

A Mass Miniature Radiography and Tuberculin-Testing Survey in African Miners

AND THEIR DEPENDANTS ON THE
COPPERBELT OF N. RHODESIA,
1957-58

BY

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In March, 1957, mass miniature radiography was started on the Copperbelt under the auspices of the Tuberculosis Research Association (Kitwe), which, since 1952, has been investigating the value of Vole bacillus vaccine in the prevention of tuberculosis in Africans.

This report presents the results of the survey at Rhokana Corporation's Rhokana Mine and Mufulira Copper Mines Ltd., carried out between March, 1957, and August, 1958.

MATERIALS AND METHODS

The mass miniature radiographic survey was carried out on surface non-scheduled mine employees and the dependents of all mine employees living in the mine African townships. All persons attending were tuberculin-tested and X-rayed with the exception of those under four years of age. Those under four years of age were tuberculin-tested only and all positive reactors were X-rayed on 10 in. x 12 in. plates. All those attending were apparently fit and no person referred by medical officers, clinic sisters or who was seen in hospital is included in the investigation. A few known tuberculous attended, but these too are not included in the analysis of results.

TUBERCULIN TESTING

Purified protein derivative (P.P.D.), obtained from the veterinary laboratory, Ministry of Agriculture and Fisheries, Weybridge, Surrey, was used. One minim of 1/100 adrenalin was added to each ml. of P.P.D. The tuberculin was applied to the cleansed skin of the forearm by means of a sterile glass rod. The tuberculin test was made with an East's modification of

the Heaf multiple puncture apparatus set at a penetrating depth of 1 mm. The tests were read 72 hours later.

MASS MINIATURE RADIOGRAPHY

At Rhokana Mine a 100 mm. Odelca camera unit with a 100 M.A. generator was set up in the X-ray department of the Association's laboratory at Nkana. At Mufulira Copper Mine a field laboratory with X-ray department was set up in the Mufulira mine township and the camera unit and generator transported and re-assembled there.

Dual reading of the films was practised. All films were read by the author, the second reading being carried out by either Dr. H. Stone, Dr. Harley Stevens or Dr. E. L. Rees.

Persons whose miniature films showed an abnormality requiring further investigation were recalled to the clinic for a clinical examination which included in all cases the taking of a pair of laryngeal swabs on consecutive days and, where indicated, large films with lateral or apical views.

BACTERIOLOGICAL INVESTIGATIONS

Smears were made from specimens of sputum when obtainable and stained by the routine Ziehl-Neelson method, using 3 per cent. acid alcohol for decolourising. Only new slides were used for the preparation of all smears. The sputum was also treated with 10 per cent. trisodium phosphate and, after centrifuging and incubation, the deposit was cultured on Dorset's egg, Lowenstein and Jensen and Kirchner's media.

Laryngeal swabs were cultured on the same media after treatment with 10 per cent. sulphuric acid, followed by 2 per cent. caustic soda.

At Mufulira all cultures were prepared and incubated initially in our field laboratory, but, usually within a week, were transferred to our main laboratory at Nkana, where the investigation was completed. Cultures were examined at weekly intervals for six weeks when, if no growth was observed, they were discarded. Smears were made from any media showing growth at the weekly examination and examined microscopically. All positive cultures were, where possible, confirmed by guinea pig inoculation and the majority of positives were so confirmed.

Table I

MUFULIRA AND NKANA, 1957-58

Tuberculosis cases found by M.M.R. classified according to type of disease and tuberculin reaction group

Number X-rayed = 7,830 men; 10,583 women; 11,826 children. Total: 30,239.

Known tuberculin-positive reactors	9,217
Known tuberculin-negative reactors not vaccinated	3,687
Known tuberculin-negative reactors vaccinated	4,755
Previous tuberculin reaction unknown	12,580

Diagnosis	Known Positive Reactors	Known Negative Not Vaccinated	Known Negative Vaccinated	No Previous Tuberculin Record	Total
P.T.B.	37	6	4	33	80
Primary T.B.	4	8	2	32	46
Tuberculous pleurisy	1	2		1	4
Healed or not clinically significant P.T.B.	22	2	2	4	30
Healed Potts' disease	3			2	5
TOTAL	67	18	8	72	165
Calc prim foci	105	7	9	141	262
Calc axillary glands	1		2	2	5

Number of cases found	165 = 5.45 per 1,000 examined
Active cases found	130 = 4.29 " " "
Active cases found in known positive reactors	42 = 4.55 " " "
Active cases found in known negative not vaccinated	16 = 4.33 " " "
Active cases found in known negative vaccinated	6 = 1.26 " " "
Active cases in persons seen for first time	66 = 5.24 " " "

INDEPENDENT ASSESSMENT OF CASES OF TUBERCULOSIS

The X-ray films of all definite and suspected cases of tuberculosis, together with any bacteriological findings, were submitted to the director, Pneumoconiosis Medical Research Bureau, or his deputy for an independent assessment.

MASS MINIATURE RADIOGRAPHY

The definition of active pulmonary tuberculosis used was that of the Department of Health of Scotland, namely, "A patient suffering from active pulmonary tuberculosis should be considered as one in whom the diagnosis is based on evidence not solely derived from the response

to the tuberculin test and who, because of tuberculous infection, may infect others; or in whom the tuberculous lesion requires treatment or some modification of the patient's normal course of living."

In children, and infants especially, an attempt was made to differentiate the primary form of pulmonary tuberculosis from the secondary form. The diagnosis of primary tuberculosis was made when the radiological findings showed hilar gland enlargement in conjunction with a parenchymal lesion and/or a positive culture from a laryngeal swab. Hilar gland enlargement was the commonest radiological abnormality seen in children, and those cases not considered to be due to tuberculous infection

showed a prevalence of 2 per 1,000 examined. Pulmonary collapse, often associated with some degree of hilar gland enlargement, was another common abnormality seen. Those not considered to be tuberculous in origin showed a prevalence of 1.6 per 1,000 examined. These two abnormalities presented a major problem in the differential diagnosis of primary tuberculosis.

Thirty thousand two hundred and thirty-nine persons of all ages and both sexes were tuberculin-tested and X-rayed; 17,659 of these (58.1 per cent.) were participants in the Vole bacillus vaccine investigation, with the result that their tuberculin reactor group had been known for at least 28 months prior to their present examination. Records showing those vaccinated and those not vaccinated were also available, and thus the population examined could be divided into four categories. Category I: those known to be tuberculin-positive reactors. Category II: those known to be tuberculin-negative reactors and not vaccinated. Category III: those tuberculin-negative reactors who had been vaccinated. Category IV: those persons tuberculin-tested for the first time when X-rayed.

The prevalence of definite cases of tuberculosis in the general population of the two mine African townships was found to be 4.29 per 1,000 persons examined (Table I). The prevalence rates in those persons known to have been tuberculin-positive and in those tuberculin-negative and not vaccinated at least 28 months prior to this examination were similar. The highest prevalence rate was found in those seen for the first time—5.34 per 1,000 persons examined. The prevalence rate in those nega-

tive reactors who were vaccinated at least 28 months prior to this examination was much lower—1.26 per 1,000 examined.

Prevalence of Active Tuberculosis Related to Age and Sex (Table II)

The prevalence of active tuberculosis in adult females was significantly lower than in adult males and in children.

The Forms of Tuberculosis and Results of Bacteriological Investigations

In children and infants primary tuberculosis was diagnosed in 78.5 per cent. of the active cases found; bacteriological proof of diagnosis was obtained in 62 per cent. of cases. In adults, on the other hand, a diagnosis of pulmonary tuberculosis was made in 93.2 per cent. of the active cases found and bacteriological proof of diagnosis was obtained in 73 per cent. of cases.

Non-Tuberculous Abnormalities

The outstanding impression of the survey was the absence of serious non-tuberculous diseases of the chest.

Pleural thickening was the commonest abnormality seen in adult males. Varying degrees of pleural thickening were present in 15.3 per cent. of all adult male chest films examined. The tuberculin reaction, at the time of X-ray, was positive in 98.8 per cent. of those whose chest film showed this abnormality. In adult females only 2.2 per cent. of those examined showed evidence of pleural thickening, but again 96 per cent. of those persons whose chest film showed this abnormality were tuberculin-positive at the time of X-ray.

Table II
PREVALENCE OF ACTIVE TUBERCULOSIS PER 1,000 EXAMINED ACCORDING TO AGE, SEX AND TUBERCULIN REACTION GROUP

Tuberculin Reaction Group	MALE ADULTS			FEMALE ADULTS			CHILDREN SIX MONTHS TO SIXTEEN YEARS		
	No. Cases	No. seen, 1957-58	Rate per 1,000 examined	No. Cases	No. seen, 1957-58	Rate per 1,000 examined	No. Cases	No. seen, 1957-58	Rate per 1,000 examined
Positive reactors .	26	4,545	5.7	11	3,749	2.9	5	923	5.4
Negative reactors not vaccinated .	4	689	5.8	2	1,054	1.89	10	1,944	5.1
Negative reactors vaccinated . .	2	776	2.57	2	748	2.06	2	3,231	0.61
Previous tuberculin reactor unknown .	12	1,820	6.5	16	5,032	3.1	38	5,728	6.6
TOTAL ALL GROUPS . .	44	7,830	5.61	31	10,583	2.8	55	11,826	4.7

Goitre, readily diagnosed from the chest film and confirmed clinically later, was the commonest abnormality in adult females, in whom a prevalence of 4.6 per 1,000 examined was found.

Pulmonary fibrosis mainly confined to the apices was a frequent finding in adults (3.1 per 1,000 examined) and in children (2 per 1,000 examined). The tuberculin reaction was positive in all cases, but apart from this finding no other evidence of tuberculosis was found on clinical and bacteriological examination.

Congenital Abnormalities

1. *Azygos Lobe*.—This was conspicuous by its absence; only six examples were seen, though we were particularly on the look-out for it.

2. *Cervical Ribs*.—These were the most common abnormality seen and showed a prevalence rate of 8 per 1,000 examined.

3. *Spina Bifida*.—Incomplete fusion of the posterior part of the cervical vertebrae was the next most common abnormality seen—a prevalence rate of 7.6 per 1,000 X-rayed.

4. *Rib Malformation, Including Bifid Ribs*.—The prevalence of this abnormality was found to be 6.2 per 1,000 examined.

Tuberculin Testing

The initial tuberculin testing and vaccination campaign carried out by the Tuberculosis Research Association at Rhokana and Mufulira mines (1952-56) showed the following tuberculin reactor rates in the population (Table III).

In Table IV the results of the tuberculin test carried out during the present survey on those

persons known to be tuberculin-negative reactors and not vaccinated at least 28 months prior to the present test (natural conversion) and on those persons known to be negative and vaccinated (natural + vaccine conversion) are shown.

DISCUSSION

X-Ray Results

A unique opportunity was presented to carry out a mass miniature radiographic survey of a community in which the tuberculin history of more than 50 per cent. of the population was known.

The Copperbelt is the most important industrial area in the Federation, but the African population cannot be classified as an industrial population for the purpose of comparison with such populations in the United Kingdom or Union of South Africa. The African is in the transition stage between a rural and an industrial population.

The influence of this close relationship to a rural environment has a very definite effect on the pattern of tuberculous infection and disease found. The main effect is to reduce the prevalence of infection and disease, particularly in those sections of the population, mostly young adult females, who have experienced relatively shorter periods of residence in urban and industrial environments. The prevalence of tuberculous infection, as ascertained by the tuberculin test, varies in different rural areas from a very low infection rate to one compar-

Table III
TUBERCULIN TEST RESULTS, 1952-56 SURVEY

Age and Sex	Total Tested and Read	Total Tuberculin Positive	Percentage Positive Reactors
Adult males	28,790	21,135	73.4
Adult females	13,699	8,897	64.9
Children 0-18 years	23,985	3,228	13.4

Table IV
TUBERCULIN CONVERSION RATES

Age and Sex	Known Negative Not Vaccinated			Known Negative Vaccinated		
	Total Tested and Read	Total Positive	Percentage Positive	Total Tested and Read	Total Positive	Percentage Positive
Adult males	667	484	72.5	759	682	89.8
Adult females	692	378	54.6	926	801	86.5
Children 0-18 yrs.	2,314	573	24.7	3,789	2,472	65.2

able to that found on the line of rail, but, generally speaking, the chance of contracting active tuberculosis in the urban and industrial areas on the line of rail is much greater than in the rural areas.

The results of the survey are summarised in Table I. One hundred and thirty active cases of tuberculosis were found, giving a prevalence rate of 4.29 per 1,000 examined for the community as a whole. Various factors are present in the community examined which would have the effect of reducing the prevalence of tuberculosis. These are, first, that more than half the adult male employees on the mine have an initial and an annual chest X-ray and clinical examination under the Pneumoconiosis Ordinance and thus enjoy one of the two main measures for the prevention of tuberculosis, namely, routine chest X-rays. Secondly, all male adult employees are subjected to a rigorous medical examination on engagement. Thirdly, the standard of living and social amenities in the mine African townships compare more than favourably with other urban African communities. Overcrowding does occur, in spite of the constant efforts of the management on prevention, but to nothing like the extent found in the non-mine townships. Wages on the copper mines are high, and for the most part the African copper miner is financially better off than most other Africans in the territory. Finally, an excellent medical service is available to them, which includes hospitals and clinics. It is thus possible that the prevalence of active tuberculosis may be higher in the non-mine African community on the Copperbelt.

Twenty-two active cases of tuberculosis were found in the two negative reactor groups. It will be noted that those who were vaccinated showed a smaller proportion developing active tuberculosis than those who were not vaccinated. This difference in proportions is statistically significant.

The forms of tuberculosis found differed only in relation to the age of the person examined. In infants and children, primary tuberculosis was diagnosed in 78.5 per cent. of the active cases, while in adults pulmonary tuberculosis was observed in 93.2 per cent. of cases. The number of cases found in the two negative reactor groups was small, but no important differences in the forms of tuberculosis found in these two groups and in the positive and unknown reactor group were observed. In the adult negative-not-vaccinated group five cases of advanced pulmonary tuberculosis and one case

of tuberculous pleural effusion were diagnosed. In the adult vaccinated group one case of advanced pulmonary tuberculosis, two cases of minimal pulmonary tuberculosis and one primary tuberculosis were observed. Though the number of cases is extremely small, it is apparent that the negative reactor to tuberculin, who is subsequently exposed to infection, does not necessarily contract the relatively benign first infection form of tuberculosis. The main value of vaccination against tuberculosis is that apparently a significantly smaller proportion of those vaccinated develop active tuberculosis.

In Table II the results found are related to age and sex. The difference in the prevalence rate for adult men and women is statistically significant: twice as many men as women were found to have active tuberculosis. The author has noted a similar trend in the tuberculosis wards of hospitals in the territory where, almost invariably, there were at least twice as many male patients as female patients. The results of this survey indicate that the lower number of female patients is due more to a lower attack rate than to the African female's reluctance to accept hospitalisation. In children, both the number of cases found and the number of positive reactors seen are small; and though apparently the prevalence rate for children is similar to that of the adult male, these results are not statistically significant. However, it is not surprising that only a relatively small number of positive reactors were examined when the reactor rate for children was only 13.4 per cent. (Table III). That the attack rate in children is more akin to that of adult males is further demonstrated in the tuberculosis wards of hospitals where the number of children under treatment is almost invariably greater than the number of adult women.

An explanation for the lower prevalence rate in adult females is provided by the relatively lower risk of infection to which the African female is exposed. During the past thirty years the number of females in the African townships on the Copperbelt has lagged behind the number of males and, in addition, the women tended to remain on the Copperbelt for shorter periods than the men. There is definite evidence of a gradual increase over the years of the "married" population on the mines and of the length of tour of duty by the males. In the early days a man would work on the mine for approximately six months and the wife tended to remain in the village. As the man's period of duty increased, so the woman tended to come to

Table V
CONGENITAL ABNORMALITIES REPORTED BY N. RHODESIA PNEUMOCONIOSIS MEDICAL
RESEARCH BUREAU

Congenital Abnormality	Africans: 15,700 Examined. Rate per 1,000	Europeans: 5,740 Examined. Rate per 1,000
Cervical ribs	6.3	1.9
Spina bifida	14.52	1.57
Bifid ribs	10.96	10.63
Absent or undeveloped first rib	1.34	2.79

the Copperbelt for a period of the man's stay. At first this period was relatively short—three or perhaps six months. Gradually the life of relative ease on the Copperbelt compared to village life persuaded the woman to spend longer periods with her husband, until to-day there is a tendency for women to remain on the Copperbelt during the period when the husband returns to the village on leave. Even to-day the men tend to foregather in large numbers for social and political activities far more frequently than do the women. Social integration of the sexes lags far behind that of the European population. All in all, therefore, the women are less exposed to the risk of infection than the men, and this is also reflected in the lower tuberculin reactor rate found in women (Table III).

The benefits of vaccination in the prevention of tuberculosis can be seen by a comparison of the prevalence of active cases in that group of the population known to have been tuberculin negative 28 months prior to the date of the present survey. In children—that section of the population known to have the lowest tuberculin rate (Table III)—the prevalence of active cases in those who had been vaccinated was considerably less than in those who had not been vaccinated. This difference is statistically significant. In adult males, too, the prevalence rate in those vaccinated is less than in those not vaccinated, though the difference is not statistically significant. The results for women, however, do not follow the same trend, but here again the difference between the vaccinated and non-vaccinated group is not statistically significant. Further studies of this section of the population are required.

The immense value of the laryngeal swab in obtaining bacteriological proof of diagnosis is clearly demonstrated. Sixty-two per cent. of the cases of primary tuberculosis in children and 73 per cent. of pulmonary tuberculosis cases in adults were bacteriologically proven by cul-

ture and guinea pig inoculation of specimens obtained by laryngeal swab. The isolation of the tubercle bacillus is all too seldom obtained to confirm the diagnosis of tuberculosis found by mass miniature radiographic surveys in Southern Africa owing to the fact that those in charge of the surveys have to rely on the examination of direct smears from specimens of sputum obtained in the field. Isolation of the tubercle bacillus is, in our opinion, an important aspect of case finding. In two surveys in the Union of South Africa, E. H. Fine *et al.* (1954, 1956), no mention of bacteriological findings is made, though all the cases were referred to chest clinics for further investigation. In a survey carried out in the Bechuanaland Protectorate in 1952, M. Schechter (1954) refers to the difficulty of obtaining specimens of sputum and bases his figures for active tuberculosis on the X-ray findings alone. J. Schneider (1954) regretted that more confirmatory evidence in the shape of positive sputa was not forthcoming, and again the diagnosis was, in the majority of cases, a radiological one. The Medical Research Council (*Brit. med. J.*, 1956), in their investigation into "B.C.G. and Vole bacillus vaccines in the prevention of tuberculosis in adolescents," obtained bacteriological proof of diagnosis in only 42.7 per cent. of cases of active tuberculosis.

Two hundred and sixty-two calcified primary complexes were observed; the majority occurred in those known to be tuberculin-positive and in those with no previous tuberculin record. A few (16) were found in the two negative reactor groups (Table I). The prevalence rate of 8.7 per 1,000 examined is an indication that the immediate prognosis of tuberculosis of the first infection type in Africans is good even in the absence of treatment.

Varying degrees of pleural fibrosis in adult African males is a common finding at *post-mortem* examination and has caused much speculation as to the underlying cause. Our findings provide further information on this

subject, namely, that 15.3 per cent. of all adult males X-rayed showed this abnormality and 98.8 per cent. were tuberculin-positive. In adult females only 2.2 per cent. of those examined showed pleural thickening, but again 96 per cent. were tuberculin-positive at time of X-ray. It would appear that the prevalence of pleural thickening is related to exposure to infection with the tubercle bacillus. R. Paul (1957) reports finding "varying degrees" of pleural thickening in 10.5 per cent. of adult male underground miners X-rayed on large films.

The azygos lobe, a fairly common congenital abnormality in Britain, was conspicuous by its absence. Only six examples were found, though we were particularly searching for this abnormality.

Cervical ribs were the most common abnormality found—a prevalence of 8 per 1,000 examined. Schneider found a prevalence rate of 5.3 per 1,000 in the Northern and Eastern Transvaal. He quotes P. D. Crimm (1952) as finding only 1.6 per 1,000 congenital rib abnormalities in the United States of America. This figure included bifid ribs and rib malformations in addition to cervical ribs. Dr. R. Paul, Director of the Pneumoconiosis Medical Research Bureau, in a personal communication, informed me of the following findings in Africans and Europeans examined at the Bureau on large plates (see Table V).

In our series of observations based on miniature films we found only 7.6 per 1,000 with spina bifida. Dr. Paul's findings on large plates confirmed our impression that a number of cases were not easily recognised as such on the miniature film. We included bifid ribs together with malformation of the first rib and found a prevalence rate of 6.2 per 1,000 examined.

TUBERCULIN TEST RESULTS

In Table III are shown the results of the initial tuberculin tests carried out by the Tuberculosis Research Association between 1952 and 1956. The low reactor rate in children of 13.4 per cent. is accounted for by the fact that 63.2 per cent. (15,163 persons) were under four years of age and in this group the reactor rate was only 6.8 per cent. Table IV shows the results of the tuberculin tests carried out on those persons who were found to be tuberculin-negative in the 1952-56 survey. The effect of vaccination is shown by the consistently higher reactor rates found in those persons who had been vaccinated compared to those not vaccinated. In children the reactor rates found in both the vaccinated and not vaccinated group were considerably lower than the rates found in adults. The lower conversion rate in the negative vaccinated group is largely due to the fact that many of the infants up to three years of age were vaccinated with a diluted vaccine, 0.005 mg. per ml., which has been shown by

Dr. Greening (1957) to result in a lower tuberculin conversion rate than full strength vaccine (1 mg. per ml.).

The conversion rates found in the negative-not-vaccinated group cannot be used to assess an annual natural conversion rate, because, although all had been negative reactors at least 28 months previously, many had had their initial test a considerably longer time prior to the date of the present survey. The Tuberculosis Research Association's progress reports (unpublished) show that the natural conversion rate for adult males is 20 per cent. per annum, for adult females 13 to 16 per cent. per annum, and for children (0-18 years) 7 to 10 per cent. per annum.

CONCLUSIONS

The results of this survey indicate that a conservative estimate of the prevalence of active infectious tuberculosis in the African population of the Copperbelt is 4.3 per 1,000.

The adult male group of this population runs the greatest risk of infection with the tubercle bacillus, and a conservative estimate of active infectious cases is 5.6 per 1,000. Owing to the relatively high tuberculin reactor rate found in this group, the measure of prevention most likely to achieve results is case-finding with mass miniature radiography. Tuberculin-testing, accompanied by vaccination of the negative reactors, would be a secondary but nevertheless an important measure of prevention. The benefit of vaccination in the prevention of tuberculosis must be greatly increased if the active infectious cases are removed from the population as a result of case-finding by mass miniature radiography.

The risk of infection in the adult female group of the population is, at present, significantly lower than in the male group; a prevalence rate of 2.8 per 1,000 may be expected. Tuberculin-testing accompanied by vaccination of the negative reactors is the preventive measure most likely to achieve results in this group. Miniature radiographic examination of the positive reactors would play a secondary but important role in the prevention of disease in this group.

The child's greatest risk of infection is from contact with adults rather than contact with other children. In children, primary tuberculosis accounted for 78.5 per cent. of the cases of active tuberculosis found. Though tubercle bacilli were isolated in a high proportion of

cases, there is no doubt that the open case of pulmonary tuberculosis (93.2 per cent. of the active cases found in adults) is a more dangerous source of infection. In children a prevalence rate of 4.6 per 1,000 can be expected.

In this group of the population there is no doubt that tuberculin-testing, accompanied by vaccination of the non-reactors, is the preventive measure most likely to achieve results. Miniature radiographic examination is not recommended for this group of the population because of the hazards of radiation. The number of positive reactors in this group is at present relatively low and is likely to remain so if the preventive measures discussed above are implemented. Thus it should be possible to X-ray the positive tuberculin reactors on large films to find those suffering from active tuberculosis.

The importance of bacteriological confirmation of the diagnosis of active pulmonary tuberculosis has recently been stressed by Arnold S. Anderson *et al.* (1959), who state that presumptive diagnosis of pulmonary tuberculosis from X-ray shadows are temporarily allowable in practice, but have no place in research reports, where diagnosis must depend upon bacteriological findings and where information must be factual for world-wide dissemination. This survey has demonstrated, in particular, the value of the laryngeal swab in case finding. Laboratory facilities, not only in Northern Rhodesia, but in the Federation as a whole, are inadequate to compete with the demands made upon them. We feel, however, that with genuine co-operation between those responsible for the prevention and treatment of tuberculosis and the pathological departments available, the laryngeal swab method for the detection of tubercle bacilli is a practical possibility. Tuberculosis hospitals and clinics must be prepared not only to take the laryngeal swab specimen, but also to inoculate and provide incubator space for the culture media. The pathologists, on the other hand, must be prepared to make the culture media for distribution to the hospitals and clinics. They must be prepared to visit these centres once a week to examine the cultures and to remove to their laboratories for further identification those media showing growth of colonies. Our observations have shown Kirchner's liquid medium to be most valuable for the culture of *M. tuberculosis* from laryngeal swab specimens. Growth of tubercle bacilli colonies occurs from the third week to the sixth week following inoculation in positive

cases. Those media showing no growth at six weeks can be discarded.

SUMMARY

- (1) The prevalence of active tuberculosis on the Copperbelt is at least 4.3 per 1,000.
- (2) Adult males are at greatest risk—5.6 per 1,000.
- (3) Mass miniature radiography of adult males combined with tuberculin-testing and vaccination of negative reactors is the most important economical measure for the prevention and spread of the disease.
- (4) Families of urban workers should be tuberculin-tested and the negative reactors vaccinated with Vole bacillus vaccine or B.C.G. The positive reactors must be X-rayed—adults on miniature films and children on large films.

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