It has been notable that the response of cases of lymphoid leukaemia has been better than that of the myeloid cases. This is probably true even when allowances are made for the small numbers and the varied clinical condition of the patients. This finding has been encouraging, since with most other therapeutic agents the response of lymphoid leukaemia has been less favourable than that of myeloid leukaemia.

Tests of renal and hepatic function have not revealed changes after treatment, and post-mortem examinations, although often demonstrating long-standing damage or infiltration by disease, have not shown signs which could be definitely interpreted as due to toxic effects from treatment.

The haemopoietic system is highly sensitive to triethylene melamine, the effects being seen on the lymphocytes, granulocytes, and platelets of the peripheral blood.

The simplification of dosing by oral administration of enteric-coated tablets has seemed to be a worth-while advance; nevertheless by its very simplicity it carries a certain danger of being used without the essential haematological controls.

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TUBERCULOSIS CASE-FINDING BY THE TUBERCULIN-TESTING OF INFANT- SCHOOL CHILDREN

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"On numerous occasions, only the tuberculin reaction of a child or adult has revealed unsuspected infectious cases among his associates."—J. A. MYERS, Minnesota.

Several years ago one of us (Tattersall, 1946) expressed the opinion that tuberculin-testing of young children should be more extensively used for case-finding in this country. Several interesting cases of tuberculosis had been discovered in this way. For example, the mother of two tuberculin-positive children was able to give a thorough account of the social contact of her daughters aged 5 and 3, which suggested that the only association they had had with anyone liable to cough was their father, who for the past year had been in Hong Kong. A message was sent advising that he should have his chest x-rayed, and he was invalided home with consumption.

This experience, after various trials and errors, led to the more extensive tuberculin survey of all the infant-

school entrants in Bournemouth during the Michaelmas term of 1951, on which a preliminary report has been published (MacDougall, Mikhail, and Tattersall, 1951). Circumstances for this work had become propitious: the mortality rate from all forms of tuberculosis in Bournemouth during 1950 had fallen to 33 per 100,000 of population, the milk cleanliness in the town was known to have been good for a number of years, and the whole-hearted co-operation of all parties concerned could be anticipated. It was decided to test about 2,000 children over a period of about ten weeks which would cover almost all the children in the infant schools who had not yet reached their sixth birthday, including all the school entrants.

Since 1947 at least 97% of the milk sold in this county borough has been heat-treated, pasteurized, or from tuberculin-tested herds, and by the end of 1951 100% pasteurization had been attained. During the past five years all milk samples tested have complied with the current prescribed standards under the regulations of the Milk Special Designations Act, 1949; and under the Food and Drugs (Milk, Dairies, and Artificial Cream) Act, 1950, the town is shortly to become a "specified area" for the retail of "designated" milk. It therefore seemed reasonable to assume that a child beginning school and found to be tuberculin-positive would have been infected from a human source. The majority of such children would have led relatively sheltered lives, being too young to have had many casual stray and unknown contacts, so that any child thus infected would probably have incurred the infection within its own immediate family circle. The Michaelmas term survey was therefore designed to seek out and examine as exhaustively as possible all the relatives and friends (especially the adults) of tuberculin-positive school entrants.

A second survey during the Lent term was designed for comparison with the Michaelmas survey. A comparable number of infant-school children were tested, and their contacts examined, but by a slightly different procedure. This paper describes the methods and results of both surveys.

The Tuberculin Test

It was thought that the Mantoux test would require the positive written consent of a parent; so it was decided to proceed with the jelly test and advise parents that the test would be applied unless they objected. This was amply justified, since the success of the work depended on the co-operation of the family contacts of tuberculin-positive children. The technique used was that described by Dick (1950), and adopted for the Medical Research Council National Tuberculin Survey (1952), although later, suspecting the incidence of positive reactors might be unduly low, a slight modification recommended by Lendrum (personal communication) was adopted—namely, reading the results on the fourth day instead of the third day after application of the test. Flourpaper abrasion of the skin was not used on children under 6 years of age. In the Michaelmas survey whenever the result of the jelly test was doubtful a Mantoux test was performed, so that we always had a definite result; parental consent for this was obtained at the reading of the jelly test.

Organization of the Michaelmas Survey

1. The medical officer of health obtained the permission of the Education and the Health Committees for the investigation, and the scheme was explained to the head teachers of the schools involved.

2. The Public Health Department forwarded printed letters in stamped sealed envelopes to the school, from which

they were addressed to the parents of the appropriate children and posted a week before the test was to be applied.

3. The following form of letter was evolved :

Dear Sir/Madam,

It is proposed to undertake the tuberculin-testing of the school children in the Borough who are attending infants' departments. The test will take place at

The action taken consists in placing a little special jelly on the child's back and strapping it in position for two days. It does not involve any injections and should not upset your child in any way.

Please remove the plaster on.....and attend at the school on.....for your child's back to be examined. Please do not allow the child to have a bath while the plaster is in position.

Unless I hear from you to the contrary, I will assume that you agree to this procedure. (Your child may already have been tested, but I hope you will be agreeable to a further test being carried out.)

You are invited to be present on the..... morning, when the test is applied, and on the..... morning, when the result is read.

The result will be communicated to you, along with any observations, in due course.

If you desire any further information I suggest that you get in touch with me.

Yours faithfully,

I. A. MACDOUGALL,
School Medical Officer.

4. At the same time the Public Health Department sent to the schools special tuberculin-test record cards which fit into the standard school health record card. Names and addresses were filled in on these cards by the school staff at the time of sending the initial letter to the parents.

5. Any objection to testing led to the removal of that child's tuberculin record card.

6. The schools were visited on Monday mornings by one of us (J. R. M.), accompanied by the school nurse for that school. It was found convenient to tuberculin-test about 200 children at a session; this produced suitable numbers at each stage of the investigation. A ten-minute explanatory talk was given to the assembled parents, usually the mothers—generally about 80% of the children were accompanied—pointing out that tuberculosis is spread by germs, explaining the significance of pasteurization of milk, and emphasizing the importance of finding any infectious cases. It was stressed that the duty of bringing all the contacts of a child with a positive reaction fell on the parents, and that only by their co-operation could the health of their child be protected. We believe that this brief address, by winning the co-operation of the family from the start, is the most important detail in successful case-finding.

7. Children were tested in alphabetical order by classes, the help of the class-mistress being invaluable in keeping the children in this order while the parents helped with the undressing and dressing of the children. Specially prepared small plasters—2 by 1½ in. (5 by 3.8 cm.)—with gauze backings were made for covering the jelly, and this additional facility in application amply justified the slight extra cost. Two hundred tests could be applied without undue haste in one and a half hours.

8. The school was revisited on the following Friday and the tests were read. In all cases where the parents were not present a printed letter giving the result was posted to them. It was found in practice, however, that nearly all the positive reactors were accompanied on the day the test was read. A further explanatory talk was then given, stressing the importance of the child being immediately x-rayed and the parents' responsibility for finding who might have infected their child. The importance of talking to the parents cannot be overemphasized; it was found that with their co-operation all the tuberculin-positive children and their family contacts, often neighbours as well, readily attended for fluoroscopy; thus the number of follow-up visits to be made by the health visitors became trifling.

9. Once the mothers' anxiety has been aroused it should be alleviated as soon as possible. Therefore, when a positive reactor was found, fluoroscopy appointments were given to the mother for each member of the household and any other friends or frequent visitors that the mother could name as seeming relevant. The health visitor listed all these persons, which information was kept on the child's tuberculin record card. If the mother was able to account for the child's infection by contact with a known case, the alleged patient's name and address were taken for confirmation. Usually this proved correct.

10. After the tuberculin tests had been read at the school the record cards were returned to the Public Health Department.

11. Although several fluoroscopy sessions were available during the following week, it was found that 90% of the contacts attended the session on the morning after the reading of the test. All the children and their contacts were screened, following the technique described by Hall and Tattersall (1950), and the results of that examination were told to the parents immediately. Only those exhibiting any fluoroscopic abnormality were filmed. The completed fluoroscopy reports were forwarded to the Public Health Department and entered on the tuberculin-test record cards. Letters were sent by the department informing each general practitioner concerned of the x-ray result.

12. All other children attending the clinic as contacts were tuberculin-tested, and this measure led to the discovery of two cases which developed tuberculous meningitis less than three months later.

Organization of the Lent Term Survey

The results of the Michaelmas investigation were considered successful enough to justify corroboration by a further survey. It was decided to tuberculin-test the remainder of the infant-school population, a comparable number of children, though on average slightly older. The whole of this second survey was carried out in a fortnight during the Lent term, and differed from the Michaelmas survey in two essential ways. First, all the tuberculin-testing was performed and read entirely by the school nurses, working in pairs. Having assisted in the Michaelmas survey, they were familiar with the procedure. Secondly, by courtesy of Dr. J. S. Robertson, the medical director, the tuberculin-positive children and their contacts were examined by the mass radiography unit.

The application and reading of the tuberculin tests were the same, but contacts were given appointments to attend the mass radiography unit and passed through their routine in the usual way. However, special sessions were arranged so that men, women, and children could attend as a family group, and they were photographed clothed. This arrangement did slightly slow down the ordinary rate at which examinees passed through. The x-ray appointment form was clipped to the mass radiography card, and when the miniatures were read the x-ray forms were completed by the medical director and returned to the Public Health Department. All abnormal films were dealt with by the usual mass radiography routine. A nurse attended these sessions to tuberculin-test any other children attending as contacts.

Results

The numbers of children eligible, tested, and tuberculin-positive are shown for both surveys in Table I.

TABLE I.—Children Tuberculin-tested

	Michaelmas Term	Lent Term
Eligible children	2,123	2,161
Refused	70 (3%)	79 (3.7%)
Absent	188 (8%)	149 (7%)
Number tested	1,865	1,933
Positive	42	135
Doubtful result	0	28

The number and percentage of positive results of the tuberculin tests are shown by age groups for the Michaelmas and Lent terms in Table II.

TABLE II.—Number and Percentage of Positive Results of Tuberculin Tests in Age Groups

Age Groups	Michaelmas Term		Lent Term	
	Total No. Tested	Total Positive	Total No. Tested	Total Positive
3 years	99	0	18	1
4-5 "	589	14 (2.4%)	135	6 (4.4%)
6-7 "	1,177	28 (2.4%)	271	16 (5.8%)
8-9 "	—	—	558	46 (8.2%)
10-11 "	—	—	753	68 (9.0%)
12-13 "	—	—	182	23 (12.6%)
14-15 "	—	—	16	3

It will be noticed from these data that the incidence of positive reactors in each age group is rather low when compared with the findings of the National Tuberculin Survey in the urban areas of Southern England. However, on closer scrutiny of the available comparable data the findings are acceptable. Bournemouth is a well-housed seaside resort with very little industry, and in many ways more comparable to a rural area than an urban one. Table III gives

TABLE III.—Percentage of Tuberculin-positive Reactors in Young School Children Found in Recent Surveys

Place	Survey*	Method	Age Groups				
			4 yrs.—	5 yrs.—	6 yrs.—	7 yrs.—	8 yrs.—
Bournemouth ..	(1)	Jelly	2.7	3.0	8.2	9.0	12.6
Radnor	(2)	"	—	3.5	2.9	5.0	5.4
Portsmouth ..	(3)	"	—	5.1	8.7	10.7	15.2
Manchester ..	(4)	Mantoux	—	4.3	14.1	20.6	16.3
Montgomery ..	(3)	10 T.U. Jelly	—	8.4	8.7	12.4	15.9

* (1) The present investigation.

(2) Jones Davies (1950), using Jensen's jelly preparation.

(3) Medical Research Council National Tuberculin Survey, 1949-50 (1952).

(4) Wolman (1952) using 1/1,000 Mantoux test on primary-school children in a working-class area of Manchester.

the incidence of tuberculin-positive reactors in primary-school children as reported in several recent investigations.

The origin of the tuberculous infection of the tuberculin-positive children is indicated in Table IV. This table also shows the number of contacts examined in each group of both the Michaelmas and the Lent term surveys, and sug-

TABLE IV.—Sources of Infection of the Positive Reactors and the Numbers of Contacts Examined in Each Group of Children

	Michaelmas Survey			Lent Survey		
	Positive Reactors	Contacts Examined	Average Age Child	Positive Reactors	Contacts Examined	Average Age Child
Traced to new cases	7	43	6.1	9*	49	5.4
Known cases not living in Bournemouth	9	50	5.5	48	129	3.0
Known cases in Bournemouth	17	already known		20	already known	
Untraced, but all available contacts examined	9	50	5.5	24	80	3.3
Untraced, but some children and contacts in this group never attended for mass radiography				34	—	—
Tuberculin reaction read as "doubtful"	0	—	—	28	—	—
Total	42	143		163	†	

* One of these children led to the discovery of two new cases of adult tuberculosis.

† In the second survey, inevitably, there was some failure to obtain full particulars in every case, and some defection of the contacts regarding attendance for mass radiography. (This was eliminated in the first survey by persistent effort and domiciliary visiting.) Altogether, 411 persons did attend the mass radiography unit, and 339 of these were the children and their contacts in the groups which were completely followed up. The remaining 72 persons were some of the tuberculin-positive children whose source of infection was not discovered and a few of their contacts. None of the children whose reaction was classed as "doubtful" was traced to a case of tuberculosis.

gests, what perhaps seems obvious, that the greater the number of contacts examined the greater the likelihood of case-finding success. Nevertheless, in 14 of the 17 new cases of adult disease the patient was a parent of the tuberculin-positive child.

The following are particulars of the contacts of all positive reactors found in the Michaelmas survey, together with the new cases of adult tuberculosis found in the Lent term survey.

Traced to New Cases (Michaelmas Survey)

Case 1.—The child's x-ray film showed left hilar gland enlargement and collapse of the lingula. Mother and three lodgers normal. No other relations in Bournemouth. Father was a sergeant instructor in the Army. He was symptomless; but x-ray film revealed bilateral pulmonary tuberculosis, and he had a positive sputum.

Case 2.—The child had a primary lesion with atelectasis of left upper lobe. The mother's x-ray film showed a small cavity in the right upper lobe and she was sputum-positive. Six other contacts were normal.

Case 3.—Child and seven contacts normal. The father's x-ray film showed bilateral pulmonary tuberculosis and he was sputum-positive.

Case 4.—Child and five contacts normal. Mother had bilateral pulmonary tuberculosis and a positive sputum.

Case 5.—Child and four relatives in the house normal. A married sister in Reading was known to have pulmonary tuberculosis, and a friend of the family had been treated for pulmonary tuberculosis in a sanatorium. The father's x-ray film showed old-standing fibrotic disease in the left upper zone and mid-zone. Sputum and gastric lavage repeatedly negative.

Case 6.—Child and six contacts normal. Mother found to have a minimal lesion in the left upper lobe, sputum negative. Sister, a known case of pulmonary tuberculosis with a positive sputum, was living in the flat below in a converted house.

Case 7.—Child and four contacts normal. Father found to have a minimal lesion in his right upper lobe, sputum negative. A stepbrother, living in Blackpool, was a known case of open pulmonary tuberculosis; he had been in contact with the child prior to his diagnosis and treatment. The child stayed with him for holidays.

Traced to Known Cases (Michaelmas Survey)

Case 8.—Child and eight contacts normal. A known Bournemouth case of sputum-positive tuberculosis visited the house regularly.

Case 9.—Living in the same house with a known case of sputum-positive tuberculosis for three years. Two other children born in house after the man had died were both tuberculin-negative.

Case 10.—Child and five contacts normal. Mother a known case of sputum-positive tuberculosis, and a relation in the same house had recently had a pleural effusion.

Case 11.—Child and six contacts normal. Had previously been living with a known case of tuberculosis.

Case 12.—Lived with his aunt, who died three years ago of pulmonary tuberculosis. All contacts already examined.

Case 13.—Child and six contacts normal. A brother, with whom the child had been in contact, was in Manchester under treatment for tuberculosis.

Case 14.—Living in the same house as a known case of pulmonary tuberculosis. All contacts under supervision.

Case 15.—Child and four contacts normal. Two young people who previously lived in another flat in the same house were known to have had tuberculosis. One died a year ago of pulmonary tuberculosis, and another three years previously of tuberculous meningitis.

Case 16.—Child and four contacts normal. Father a known case of pulmonary tuberculosis under treatment in a sanatorium in America.

Case 17.—Child and four contacts normal. Close contact with a known case of pulmonary tuberculosis who died 18 months ago.

Case 18.—Child and five contacts normal. Recently moved to this country from China, where he was known to have been in contact with a case of tuberculosis.

In six other cases one of the parents had died of tuberculosis during the child's life, and all other contacts had been examined. In nine further cases the child had a tuberculous parent under supervision at the Bournemouth Chest Clinic, and all other contacts had been examined.

Source of Infection Untraced (Michaelmas Survey)

Case A.*—This child's x-ray film showed a resolving primary lesion. Mother was normal. Four siblings were tuberculin-positive. One had segmental atelectasis, while another developed tuberculous meningitis 11 weeks after being tuberculin-tested. The father was dead, and, although several visitors to the household were examined, a lodger consistently refused examination.

Case B.—Child showed a primary lesion in the left lung. A like twin was found to be tuberculin-negative. The twin was observed over a period of four months and remained tuberculin-negative. Eight contacts were examined, all normal. They lived in a guest-house, and it seemed possible that they might have had unknown contact with a case of active tuberculosis.

Cases C and D.—Child and ten contacts normal.

Cases E and F.—Child and five contacts normal.

Case G.—Child and three contacts normal.

Cases H* and I.—Child and two contacts normal.

Traced to New Cases (Lent Survey)

Case J.—Child normal. Sister showed thickening of right interlobar septum, enlargement of hilar glands and atelectasis of right upper lobe; admitted to sanatorium. Brother, x-ray film normal. Mother, calcified foci right upper lobe. Father, infiltration and cavitation left upper lobe; sputum-positive. Sister, aged 9 months, found to be patch-positive; maintained under weekly observation and two weeks later developed tuberculous meningitis.

Case K.—Child had a primary lesion in the left upper lobe. Four contacts normal. Father had infiltration in right upper lobe; sputum-positive.

Case L.—Child and four contacts normal. Father had infiltration and cavitation in right upper lobe, sputum-positive.

Cases M and N.—Child and five contacts normal. Aunt and uncle, both living in the same house, found to have pulmonary tuberculosis. Uncle had infiltration and cavitation in both upper lobes; sputum-positive. Aunt had minimal lesion in right upper lobe; sputum and gastric lavage negative.

Case O.—Child and five contacts normal; lodger in same house had fibrosis in right upper lobe.

Case P.—Child and three contacts normal. Sister, aged 20, had a minimal lesion in her first left interspace.

Case Q.—Child had collapsed right middle lobe; three contacts normal. Mother had minimal lesions in her second left interspace.

Case R.—Child and two contacts normal. Father had infiltration in right upper lobe; sputum-negative.

Case S.—Child and five contacts normal. Father had a minimal lesion in the right upper lobe; sputum-negative.

Discussion

This investigation was possible only through close co-operation between the chest physicians and the medical officer of health. Whether diagnostic or preventive, it illustrates the importance of such collaboration in anti-tuberculosis work.

The results show that for every 250 tuberculin tests applied in the schools a new case of adult tuberculosis was

discovered among the contacts. As mass tuberculin-testing can be carried out cheaply, this case-finding method is relatively inexpensive.

Only 411 persons passed through the mass radiography unit in the Lent survey, yet 10 new cases of adult tuberculosis were found. Such a group is obviously eminently suitable for mass radiography examination. However, in order to make use of the mass radiography unit in this way, it is necessary to carry out a large number of tuberculin tests in a relatively short time. In this particular investigation 411 examinees were easily dealt with by the unit in a fortnight in addition to other work, but it involved considerable rearrangement of the school nurses' programmes to enable them to apply and to read nearly 2,000 tuberculin tests during the same period. On the other hand, when the survey was protracted over a whole school term the tuberculin-testing was more easily arranged, but the examination of the contacts at the chest clinic involved some adjustment of the weekly clinic sessions there. It would seem that both procedures are equally satisfactory for finding cases, and the choice should depend on local facilities.

The particular value of this case-finding technique is that it "gets at" the unsuspected case by a "back-door" approach, and would seem to be especially suitable for an urban area where the milk had been extensively pasteurized during the past five years.

ADDENDUM.—Since this article was submitted for publication two more untraced cases in the Michaelmas survey have been traced to a source case.

Case A.—After prolonged and persistent efforts by the health visitor the lodger was persuaded to attend; the x-ray examination showed bilateral pulmonary tuberculosis, and he had a positive sputum.

Case H.—The mother of this child eventually attended, and the x-ray examination revealed a minimal lesion in the right upper lobe. Sputum was repeatedly negative.

This brings the total of new cases in the Michaelmas survey to nine and the total number of new cases discovered to 19.

Summary

Two tuberculin surveys of infant-school children were conducted with the object of discovering adult tuberculosis among the household contacts of the tuberculin-positive children.

In the Michaelmas survey, 1,865 children were tuberculin tested by a chest physician and the contacts of positive reactors examined by fluoroscopy. In the Lent survey, 1,933 children were tuberculin-tested by school nurses and the contacts of positive reactors examined by mass radiography. In both surveys one new case of adult tuberculosis was found among the contacts for every 250 tuberculin tests applied in the schools. The co-operation of the mothers of the children in persuading the contacts to attend is regarded as a most important detail in the scheme.

This would appear to be a cheap and effective case-finding method, especially suitable in an urban area where the milk is pasteurized.

Our thanks are due to Dr. J. S. Robertson, medical director of the mass radiography unit; Mr. Childs, the education officer for Bournemouth; the Primary Education Committee for permission to carry out this investigation; and also the head teachers and staffs of the schools concerned and the staff of the health department and chest clinic.

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