The head master was informed that I did not guarantee, and indeed did not expect, that all of these sixteen boys had ceased to be carriers; it was considered that the risk of massive infection from them had, at any rate, been eliminated, and, moreover, that after all the Schick-positives had received a course of immunizing injections it might be advantageous to turn some carriers loose among them to encourage the development of complete herd immunity, even at the expense of an isolated case or two of mild clinical diphtheria.

A Daily Routine Examination

With the object of ensuring early detection of any new case of diphtheria a daily routine examination of all pupils was for the first fortnight included in Miss Draper's search for carriers. Thereafter the daily examination was carried out by the school nursing staff, and was limited to the Schick-positives, who were examined daily for another three months. Dr. Cooke or I was informed immediately of any clinical condition suggestive of diphtheria. In this way there were discovered three cases of faucial diphtheria, H. S., E. S., and A. P., whose illnesses commenced respectively on February 22nd, March 2nd, and March 12th, 1933. All three were Schick-positives who had received the first injection of 1 c.cm. Schick-prophylactic T.A.F. All three had comparatively mild attacks of diphtheria, and made very rapid recoveries. This may be contrasted with the course of the illness of the first four patients, of whom one died, one almost died, one developed severe and long-lasting post-diphtheritic paralysis, and the fourth had quite a severe illness.

While the comparative mildness of the diphtheria exhibited by H. S., E. S., and A. P. was probably due in large part to the relatively early administration of the anti-diphtheritic serum, by clinical impression was that their diphtheria was of a mild nature from the onset. If this clinical impression is correct, possible alternative explanations are that, as a result of the first injection of T.A.F., they had developed either a considerable degree of immunity or facility to develop it rapidly when required, or that, owing to the removal of the frankly clinical diphtheria carriers from the school community, they had received relatively small doses of the diphtheria organisms from missed carriers.

Summary and Conclusions

In this residential school of 310 pupils, with exceptional opportunity for droplet infection in the somewhat crowded dormitories, and a synchronous prevalence of scarlet fever, a threatened epidemic of virulent diphtheria was stamped out within five weeks without further fatality and with very little further morbidity. Three agents were used to secure this result: (a) Schick-testing and immunization, (b) detection and temporary isolation of carriers, and (c) routine daily examination of pupils for new cases over a period of three and a half months.

All three agents played a vital and separate part in securing the good results obtained. The Schick-immunizing agent employed was T.A.F.—two 1 c.cm. injections being given at four weeks' interval. No general or local secondary reactions of any magnitude were observed. From the administrative point of view it should be emphasized that the great virtue of T.A.F. as an immunizing agent is that it seldom causes any undesirable secondary reaction. A diphtheria-immunizing agent capable of producing immunity with one injection and with greater rapidity than T.A.F. is greatly to be desired; but unless such an agent compares favourably with T.A.F. in respect of secondary reactions it should not replace it for general use. We do want a diphtheria-immunizing agent comparable with small-pox vaccination for certainty and

speed, but not at the expense of comparison with vaccination for severity of general and local reaction.

The experience outlined above suggests that Schick-testing and T.A.F. immunization, combined with detection and temporary isolation of carriers and adequate precautions to ensure early detection of new cases of diphtheria, will suffice to stamp out quickly a threatened epidemic of virulent diphtheria without further mortality, with little further diphtheria morbidity, and with no appreciable undesirable secondary reactions, in any community where the necessary administrative procedures can be carried out efficiently. If T.A.F. can do so much it should not be too readily discarded for "one-shot" diphtheria-immunizing agents until, as already stated, one is secured which compares favourably with T.A.F. in regard to absence of undesirable secondary reactions.

UNDULANT FEVER AND CONTAGIOUS ABORTION IN NORTHUMBERLAND

BY

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The results of the examination of a first series of Widal sera for agglutinins to *Br. abortus* were recorded in a previous note (Messer, 1932). The investigation has been continued, and in the past three years sera from 425 patients have been examined. In sixteen (3.7 per cent.) of these a diagnosis of undulant fever was considered justified on serological and clinical grounds, the serum titres being as follows:

1 in 125 ...	2 cases	1 in 1,500 ...	5 cases
1 in 250 ...	1 case	1 in 2,000 ...	2 cases
1 in 1,000 ...	2 cases	1 in 3,000 ...	2 cases

In the remaining two cases complete agglutination occurred in a serum dilution of 1 in 250, but the end-titre was not ascertained; fifty of the sera agglutinated *R. typhosus* and eighty-nine *B. paratyphosus* B in significant titres. The bacterial suspensions used were those supplied by the Oxford Standards Laboratory and the minimum "reduced titre" observed among the sixteen cases of *abortus* infection was 62.5.

Some discussion has centred round the significance of the agglutination reaction in the diagnosis of undulant fever. The consensus of opinion, however, with which the experience here recorded agrees, is that the test has much the same value and limitations as the Widal reaction in enteric infection. Both tests require to be interpreted in the light of what is known of the distribution of antibodies in the population at large, and having regard particularly to the occurrence of agglutinins resulting, in the case of enteric infection, from preventive inoculation, and, in the case of undulant fever, from the latent infections which are especially liable to occur in certain occupational groups. The difficulties thus arising are, however, simplified to some extent by the fact that a majority of active *Brucella* infections are accompanied by antibodies reacting in high dilution—1 in 1,000 or more—and such titres may usually be accepted as diagnostic. Equivocal results can frequently be elucidated by means of repetition of the test at intervals.

Clinical Features

Clinically, the cases that have been met with may be roughly divided into two groups. The first consists of six cases of a more or less mild—even ambulant—type in which the chief symptoms were headache, fatigue, loss of appetite, weakness, and sweating, especially at night.

Although mild, several of these cases ran a prolonged course. The remaining cases constitute a heterogeneous group in which the illness was of a more acute nature with a very varied symptomatology. Among the initial diagnoses tentatively advanced were enteric fever, tuberculosis, gall-stones, and arthritis. Brief notes of some of the more interesting of these are appended.

CASE I

Male, aged 74, clerk in drapery store. Illness began in August, 1931, with loss of appetite, asthenia, and persistent temperature. No other symptoms or physical signs. Temperature ran a curious course, consisting of sharp febrile bouts initiated by a rigor and lasting five or six days, alternating with varying periods of normal temperature, the illness being described as somewhat resembling malarial attacks. Patient became progressively weaker, and the illness terminated in January, 1932, with rigor, delirium, and death. Serum titre against *Br. abortus*, 1 in 3,000 on November 3rd, 1931.

CASE II

Male, aged 44, dairyman. In October, 1931, complained of pain in right hypochondrium and was sent to hospital with diagnosis of gall-stones. After being under observation for a few days was operated on, but nothing was found. Was transferred to a medical ward till temperature settled, but after return home had haemoptysis, and later numbness of left hand, especially middle, ring, and little fingers, with loss of power for gripping. These symptoms gradually disappeared and he was ultimately able to return to work, the total duration of his illness being about twelve months. Serum titre against *Br. abortus* on November 11th, 1931, 1 in 250. The dairy herd with which the patient worked consisted of tuberculin-tested cattle. Specimens of blood were obtained from all the animals in the herd—twenty-eight cows, one bull, and six calves. Of the twenty-eight cows the serum of two agglutinated *Br. abortus* at 1 in 2,500, ten at 1 in 1,000 (four had been vaccinated), two at 1 in 1,500, two at 1 in 250 (one had been vaccinated), three at 1 in 50, and one at 1 in 25; eight were negative. The serum of the bull was negative. Of the six calves the serum of one agglutinated at 1 in 25, one showed a trace only at 1 in 25, and the remaining four were negative.

CASE III

Female, aged 41, housekeeper on a smallholding. Duties included milking. On October 30th, 1932, suddenly seized with acute abdominal pain and sickness and very severe rigor. When seen was collapsed and shivering. Temperature 101° F., pulse rapid and poor. Complained of severe gastric pain. Next day very much better, and by November 4th insisted on commencing work. Seen again on November 17th. Was then looking very miserable and complained of always feeling cold and tired. Temperature 101.6°. Admitted to hospital for observation and nursing. After admission only symptoms were weakness and night sweats, temperature ranging from 97° to 98° in the morning to 102° to 103° at night. Serum titre against *Br. abortus*, 1 in 2,000 on November 23rd, 1932. Four of the six cows which this patient milked were subsequently found to give positive agglutination reactions.

Contamination of Milk Supply

Since attention was first directed to the occurrence of *Br. abortus* infections in this country a number of observers have reported on the extent to which the milk supply is contaminated with this organism. As regards ordinary market milk the percentage of positive samples varies in different circumstances from about 20 to 40, and recent work by Pullinger (1934) indicates that certified and Grade A (T.T.) milks are equally liable to be infected. During 1932-3 a series of milk samples sent to this laboratory for examination for *B. tuberculosis* was also examined for *Br. abortus*. The method adopted was the demonstration of agglutinins in the serum of guinea-pigs inoculated subcutaneously with the deposit obtained by centrifuging 50 c.cm. of the sample for thirty minutes at 3,000 revolutions per minute, the

animals being killed after six weeks. Two animals were used for each test for *B. tuberculosis*, but only one of each pair was examined for *abortus* agglutinins. A serum titre of 1 in 20 or higher was accepted as evidence of infection. Of 720 samples so examined 145 (20.1 per cent.) were positive; thirty of the samples were of Grade A milk, six (20 per cent.) being positive, while the only sample of certified milk included in the series was also positive. In addition, eighteen (23.6 per cent.) of seventy-six samples from individual animals suspected by veterinary officers to be suffering from tuberculosis were found to contain *Br. abortus*.

Pullinger reports that of 105 samples of non-graded milk from herds in Cheshire thirty-nine (37 per cent.) contained *Br. abortus*, while of 104 similar samples from Somerset only twenty (19.2 per cent.) were positive. He suggests that this difference may be largely accounted for by variation in the size of the herds, though the possibility that the incidence of the disease is actually greater in the former county cannot be excluded. The present investigation affords some results bearing on this point which may be of interest. The majority of the samples were collected directly at farms in the county. In 401 instances the number of animals constituting the herd was stated, and the following table shows the proportion of positive samples according to the size of the herd. Smith (1932), who, however, used a more thorough technique and included cultural as well as agglutination tests, has published data on similar lines relative to Aberdeen, and although the size of the herd was stated in terms of the daily supply in gallons, Smith's figures may be modified for purposes of a rough comparison with the present results as shown in the table, if it be assumed that the average yield per cow is two to two and a half gallons per day.

Number of Cows in Herd	Aberdeen *			Northumberland		
	No. of Samples	No. +	% +	No. of Samples	No. +	% +
1-9	38	24	24.4	235	21	10.2
10-19	102	26	25.5	122	24	19.6
20-29	51	19	37.2	49	18	36.7
30 +	28	10	35.7	25	10	40.0
Totals	279	79	28.3	401	73	18.1

* Modified from Smith.

Epidemiological Considerations

From the epidemiological standpoint no wholly satisfactory account of undulant fever appears to be possible as yet. Foreign opinion seems inclined to regard the disease as an occupational one, but the evidence collected by Champneys (1933) strongly suggests that in this country, while a small proportion of cases are due to direct contact with cattle, the majority result from the consumption of infected milk. Other possible sources of infection, such as contact with pigs, sheep, horses, dogs, or the consumption of milk products such as butter, cheese, ice-cream, are probably unimportant (Smith, 1934). There are certain difficulties in the way of accepting milk as the vehicle of infection, the chief being, first, that the number of (clinical) infections appears to be extremely small in proportion to the number of persons who may be presumed to be at risk, and secondly, that the incidence of the disease falls chiefly on adult males. By way of explanation of the paucity of cases it is suggested that a process of latent immunization takes place analogous to that known or conjectured to occur in other infections, and the age and sex incidence is accounted for

on the supposition that women and children are larger consumers of milk than men and consequently form a more highly immunized group in the community.

This hypothesis, however, itself creates a difficulty, since naturally acquired immunity postulates contact with the infecting agent, and clinical disease may be expected to occur most frequently among those undergoing the immunization process—that is, as regards undulant fever, those having close contact with cattle and those most accustomed to drink milk, presumably children. It has been demonstrated that latent *abortus* infections are much most frequent in the occupation group mentioned than in the population as a whole (Wilson, 1932), and there is some reason to suppose that clinical disease occurs among them more frequently than the recorded incidence would suggest. In this respect, therefore, the hypothesis outlined may not be greatly at variance with the facts. But among children both latent infection and clinical disease are apparently very uncommon, a remarkable circumstance having regard to the known incidence of *abortus* infection of milk. It is possible that the disease manifests itself in a somewhat different manner in children, and in them a mild febrile disturbance is perhaps more likely to escape adequate investigation, its real nature remaining undiscovered. On the other hand the validity of the assumption that children are in fact large consumers of milk may be worth reconsideration. Inquiries such as those of Savage (1926), Gellatly (1933), and Burns (1933) in Somerset, Cambridgeshire, and Durham respectively suggest that the use of milk as a beverage in this country is decidedly rare. One wonders, indeed, whether the

drinking of milk, so far from being common among children, is not rather a habit acquired by adults, and one is led to speculate on the results which may follow the contemplated widespread distribution of raw milk in schools.

It has been suggested that the virulence of *Br. abortus* for man is being gradually increased by animal passage, and that ultimately case-to-case infection may follow and a fresh public health problem arise. Contagious abortion of cattle, however, appears to be a disease of some antiquity. Hull (1930) states that it was recorded by Moscall as long ago as 1567, and quotes from *The Complete Farmer* of 1807 instructions for dealing with infected animals. Any abrupt exaltation of virulence at this stage appears unlikely, but it does seem possible that the virulence of the *Brucellae* may be maintained through the exchange of strains between different animal species.

I desire to express my thanks to Drs. J. C. Yeoman, R. L. Dagger, and J. C. Mackay for permission to publish the clinical notes of their cases, and to Professor T. J. Mackie for advice and criticism in preparing this memorandum for publication.

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PROGNOSIS OF HAEMATEMESIS

A STATISTICAL REVIEW

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When considering the prognosis of any disease it is necessary to carry out a statistical investigation of a large number of cases of the condition. In the case of haematemesis this has been done frequently with conflicting results.

Hurst⁶ (1928) gives a mortality of 2.5 per cent. among cases of haematemesis following peptic ulcers at Guy's Hospital, and suggests that the stomach should be washed out with ice-cold water. At the Bellevue Hospital, New York, Hinton⁵ (1931) found a mortality of 20 per cent. among fifty-two cases of gross haemorrhage. Gordon-Taylor³ (1934) states that at the Middlesex Hospital the total mortality of haematemesis following peptic ulcers treated medically was 24 per cent., and that the mortality in those cases in which a second large haemorrhage occurred was 78 per cent. Aitken¹ (1934) divided the cases of haematemesis at the London Hospital into two groups—moderate and severe. The total mortality of both groups was 11 per cent. Most of the moderate cases recovered, whereas twenty-seven out of sixty-three severe cases died (43 per cent.). Meulengracht⁷ (1933) has recently treated 119 cases with a liberal diet immediately after the haematemesis: there were only two deaths in this series. This appears to be an entirely new method of treatment, the value of which it is difficult to assess. Chiesman² (1932), at St. Thomas's Hospital, reviewed 191 cases of haematemesis and gross melaena following peptic ulcers (occurring during the period 1925 to 1931 inclusive). The total mortality was 27 per cent., but in cases in which the haemorrhage was continued or repeated within twenty-four hours after commencement of treatment a mortality of 74

per cent. was shown. He did not distinguish between the severity of the different cases.

Cases Analysed

We have made a complete analysis of those cases which were admitted to St. Thomas's Hospital during the years 1924 to 1933 inclusive on account of, or with a history of, significant haematemesis or gross melaena occurring within fourteen days before admission, and also of those cases which developed significant haematemesis or gross melaena in hospital.

By significant haematemesis or gross melaena we mean that which is the obvious result of acute bleeding into the intestinal tract, thereby excluding a large number of cases which vomited small quantities of blood or had slight melaena. We have not divided the cases into aetiological groups, because of the difficulty of deciding the cause immediately following admission, and because even on discharge the cause is not proved in a number of cases. This difficulty is emphasized by Shaw⁸ (1933), who referred to Gutman's⁴ figures, in which in 21 per cent. of the cases no cause could be found.

We have divided the cases into two groups, according to their condition on admission to hospital, or (in the few cases which bled in hospital) immediately after the occurrence. Post-operative cases were excluded.

Group 1. Severe.—The cases whose clinical condition led one to suppose that the haemorrhage was severe, or those in which the examination of the blood showed the haemoglobin to be below 20 per cent.

Group 2. Moderate.—The cases whose clinical condition was not grave, or in which the haemoglobin was above 20 per cent.

By employing a strict definition and subdivision of haematemesis and melaena we have excluded a large number of cases which vomited up small quantities of blood or had slight melaena. Further, a number of cases have been placed in the moderate group which, with