The data obtained show consistent changes to take place, the albumin concentration falling and the α_2 globulin concentration rising progressively with increasing activity and extent of disease. Conversely, these fractions were restored towards normal as the disease became quiescent and arrested. Treatment with anti-tuberculosis drugs led to a similar effect.

As an index of activity in tuberculosis, the albumin/ α_2 ratio was much more sensitive than the E.S.R.

The albumin/ α_2 ratio provides a useful objective index for assessing activity of disease in patients with tuberculosis.

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SOURCES OF TUBERCULOUS INFECTION IN AN AREA CONTAINING BOVINE TUBERCULOSIS

BY

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Case-finding of tuberculosis by the tracing of sources of infection of tuberculin-positive children has been used in many areas. Tattersall (1946, 1952) in particular and MacDougall *et al.* (1953) have advocated this method. Tattersall points out that in areas where the milk is known to be "safe," infection of tuberculin-positive school entrants can often be traced to a human source.

The difficulties of such a method in areas where bovine tuberculosis spread by milk was suspected were thought to be considerable, although on occasion tuberculin-testing of schoolchildren has been done in a limited area to estimate the damage done by a tuberculous cow (Hall, 1950; Kind and Brough, 1954).

During four months in 1954 five cases of tuberculous cervical glands and one case of tuberculous peritonitis were discovered amongst the children of a small market town X (population 7,400). In each case there was a history that the child had been drinking raw milk from one particular dairy. At that time milk from all four dairies in the town had been satisfactory to bacteriological and statutory tests for a number of years. It was decided, therefore, to do a tuberculin survey of the

schoolchildren of this town, on lines similar to those used by Tattersall, in order to determine the sources of infection of the tuberculin-positive children and discover whether that source was human or bovine.

Method

Of the 1,360 schoolchildren, 1,063 were tuberculin-tested, using the multiple puncture technique (Heaf, 1951), by the school medical officer (K. M. H.), who also read the results. The families of the tuberculin-positive children were then tuberculin-tested by the health visitor, using the same technique, so that the result of the whole family could be available when they attended for interview at the chest clinic. At these interviews the parents were questioned (by C.J.S. or D.F.v.Z.) with a view to discovering the source of the child's infection. The whole family was x-rayed; because of the large numbers and the limited local x-ray facilities a special visit of the M.M.R. unit was arranged.

Both the interviewers have worked in the area for more than five years and knew most of the notified cases; they also had had considerable previous experience at interviewing families for the purpose of discovering sources of tuberculous infection. Parents were asked about contact with known or possible cases of pulmonary tuberculosis. Only a definite history of direct contact with a proved case was accepted as a possible source of infection. Parents were also questioned about the milk supply during the child's life, especially as regards the drinking of raw milk from farms, and also the sources of supply in the town itself.

We found 260 of the schoolchildren to be tuberculin-positive. Seven of the children came from a children's home with no recent family contacts. Three children had been investigated recently and the information required was already known. One child had had B.C.G. We interviewed 219 families and 416 adults were x-rayed (1.9 per family). There remain nine families that have defaulted. In the families that have been seen, 44 adults refused x-ray examination, so that 90.4% of adults have been x-rayed.

Results

Table I shows the tuberculin-positive rate at different ages. It also gives the rates for similar ages for the town of Ipswich. Ipswich is the county town, and has practically all its milk pasteurized. As 1,338 Ipswich schoolchildren have been tuberculin-tested by the same technique during this year, this probably gives a fair comparison.

TABLE I.—Tuberculin-positive Rates at Different Ages

Age Groups	Town X	Ipswich
5-6 years	10.9% of 174	6% of 494
7-9 " " " " "	18.6% " 377	16% " 73
10-12 " " " " "	32.8% " 289	12% " 538
13-15 " " " " "	31.4% " 210	29% " 233

Although town X has a higher tuberculin-positive rate than Ipswich, all the information available indicates that there is relatively far more pulmonary tuberculosis in Ipswich. Thus if Ipswich is divided into seven areas of between 7,000 and 10,000 voters in each area (by the electoral roll), then the number of known cases of pulmonary tuberculosis varies from 47.7 to 116 per 10,000 voters in these areas, whereas the figure for town X is 40.7 per 10,000 voters lower than the best area of Ipswich. A similar index worked out for patients with tuberculosis who died or had a direct positive sputum during 1954 varies from 4.6 to 20.7 in Ipswich, but is only 3.7 in town X.

The reverse occurs with non-pulmonary tuberculosis, Ipswich areas having an index of 7.3 to 15.8, whereas town X has 27.8 per 10,000 voters.

Of the 260 tuberculin-positive children, 37 have a definite history of contact with a known case of tuberculosis either in

town X or elsewhere. A further 25 children had lived most of their lives outside the town and had drunk raw milk direct from a farm at some time. The remaining 198 positive children had no history of contact, and except for short periods had always had their milk supply from the local dairies. These children were listed according to the dairy that supplied them. Where children had had milk from more than one dairy, they were assigned to each of the dairies that had supplied their milk.

Table II shows the number of tuberculin-positive children in age groups assigned to the dairies that supplied their milk. It is obvious that dairy A is related to many of the younger tuberculin-positive children. Thus of the 40 positive children aged 7 or less, 31 had milk from dairy A.

TABLE II.—*Tuberculin-positive Children in Relation to Source of Milk Supply*

Age	Dairy A	Dairy B	Dairy C	Dairy D
0-5 years	13	—	2	2
6 " " " " " "	7	—	2	2
7 " " " " " "	11	—	1	—
8 " " " " " "	14	8	7	3
9 " " " " " "	11	7	11	4
10 " " " " " "	6	5	5	4
11 " " " " " "	4	5	16	7
12 " " " " " "	5	6	9	4
13 " " " " " "	5	7	11	4
14 " " " " " "	6	4	9	1
15 " " " " " "	2	3	4	2
16 " " " " " "	2	3	2	1
Total	86	48	79	34

TABLE III.—*Tuberculin-positive Children in Relation to Each 120 Gallons of Milk*

Age	Dairy A	Dairy B	Dairy C	Dairy D
8 years and under	45	8	1.7	2.3
9 " " " " " " over	41	40	9.6	9.0
	86	48	11.3	11.3

The quantities of milk supplied by each dairy varied greatly, as follows: dairy A, 120 gallons; dairy B, 120 gallons; dairy C, 840 gallons; and dairy D, 360 gallons. If this variation is taken into account the figures have an added significance. If the positive children are related to the dairies for each 120 gallons of milk supplied daily, the

Age distribution of positive children in relation to each 120 gallons of milk supplied daily.

the two years preceding the investigation at least four samples of milk from each dairy had been tested for tubercle bacilli with negative results.

Dairy A.—Milk sold by this retailer was the produce of his own farm. Undesignated milk was sold until the summer of 1954, when he made application for a T.T. licence. His herd was examined by the divisional veterinary officer, who found that 19 out of 24 cows reacted to the intradermal tuberculin test.

Dairy B has for the past four years sold T.T. milk only. It previously sold undesignated milk.

Dairy C has sold only pasteurized milk for the last 19 years.

Dairy D has sold only pasteurized milk for the last four and a half years. Previously sold T.T. and undesignated milk.

Although we have no proof that the tuberculin-positive children were infected via milk, we believe that the histogram, taken in conjunction with this information about the dairies, tells a fairly clear story of the tuberculous epidemiology in this town. It seems as though dairy A has been responsible for a large proportion of the recent tuberculous infection, and that probably dairy B was also selling infected milk up to about 1950. In this respect it is interesting to note that Wilson *et al.* (1952) found that bovine infection was greatest in the 5-9 age group. This would also fit in for the infection caused by dairies A and B, bearing in mind that the infection from dairy B occurred some four years ago.

Tuberculous Disease

Pulmonary.—Although 37 tuberculin-positive children were found to have been in contact with pulmonary tuberculosis, no new case of pulmonary disease was discovered amongst the 380 adult contacts x-rayed. The abnormalities found on x-ray examination consisted of one case of congenital heart disease, three cases of bony abnormalities, and one case of calcified primary tuberculosis. The calcified primary lesion was interesting as an illustration of how easy it is to assume a source of tuberculous infection wrongly. The family concerned consists of parents and four children. The youngest child, born in 1950, was found to have a tuberculous shoulder in 1952. At that time another of the children, born in 1947, was also tuberculin-positive, but the two born in 1943 and 1949 were negative. No source at the home was discovered, and it was assumed that bovine tuberculosis was responsible. In the present survey the child born in 1949 had converted to positive and the eldest child was still negative. On x-ray examination, the child born in 1947 has a calcified primary lesion in the lung. The rest of the family have normal x-ray films. Presumably, therefore, the three youngest children have been infected from a human source. We feel that the negative x-ray results help us to justify our contention that most of the tuberculous infection in town X was bovine in origin.

Non-pulmonary.—When the survey started we already knew of seven recent cases of tuberculous cervical glands, all supplied with milk by dairy A. During the survey 12 further cases of cervical glands were found. Three had already been treated but not notified; eight were previously unknown (two required early radical treatment, and seven had large, non-fluctuant glands present for many months); and one non-fluctuant case was supplied by dairy B. The first 11 cases were supplied by dairy A.

Discussion

The method of this survey was not new. Certain aspects, however, need discussion when the area surveyed contains both human and bovine tuberculosis.

All the tuberculin-positive children (except nine defaulters) and 416 of their 460 adult contacts were x-rayed to exclude pulmonary tuberculosis. No case of active pulmonary tuberculosis was found. This inability to discover pulmonary tuberculosis would suggest a failure to those who believe that mass x-ray surveys can solve the problems of tuberculous epidemiology. Without the interviews, the tuberculin-testing and x-raying would have failed to produce the evidence concerning the pathways of infection, although they demonstrated a high tuberculin rate with no obvious human cause. We believe, therefore, that where both human and bovine tuberculosis are suspected a survey such as this is necessary to see the pattern of the infection clearly. This town has had three visits from the mass miniature x-ray unit in the past; cases of pulmonary tuberculosis have been found, but nothing was discovered concerning the bovine infection.

Francis (1950) showed that there was an inverse relationship between the incidence of bovine tuberculosis and the death rate for human tuberculosis. He says: "One cannot help wondering whether exposure to tubercle bacilli in milk does not, after all, provide a protection against the more dangerous respiratory infection in later life." He discusses other evidence in favour of this view (Lichtenstein, 1924; Madsen *et al.*, 1942; Holm and Holm, 1945). The idea that bovine tuberculosis may protect against human tuberculosis is not new, and presumably formed part of the basis of vaccination with B.C.G. Our survey would appear to produce further suggestive evidence in favour of this idea. As stated, Town X has a higher tuberculin-positive rate than its neighbouring town of Ipswich, and the present survey seems to show that this is related to bovine infection. Town X, however, has a much lower rate for pulmonary tuberculosis. There are, of course, other possible explanations, as the two towns, although neighbouring, are not comparable in respect of size of population, industry, housing, etc. Nevertheless, it will be interesting to discover in future surveys what effect the abolition of bovine tuberculosis may have on the incidence of human tuberculosis.

This survey has made us think more about tuberculin-sensitivity rates in relation to bovine and human tuberculosis spread by milk. It seems to us that one infectious cow supplying milk to a dairy can infect many more children in a few months than an open case of phthisis can in a lifetime. The phthisical patient could perhaps achieve a similar disaster by spitting into T.T. milk. Possibly the very high tuberculin-positive rates quoted in the past (Hart and Wright, 1939; M.R.C. National Tuberculin Survey, 1952) were more a reflection on the milk supply than an indication of pulmonary tuberculosis in the community. Great care is necessary when interpreting tuberculin sensitivity rates of the past and present. It should not be assumed that a falling tuberculin sensitivity rate is necessarily an indication of improved human infection rates unless the part played by bovine tuberculosis can be reasonably assessed. Indeed, if the theory of the protection from bovine infection is correct, a falling tuberculin sensitivity rate can coincide with an increasing rate of pulmonary tuberculosis.

We hope the findings of this survey are a reflection of a murky past and will not recur. We are not entirely confident about this. It seems that even with milk that is pasteurized or from T.T. herds there are still ways in which milk infected with tuberculosis can be sold to the public. Although there is control over the milk and cattle there is no direct control over those who attend the cattle or "handle" the milk. There are records of severe and sudden epidemics of bovine tuberculosis in cattle caused by an attendant having bovine tuberculosis of the lungs (Nielson and Plum, 1940; Tice, 1944). Such epidemics can occur between the biannual tuberculin testing of herds. It also is quite possible for a milk-handler with pulmonary tuberculosis to infect the milk direct. It seems to us that the only real safeguard against bovine tuberculosis is a policy aiming at complete eradication of bovine tuberculosis in the cattle combined with the present policy of increasing T.T. herds and pasteurization.

In view of our recent experience we cannot believe Lethem's (1955) optimistic views that glands of the neck and infection with bovine tubercle are things of the past. Such a view seems premature.

Summary

An outbreak of bovine tuberculosis in a small town was traced to its source.

A tuberculin survey of the schoolchildren of the town showed that most of the younger children who had been infected had acquired their infection from milk.

A comparison is made of tuberculosis in this town and in the town of Ipswich, where the milk is "safe." Although this town has a higher tuberculin-positive rate

and relatively more non-pulmonary tuberculosis, there is evidence that it has far less pulmonary tuberculosis.

The theory that bovine tuberculosis may offer some protection against human tuberculosis is discussed as a possible explanation of these figures.

Where both bovine and human infection are known to occur, it is necessary to interview parents of infected children to help determine the source of infection.

The present safeguards against bovine tuberculosis are regarded as inadequate.

Our thanks are due to Miss E. L. Almbad, health visitor in town X, for all her help, and to Dr. T. O'Riordan, medical director of the mass miniature radiography unit, for his co-operation. Two of us (C. J. S. and D. F. v. Z.) are in receipt of a research grant from the East Anglian Regional Hospital Board, which made some of this work possible.

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ANTERIOR APPROACH FOR BILATERAL ADRENALECTOMY

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During the course of radical gastrectomy for carcinoma of the stomach, in which the spleen and pancreas together with the entire stomach are dissected away *en bloc*, we have been struck by the magnificent exposure which a transverse approach gives to the adrenal glands. In the light of our experience in many such cases we have adopted the anterior approach for bilateral adrenalectomy. The approach is similar to that described by Aird (1955), but differs in certain important respects.

Technique

The patient, a female in this case, is positioned on the operating-table as for cholecystectomy, but with the gall-bladder rest only slightly elevated and placed at a lower level. The table is tilted head downward to about 10 degrees. After removal of both ovaries through a lower midline incision, the upper abdomen is explored by a curved transverse incision with its convexity upwards. The placing of the incision is illustrated in Fig. 1. After the abdomen is opened a self-retaining retractor of the Finichetti type is inserted.

The left adrenal gland is approached first, by cutting along the lateral leaf of the lineo-renal ligament. This incision is started 2 in. (5 cm.) behind and lateral to the spleen,