammes. The average total amount of carbon, therefore, was 7·863 grammes; but we have seen that the carbon due to the acetates and carbonates in the urine of an alcoholised dog was 0·960 gramme and 4·304 grammes respectively, equalling 5·264 grammes. This amount, deducted from the total amount of carbon in the urine, gave 2·602 grammes, which was almost exactly equal to the amount of carbon found in the urine of a normal dog, hence no new carbon compound was present.

Experiment 23.—The animal was now killed and its body examined. The alimentary canal was found to contain a small amount of mucus and faeces in which no trace of any new carbon compound could be detected. This note has reference to Classes A and B also. The mixed gases were drawn off by an air pump, and the carbon, hydrogen, and oxygen found to be 2·4 per cent., while on applying the calcium chloride method for the detection of the aldehyde no appreciable quantity of it was discovered to be present. Therefore 2·4 represents the percentage of alcohol given, proved to be alcohol as under Experiment 4, Class C.

Experiment 24.—The blood of two dogs was drawn off and the air pump applied when it was found that the amounts of carbon, hydrogen, and oxygen were only 2·2 per cent. for two dogs, or 1·1 per cent. for one dog, of the alcohol administered. The gas was proved to be alcohol by all the tests given, and there was some indication that aldehyde was present.

Experiment 25.—The livers of the animals were minced

and the air pump applied to them. To the gases obtained the ordinary tests for the detection of the presence of aldehyde and alcohol were applied, with negative results. Moreover, on combusting some portion of the gas after passing through lime, carbon was shown to be absent; hence neither alcohol nor aldehyde was present.

Experiment 26.—Two livers were again taken, freed from glycogen (in order not to complicate the extraction of the acetic acid) and on application of the test previously described a compound was obtained which weighed 7·10 grammes, or 3·55 grammes for one liver. On being examined it answered to all the tests previously tried for the detection of acetic acid, and was therefore acetic acid.

In conclusion, then, we observe from these experiments that when alcohol to the amount of $\frac{1}{750}$ th part of the body weight of the animal was administered to it a little more than 5 per cent. of that amount was excreted; and since no aldehyde or other alcohol derivatives are found in the expired air, in the urine, in the blood, or in any part of the body of the animal after death, we may conclude that the remainder—nearly 95 per cent.—is made use of as a food. When, as under Class B, we administer double the quantity of alcohol of that in the previous experiment we find that a little more than 6 per cent. is excreted; and here, for the first time, acetic aldehyde makes its appearance in the expired air. From this we may perhaps conclude it to be the first indication of failure on the part of the animal system to deal with so large a quantity of alcohol, and more especially so since at the same time we find no aldehyde in the urine or elsewhere in the animal body. When, as in the last set of experiments (Class C), we administer a very large dose we observe that rather more than 49 per cent. of alcohol or its equivalent is excreted. We thus notice an absolute failure on the part of the animal body to utilise about half of the quantity of the alcohol administered. We find that the compounds into which the alcohol has been formed are aldehyde, alkaline acetates, alkaline carbonates, and we may fairly assume carbon dioxide and water. In addition to these, however, it is quite possible that other carbon compounds excreted from the animal may exist, but after most careful investigation we fail to find them by the chemical means we employ in any appreciable quantity and therefore we may assume them to be practically absent.

To sum up shortly, *in small doses only* alcohol is most undoubtedly a food, but as when large doses are taken about 50 per cent. of it is excreted from the system it cannot then be considered a food in the proper sense of that term, and if still larger quantities be taken it is more than probable that this contention would apply with even greater force.

TABLE I.—Summary of Experimental Results, showing the Average Percentage Quantities.

Number of experiments.	Amount of alcohol given.	Alcohol in the expired air.	Aldehyde in the expired air.	Alcohol in the urine.	Aldehyde in the urine.	Alcohol in the body.	Aldehyde in the body.	Alcohol and aldehyde in the blood.
(A) 6	16 grammes. }	2·15	0	2·89	0	0	0	0
(B) 6	32 grammes. }	2·23	2·21	2·21	0	A trace.	0	0
(C) 6	64 grammes. }	3·32	3·9	41·1	2·7	2·4	0	1·1

TABLE II.—Showing the Non-volatile Carbon Compounds found in the Urine.

Amount of alcohol given.	Carbonates.	Acetates.
(A) 16 grammes. }	0	0
(B) 32 grammes. }	0	0
(C) 64 grammes. }	4·304 grammes.	2·4 grammes.

THE VALUE OF HETOL IN PULMONARY TUBERCULOSIS.

By T. BARRETT HEGGS, M.D. ABERD.,
LATE HOUSE PHYSICIAN TO THE SUSSEX COUNTY HOSPITAL.

THE value of hetol (the synthetic cinnamate of sodium) given intravenously is still undecided, the short periods of treatment followed rendering a number of observations useless. Two of the following cases were injected for about six months and the others for six or seven weeks. Tubercle bacilli were found in the sputum of all the cases. The blood for counting was always taken four hours after a meal and at the same hour on alternate days in each case. The technique and method employed were the usual and the same in all cases: thorough disinfection of the skin, using a four-hours perchloride compress and sterilisation of all instruments. Any sufficiently large veins of the arms were used. The method of graduated increase of dose on alternate days as advised by Professor Landerer was followed, though, finding no ill-effects, the increase was often more rapid than he advises. The maximum dose varied from 20 to 50 milligrammes, never getting any ill-effects. The leucocytosis was not in proportion to the amount of injection. The maximum leucocytosis was generally obtained with about 20 milligrammes. In all the cases a definite leucocytosis was produced by each injection; often the normal count was doubled. For the use of the notes I am indebted to the medical staff of the Sussex County Hospital.

CASE 1.—A man, aged 29 years, was admitted to hospital on June 11th, 1903. He had hæmoptysis two years ago, in March, 1902, and again in April, 1903. He had three severe hæmoptyses in the five days before admission. There were very definite constitutional symptoms. He had lost seven pounds in weight in the last three months. There were marked signs of active tubercle (consolidation with numerous crepitations) at both apices, the right side worse; also the apices of both the lower lobes were affected. There was slight hæmoptysis four days after admission. Injections commenced seven days later. His weight was 9 stones 10 pounds. Reaction to hetol gave a marked leucocyte count four hours after injection of two milligrammes of 13,400 per cubic millimetre (his normal was 8000). The sputum decreased and disappeared. After six weeks of treatment (16 injections) only an occasional sibilus was to be heard at the right apex behind. There were no adventitious sounds over the rest of the lungs and no cough and the patient was much better. His weight was 9 stones 10 pounds. Severe indigestion complicated his case and interfered with his gain of weight.

CASE 2.—A woman, aged 35 years, was admitted to hospital on August 14th, 1903. She came from a phthisical family. The duration of her illness had been six months. There were diffuse active infection of the right lung and some catarrh of the left bronchial tubes. There were frequent cough and copious muco-purulent sputum. On August 20th hetol was commenced. The patient's weight was 5 stones 6½ pounds. The cough and sputum gradually subsided. On Oct. 9th the right base and axilla were quite dry and there were only crepitations at the right apex and at the left apex behind. From now the patient was treated while an out-patient in exceedingly poor surroundings, coming to the hospital on alternate days for injections till Jan. 4th, 1904. Improvement was maintained in spite of her circumstances (she had six children, the eldest being 12 years of age). After five months of injections crepitation was only to be heard at the left apex, the rest of the lungs being quite dry. Her weight was 5 stones 9½ pounds. There were no sputum and very little cough and her general condition had much improved. This patient also took cod-liver oil latterly.

CASE 3.—A man, aged 35 years, was admitted to hospital on Feb. 22nd, 1903. He had had hæmoptysis five years ago; the sputum and cough had been worse lately. He was admitted after hæmoptysis (about four ounces). His tem-
perature was 100° F. There were marked active signs at the right apex and some consolidation at the left apex. Injections were begun on March 9th. His weight was 10 stones 2 pounds. The leucocyte count was 7500 per cubic millimetre; four hours after injection of one milligramme it was 11,500; after eight milligrammes it was 12,750; and after 11 milli-
grammes 16,000. On April 16th, after 20 injections, his