parasites to renew their activity. Staining experiments appear to show that the syphilitic parasite has a prevailing positive (hydrogen) charge on its surface, therefore in late syphilis the protein particles correspond in many ways to the parasites they are attacking. The changes the protein particles in the serum undergo also take place in the protein particles which form the protoplasm of lymphocytes and plasma cells. Where cells are concerned, should these changes be pushed too far, the source of supply of these particles is attacked—namely, the nucleoli. When this is the case the particles become so physically altered as to behave as parasites themselves to the cells surrounding them, a condition of auto-parasitism which I believe malignant disease to be. If correct, then a parallel exists between these experiments undertaken with serum and cerebro-spinal fluid in vitro and the changes which the protein particles undergo in vivo when they are pushed to resist an injury, a poison or a parasite, and in the attempt become malignant. A point worth mentioning in favour of the view that certain of the protein particles in a syphilitic serum are lipoid-globulin bearing a positive charge and simulating parasites is the fact that the body does attempt to get rid of them. In early syphilis they are excreted through the glomerular membrane of the kidney, likewise may be the case in late syphilis, thereby accounting for the fact that many of the cases of syphilitic proteinuria are not due to nephritis but to ultra-filtration from the blood. In late syphilis they may also be excreted into the peritoneum, giving rise to the condition called pseudo-chylous ascites. The particles which appear in the cerebro-spinal fluid in cases of degeneration and which are responsible for the gold-sol reaction are also in my opinion excreted particles which possibly get into the cerebro-spinal fluid by ultra-filtration through the choroid plexuses.

Summary.

1. Shaking a cerebro-spinal fluid with toluene, xylene, or benzene the day after it is withdrawn will enable one at once to determine whether the lesion is degenerative or not.
2. This test may be still further confirmed by treating another portion of the fluid with formaldehyde before it is shaken with a hydrocarbon.
3. The various proteins merge into one another; there is no hard-and-fast line between albumin and globulin, and globulin and lipoid-globulin. The differences between them are physical rather than chemical.
4. The complement-fixation test is regulated by the ions on the surface of the protein particles—their number and electric charge.
5. The gold-sol test is dependent upon the presence of certain protein particles (lipoid-globulin) which have a prevailing positive electric charge on their surface.
6. The gold-sol test carried out with distilled water will readily serve to distinguish a normal fluid from a fluid from a case of degeneration, because the latter only will precipitate the colloidal gold and in the first few tubes only. This may be confirmed with the fluid pipetted off from the hydrocarbon emulsion, because only those fluids from cases of widespread degeneration will precipitate colloidal gold. A diminution in the precipitation of colloidal gold in the first tube when the fluid has been treated with acetic acid indicates degenerative encephalitis (G.P.I.). This may be confirmed by the slight precipitation which occurs in fluids which have been treated with ammonia and allowed to rest before being tested and which is only met with in cases of degenerative encephalitis.
7. The lipoid-globulin particles simulate parasites in certain ways and those found in the cerebro-spinal fluid in degenerative cases are waste products which have reached the fluid by ultra-filtration through the choroid plexuses.
8. Treating a normal fluid and serum with an acid makes the protein particles therein approach as near as possible to those normally met with in syphilis.

In my opinion these further experiments go some way to support the views I have been expressing for some years on the rationale of immunity and chemotherapy. Finally, I wish to express my deepest gratitude for the valuable assistance given to me by my co-workers, Dr. R. L. Mackenzie Wallis, Mr. J. Patterson, and Mr. J. Ward.

TREATMENT OF DIPHTHERIA CARRIERS WITH DETOXICATED KLEBS-LÖFFLER VACCINE.

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THE problem of the human carrier of bacterial infection is one of ever-increasing importance and one which must be grappled with very seriously in the near future. The term "carrier" denotes a person who harbours virulent pathogenic organisms and is capable of infecting others, though not himself exhibiting any of the clinical signs of the disease. No effort has been made to deal with this great danger to the community by legislation, with one trifling exception.¹ Until carriers can be cured or the occurrence of carriers prevented, little can be done in the way of law-making; the problem is exceedingly difficult and complicated and the carrier much more common than is frequently imagined. In the United States some legislative effort has recently been made to deal with the question. For example, Illinois has prohibited typhoid convalescents from handling milk, food, and so on, until the excreta are certified bacilli-free. A substantial fine (\$200) is imposed for each offence. In this country, however, there is little incentive to search for carriers, and our facilities for dealing with them successfully when found are very limited and unsatisfactory.

C. E. Simon² has emphasised the grave importance of the carrier problem in no uncertain manner. He estimates that in 1915 there were in New York 2679 diphtheria carriers; he hopefully assumes that there must have been roughly 25,000 typhoid carriers. It may be conceded that control of the typhoid carrier is easier than that of the diphtheria carrier who disseminates his organisms constantly at all times and in all places. Lacking absolute curative measures, adequate legislation would involve the rigid control of all convalescents and the quarantine of all detected carriers, whether convalescent, contact, or non-contact. This is obviously impracticable; the only alternative is some workable measure whereby the activities of such carriers may be limited. As a general rule the latter are searched for only after a serious epidemic. Were it not so, the number of known carriers would be very much increased. Cases of delayed resolution after diphtheria, where the bacilli persist for periods up to three months, are well known and not uncommon. These frequently clear up spontaneously, and, as has already been shown by J. L. Brownlie,³ can be readily cured by small doses of stock diphtheria vaccine. F. M. Wood⁴ also has claimed that by employing his vaccine-antitoxin treatment of diphtheria the possibility of a "positive throat" and, later on, of a true carrier being established is removed. He thinks that the ultimate result of this treatment when used for cases of diphtheria, for "positive throats" and carriers, and for immunising contacts, would be the complete control of diphtheria epidemics.

The "Positive Throat."

We must differentiate between the "positive throat" and the true diphtheria carrier. In the former the bacilli may disappear spontaneously and with energetic treatment will clear up within a reasonable period. The throat which will not clear up, however, and in which the diphtheria bacilli persist with unabated virulence in spite of the most energetic measures of disinfection, constitutes the true carrier. He may harbour these virulent bacilli for indefinite periods and the organisms do not lose their virulence with the lapse of time. He may, however, develop a clinical diphtheria at any time. (Only the virulent bacilli will kill a guinea-pig.) While one must admit that the results of the long and varied list of disinfectant measures and other so-called curative agents have been exceedingly futile, a very considerable percentage of early "positive throats"

were successfully cleared up in the long run. This type of throat proved to be readily curable by one or two doses of stock diphtheria vaccine. Many of the early "positive throats," which doubtless would have baffled disinfectant measures, also responded to this treatment when tackled early. The treatment of the "chronic throat" by stock vaccines proved infinitely superior to the unreliable local antiseptic throat applications. Up to the present time, however, we are aware of no previous effort which has successfully cured the true, well-established diphtheria carrier.

Immunity.

Immunity results from the activities or products of the living tissue cells. Its nature is complex, as also are the factors which influence it. Leonard Hill⁵ has shown that natural immunity is greatly influenced by metabolism—depression of the basal metabolism lowers resistance, and vice versa. Further, the toxicity of a bacterium depends on the balance between the toxin and its specific antibody. By altering their relationship, the toxicity of a bacterium may be proportionately enhanced or diminished.⁶ The relation of an individual to any pathogenic organism may be one of hypersensitivity, susceptibility, or immunity. On complete recovery from an infection there is an enhanced immunity towards the specific organism for a time. This rise of resisting power can be secured by injections of vaccines, by injections of foreign proteins, or by other artificial means which secure a rise of temperature. We have, therefore, a specific and a non-specific immunity. The latter may be, in certain cases, more effective than the former on account of the fact that many of the specific vaccines so far at our disposal have been rendered ineffective by the presence of a high toxin content. Since, as a rule, endo-toxin does not appear to produce, or in any way aid the production of, specific antibodies, its presence in any vaccine is a definite handicap in that it limits our dosage and in most cases ties us down to a dose-maximum which is inefficient. The dosage of any vaccine is most important. It should always be the largest possible, consistent with the absence of any general shock reaction. With a toxic vaccine the largest possible dose is usually very small and inadequate, and the amount of antibody formation is proportionately minute. In the case of a foreign protein which, though a non-specific entity, successfully produces a specific antibody, the general upset is nil, but the rise in temperature is very marked; such a foreign protein might be a colloidal protease. This would secure an adequate specific antibody production without the general upset of "protein shock." This it accomplishes by the aid of, or through the resulting production of, a very definite rise of temperature.⁷ It would be interesting to know what influence the process of immunisation has upon the basal metabolism.

That a carrier possesses a certain amount of immunity seems reasonable. It is clear, however, that a rise of his immunity curve to a considerable degree is necessary before his antibody armament can deal successfully with the organisms which he harbours. His immunity would seem to be usually sufficient to inhibit the organisms, but quite insufficient to exterminate them; in other words, there is a balance of power. The clinical effect of a detoxicated Klebs-Löffler vaccine in increasing the immunity is well demonstrated in the following cases. (We were a little surprised to find that in these a mixed vaccine was unnecessary.) It has been suggested that detoxicated vaccines prepared after the manner of D. Thomson⁸ have the power of producing an artificial rise of the immunity curve without a corresponding improvement in the clinical picture.⁹ This has never been our experience; the effect of the detoxicated vaccine in causing the degeneration and disappearance of bacilli in carriers of several years' standing is illustrated in the cases we quote. Such a degeneracy in morphological appearance of the cultured organism, followed by its complete disappearance, was noted in the "positive throat" cases treated by stock diphtheria vaccine by Brownlie.³

A. Zingher¹⁰ has shown that so far any effort in isolating and treating diphtheria carriers has accomplished little or nothing in securing the cure of the

carriers or the diminution of the incidence of diphtheria. He maintains that every infant below 12 years of age should be actively specifically immunised with toxin-antitoxin. It would seem that prophylactic injections of a detoxicated Klebs-Löffler vaccine in doses of 200 to 8000 million in the case of infants and 8000 to 200,000 million in the case of adults would give a considerable degree of immunity. Such doses may be given without risk of any general or local reaction whatever.

Cases.

Towards the end of 1919 Case 2 was treated at our suggestion on the lines of non-specific immunisation. The general reaction was severe and the dosage difficult to regulate. Virulent bacilli persisted, however, and for several reasons the effort was abandoned. Specific immunisation, when possible, would seem to be much the more powerful, especially when such a non-toxic agent is available, but doubtless there is a large field of usefulness for the non-specific treatment. At the moment other long-established carriers, both of typhoid and diphtheria, are under treatment on the lines of specific immunisation indicated; their progress is decidedly promising. The three cases detailed below show the results attainable.

CASE 1.—X., a married woman, aged 52, had a severe attack of diphtheria in September, 1918, followed by pharyngeal paralysis. She was discharged from hospital after two negative swabs, her stay having lasted four weeks. We were unable to discover whether these swabs were taken from throat and nose, or throat only. In March, 1919, she had a nasal polypus removed. In January, 1920, three children whom she looked after took diphtheria, and a swab showed that she still harboured bacilli. Local treatment failed to affect the bacilli in any way, and on April 9th, 1920, 18 months after her attack of diphtheria, her throat swab showed abundant organisms present. On this date treatment with detoxicated Klebs-Löffler vaccine was commenced. Table I. is an account of the treatment received and progress made:—

TABLE I.

Date in 1920.	Dose of K.L. vaccine (millions).	Method of administration.	Maximum pulse.	Maximum temp.	Pathologist's report.
9/4	200	Subcut.	62	96.8	Positive.
13/4	300	"	68	97.8	"
17/4	600	"	70	96.8	"
21/4	1200	"	70	97.0	Involution forms.
25/4	2400	"	80	97.0	Negative.
29/4	3600*	"	68	97.6	Involution forms.
3/5	200	Intraven.	68	97.4	Negative.
7/5	400	"	70	96.4	Non-lethal to guinea-pig.
11/5	800	"	70	96.6	Negative.
14/5	1600	"	80	97.0	"
19/5	3200	"	78	97.0	"

* Vaccine supply running short.

All subsequent swabs have been negative. During the above vaccine course she had no other treatment whatever. She improved in general health in the most remarkable manner, and the psychological effect of being informed that she was on the road to cure was equally marked.

CASE 2.—Y., a girl, aged 12, was discovered to be a carrier during an outbreak of diphtheria in March, 1917. She was held responsible for three consecutive outbreaks, during which three deaths occurred. From that time onwards she was kept under close observation, and regular throat and nose swabs were taken. These in every case proved positive. During the years 1918 and 1919 she was four times in hospital for considerable periods, but all efforts to destroy the organisms were unavailing. From May to July, 1918, she underwent a course of "606" treatment. She has a characteristic saddle nose, quite devoid of septum, and showing an exceedingly unhealthy naso-pharynx. An effort was, therefore, made to improve this condition before proceeding further with the endeavour to eradicate the diphtheria bacilli. The latter, however, persisted. In the latter part of 1919 non-specific immunisation was tried unsuccessfully. On April 29th, 1920, she came under our care, and a swab taken at that time proved positive. The organism which she had harboured over a period of at least three years proved lethal to a guinea-pig on May 7th, 1920. After a course of vaccine treatment she was entirely free from bacilli, and was returned to her home. She received no other treatment, either general or local, during her vaccine course (Table II.).

Two months later a Klebs-Löffler bacillus was again demonstrated in her nose. It proved, however, non-lethal to a guinea-pig. During these months this patient had

constantly nursed a baby sister, and also an infant of a next-door neighbour. She had, moreover, slept all the time in a bed with two younger twin sisters. At the date of this positive swab a similar organism was demonstrated in the noses of both these sisters. In no case have any symptoms supervened. This clinical evidence supports the pathological finding that the organisms present are not those which give rise to the disease diphtheria, although similar in

TABLE II.

Date in 1920.	Dose of K.L. vaccine (millions).	Method of administration.	Maximum pulse.	Maximum temp.	Pathologist's report.
29/4	100	Subcut.	62	97.0	Positive.
3/5	200	"	72	97.0	"
7/5	400	"	72	96.8	Lethal to guinea-pig.
11/5	800	"	80	96.8	Positive.
14/5	1,600	"	76	97.0	"
19/5	3,200	"	72	97.0	"
4/6	6,400	"	84	96.8	"
8/6	8,000*	"	74	97.0	Negative.
12/6	8,000*	"	86	97.0	"
16/6	16,000	"	70	96.6	"
21/6	32,000	"	74	96.8	"

* Vaccine supply running short.

morphology. That is, the organisms may be an essentially different type, or they may be the original strain denuded of all virulence by the treatment. The former theory seems the more likely, but even if the latter be correct, the practical point that emerges is that not a trace of virulence returned to the organism on passage through the throats of the twin sisters of the case. However, the course was given, as shown in Table III.:

TABLE III.

Date in 1920.	Dose of K.L. vaccine (millions).	Pathologist's report.
15/9	—	Positive, but non-lethal to guinea-pig.
16/9	40,000	Positive.
20/9	80,000	Positive, but non-lethal to guinea-pig.
24/9	160,000	Negative.
29/9	250,000	"

She was sent home on 6/10/20. Meanwhile the positive throats of the contact children already mentioned had cleared up without any treatment and without developing symptoms of any sort.

CASE 3.—Z., a soldier, 26 years of age, was wounded very severely in the face in Belgium on August 2nd, 1915. The nose was completely blown off by a sniper's ricochet bullet. The wounds were cleaned at the base, and two further operations were undertaken four weeks later, while nine weeks later still, at Grayson-road Ear and Throat Hospital, two further operations were performed. At this time the patient had erysipelas, from which he recovered. He was then discharged from the army and admitted to Queen's Hospital, Sidcup, where two plastic operations were performed. These included a graft from a rib cartilage in April,

TABLE IV.

Date in 1920.	Dose of K.L. vaccine (millions).	Pathologist's report.
12/7	4,000	Throat and nose positive.
6/7	12,000	" " "
20/7	24,000	" " "
5/8	48,000	Throat and nose involution forms only.
9/8	96,000	Throat and nose positive.
13/8	120,000	Nose involution forms, throat negative.
17/8	100,000*	Nose positive, throat negative.
21/8	150,000	Nose involution forms, throat negative.
25/8	200,000	Nose positive, throat negative.
30/8	250,000	Nose involution forms, throat negative.
3/9	300,000	Non-lethal to guinea-pig.
7/9	350,000	—

* Supply of vaccine had run out.

1918, which was very successful. He was discharged from hospital and proceeded to his home, where, in August, 1918, three cases of diphtheria occurred. The patient himself had no attack, but Klebs-Löffler bacilli were demonstrated in his nose, and were found to be virulent. Ever since that date these organisms have persisted, and numerous animal inoculations over this period of 23 months showed the organism had lost none of its virulence.

Treatment with detoxicated Klebs-Löffler vaccine was undertaken on July 12th, 1920, and an intensive course proceeded with. Involution forms appeared on August 5th, and

on Sept. 3rd the organism proved non-lethal to a guinea-pig. All the doses of vaccine were given subcutaneously, the patient travelling 20 miles by rail to receive the injections, and returning home the same day. On no occasion did he experience the slightest reaction or trace of discomfort, either generally or locally. The vaccine was supplied to us in strengths of 2000, 20,000, and eventually 100,000 millions per c.cm.

Table IV. is an account of the dosage employed, accompanied by the pathologist's reports.

Suggested Course.

In each of the tables above a check in the increase of dosage will be noticed. The reason for this was that the initial stock of vaccine had run out before the arrival of new supplies. The following course might be suggested as suitable for the treatment of chronic diphtheria carriers. (Table V.)

TABLE V.

Day.	Dose in millions (subcutaneously).	Dose in c.c.	Pathologist's report.
1	5,000	0.05	On swab and effect on guinea-pig.
5	10,000	0.1	—
9	20,000	0.2	—
13	50,000	0.5	On swab.
17	100,000	1.0	—
21	120,000	1.2	On swab.
25	150,000	1.5	—
29	200,000	2.0	On guinea-pig inoculation.
33	250,000	2.5	—
37	300,000	3.0	On swab.
41	320,000	3.2	—
45	350,000	3.5	On guinea-pig inoculation.

* Continue the swabbing monthly; should bacilli reappear continue thus:—

Day.	Dose in millions (subcutaneously).	Dose in c.c.	Pathologist's report.
1	50,000	0.5	On guinea-pig inoculation.
5	100,000	1.0	—
9	200,000	2.0	—
13	300,000	3.0	On swab.

By such repeated short courses (when they are required) at, say, three-monthly, and, later, six-monthly intervals, the patient's immunity will be maintained at its maximum.

Concluding Observations.

The length of time during which these cases were carriers of virulent bacilli is important. Since vaccines when given in sufficient doses can have such a marked effect on the virulence of the organism or on the organism itself in such difficult cases they will certainly cure convalescents where resolution is delayed. This has been pointed out by Brownlie.³ It is generally conceded that the convalescent with an otherwise unhealthy naso-pharynx is most prone to become a chronic carrier. Here we have a point in common in all three cases quoted; in the first a nasal polypus, in the second congenital syphilis, and in the third a gun-shot wound. The first had an attack of diphtheria, while the other two had not. In spite of these ideal conditions for bacterial growth disappearance of the virulent diphtheria bacilli followed detoxicated vaccine treatment. Other organisms with the same morphology, but non-pathogenic, can still flourish on the site, as a mixed vaccine was not used.

Exactly what determines the chronicity of carriers is not yet by any means clear. We are still unaware of the mechanism whereby the convalescent with delayed resolution becomes free. In spite of a multitude of varied efforts, no certain means of clearing up chronic carriers has yet been evolved. The cure of carriers is the most hopeful form of prophylaxis. One would expect the vaccine to confer more or less protection on those exposed to infection. Here we have, then, a method of promising efficiency in dealing with contacts, convalescents, and carriers. Antitoxin protects only from the toxin produced by the living Klebs-Löffler bacilli in the tissues. The vaccine prevents the growth and life of the bacilli. In a case of diphtheria both vaccine and antitoxin should be given. The advantages of dosage allowed by employing detoxicated vaccine must not be overlooked. The dosage employed in Case 3, with good effect and no trace of general or local reaction, is particularly striking.

It is with pleasure that we express our thanks to Dr. J. P. Watt, medical officer of health, Aberdeenshire, for placing these carriers at our disposal, and for a detailed history of Case 2; to Dr. Harry J. Rae for facilities for dealing with Case 3; and to Messrs. Genatosan, Ltd., 12, Chenies-street, W.C., for keeping us supplied with vaccine in constantly varying strengths at a time when dosage was an unknown quantity.

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FURTHER EXPERIMENTS FOR PRESERVATION OF LEMON-JUICE.

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THE preparation of a concentrated form of lemon-juice conserving its antiscorbutic properties has been described in a previous report (April, 1920).¹ The juice of fresh lemons is evaporated down in vacuo at room temperature to a specific gravity of 1.3; it is then a dark yellow, viscid, and very acid fluid, easily made into solid tablets with lactose, &c., and keeping well either in the concentrated juice or tablet form. (In the laboratory preparation of the tablets a small proportion of gum tragacanth was added to give firmness to the final product. In a manufacturing process the great compression available will enable the addition of gum to be dispensed with, and it is essential that it should be as its presence very seriously diminishes the solubility of the tablets.)

The following additional experiments have been carried out.

Keeping Properties of the Concentrated Juice.

(a) A basin of the evaporated juice was exposed for half an hour to the air, then covered and kept in the dark at room temperature. After one, two, and three months this showed neither growth of moulds nor evidence of fermentation. (b) Test-tubes of the juice were heavily inoculated with *aspergillus*, *penicillium*, and *mucor*; no growth has taken place. It is therefore evident that the concentrated juice may be kept indefinitely without becoming mouldy or fermenting. This is probably due to the intense acidity and viscosity; on dilution of the juice with water it rapidly becomes contaminated with bacterial growth. Commercial malt extract behaves in much the same way.

Animal Experiments.

These were carried out to determine whether short periods of exposure to a high temperature, or longer periods at a lower one, could be used without destruction of the antiscorbutic properties for (1) preservation of the original lemon-juice before transit to England; (2) assistance in concentration of the juice in England for preparation of tablets or storage in this concentrated form. Young guinea-pigs of about 300 g. were used. The basal diet was ship's biscuit 40 g., milk sterilised for one and a half hours, 60 c.cm. liq. calcis, and a feed

of bran and oats one day per week for anti-beri-beri vitamins. The cages were large, and the room was warm though well ventilated.

First series.—Fresh filtered lemon-juice boiled for five minutes before concentration. Four animals were given daily 1/5 tablet equal to 4.4 c.cm. of fresh lemon-juice. One died on twenty-ninth day, all the others grew normally. Two animals were given 1/10 tablet, equal to 2.2 c.cm. of fresh lemon-juice; both did quite well. One animal was given 10 c.cm. of boiled de-acidified lemon-juice daily; this also grew quite well. Thus 6 out of 7 treated with lemon-juice which had been boiled for five minutes were completely protected over a period of 90 days.

Second series.—Fresh filtered lemon-juice heated to 58° C. for 45 minutes before concentration. Four animals were given daily 1/5 tablet, equal to 4.4 c.cm. of fresh lemon-juice; one of these began to lose weight on the fifty-third day and died apparently from inanition on the sixty-ninth day, no signs of definite scurvy being present. Two were given 1/10th tablet, equal to 2.2 c.cm. of fresh juice. In one progressive loss of weight began on the sixtieth day, on the sixty-fifth day marked paralysis of the hind legs developed, with painful joints; on the seventieth day the subject was put on normal diet and recovered slowly, though the knees remained stiff from contraction, probably fibrosed clots. Thus two of the six animals showed signs of deficiency disease, but in neither were scurvy signs marked. It would appear that though protection was given it was not so complete as in the animals treated with the unheated juice or with the juice boiled for five minutes only, and it follows that boiling for a short period which would sterilise the lemon-juice does not destroy the antiscorbutic factor.

Controls.—Two animals were fed on basal diet only. These began to lose weight on about the twenty-fifth day and both died, one on the thirty-ninth and

Graph showing growth of guinea-pig 37 (receiving 1/10 tablet, equivalent to 2.2 c.cm. of lemon-juice, boiled for 5 min.), and of guinea-pig 47 (receiving 1/10 tablet of lemon-juice, heated at 58° C. for 45 min.). ——— No. 47. - - - - - No. 37.

one on the forty-first day. General scurvy signs and enlarged suprarenals were found post mortem. Two animals were given 1 c.cm. of fresh whole blood daily with the basal diet. One showed signs on the twenty-fifth day and became steadily worse, with faceache position, diarrhoea, ophthalmia, and great emaciation; on the twenty-seventh day it was given cabbage ration and made a complete recovery. The second showed signs on the twenty-fifth day and died on the thirty-eighth. Post mortem there were marked gastro-intestinal changes, with enlarged wrist-joints and suprarenal bodies. The addition of fresh blood to the diet appeared to give rise to intestinal fermentation and did not prevent the onset of signs of deficiency disease in guinea-pigs.

¹ See THE LANCET, May 22nd, 1920 (p. 1102).