

X-ray survey for pulmonary tuberculosis and chest diseases in the Ok Tedi region of Western Province, Papua New Guinea

PAUL E. SPICER¹ AND GLENN LUCENA²

AEA Medical Services, Lihir Island and Ok Tedi Mining Ltd, Tabubil, Papua New Guinea

SUMMARY

X-ray photofluorography is a relatively expensive way to detect pulmonary tuberculosis (PTB). Those patients with suggestive positive chest X-ray still require Mantoux skin testing, blood tests and a positive sputum smear for the acid-fast bacillus *Mycobacterium tuberculosis* to make a definitive diagnosis of PTB. Photofluorography does detect most pulmonary pathological conditions, including lesions suggestive of PTB, and possible cardiac abnormalities. It is more cost-effective for large numbers in urban areas where there is poverty and overcrowding; and it is useful in early detection of cases of PTB. It is impractical to use in the isolated mountainous areas in the highlands region of Papua New Guinea and in Western Province, and where there is no road system. It cannot detect other forms of TB. In children and infants it is difficult to obtain good quality films and to interpret them. The scoring chart devised by Biddulph and Edwards is an excellent alternative where a diagnosis is not obvious in a chronically ill child. Active case detection by health workers in the field offers an excellent chance of finding TB cases. Although the cost of staining and looking at sputum smears and performing Mantoux tests can also be time consuming, these methods are relatively less expensive and more accurate. A simple method of processing sputum before Ziehl-Neelsen staining using ordinary household bleach vastly improves the detection rate of acid-fast bacilli. The new technology of demonstrating positive TB antigens in the blood of patients with active disease is still being assessed.

Introduction

A mass chest X-ray screening for the detection of pulmonary tuberculosis (PTB) and other chest diseases took place in 1992-1993 in the remote rugged area of the Star Mountains in the north-west of Western Province, Papua New Guinea (PNG). The giant copper mine of Ok Tedi Mining Ltd (OTML) has been mining in the area since 1984 and there has been frequent migration of workers, their families and friends over the last few years. This has brought together hundreds of people who would have normally lived in remote villages in other parts of PNG. Many had left their gardens and livelihood behind in search of riches at Ok Tedi and initially had no regular source of food

and income. They lived in overcrowded unsanitary conditions in the shanty town and villages which sprang up just outside Tabubil. These conditions are ideal for the spread of tuberculosis (TB).

Because of the transport infrastructure already in place at Tabubil a truck and caravan carrying the portable X-ray unit and a generator were able to visit villages close to the mine in the upper North Fly region, north of Ningerum. Where this was not possible the caravan was parked on a road where villagers were within a reasonable walking distance. There were some very remote villages with a low population who were unable to be screened. The total number of adults not

¹ AEA Medical Services (Lihir Island, Papua New Guinea), c/o 5 Charlekata Close, Freshwater, Cairns, Queensland 4870, Australia

Formerly Chief Medical Officer, Ok Tedi Mining Ltd, Tabubil, Western Province, Papua New Guinea

² Senior radiographer, Ok Tedi Mining Ltd, Tabubil, Western Province 332, Papua New Guinea

screened in these villages would have been approximately 150 persons or 4.1% of all villagers and 2.8% of total persons screened. However, some were X-rayed if and when they came to town. Before the actual screening the medical teams on patrol undertook a health education briefing on TB and X-ray screening. Most, but not all, adults in the area took advantage of the screening and we estimate that a further 100 persons declined to be X-rayed. These people, together with those unable to attend because of isolation, make a total of approximately 250 persons, or 5% of the village population, that were not screened. Opportunity was taken also to X-ray all OTML and subcontractor employees, most of whom were X-rayed over an extended period of time.

Materials and Methods

A pre-used ex-USAF portable X-ray machine with an associated photofluorography unit was obtained from the Philippines following the dispersal of the US base there. Senior management of Ok Tedi Mining Ltd supplied an old renovated truck and built a 'caravan' out of spare materials to house the X-ray machine. The only new equipment was a Lister generator bought from Australia.

The patient and the X-ray tube were enclosed inside a rubberized lead curtain of 0.30 mm (lead equivalent) with 1.0 mm lead equivalent operator's shielding behind the tube. The radiographer wore an extra light lead gown (0.30 mm lead equivalent) and also an electronic personal dosimeter (EPD-Siemens). Guidelines, as set out by the National Health and Medical Research Council of Australia, for the proper use of miniature imaging on 70 mm film and radiation protection were followed (1).

Photofluorography is the technique of photographing the fluoroscopic image. As opposed to orthodox photography, no camera shutter is used, the film exposure being determined by the duration of the X-ray exposure itself as timed by the X-ray apparatus. This is made possible by the light-tight hood fluorescent screen and camera (2). The films obtained were 70 mm x 70 mm on a roll of 100 or more. A Canon X-ray mirror camera (for chest), model CXM5-70A, was

used. Fluorescent screens and films were green sensitive. A single-shot technique was used. From the image intensification and the type of X-ray apparatus used we estimated the higher exposure to be in the order of twice that of conventional chest X-ray (2).

Viewing took place on a 'homemade' fluorescent lighting strip and using a magnifying lens. The patients with abnormal films or those showing suspicious pathology were asked to present for the regular-size chest X-ray at the hospital. The films were viewed essentially by one doctor (PES) who appraised both the small MMRs (mass miniature radiographs) and the larger normal sized chest X-rays. Any patient with a suspicious film or one difficult to interpret was subjected to a searching history regarding occupation, general health status and family contact with TB. Other tests such as Mantoux, ESR (erythrocyte sedimentation rate) and sputum (x3) for Ziehl-Neelsen stain for acid-fast bacilli (AFB) were performed; these are necessary to make a definitive diagnosis (3).

Each film taken was numbered and correlated to a patient, who was registered on first presentation. The sex, age, occupation, employer and any relevant personal or family history of TB of each patient were recorded. All adults and children over 12 years of age were screened. Younger children were X-rayed if there was a significant history or physical signs suspicious of TB. Pregnant females were excluded. An average of 100 patients per day were screened. A total of 53 working days were spent at the task.

Results

The results of the survey are set out in Table 1.

Discussion

TB is one of the re-emerging diseases of worldwide proportions (4,5). In Papua New Guinea, where the population is growing rapidly, where there is overcrowding in the larger centres and complacency about health, and where public health facilities are not always of a high standard, the re-emergence of diseases such as TB is becoming apparent.

TABLE 1

RESULTS OF THE SURVEY

	OTML employees	Contractors	Villagers	Total
Called back for:				
Full-size X-ray	78	44	190	312
Clinical assessment	63	23	27	113
Positive TB	2	3	10	15
Previously with TB or a member in family with TB	17	14	34	65
Subtotal of callbacks	160	84	261	505
Normal X-ray	954	538	3347	4839
Total number X-rayed	1114	622	3608	5344*

OTML = Ok Tedi Mining Limited

* 3327 males, 2017 females

Non-compliance with therapy is also a factor in the spread of the disease and this will also give rise to drug-resistant strains of *Mycobacterium tuberculosis* (6).

The opportunity to X-ray all the OTML employees was taken. This included all miners and those working in the mill as well as all the administration staff. Two were found to be suffering from PTB. None, as expected, had silicosis or other mining-related pulmonary diseases.

Other pathological changes found in the screening process were heart disease, either left ventricular hypertrophy suggesting hypertension or valvular disease, or a misshapen heart shadow indicating intrinsic cardiac, valvular or pericardial pathology. These patients were asked to return, some for full-size chest X-ray and others for clinical assessment. A number of chest silhouettes showed the patient to be obese. These patients were also asked to return for assessment. Several were found to have diabetes, hypertension and associated vascular problems. A few elderly patients were found with chronic obstructive airways disease (COAD). This survey did not include children under 12 years of age. Their diagnosis was made principally on clinical grounds and they were X-rayed if there was sufficient evidence to suggest TB or

pulmonary pathology. The diagnosis of TB on clinical grounds is certainly cheap and reasonably accurate (7).

Other forms of TB such as scrofula or bone, renal, mesenteric or meningeal TB were not detected using this screening method. However, the health education factor was found to be significant in making people aware of TB as a disease and its spread via the sputum or droplets. Also a short history was taken to ascertain if there was a possibility of other forms of TB or other diseases.

The actual cost for the detection of the 15 positive PTB patients was K13,759 or K917 per patient. This includes K4498 for the cost of films, chemicals and diesel, K8761 for the radiographer's time and K500 for the doctor's input. This calculation does not include capital costs, which were USD20,000 for the X-ray unit and USD8000 for the generator, apart from the renovated truck and caravan provided by OTML. If capital costs are included then the cost per positive TB patient would be K2783 (at the time of the survey). Since most human TB is initially spread in droplet form any one case of PTB found early, perhaps before that patient is aware of being sick, does prevent further spread of the disease. Antituberculosis therapy for six months is relatively expensive. Drug therapy is

calculated at K274 per month for A regimen and K50 per month for B regimen - the total is K748 for drugs. This is excluding the initial hospitalization costs. The treatment and protocols are time consuming for the health care providers. The 15 TB positives plus a total of 178 people (Table 1) were called back for assessment, either to present for physical examination or to be checked for PTB because they had a relative who was already positive for the disease. These patients, though not diagnosed with TB, also benefited from the survey. The detection of other diseases plus the health awareness aspect provide additional benefits for the costs outlaid.

The 5344 small 70 x70 mm films generated a further 312 full-size chest X-rays, of which 193 had pathology. It can be seen that the cost of detection of PTB is high and it would not be either practical or cost-effective to use photofluorography in many isolated rural areas. However, its use in urban areas, particularly where there is a dense population, overcrowding, poor hygiene, low incomes etc - the classical conditions for the spread of TB - may well be a cost-effective weapon. The best approach for isolated rural areas is to train all local health workers - health extension officers (HEOs), nurses, maternal and child health (MCH) workers and aid post orderlies (APOs) - in Papua New Guinea. They would be more familiar with their local patients and could and should actively look for and detect all forms of tuberculosis and refer them to the nearest health centre (7).

In children it is sometimes difficult to make a definitive diagnosis of TB. For those infants and children who fail to thrive, have a nonspecific chest X-ray, equivocal Mantoux test and possibly a high erythrocyte sedimentation rate, a scoring chart devised by Prof. John Biddulph and Dr Keith Edwards (8) for the probable diagnosis of TB in the absence of other diseases should be used appropriately.

A simple, safe and inexpensive method of processing sputum before Ziehl-Neelsen (ZN) staining using ordinary household bleach vastly improves, by nearly double, the detection rate of AFB (9). This method has been tried and evaluated at Lihir Medical Centre and is now being routinely used there.

New technology where TB antigens can be demonstrated in the blood of patients with active disease is being evaluated and may well save on time and money if the tests prove to be specific and accurate.

ACKNOWLEDGEMENTS

We thank the senior management of Ok Tedi Mining Ltd for their generous help and financial support and also to all the staff of Ok Tedi Mining Ltd Medical Department.

REFERENCES

- 1 **National Health and Medical Research Council of Australia.** Recommendations for Minimizing Radiological Hazards to Patients. Canberra: Australian Government Publishing Service, 1986.
- 2 **Van Der Plaats G.J.** Medical X-Ray Techniques in Diagnostic Radiology, 3rd edition. Netherlands: Kluwer Academic, 1969.
- 3 **Edwards CRW, Bouchier IAD.** Davidson's Principles and Practice of Medicine, 16th edition. Hong Kong: ELBS, 1991:364-373.
- 4 **Longbottom H.** Emerging infectious diseases. *Commun Dis Intell* 1997;21:89-93.
- 5 **Communicable Diseases Intelligence.** World Health Organization tuberculosis notification update, 1994. *Commun Dis Intell* 1996;20:164-166.
- 6 **Morse SS.** Factors in the emergence of infectious diseases. *Emerg Infect Dis* 1995;1:7-15.
- 7 **Crofton J, Horne N, Miller F.** Clinical Tuberculosis. London: Macmillan, 1992.
- 8 **Papua New Guinea Department of Health.** Standard Treatment for Common Illnesses of Children in Papua New Guinea, 6th edition. Port Moresby: Department of Health, 1993:95-97.
- 9 **Habeenzu C, Lubasi D, Fleming AF.** Improved sensitivity of direct microscopy for detection of acid-fast bacilli in sputum in developing countries. *Trans R Soc Trop Med Hyg* 1998;92:415-416.