UNDULANT FEVER CONVEYED BY MILK*

BY

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I have been asked to open this discussion on milk-borne diseases with a consideration of the part played by milk in the spread of undulant fever. Now I am not going to pretend that in this country undulant fever is either the commonest or the most serious disease conveyed by milk, but its significance in this respect is certainly far from negligible even here, and in some foreign countries it has loomed very large in recent years. One indication of this is that in the time at my disposal it will be impossible for me to deal with more than a small fraction of the evidence which has accumulated of the dangers arising from milk containing organisms of the *Brucella* group.

The first indication of this danger was, as you know, given by Horrocks,¹ who, following up Zammit's discovery² of the natural infection of Maltese goats with the *Brucella melitensis*, found this organism in large numbers in the milk of one of these animals. Further investigations by the British Commission on Mediterranean Fever showed that the blood serum of about 40% of the goats in Malta agglutinated the causative organism and that numbers of apparently healthy goats in every herd were excreting *M. melitensis* in their milk and urine. The outcome of these discoveries was of course the famous order to the naval and military forces at Malta forbidding the consumption of unboiled goat's milk, one of the most dramatically successful prophylactic measures ever taken in the history of preventive medicine.

This step, however, did not end the career of caprine crime, and goats are still spreading this serious disease not only in Malta but in all Mediterranean countries, in the southern portion of the United States, and elsewhere, the chief but not the only vehicle of this infection being their milk. That the same role was being played by sheep was unsuspected until Dubois³ reported in 1910 four groups of cases of *melitensis* infection among sheep on different farms in the department of the Gard (France), with three of which human cases of the disease were associated. Subsequent investigations have clearly established that sheep, so far from being exceptional vectors of the disease, are probably the most important agents of its spread in France. The conditions in that country are, however, exceptional, and in Denmark, Sweden, Germany, Switzerland, Holland, South Africa, Rhodesia, the United States and other countries, among which is our own, the chief agent of spread is not the goat or the sheep but the cow. The story of how the cow came to be suspected and was eventually convicted, starting with Alice Evans's⁴ discovery of the very close relationship between the *Micrococcus melitensis* of Bruce and the *Bacillus abortus* of Bang, I have told elsewhere,⁵ and there is no time for it here. I would like, however, to draw attention to the fact that the view held at first that bovine infection is nearly always conveyed by infected milk has had to be modified in recent years in consequence of the important part which direct contact with infected cattle has now been shown to play in the transmission of infection to man.

I am only concerned now with undulant fever conveyed by milk, and there is good reason to believe that the consumption of cow's milk containing the *Brucella abortus*, the cause of contagious abortion in cattle, has been and still is the commonest cause of undulant fever in Great Britain. Before considering the situation in this country it is essential that I should give a brief account of the evidence in regard to milk recently obtained in countries

where many more cases of the disease have been reported and studied. First of all I must recapitulate a few of the facts with regard to the animal disease known as contagious abortion of cattle and due to infection with the *Brucella abortus*. Bovine animals of both sexes and at all ages are liable to this infection, but the disease is most severe in young heifers. Abortion usually occurs between the fifth and seventh month of pregnancy, but some cows abort about the first or second month. Not only is the disease often unsuspected but even abortion often passes unnoticed. This is largely because, as the British Commission found with the Maltese goats, the animal's general health is usually quite unaffected.

Pathological changes are generally confined to the uterus though the organisms may be widely scattered and the udder usually becomes infected, so that apparently healthy animals may excrete large numbers of *Brucellae* in their milk, the organisms again making their way to the uterus when pregnancy occurs. An important point to note is that something like 80% of aborting cows only abort once, though they may continue to harbour and excrete the organism for a long time after aborting. (Schroeder and Cotton observed a cow which continued to excrete the organism in her milk for seven years.)

Moreover a large proportion (perhaps 50%) of infected cows never abort, and the *Brucella abortus* has often been found in the milk of cows which have never aborted. About 30% of infected cows excrete the organism in their milk sooner or later.⁶ In most countries where cattle raising is of any importance contagious abortion is rife and a serious proportion of the milk supply is infected with the causative organism. In America, for instance, Schroeder and Cotton⁷ found the abortion organism in over 10% of 77 samples of market milk which they examined, and in the milk distributed by 6 out of 31 dairies (over 19%). In Pomerania (Germany) Pröscholdt⁸ examined 3,000 samples of whole milk by guinea-pig inoculation (the most reliable method) and found that 27.5% of these samples contained the *Br. abortus*. Even higher proportions have been found by other observers in different countries. Some infected cows, apparently never excrete the organism in their milk, but such excretion is often intermittent.⁹

In Great Britain, unfortunately, very little work has been done to ascertain the extent to which the milk supply is contaminated with the organism of contagious abortion, nor are there any statistics available to show what proportion of our milch cows are infected. Rabagliati⁹ believes that at least 50% of our herds contain infected cows, and other experienced veterinarians have given similar estimates.

Wilson and Nutt's¹⁰ investigation of the milk supply of Manchester, in which they examined 488 samples and found that 5.7% of single milks and 8.8% of mixed milks contained the *Br. abortus*, is still almost the only observation on record indicating the extent to which the milk supply of this country may be infected; but Cruickshank and Barbour⁸ recently found that 4 cows out of a herd of 37 (i.e. 10.8%) supplying a Scottish institution with milk were infected.

Further systematic examinations of milk supplies in Great Britain, if possible by guinea-pig inoculation, are badly needed, but if, as can hardly be doubted, these reveal that a considerable proportion of our unpasteurized milks contain the *Br. abortus*, what is the explanation of the small number of human cases of undulant fever so far discovered? At the time of writing only 34 definite cases of endemic origin in England and Wales and 5 in Scotland are known to me, though I have in addition records of a number of unproved cases in some of which the probability of this infection having occurred appears to me to be quite strong. In Rhodesia, on the other hand, where contagious

* Read in opening a discussion on Milk-Borne Diseases Other Than Tuberculosis in the section of Pathology and Biochemistry at the Annual Meeting of the British Medical Association, Eastbourne, 1931.

abortion is not so rife as in this island, Bevan¹⁰ reports that more than 200 human cases (in a European population of only 45,000) have been diagnosed serologically within the last ten years. In the United States 1,305 cases were reported during 1929.¹¹ In Denmark between 300 and 400 cases have been diagnosed every year since Kristensen started his systematic investigations.

I have no time now to discuss the possible explanations of this remarkable contrast between the small number of human cases reported in Great Britain and the wide distribution of bovine contagious abortion, but I venture to predict that further investigations will show that undulant fever is much commoner with us than would appear at present, a large proportion of the infections being so slight that the patients never call in a doctor and perhaps never regard themselves as definitely ill. In that case, you may say, the disease is hardly worth bothering about. Let us beware, however! Undulant fever is a disease full of unexpected tricks, with an epidemiology many parts of which are still shrouded in mystery. Take for instance the unexpected discovery in America of infection of swine with a *Brucella* highly virulent to man, or the recent finding in the Jura Alps of human cases of bovine origin when infection from this source was supposed to be practically non-existent in France. The English strains of *Brucella* are, moreover, not all benign, or at any rate some of the population have a susceptibility to them which is far from negligible. It is no joke when you have taken care of your health and always drunk the most expensive graded milk to be incapacitated for five or six months with a disease which, if not dangerous, is at any rate most miserable and depressing.

To return to milk, it should be noted that undulant fever, unlike some of the milk-borne diseases of which we shall hear presently, does not occur in epidemic outbursts among the consumers of an infected supply. It is true that considerable groups of cases have occurred in connexion with a single supply, especially in institutions producing their own milk,^{8, 12, 13, 14} but individual susceptibility seems to play such an important part that usually only a small proportion of the consumers are affected. Even when a group of cases appears in one place it is often impossible to trace them to a single milk supply, or to any other common origin, as you will see was the case in the group occurring in this town, of which Dr. Shera is going to tell you presently.

It has only been possible in the short time at my disposal to give a fleeting glimpse of the problem presented by the spread of undulant fever by means of milk; but I hope that I have succeeded in showing that it is an intricate problem and an important one, that it must be taken seriously into account in the consideration of any measures designed to protect the milk consumer from disease, and finally that research in this direction is urgently needed and provides a most fascinating and profitable field for the bacteriologist, the veterinarian and the epidemiologist.

REFERENCES

- ¹ Horrocks: *Report of Royal Society's Commission on Mediterranean Fever*, 1905, Part III, p. 84.
- ² Zammit: *Ibid.*, p. 83.
- ³ Dubois: *Rev. Vétér.*, September, 1910, p. 540.
- ⁴ Evans: *Journ. Inf. Dis.*, 1918, 22, p. 580.
- ⁵ Dalrymple-Champneys: Ministry of Health Reports on Public Health and Med. Subjects, 1929, No. 56.
- ⁶ Schroeder and Cotton: *Ann. Rep. Bur. Animal Industry, U.S. Dept. Agric.*, 1911, XXVIII, p. 139.
- ⁷ Pröscholdt: *Zeitschr. f. Milch-u-Fleischhyg.*, 1929, Hft. 15, s. 277.
- ⁸ Cruickshank and Barbour: *Lancet*, Apr. 18th, 1931, p. 852.
- ⁹ Rabagliati: *Public Health*, Feb., 1931, p. 135.
- ¹⁰ Bevan: *Veter. Record*, 1931, Vol. 18, No. 20, p. 547.
- ¹¹ Hardy, Jordan, Borts, and Hardy: *Nat. Instit. Health Bull.*, 1931, No. 158, Dec., 1930.
- ¹² Farbar and Mathews: *Ann. Int. Med.*, 1928, Vol. 2, p. 875.
- ¹³ McAlpine and Mickle: Undulant Fever Symposium, 1929, Amer. P. H. Assoc., p. 12.
- ¹⁴ Orr and Huddleston: *Ibid.*, p. 34.

FOUR CASES OF UNDULANT FEVER*

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The four† cases about to be described occurred here in Eastbourne at the latter end of 1930. The first was a youth, aged 16, who was admitted to the Princess Alice Hospital on September 15th. The second was a member of the visiting surgical staff of this hospital, but not actually in attendance on the first case. The third was a boy at one of the schools here, and the fourth was a former house-surgeon to the hospital above mentioned, who was staying in Eastbourne on holiday. Whether there was any direct infection between the various cases is a point for speculation. The house-surgeon was engaged to be married to the sister in charge of the ward in which the first case occurred, and the practitioner attended the school in which the third case occurred. The last two patients became ill at the same time, so that a simultaneous origin from a common milk supply is much more probable than a direct infection. The public health authorities were, unfortunately, unable to trace the source of infection via milk, but this was almost certainly the mode of origin. It will be as well to sketch the clinical histories and pathological findings first, and then to compare the cases afterwards.

CASE 1

G. M., aged 16, was admitted to the Princess Alice Hospital on September 15th, 1930, and was discharged cured on December 10th. There was a history that in August, 1930, he camped on a farm near Pevensy, and drank a good deal of milk at that time. About a month before admission he complained of malaise, tiredness, anorexia, constipation, shivering, headache, and backache. A week later he gave up work and went to bed. For three weeks he had been running a temperature between 100° and 104° F., and was attended by Dr. Percy Vosper of Hailsham. There had been no nausea, no vomiting, and no diarrhoea.

The blood count on October 9th showed the following features: red cells, 5,360,000 per c.mm.; haemoglobin, 63 per cent.; colour index, 0.58; leucocytes, 5,600 per c.mm.—of these, 60 per cent. (3,360) were neutrophils, 30 per cent. (1,680) were lymphocytes, 10 per cent. (560) were monocytes—and 24 per cent. were immature neutrophil cells. Eosinopenia was present, also some microcytosis. The leucocyte count on October 16th was 4,400 cells per c.mm. On October 24th the blood count was as follows: red cells, 5,980,000 per c.mm.; haemoglobin, 76 per cent.; colour index, 1.06; leucocytes, 4,600 per c.mm.—of these, 55 per cent. (2,530) were neutrophils, with 28 per cent. immature forms, and 45 per cent. (2,070) lymphocytes. An enteric group infection was suggested.

On October 27th, the diagnosis still being obscure, and headache being a prominent symptom, a detailed examination of the spinal fluid was made, including a cell count, estimation of chlorides and total protein, Pandy and Nonne-Apelt tests, a gold-sol curve, and a bacteriological examination, with negative results throughout. The blood was also examined for the Wassermann and tubercle complement-fixation tests, and on October 15th and 20th the Widal reactions against *B. typhosus*, *B. paratyphosus* A, B, C, and the *Salmonellas* were done, with negative results. A throat swab was taken, as there was sore throat (see Case 4), but this was negative to Klebs-Loeffler bacillus. On October 27th the blood was agglutinated against *Brucella abortus*, and was found to be strongly positive up to 1 in 5,000 (2,500 units). On December 9th, the day before the patient was discharged from hospital, the blood was positive up to 1 in 500 (250 units). Blood cultures were negative on two occasions. Partial anaerobiosis was tried by means of pyrogallic acid and soda desiccating jar.

* Read to the Section of Pathology at the Annual Meeting of the British Medical Association, Eastbourne, 1931.

† After going to press a fifth case was subsequently traced, which had left the town.