

tuberculin alone permits us to ascertain what degree of success has been obtained, and the struggle is well worth the trouble. The victory against tuberculosis of the ox promises not only a considerable economic gain ; it will also do away with one of the sources, not the least important, of tuberculosis of the human subject.

REPORT ON THE PNEUMOBACILLUS AND PNEUMOBACILLIN.

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III. PNEUMOBACILLIN.—ITS DIAGNOSTIC PROPERTIES.

I HAVE given the name of pneumobacillin to glycerine extracts of natural or artificial liquids in which the pneumobacillus liquefaciens bovis has propagated.

That is to say that I have prepared the pneumobacillin with artificial bouillon and with serosity from pleuro-pneumonic lesions.

In both cases one first sterilises the liquids by submitting them for twenty minutes to a temperature of 80°, which permits one to attain the desired object with the least possible alteration of the active substances. Afterwards one associates with them such a quantity of glycerine that, when the liquid is reduced to one-fourth, one obtains a 40 per cent. solution of glycerine. Finally the liquid is filtered across flannel, thus avoiding the impoverishing influence of mineral filters. Filtration through a porcelain filter gives a more limpid but less active liquid. One thus prepares a liquid which is non-putrescible, of a brownish colour and unpleasant odour, and which contains toxic substances formed in the bouillon or the pulmonary serosity under the influence of the pneumobacillus.

In 1888, I demonstrated that one of these substances, possessing the chemical characters of the diastases, exercises under the skin remarkable inflammatory effects.

But I am not now concerned with recalling these local effects, or the particular product that can be isolated from the material, but rather with examining whether the pneumobacillin as a whole will determine in animals carrying pleuro-pneumonic lesions functional disturbance so well marked as to make the pneumobacillin serviceable as a diagnostic agent, in the same manner as tuberculin and mallein are for tuberculosis and glanders.

I may say at the outset that pneumobacillin determines functional disturbance even in healthy animals.

If it is introduced into the veins these effects are considerable, and they attain the utmost gravity if the dose is sufficiently large, for 5 or 6 cubic centimetres injected into the jugular may cause the death of an ox of 400 to 500 kilogrammes in a few minutes.

With a medium dose the pneumobacillin causes acceleration and augmentation of the force of the heart-beat, acceleration of the respiration, cough, a staggering gait, sometimes coma, a hypersecretion

on the part of the intestine, kidneys, respiratory passages, and the lachrymal and genital organs; an elevation of temperature, an intense vaso-dilatation, both superficial and deep, for if the animal succumbs the autopsy reveals a violent congestion of the intestines and of some of the pulmonary lobules.

These effects are sometimes so pronounced immediately after intravenous injection that the death of the subject appears imminent.

The general effects present themselves also after the injection of pneumobacillin into the subcutaneous connective-tissue, which constitutes an important fact in view of the object of the present research.

They may also cause death if administered in very large doses, or if one encounters an exceptionally sensitive subject.

Generally doses of from 1 to 3 cubic centimetres, according to the size of the animals of the bovine species submitted to injection, produce the following disturbances in from six to eight hours: injection of the superficial mucous membranes, slight rise of temperature, some dulness and diminution of appetite, shivering, restlessness, disturbance of the pulse and respiration, and a transient diarrhoea.

At the point of inoculation there forms an œdematous swelling, as large on an average as the palm of the hand, and more or less painful according to the subject.

I have concentrated my attention on the local effects and on the disturbance of the temperature, pulse, and respiration. I have tried to ascertain what is the characteristic reaction of the system in the presence of pneumobacillin.

It soon became apparent to me that the local inflammatory effect offered little interest, for it varied within rather wide limits in healthy animals. It was therefore impossible to draw from it any diagnostic sign.

With regard to the thermic, circulatory, and respiratory reactions, they are generally more marked in pleuro-pneumonic subjects than in healthy animals.

The mean reactions deduced from over 100 experiments are:

I. For the temperature: $1\cdot08^{\circ}$ in animals suffering from acute pleuro-pneumonia; $1\cdot27^{\circ}$ in subjects attacked with subacute pleuro-pneumonia; $1\cdot18^{\circ}$ in animals carrying necrotic lesions of the lung; $0\cdot6^{\circ}$ in animals exempt from pleuro-pneumonia.

II. For the pulse: 13, 15, 21, 13 pulsations more per minute in the preceding categories.

III. For the respiration: 5, 16, 14, 4 respirations more per minute.

If in each group we add up the reactions in spite of the diversity of their nature the characteristic reaction will be numerically represented thus: $19\cdot08$ in animals attacked with acute pleuro-pneumonia; $32\cdot27$ in subjects attacked with subacute pleuro-pneumonia; $36\cdot18$ in animals carrying a sequestrum; $17\cdot6$ in animals exempt from pleuro-pneumonia.

The assertion previously made is thus found justified, the healthy animals presenting the fundamental reaction in a less marked degree than those affected with pleuro-pneumonia. The difference between the characteristic of the healthy subjects and subjects suffering from acute pleuro-pneumonia is only slightly marked; however, one must not be led into an error by that, first because the temperature, pulse, and respiration at the outset of the observation are much more elevated

than in the first; and again because the principal element of the characteristic of healthy subjects will be drawn from the pulse, and because a very notable augmentation of the number of pulsations will coincide with a very feeble modification of the respiration and temperature.

It does not suffice to formulate this difference as a principle; it is necessary to examine the means of using it as a diagnostic in subacute or chronic cases of pleuro-pneumonia.

Here commence difficulties greater than in the employment of mallein and tuberculin.

The first relates to the dose of pneumobacillin which it is necessary to employ.

All subjects, without exception, react to strong doses. Consequently, it is necessary to determine what doses are capable of influencing in a sensible degree only such animals as are predisposed by the disease to react more markedly to the effects of the diagnostic.

Practice has demonstrated that it is necessary to stop with the following quantities:—1 cubic centimetre for animals weighing 200 kilogrammes or less; 2 cubic centimetres for animals weighing from 200 to 400 kilogrammes; 3 cubic centimetres for animals of a greater weight.

The second difficulty relates to the thermic reaction. That ordinarily is considerable in glandered or tuberculous animals under the influence of mallein or tuberculin, while, save exceptionally, it is only moderate in pleuro-pneumonic subjects submitted to the action of pneumobacillin. It is therefore impossible to draw from it any characteristic diagnostic symptom. In animals suspected of pleuro-pneumonia, still more than in cases suspected of glanders or tuberculosis, it is indispensable to take into consideration all the functions, all the organic symptoms, in order to note minutely the disturbances which have to be appreciated conjointly with those of temperature.

The observations ought to be made every two hours, beginning at the time of injection, and continuing till the twelfth hour.

Ordinarily it is at the sixth hour that the most marked modifications are observed, sometimes a little later, sometimes a little sooner. The maximum of the circulatory and respiratory disturbances are shown later than the maximum of the thermic disturbance.

It is this that has induced me to advise that the observations should be continued up to the twelfth hour if necessary.

However, if at the end of the six or eight hours one sees that the temperature and the number of pulsations and respirations fall, the observations may be suspended.

At the outset the animal often presents a lively excitement resulting from the pain provoked by the injection of pneumobacillin into the meshes of the connective-tissue. This excitement soon disappears, and it is followed by restlessness and agitation, the subject moves about, changes from one leg to the other, licks itself or rubs itself against the manger more frequently than ordinarily; from time to time it stares fixedly, the neck extended, and the head low.

Rumination is suspended, and the left flank is elevated by an accumulation of gas in the rumen.

The ocular conjunctiva is injected. Tears escape from the nose,

and soon flow from under the free border of the lower eyelid ; the saliva escapes from between the lips, and mucus from the vulva.

The ears and the bases of the horns are alternately hot and cold.

The muscular masses of the shoulder and thigh are agitated by rigors. They coincide often with some nystagmus.

The temperature rises from 0.6° as a minimum to 2.7° as a maximum. The respiration becomes short and accelerated. Sometimes its frequency is excessive, 70 to 80 movements per minute, and as this disturbance coexists with difficulty of respiration the observer may feel anxious for the life of the subject. But, after having lasted for an hour or two at the most, it gradually calms down.

Of the numerous animals which have been submitted to the test by M. Robcis, Sanitary Veterinary Surgeon at Paris, in one only has he seen asphyxia supervene owing to the formation of an acute œdema of the lung.

At the moment when the chief reactions attain their maximum one ordinarily observes some diarrhœa, and sometimes sweating at the points of election.

It may happen that an animal obstinately rests one leg. If one makes it walk it goes lame on that member, and when the latter is examined it is found to display an exaggerated sensibility in one of the articular or tendinous regions.

If inquiry be made it will be learned that the subject has been lame for a longer or shorter time.

The pneumobacillin, thanks to its congestive properties, has had the effect of reawakening some old synovitis or arthritis, related probably to an attack of pleuro-pneumonia.

This symptom has in the species a great value.

At the first milking after the injection one observes a diminution in the amount of milk, and the same on the following day, although apparently all the other functions may have returned to the normal.

Such is the combination of symptoms presented by animals of the bovine species submitted to the action of pneumobacillin.

If in suspected premises some of the subjects present this combination in a marked degree, they are certainly, or almost certainly, the subjects of pleuro-pneumonia.

But these disturbances are not always found combined in the same subject, and those which manifest themselves have not always the same intensity.

It may be remarked that the animals submitted to the test are far from presenting the disease at the same period ; some are struck with a pleurisy or a commencing pleuro-pneumonia ; others with an acute, subacute, or chronic pleuro-pneumonia. Some carry at the same time acute and subacute lesions, others old lesions surrounded by recent inflammation, still others old lesions more or less isolated from the surrounding parenchyma. I have observed that, according to their nature, the lesions impress a particular stamp on the reactions.

For example, in cases of acute pleuro-pneumonia the thermic, respiratory, and circulatory reactions are frequently not very considerable ; they are on the contrary more marked in the cases of subacute pleuro-pneumonia, or of subacute lesions surrounding chronic lesions, or of chronic lesions imperfectly encysted. In order to be well able to

appreciate a reaction it is therefore necessary to take into consideration the previous state of the animal, and the difference between this state and the maximum figure expressing the reaction.

One hence sees the necessity of dividing the suspected subjects into at least three groups according to their initial temperatures.

First Group.—Animals whose temperature is near 40° or exceeds 40° , in which case acute lesions may be suspected.

Second Group.—Animals having a temperature of 39° or over, in which one may suspect the existence of subacute lesions, or of simultaneous acute and subacute.

Third Group.—Animals in which the temperature does not exceed 38.5° , and in which one may suspect more or less sequestered chronic lesions.

If the three capital reactions presented themselves in all subjects with a regularly proportional intensity, it would suffice to add them empirically, and to compare the result of the operation with a graphic table representing the characteristic mean reaction.

As this is not always the case it is necessary to recognise a subordination in the reactions, and to know how to appreciate their intrinsic and their relative value.

(a.) In the three groups the circulatory reaction is less important than the others, since it is found to be very elevated in healthy animals. Consequently, if it alone were well marked it would be necessary to guard against concluding that the case was one of pleuro-pneumonia.

For example, two animals of the third group having presented the following reactions: 0.9° for the temperature, 2° and 4° for the respiration, 25° and 20° for the circulation, were healthy.

(b.) On the contrary, the respiratory reaction has a great importance, especially in animals of the second and third groups. Regarded by itself, if it is extremely elevated, it may warrant the gravest suspicions. But in that case the subjects ought to be submitted to a new test after the lapse of some days. If it coexists with a medium circulatory reaction and other secondary disturbances, especially if it is rapidly developed, it indicates the existence of pleuro-pneumonia.

The following shows a case of subacute lesions and a case of chronic encapsuled lesions, where a very marked respiratory reaction was associated in such a way as to warrant a positive diagnosis:—

Subacute lesions	{	Thermic reaction . . .	0.6°
		Respiratory reaction . . .	62
		Circulatory reaction . . .	13
Chronic lesions	{	Thermic reaction . . .	0.6°
		Respiratory reaction . . .	50
		Circulatory reaction . . .	28

The diagnosis would be the same if the respiratory reaction were combined with a medium thermic reaction slightly exceeding 1° .

(c.) In all the groups an exceptionally marked thermic reaction, of 2° , or over, is almost certainly the indication of pleuro-pneumonic lesions. When it coincides with strong circulatory and respiratory reactions it ordinarily indicates a commencing pleuro-pneumonia or one in the way of evolution.

Here are two examples :—

Commencing pleuro-pneumonia	{	Thermic reaction . . .	2·5°
		Respiratory reaction . . .	42
		Circulatory reaction . . .	22
Acute pleuro-pneumonia . . .	{	Thermic reaction . . .	2·3°
		Respiratory reaction . . .	34
		Circulatory reaction . . .	32

Associated with the medium or slight circulatory and respiratory reactions it will indicate rather the existence of sequestra, still imperfectly isolated from the surrounding parenchyma. Such are the following two cases :

Sequestrum	{	Thermic reaction . . .	2·1°
		Respiratory reaction . . .	26
		Circulatory reaction . . .	10
Sequestrum	{	Thermic reaction . . .	2·1°
		Respiratory reaction . . .	5
		Circulatory reaction . . .	4

This last case is very interesting because of the strong thermic reaction.

(*d.*) A moderate thermic reaction, comprised between 1° and 1·8°, which is upon the whole the most frequent, has a great value in animals of the third group, and even in those of the second group, when it is combined with notable respiratory and circulatory reactions. These medium triple reactions indicate sequestra or some old pleural lesions.

I will give several examples of general reactions :

Group 2.

Sequestrum	{	Thermic reaction . . .	1·7°
		Respiratory reaction . . .	30
		Circulatory reaction . . .	52
Sequestrum	{	Thermic reaction . . .	1·2°
		Respiratory reaction . . .	16
		Circulatory reaction . . .	24

Group 3.

Chronic pleuro-pneumonia	{	Thermic reaction . . .	1·5°
		Respiratory reaction . . .	21
		Circulatory reaction . . .	25
Sequestrum	{	Thermic reaction . . .	1·5°
		Respiratory reaction . . .	11
		Circulatory reaction . . .	26
Chronic pleurisy	{	Thermic reaction . . .	1·8°
		Respiratory reaction . . .	16
		Circulatory reaction . . .	20

(*e.*) Feeble thermic reactions, below 1°, are not always to be neglected. They may suffice to indicate acute pleuro-pneumonia, if they

occur in a case where the temperature was previously very elevated, and the respiration and circulation were previously accelerated, with symptoms of acute disease. In such a case the respiratory and circulatory reactions, or the latter alone, are sometimes negative.

The following is an example of this kind :—

Acute pleuro-pneumonia	{ Thermic reaction . . .	0.6°
	{ Respiratory reaction . . .	4
	{ Circulatory reaction . . .	8

The following are two other cases where a thermic reaction of 1° was combined with a negative respiratory reaction :

Acute pleuro-pneumonia	{ Thermic reaction . . .	1°
	{ Respiratory reaction . . .	—4
	{ Circulatory reaction . . .	+8
Acute pleuro-pneumonia	{ Thermic reaction . . .	1.1°
	{ Respiratory reaction . . .	—10
	{ Circulatory reaction . . .	+18

(f.) But if these feeble thermic reactions are offered by animals of Group 3, in which the initial temperature oscillates between 38° and 38.5°, and in which the pulse and respiration are calm, it is necessary to act with reserve.

In the experiments made with M. Robcis more than half of the subjects that presented a thermic reaction inferior to 1° were exempt from chronic pleuro-pneumonia.

However, the line to be followed varies according to the value of the other reactions.

If the respiratory reaction and the other functional disturbances have been of a certain importance one will submit the subjects to a new test ; if necessary, the dose of pneumobacillin may be increased when the animals are of large size.

If all the reactions have been as feeble as the thermic reaction one will form a negative diagnosis.

Despite the care in establishing a subordination between the functional disturbances, and in basing one's judgment on the combined reactions and not on any one in particular, one is exposed to making some mistakes.

In certain very rare cases the reactions are absent without one being able to find a reason for it. Thus, a subject of the third group that carried several sequestra presented the following reactions, which were such as to warrant one in concluding that the animal was not the subject of pleuro-pneumonia :

Thermic reaction	0.3°
Respiratory reaction	2
Circulatory reaction	8

In other circumstances the reaction is not absent, but there are produced reactions *apropos* of affections which have nothing to do with pleuro-pneumonia, such as tuberculosis, echinococcus cysts in the lung, lobular and interlobular alterations set up around a piece of straw which has penetrated into the bronchioles—alterations which one sometimes encounters in the ox.

I relate here examples of these cases :

Tuberculosis .	{	Thermic reaction .	1°	.
		Respiratory reaction .	24	
		Circulatory reaction .	6	
Echinococcus .	{	Thermic reaction .	2.5°	
		Respiratory reaction .	14	
		Circulatory reaction .	14	
Particle of forage	{	Thermic reaction .	1.3°	
		Respiratory reaction .	6	
		Circulatory reaction .	6	

There, it is true, with the exception of the thermic reaction, the other characteristics have been very feeble.

On one occasion the effect of pneumobacillin was tried on a cow suffering from mammitis. All the reactions were very marked, as one may judge from the following figures :—

Mammitis {	Thermic reaction . . .	2.7°
	Respiratory reaction . . .	86
	Circulatory reaction . . .	22

Finally, some animals, apparently healthy, showed themselves so sensitive to medium doses that one might have supposed them the subjects of pulmonary or pleural lesions. However, in these animals it is very rare to find the three capital reactions in combination.

That is shown in the following example :—

Thermic reaction	1.4°
Respiratory reaction	19
Circulatory reaction	10

Here the three reactions are medium and sufficient. I will cite a second where the respiratory reaction was almost altogether absent :

Thermic reaction	1.4°
Respiratory reaction	4
Circulatory reaction	12

These failures or false reactions do not apply exclusively to pneumobacillin. The other known diagnostic agents, tuberculin and mallein, also present them more or less.

The diagnostic agents have nothing absolutely specific. By their action on the media of the organism and on the nervous system, by their vaso-dilatator influence, exercised particularly in a reflex way around the material lesions of the tissues, they light up fever, either directly or indirectly, by the aid of the pyrogenic products which are formed to an excessive extent in the diseased elements.

In support of this I may here cite the equivalence of the thermic reaction which I produced in eight horses, glandered or suspected of glanders, with mallein and pneumobacillin.

However, if the diagnostic agents have nothing specific, nevertheless one cannot be used to take the place of the other in every case, for they possess ordinarily a particular adaptation which makes it preferable to employ one reagent rather than another for a particular disease.

Thus pneumobacillin produced sufficient thermic reactions in the case of glands, but it caused local reactions which were less extensive and less distinct than mallein did. There is therefore reason in such a case to prefer mallein.

Conclusions.—The use of pneumobacillin as a means of diagnosing pleuro-pneumonic lesions requires a more attentive and more complex observation than mallein and tuberculin do in the diseases for which they are respectively used.

Save in exceptional cases the thermic reaction alone does not enable one to form a judgment. It is necessary to consult and weigh all the terms of the characteristic reaction.

The thermic reaction is in some way exceeded by the respiratory reaction.

When these two reactions coexist and the second is important, the existence of pleuro-pneumonia is almost certain.

The diagnosis is easiest if all the three elements of the characteristic reaction are present in a marked degree, and it is still more easy if this is accompanied by other very marked functional disturbances, having their seat in the glandular or muscular systems.

The value of the reaction is not absolute; it is subordinate to the previous state of the temperature, pulse, and respiration.

The thermic reaction in particular is subordinate to the previous state; a feeble reaction may be important in cases where the previous temperature has been very elevated or almost normal.

Very complete observations ought to be taken every two hours, starting from the moment of injection, and continuing for eight hours at the least or twelve hours at the most.

The practitioner may modify this rule according to his personal experience.

The use of pneumobacillin thus requires attentive observation and an enlightened and prudent appreciation.

It will render service in stamping out pleuro-pneumonic outbreaks of all sorts, particularly recent outbreaks. It will denounce especially the subjects which carry circumscribed lesions, subjects which after some days of ill-defined sickness recover the appearance of health, and threaten to conserve the virus for a long time in the pulmonary sequestra; it will also denounce the existence of other pulmonary lesions, tuberculous or parasitic.

The method of diagnosis which I recommend is capable of some improvement. That may come from a more extensive practice, and perhaps from a greater ability to prepare pneumobacillin more exactly adapted to the reactions which one desires to provoke.

RABIES IN INDIA.

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I FIND on reading the veterinary papers that there has been a considerable increase in the number of cases of rabies in England during the past year, and thinking it might interest practitioners at home to compare the disease as it shows itself in India, I have penned the following notes.