IS CHEST X-RAY SCREENING FOR PULMONARY TUBERCULOSIS BY MASS RADIOGRAPHY — A COST-EFFECTIVE TOOL IN A MILITARY POPULATION?

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INTRODUCTION

PULMONARY tuberculosis is a classic disease that satisfies all the criteria for screening (Wilson and Junger, 1968) and has been carried out extensively with mass radiography. However its contribution to lowering the risk of infection by tuberculosis is contradictory (Colley, 1974). Pulmonary tuberculosis screening by mass miniature radiography has been standard practice in the Malaysian Armed Forces since its inception. It is carried out prior to entry and at regular intervals of 1-4 years for different categories of personnel, on special occasions and on discharge. This study is to assess its effectiveness in a military population.

MATERIALS AND METHODS

A 10-year data from 1969-1978 based on medical boards* submitted to Medical Directorate, Ministry of Defence on all tuberculosis cases detected in military personnel form the primary source for this study. All tuberculosis cases are medically boarded. Relevant information was abstracted from the proceedings of the medical board. Only pulmonary tuberculosis cases bacteriologically confirmed and abacterial cases recommended treatment during the period by chest clinic physicians or medical specialists are included in this study. This data was supplemented with notifiable diseases data which contributed six additional cases not medically boarded to the study cases.

Two other data sets used were the monthly health return in which the total number of individuals subjected to MMR are recorded and monthly X-Ray return from units. Unfortunately, the monthly health returns is available only from 1975 onwards and the monthly X-Ray return for 1978 only.

RESULTS

279 cases of pulmonary tuberculosis were diagnosed during the 10-year period, of which 112 (40%) were picked up in "healthy" subjects by mass miniature radiography (MMR) and 167 (60%) were due to investigations resulting from sick reporting (symptom-motivated group). Figure 1 shows the mode of detection of the cases. In all years except in 1970 and 1972, the percentage of symptom-motivated cases exceed the asymptomatic group. The percentage of symptom-motivated cases range from 41.2% in 1970 to 77.3% in 1978. From 1974, the percentage of asymptomatic cases has gradually decreased from 48.7% to 22.7%.

Figure 2 shows the mode of detection of infectious cases. Infectious or bacillary cases are here defined as cases with sputum positive for tuberculosis bacilli either by smear or culture or both. The non-infectious cases were negative on smear examination and grew no tubercle bacilli on sputum culture. 80.6% infectious cases, which are of epidemiological importance for their greater potential to spread the infection, belong to the symptom-motivated group and only 19.4% were picked up by MMR. Detailed data on all the infectious cases as to their smear or culture status is not available. Of the non-infectious cases, 61% were picked up by MMR. The sputum status of 7 cases are not known.

* A medical board is the association of two or more medical officers called upon by an appropriate authority to render a joint report on the medical condition of an individual.

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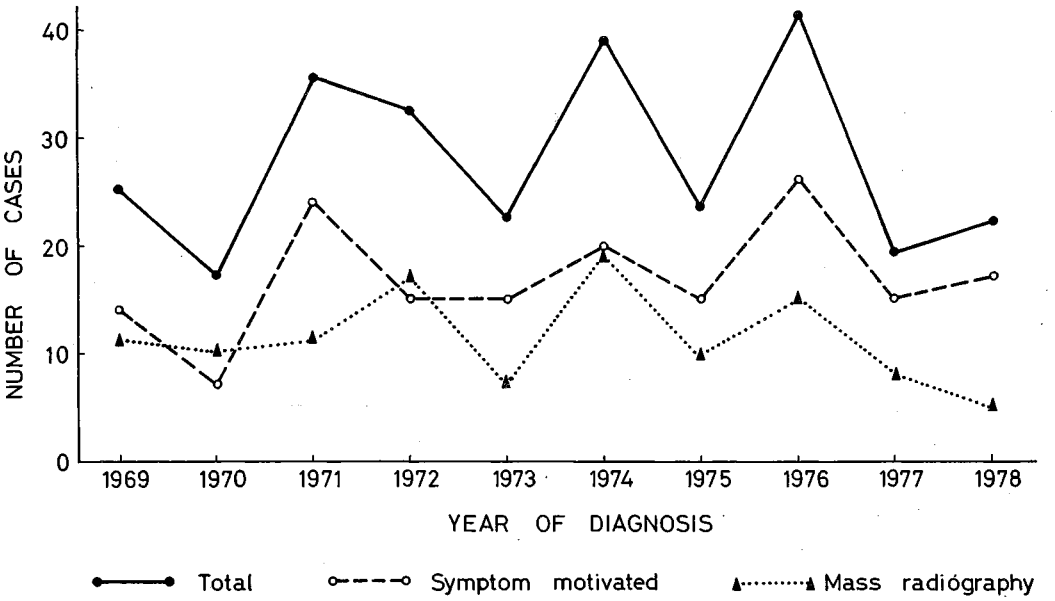

Fig. 1: Mode of detection of pulmonary tuberculosis cases

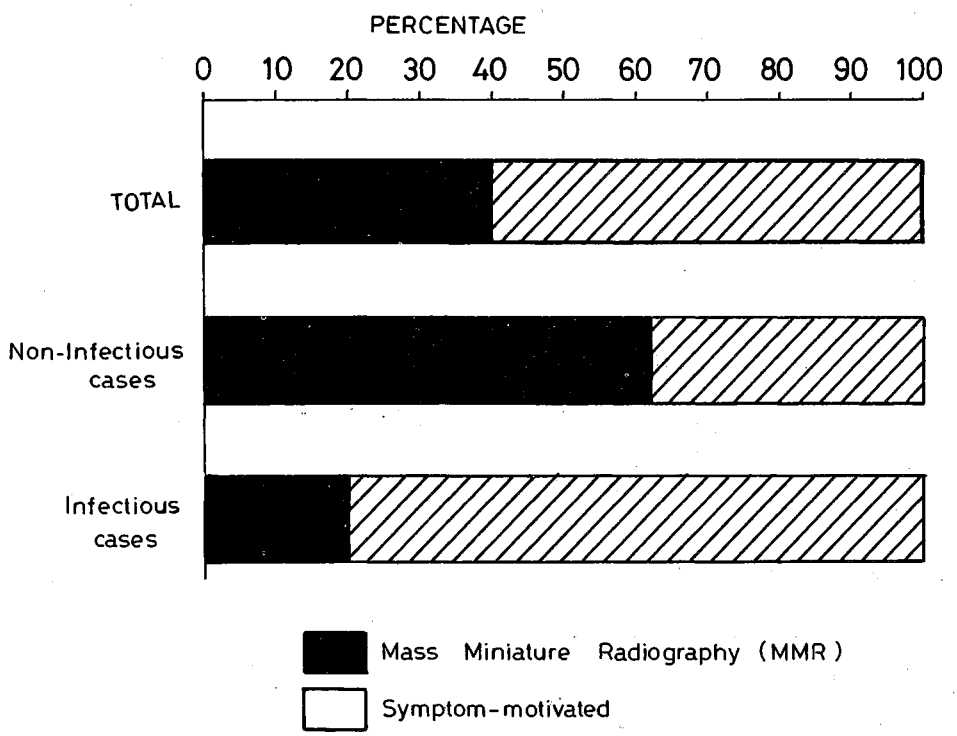

Fig. 2: Mode of detection of pulmonary tuberculosis cases for the 10 year period [1969 — 1978]

Figure 3 shows the number of chest X-Rays taken (excluding pre-employment X-Rays) and the number of pulmonary tuberculosis cases picked up through it. The yield from MMR has decreased over the years. For every case picked up in 1975, 1919 X-Rays had to be done, in 1976, it was 1 in 1458 but in 1977 it was 1 in 2935 and in 1978 1 in 6697. The low yield does not appear to be the decrease in incidence of pulmonary tuberculosis in the community though the incidence from 1977 and 1978 shows a distinct fall as shown in Figure 4. It's highest incidence was 64 per 100,000 in 1971 and now it is around 30/100,000 in 1977 and 1978. A gradual fall in the country's annual incidence of all tuberculosis cases is also noted as seen in figure 5 taken from National Tuberculosis Centre (NTBC), Kuala Lumpur.

DISCUSSION

The Malaysian Armed Forces programme for pulmonary tuberculosis prevention and control depends primarily on routine MMR screening at regular intervals and secondarily on treatment of the cases and contact tracing with appropriate management. All entrants therefore undergo a pre-employment chest X-ray and thereafter at 4 yearly intervals for all ranks except aircrew personnel, and officers of the rank of lieutenant-colonel who are 40 years and above, 2 yearly, and food handlers and navy personnel yearly. All are required to have a chest X-ray prior to attending courses (local and overseas), on posting to Sabah/Sarawak, on extension of service, on change of Corps, and on discharge, if one had not been done within the past six months as set out in the Armed Forces Medical and Technical Instruction No. 3.20. On average, a serviceman undergoes a minimum of 10 and usually around 15 to 20 chest X-rays during his career of 21 years or more.

The primary object of mass radiography is to detect all cases of pulmonary tuberculosis at an early stage of the disease i.e. when they are positive by culture only (Toman, 1976). At this stage of the disease, their infectivity is similar to the non-infectious cases (Shaw and Wynn-Williams, 1954). This objective was not achieved in this military population. Of the 279 cases in this study, only 112 cases (40%) were picked up by mass radiography. 60% of the cases were therefore missed. Of the 112 cases, 28 were infectious and of the total pool of infectious cases, MMR's contribution was only 19.4%. Similar results were found in Peninsular Malaysia with MMR case-finding in the 1960's according to NTBC statistics. To possibly detect all cases by MMR, the interval required should be less than 4 months (Pinnar, 1947). This of course is impractical in terms of cost, manpower and time.

Early detection of cases bestows little advantage with regard to prognosis as chemotherapy is effective at all stages of disease (Colley, 1974). It also has no significant benefit in preventing subsequent cases (WHO, 1974). The symptom-motivated group, of whom 116 were infectious, infected only two other soldiers in the 10-year period, who were picked up during contact tracing. The MMR group cases did not infect other soldiers. It must be admitted that contact tracing, however, has been a dormant feature of public health practice in the Malaysian Armed Forces and some of the cases may have acquired their infection from contact with infectious soldiers. Records of the total number of contacts investigated are not available. Poor results were also obtained by Lange (1966) with contact tracing among Gurkha soldiers. Studies by the British Thoracic Association (1978) showed a tuberculosis morbidity of 3.5% for close contacts and 11% for contacts of smear-positive PTB cases. The reason for this discrepancy could possibly be due to early reporting to readily accessible medical facilities in the armed forces and/or to the high immunity levels as a result of BCG vaccination in early childhood as well as later years. BCG in this country was begun in 1961 for newborns, children aged 6 and less and primary school children and extended to those in the 20's in 1970 (National Tuberculosis Centre, 1973). Coverage has been good in this programme. BCG has been shown to be highly effective in preventing the development of tuberculosis (Styblo and Meijei, 1976). The incidence of pulmonary tuberculosis is also on the decline in the Forces and in the country as a whole as seen in Figures 4 and 5.

Cases labelled as tuberculosis on the basis of a radiological abnormality alone with a negative sputum smear and culture has been studied by a number of workers. Yerushalmy (1969) found that 25% of active tuberculosis cases were missed by experienced radiologists reading 70mm films.

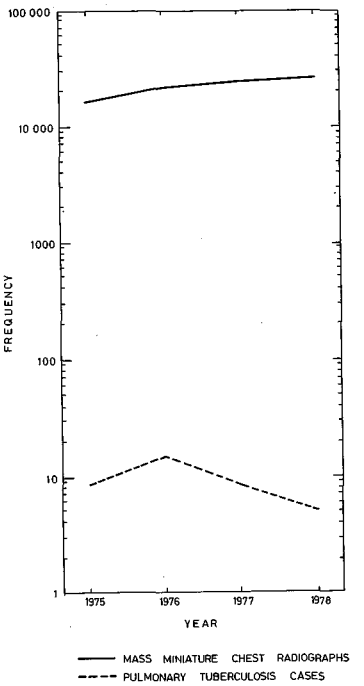

Fig. 3: **Frequency of pulmonary tuberculosis cases to chest x-rays done**

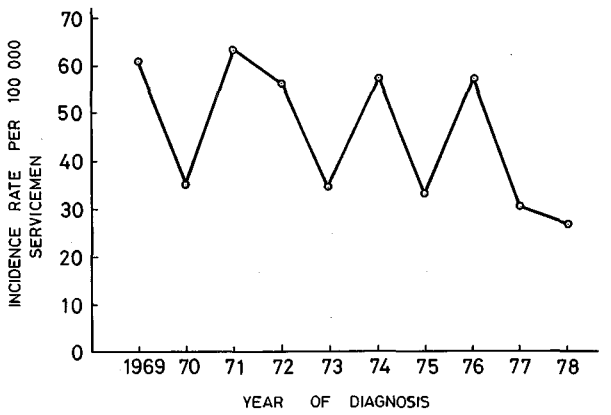

Fig. 4: **Incidence of pulmonary tuberculosis per 100,000 service personnel for 1969 — 1978**

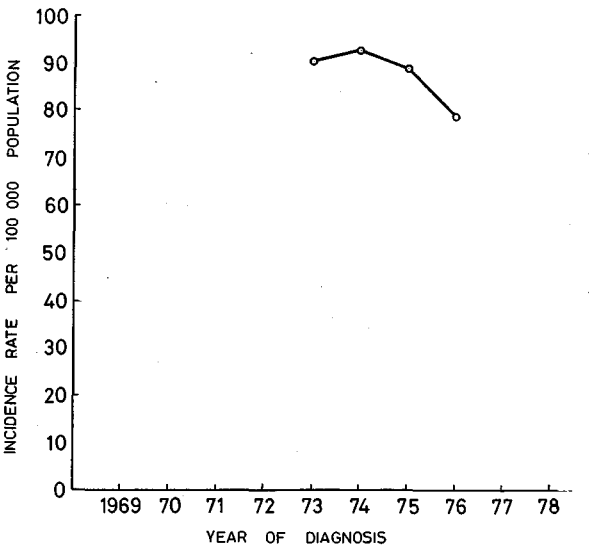

Fig. 5: **Annual incidence of tuberculosis per 100,000 population for Malaysia 1969 — 1978**

He also reports substantial inter-observer and intra-observer difference in the interpretation of pulmonary abnormalities in chest X-ray readings. In another study, Raj Narain et al (1968) found that sputum-negative PTB cases classified as "active" on the basis of an X-ray were in fact very unlikely to be cases of PTB. Only 10% were sputum-positive on repeated examinations. In this study, 84 MMR group cases were sputum-negative. Based on above study findings, 75 cases are "overdiagnosed".

A by-product of PTB screening programmes is the possibility of early detection of lung cancer, sarcoidosis, cardiac abnormalities and other conditions. Martin (1975) notes that the yield is small in terms of treatable diseases whose prognosis is likely to be improved by earlier diagnosis. In our experience, the yield in a young population such as ours has been practically nil.

Cost-wise, the South Korean study (Feldstein et al, 1973) indicate the cost per case treated as US$9500 and cost per X-ray as US$21.50 For the 4-year period 1975 to 1978, 37 cases were picked up by mass radiography from 73313 chest X-rays, done i.e. a yield of 1 case per 1981 chest X-rays. It is to be noted that the number of X-rays given is an under-estimate of the true figure. For 1978, the figures on chest X-rays in monthly X-ray return added 1307 X-rays to the figure recorded on the monthly health return alone. Every case detected cost US$42591.50, the total price of 1981 X-rays. Cost of all items have increased but the ratio of treatment cost to cost per X-ray may remain about the same. South Korea's index of living is about the same as that of Malaysia and hence the same ratios for cost calculation has been made. Mass radiography is, therefore, an expensive tool to employ for early detection of pulmonary tuberculosis. Heaf (1956) mentions that MMR is an unprofitable method of case detection if the incidence of tuberculosis is less than 2 cases per 1000 persons examined.

In the equation, benefit vs cost, the hazards from radiation must also be considered though a value in monetory terms cannot be readily calculated. The radiation dose in MMR (photo-fluography) exposure is 10 or more times greater that standard chest X-rays (14" x 17") (Nelson, 1971). No doubt even at this level, the risk, though very small, is acceptable only if it provides an equitable benefit to the individual. It should therefore be limited to the bare minimum as, at the time of entry (pre-employment) to serve as base-line data and to exclude pulmonary tuberculosis cases, for contact tracing, at the time of discharge to prevent later claims for compensation and prior to overseas courses which is mandatory for entry to host countries. 25 of the 112 MMR group cases were as a result of use for the last 3 purposes mentioned above and 1 as a result of pre-operative chest X-ray. No age or occupational group has been found to be at increased risk of infection. Even hospital personnel do not show any excess risk when compared to other groups. 20 cases had contact with family members with PTB. For the majority of cases this information was not recorded. WHO (1974) recommends that indiscriminate pulmonary tuberculosis case-finding by mass radiography even in countries where the prevalence is high should be abandoned.

SUMMARY

279 cases of pulmonary tuberculosis were diagnosed during a 10 year period from 1969 to 1978. 60% as a result of self-referral and 40% from mass miniature radiography of the chest. For every case of pulmonary tuberculosis picked up, the number of MMRs required has been steadily rising from 1 in 1900 to 1 in 6700. Using South Korea study figures, it costs US$42600 for a case of pulmonary tuberculosis detected by MMR. Besides being not cost effective, there is little advantage in early detection with regard to prognosis, in preventing subsequent cases and in picking up other lung or cardiac abnormalities. Unnecessary radiation results from frequent MMR whose dosage is 10 or more times greater than standard chest X-rays. MMR should be limited to contact tracing, prior to overseas courses and on termination of service.

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