THE PREVENTION OF TUBERCULOSIS IN GURKHAS*

Colonel S. E. LARGE
M.B.E., M.D., F.R.C.P.(Edin)., M.R.C.P.

Cambridge Military Hospital, Aldershot

Introduction

TUBERCULOSIS has always been common in Gurkha soldiers and in an endeavour to reduce its incidence a comprehensive control scheme was put into effect in January 1952, in the Brigade of Gurkhas serving in the Far East.

It is the purpose of this paper to outline the preventive aspects of the control scheme, to assess their effects by studying tuberculosis incidence in the Brigade of Gurkhas and to recommend changes which might lead to a decline in incidence in the future.

The control scheme comprises both curative and preventive measures. A detailed account of the former is outside the scope of this work but it is proper to mention them briefly because the effective cure and disposal of patients in any community contributes to a reduction in incidence, so that curative measures are in a sense also preventive.

Curative measures

The curative measures have consisted of the treatment of all Gurkha patients by up to date methods in a 100 bed Gurkha Sanatorium which was opened in Malaya at the end of 1951 at the British Military Hospital, KINRARA. All Gurkhas with tuberculosis have been sent there for investigation and treatment wherever they may have been serving when their disease was discovered, and the sanatorium has provided a centre where records have been maintained and whence supervision has been exercised over the control scheme as a whole. Thoracic Surgery, for those patients needing it, has been carried out at the Connaught Hospital (The Army Chest Centre)† at Hindhead, Surrey where patients have been sent by air or sea after varying periods of preliminary chemotherapy and hospital treatment at Kinrara.

Until 1957 all Gurkhas with tuberculosis were invalided out of the army after treatment. In October, 1957 it was agreed that successfully treated cases could continue serving with their units if they so wished. Many Gurkhas have elected to do this, although some chose to take their discharge instead. There have been very few cases whose condition after treatment has been such that they could not continue serving if they wanted to. Many Gurkhas now return to their units after very short periods of hospital treatment, lasting only 6 weeks in some cases. When they return to their units, they undertake light duties and continue to take their drugs under the supervision of the unit Medical Officer.

For those Gurkhas who have been discharged from the army on pension a dispensary scheme has recently been established in Nepal, staffed by Gurkhas (many of whom are cured tuberculous patients themselves) under RAMC and QARANC

*Part of a Cambridge MD thesis.
†Since October 1961, established at the Chest Wing, the Cambridge Military Hospital, Aldershot.

supervision, where facilities are now available for the follow up and treatment of all tuberculous ex-soldiers.

The effects of these measures on serving soldiers and pensioners can be judged from the following information relating to mortality and morbidity.

Serving Personnel

Over 200 Gurkhas have returned to duty with their regiments since 1957, and most of these sooner or later achieved full unrestricted duties. All are medically examined at regular intervals. None has relapsed.

Deaths from tuberculosis amongst serving Gurhas have been as follows: 1948, four; 1949, four. Since 1949, there have been only four deaths amongst serving soldiers; in 1951 (two), 1953 (one) and 1959 (one). I have been unable to obtain the figures for the years before 1948.

Ex-soldiers in Nepal

Mortality and morbidity in ex-soldiers (pensioners) invalided to Nepal on account of tuberculosis which had been treated during army service has declined steadily. Of 55 men discharged in 1948 and 1949, 21 had already died by January, 1961 when the tuberculosis register was compiled; and of 75 men discharged in 1950, 38 had already died. On the other hand, there have been only one or two deaths from each annual group of more recently discharged pensioners.

When allowance is made for the different lengths of time that successive annual groups of pensioners have been back in Nepal, the death rates still bear out the improvement brought about by modern treatment given during army service. Thus amongst men discharged before 1952 who had had little or no chemotherapy during their initial treatment, the death rate per annum in Nepal has been between 4.6% and 9.0% compared with a rate of under 1% in those men discharged since 1955, who had had full courses of antituberculosis drugs.

Morbidity shows a similar trend. Of 56 pensioners discharged before 1952, 16 (29%) had active disease in need of treatment when examined in January, 1961. But of 291 men discharged in 1955 and later, only 18 (6.2%) were suffering from active tuberculosis, the remainder having disease which was regarded as healed or arrested.

Preventive Measures

The principal preventive measures in use since 1st January, 1952 in the Brigade of Gurkhas have been based on the protection of tuberculin negative soldiers by vaccination with BCG, the early detection and immediate isolation of active and infectious cases, and the enhancement of individual resistance in all officers and soldiers of the brigade. These principles have been carried out in practice as follows (Ingham, 1960; Mackay-Dick, 1960):—

(a) *Recruits*
  (i) Medical examination, including chest x-ray of all would-be recruits. Those with active or doubtfully active disease have not been accepted for service.
  (ii) Tuberculin testing of all recruits.
  (iii) Vaccination of all negative reactors with BCG.

(b) *Serving personnel*

(iv) Tuberculin testing and vaccination of all negative reactors. (This measure was introduced in 1958. Until then it had applied to recruits only.)

(v) Early diagnosis and isolation of infectious cases through a combination of methods.

(a) Regular medical examination by unit Medical Officers.

(b) Regular examination by Mass Miniature Radiography (MMR).

(c) Immediate notification and admission of cases.

(d) Detection and follow up of "contacts" of notified cases.

(vi) Enhancement of individual resistance.

(vii) Supervision of the cured case.

(c) *Families*

All Gurkha wives and children actually living at their husband's duty station in Malaya, Singapore, or Hong Kong have been accorded similar treatment to their husbands, including radiography, tuberculin testing and vaccination if necessary on first arrival from Nepal.

Medical examination and chest radiography on enlistment

All potential Gurkha recruits have been medically and radiographically examined at recruiting depots in Nepal, and all with clinical or radiographical evidence of active, or apparently arrested disease of such a nature that its future stability could not be relied upon, have been rejected for army service. During the 1959 recruiting season, 1,300 youths were x-rayed before enlistment and 18 (1.4%) were rejected for service on account of radiographical evidence of tuberculosis. Ten of these were judged to be suffering from active disease. In the 1960 recruiting season, 16 (1.2%) out of 1,350 were rejected. The only figures available from previous intakes are less detailed and relate only to the numbers discharged in Nepal on account of "abnormal chest x-rays" (Director of Medical Services, G.H.Q., Far East, 1955). 1952, 1%; 1953, 3.5%; 1954, 5.5%. Aspin (1946) found that 1% of young recruits examined by radiography had tuberculous lesions at enlistment many of whom were considered to have active disease.

Quite apart from the light which these figures shed on the prevalence of tuberculosis in young people in Nepal, they do emphasise the vital importance of chest radiography in eliminating infectious or potentially infectious cases from the army at the very earliest stage of army service. No preventive scheme which omitted these measures would be complete.

The early diagnosis and immediate isolation of infectious cases

This has been achieved through a combination of methods—the careful supervision and regular medical examination of soldiers and families by unit medical officers; regular examination by mass miniature radiography (MMR); the notification of all newly diagnosed cases and their immediate isolation until proved non-infectious; and the careful tracing and follow up of all contacts of notified cases.

Mass miniature radiography

The mass miniature radiography scheme in the Brigade of Gurkhas began in 1952 with one mobile team operating in Malaya which visited units as often as possible during their rest periods between jungle operations. Since 1956 three teams have been available, one in Singapore, one in Malaya and one in Hong Kong. The policy has been for every Gurkha soldier to have his chest x-rayed every 12 to 18 months but it has not always been possible to do this. In addition to visiting and examining every unit regularly, priority has been given to known contacts of notified cases and to men returning from leave in Nepal.

MMR is an unprofitable method of case detection if the general tuberculosis morbidity is low or if the rate of discovery is less than 2 cases per 1,000 persons examined (Heaf, 1956). However, in the Brigade of Gurkhas tuberculosis morbidity is not low, and the yield of fresh cases discovered by MMR has been high. Ingham (1960) analysed the results of MMR over the period from 1st September, 1956 to 30th June, 1958. He showed that the incidence of tuberculosis per thousand people examined was as follows: Gurha troops 4.05; Commonwealth troops 1.2; Malay and Singapore Civilians employed locally in military establishments 9.8. This indicates a high incidence of previously undiagnosed pulmonary tuberculosis in Gurkha soldiers compared with Commonwealth troops, and shows a high incidence among those of the civil population working within military units.

The mode of detection of all new cases admitted to the Gurkha Sanatorium since 1952 has been as follows: Over the ten year period 1952 to 1961 inclusive, 324 cases were discovered by MMR compared with 312 discovered as a result of having reported with symptoms. In the first five years (1952 to 1956), the ratio of MMR to symptomatic case detections was 1 to 1.6; in the second five years (1957 to 1961) it was 2 to 1. Gurkhas are a stoical uncomplaining race; they do not report symptoms readily. Their disease has to be far advanced (and often highly infectious) before they will think of reporting to a medical officer. In such people the importance of early case detection by MMR can hardly be over-emphasized.

The chronic carrier, by which I mean the undiscovered chronic infectious case, usually of fibro cavitary disease, is gradually being eliminated from the Brigade of Gurkhas through the widespread application of MMR. Once or twice a year one is still found, usually in some senior Gurkha officer or N.C.O., who for some reason has escaped the usual routine examination by MMR, but the problem is no longer a serious one and the main yield from examination by MMR now consists of relatively early cases before they develop to the stage of chronicity. Such cases respond well to treatment and the effects of early detection and early treatment have been shown in the large numbers of men who have been able to return to duty in recent years.

Theoretically the ideal way to use MMR would be for everyone to have a radiographic examination of his chest carried out at least once a year. This is quite impracticable in most civilian communities owing to limitations of staff and equipment, and there can be few other groups as large as the Brigade of Gurkhas in which every one has had the advantage of regular chest radiography over a period of years. The precise effect this may have had on disease incidence in the brigade is hard to judge because other control measures have certainly contributed to the recent commencement of a

gradual decline in incidence but one need only consider the potential infectivity of those patients who would have gone undetected, perhaps for years, if MMR had not been available, in order to appreciate that its influence must have been considerable.

Because equipment has been available for the regular examination of all members of the brigade, the need to define priorities for its use has not been so pressing as it often is in civilian communities where resources are more limited. Nevertheless, attention has been particularly directed in the Brigade of Gurkhas to the contacts of known cases, and recently all soldiers returning from leave in Nepal have had their chests x-rayed as it had long been felt that such men were particularly liable to develop tuberculosis. A considerable number of cases has been detected in this way.

Crofton (1960) has defined "danger" groups in civilian life as those in which an unknown infector, such as a school teacher, can do a great deal of harm. In the army, such groups are already adequately covered by regular radiography, but local civilians in employment with Gurkha units, amongst whom Ingham (1960) showed a very high rate of fresh case detections by MMR, should certainly receive closer attention in future from army MMR teams.

Detection and follow up of contacts

The procedure for detecting and following up contacts is started in the unit as soon as the case is diagnosed. Contacts are regarded as any persons living with, working with or intimately associated with a person who has been notified as a case of pulmonary tuberculosis. The procedure consists of tuberculin testing any contact who has not had a recent tuberculin test or who has not had BCG. Any negative reactor thus discovered is vaccinated. Contacts are also medically examined and have a chest-x-ray taken (MMR or full plate). This medical and radiological examination is repeated every three months for two years. Contact registers are maintained, and the medical records of every contact are clearly marked with a red label so that if he is posted to another unit he may be readily identified from his medical documents. It is surprising that so thorough a system of contact tracing and follow up has not yielded a greater crop of fresh case detections. Out of 463 Gurkha soldiers admitted to the sanatorium in the seven years from 1955 to 1961, only 20 were detected as a result of contact action. It is possible that man-to-man spread of tuberculosis infection does not often occur within the Brigade of Gurkhas and this may be due to the rapidity with which infectious cases are detected and isolated.

Although the yield of fresh case detections has been small it has, none the less, been very important, particularly since 10 of the 20 cases so discovered were infectious, with open cavities and sputum positive for M. Tuberculosis. They were symptomless, and but for "contact procedure" they would have remained undiscovered until the next routine visit by the MMR team.

Twelve of the 20 cases detected through "contact procedure" were discovered within six months of notification of the index case; eight of these were found on the first examination carried out within a few days of notification. The remaining eight cases were not detected until between 9 and 24 months after notification of the index case. In all these, contact procedure had lapsed because the soldiers concerned had gone on leave and so had missed regular medical and x-ray examinations. Those contacts

whose x-rays during the first six months of "contact procedure" showed no disease, continued to have clear x-rays until the two year period had been completed.

The lesson to be learned is clear. No contact must be allowed to miss any of his first three medical and radiological examinations. As a further precaution, another x-ray should be taken six months later. This should ensure adequate coverage pending the next routine visit by the MMR team. By reducing the number of contact examinations in this way, radiological facilities will be spared, and greater effort will be directed towards ensuring that no contact misses any of his medical or x-ray examinations.

Supervision of the cured case

Until quite recently the problem of supervision of the cured case did not arise because all Gurkha cases, without exception, were invalided to Nepal after treatment and they were never returned to duty in the army, where they might have infected their comrades. With the advent of chemotherapy, however, and the introduction of partial lung resection as a definitive form of treatment, the position has changed. Now the great majority of cases are retained in the army, some returning to their units after as little as six weeks in hospital. Supervision of the cured case has therefore become a matter of the greatest importance in the control scheme and one which is receiving increasing attention.

No soldier is returned to his unit until x-ray shows that his cavities have closed and his sputum has been negative for tubercle bacilli on direct smear and culture on at least three consecutive occasions. Radiological opacities in the lung must have reached a point when little further change is considered likely; his E.S.R. must be normal; and he must be free from any signs of toxaemia.

After he returns to his unit the soldier is permitted to carry out normal regimental duties, but he is not allowed to take part in any activities involving severe physical or mental stress. He is medically examined and has a chest radiograph taken at least every three months until his period of chemotherapy (usually given for 24 months) has been completed.

It is most important, in this scheme of aumbulant treatment, to ensure that patients take their drugs. For this purpose registers of patients under treatment are kept by regimental medical officers, and patients are paraded twice each day so that the drugs can be taken under supervision. In this respect Gurkha soldiers are a more tractable body of patients than civilians. The results have been good. No serving soldier who has had tuberculosis has yet broken down with re-activated disease while in the army, and the numbers who have done so after their return to Nepal have been small.

The enhancement of resistance

Resistance to initial or primary infection can be raised in those who are susceptible, that is in those who are tuberculin negative, by vaccinating them with BCG. This aspect of prevention is considered elsewhere (Large, 1965). In those who are vaccinated, and those who are already tuberculin positive as a result of a previous naturally acquired primary infection, resistance can be enhanced in a number of ways, namely the provision of good pay; a well balanced nutritious diet; spacious and well ventilated

living quarters; a disciplined, well regulated healthy mode of living, including facilities for sport and leisure activities; regular medical attention, and facilities for travel and regular leave every 3 years in their own country. In short, all that is implied in the term "A high standard of living." These aspects of prevention are fully taken account of in the Brigade of Gurkhas. Their effects on the incidence of tuberculosis cannot be measured statistically; but if improved physique and high standards of general health mean increased resistance to tuberculosis, and it is generally assumed that they do, there can be no doubt that the Gurkha soldier should be capable of resisting tuberculous infection. The average recruit puts on 13 lb. in weight and grows nearly one inch in height during his first year of military service, and one has only to see the soldier on leave in Nepal beside his civilian contemporary to appreciate the difference in their physique and appearance.

TABLE I

Primary and Pulmonary Tuberculosis

Annual Admissions to Gurkha Sanatorium, 1952-1961

		Admission rate per 1,000 brigade strength
1952	78	6.7
1953	79	6.7
1954	73	6.1
1955	54	4.5
1956	72	5.9
1957	100	8.0
1958	71	5.6
1959	49	3.7
1960	66	4.8
1961	51	3.5
	TOTAL 693	

Effects of the Control Scheme

The effects of preventive measures can best be judged by studying trends in incidence. Over the 10 year period, 1952 to 1961 inclusive the annual incidence per thousand in the Brigade of Gurkhas fell from about 6.0 to 3.5 (Table 1). The figures refer to admissions to the Gurkha Sanatorium, British Military Hospital, Kinrara, Malaya, of all cases of active pulmonary tuberculosis in Gurkha soldiers, including cases of primary tuberculous pleural effusion and primary lung complexes as well as all cases of progressive post-primary pulmonary tuberculosis of the adult or reinfection type. Since every case of proven or suspected tuberculosis has been admitted to Kinrara wherever he may have been serving when his illness was discovered, the figures accurately represent incidence of the disease over the period.

There have been fluctuations in the admission rates from year to year; nevertheless, two main trends are apparent. First, there was little change in the rates over the first 5 years when the annual average was about 6.0 per thousand per annum. Secondly,

following a peak of 8.0 per thousand in 1957, there has been a steady decline over the last five years of the survey to the lowest recorded figure of 3.5 per thousand in 1961. There are no similar figures available from the years before 1951 with which to compare the present rates. It is therefore, hard to judge whether the figures shown from 1952 to 1956 were typical of previous years or whether they were themselves unnaturally high as a result of fresh case detections due to MMR (which had been introduced in 1952). There is no doubt, however, about the decline in incidence which is apparent since 1957. This has occurred although MMR activity was increased, and it would be reasonable to suppose therefore, that it was due to the total combined effects of the preventive measures described previously.

Incidence related to year of enlistment

The numbers of cases of primary and pulmonary tuberculosis admitted over the ten year period 1st January, 1952 to 31st December, 1961, set out according to their year of enlistment, are shown in Table 2. The last column shows the incidence per thousand per annum shown by each annual intake, based on admissions over the

TABLE II

Primary and Pulmonary Tuberculosis

Admissions between 1st January, 1952 and 31st December 1961 related to year of enlistment

Date of enlistment	*Number of recruits*	*Number of yrs. during which cases occurred*	*Men x years observation*	*Number of admissions*	*Admissions per 1,000 per annum*	
Before 1945	Not known	10	Not obtainable	209	Not obtainable	
Nov. 1945	400	10	4,000	18	4.5	Pre-1951 recruits
Nov. 1946	500	10	5,000	23	4.6	
Nov. 1947	500	10	5,000	32	6.4	
Nov. 1948	2,800	10	28,000	167	6.0	
Nov. 1949	1,200	10	12,000	77	6.4	
Nov. 1950	450	10	4,500	23	5.1	
Nov. 1951	680	10	6,800	19	2.8	Post-1951 recruits
Nov. 1952	965	9	8,685	34	3.9	
Nov. 1953	617	8	4,936	14	2.8	
Nov. 1954	536	7	3,752	10	2.7	
Nov. 1955	1,047	6	6,282	18	2.9	
Nov. 1956	886	5	4,430	8	1.8	
Nov. 1957	1,134	4	4,536	14	3.1	
Nov. 1958	1,185	3	3,555	11	3.1	
Nov. 1959	1,152	2	2,304	9	3.9	
Nov. 1960	1,299	1	1,299	7	5.4	
1945-1950	Recruits 5,850	(Pre 1951-recruits) 10	58,500	340	5.8	
1951-1960	Recruits 9,501	(Post 1951 recruits) 1—10	46,579	144	3.09	

whole ten year period, or on lesser periods in the case of those intakes after 1951. The incidence shown by the intake of 1947, 1948 and 1949 has been higher than that shown by any other intake. In general, the incidence shown by the men who enlisted in 1951 and subsequently, has been lower than that shown by the men who enlisted before 1951; the sharp fall in incidence from 5.1 shown by the 1950 intake to 2.8 shown by the 1951 intake is particularly noticeable. (The reason for the high rates shown by recruits of the 1960 intake is because all cases occurred during a single year (1st January, 1961 to 31st December, 1961). This was their first year of service, a year in which the incidence has always been higher than in subsequent years).

If the men recruited in 1951 and afterwards (hereafter referred to as the post-1951 recruits) are grouped together (Foot of Table 2) their combined incidence per thousand per annum has been 3.09. The corresponding figure for the men recruited between 1945 and 1950 (the pre-1951 recruits) has been 5.8.

These rates have been based on the strengths of recruit intakes at enlistment. There has, however, been a small wastage of men each year from every intake and this must have reduced the strengths of the older intakes more than the younger. If this could have been taken into account, it would have emphasised still further the contrast in incidence which has been shown between the pre-1951 and the post-1951 intakes.

The most probable reason for the contrast, and for the sudden drop in incidence shown between the intakes of 1950 and 1951, is that all tuberculin negative recruits since, and including, the intake of 1951 have been vaccinated with BCG on joining the army, whereas the pre-1951 group contained many men who were tuberculin negative on enlistment and who were not vaccinated until 1958 when the BCG scheme was extended to include all men then serving. In other respects the groups were comparable, having been subjected to the same standards of medical and radiological screening on enlistment and during army service, and exposed during service to the same environmental conditions. This point is discussed further elsewhere (Large, 1965).

Incidence related to age and length of service

Over the ten year period of study (1952 to 1961), men recruited before 1951 were older and had longer service than men recruited subsequently. It is important, therefore, to consider whether these factors had any bearing on the contrast in incidence already demonstrated between the pre-1951 and post-1951 groups.

The facts regarding age and length of service, and their relation to incidence, based as before on admissions over the 10 year period 1952 to 1961, are set out in Table 3. Men are enlisted in Nepal in November each year. For the purpose of this paper I have counted their army service from the 1st January of the following year. A 1951 recruit, aged 17 on enlistment, would complete his first year of service on 31st December, 1952 and he would then be 18 years old.

Amongst those men enlisted before 1951 (pre-1951 recruits) the number of admissions was highest between their 6th and 10th years of service. This is shown most clearly in the 1948 and 1949 intakes. The most probable explanation for this is that at the time these men reached their 6th to 10th year of service it happened that MMR was being more widely used than before in the Brigade so that many previously

TABLE III
Primary and Pulmonary Tuberculosis
Admissions in each year of service

Year of enlistment	*No. of recruits*	*Nos. of cases of tuberculosis occurring by years of service*																
		1st *yr.*	2*nd* *yr.*	3*rd* *yr.*	4*th* *yr.*	5*th* *yr.*	6*th* *yr.*	7*th* *yr.*	8*th* *yr.*	9*th* *yr.*	10*th* *yr.*	11*th* *yr.*	12*th* *yr.*	13*th* *yr.*	14*th* *yr.*	15*th* *yr.*	16*th* *yr.*	*TOTAL*
1945	400	*	*	*	*	*	*	4	5	2	0	0	3	2	1	1	0	18
1946	500	*	*	*	*	*	4	6	2	1	1	4	2	1	0	2		23
1947	500	*	*	*	*	4	8	1	1	2	5	5	2	2	2			32
1948	2,800	*	*	*	12	14	19	15	26	33	12	11	16	9				167
1949	1,200	*	*	4	3	7	7	8	11	10	12	7	8					77
1950	450	*	4	3	2	2	2	3	3	2	1	1						23
1951	680	5	2	1	2	2	1	1	1	4	0							19
1952	965	9	3	2	5	5	6	2	1	1								34
1953	617	3	4	0	1	1	2	3	0									14
1954	536	2	0	4	1	2	1	0										10
1955	1,047	5	0	5	0	3	5											18
1956	886	5	0	0	2	1												8
1957	1,134	2	3	7	2													14
1958	1,185	2	6	3														11
1959	1,152	6	3															9
1960	1,299	7																7

* Figures not available (Sanatorium not open until 1951)

undetected cases were unmasked. It is unlikely to have been due to increasing age and length of service. If it had been, a similar trend might have been expected in the post-1951 recruits; but this has not been demonstrated. Instead, most post-1951 intakes have shown a large number of admissions in the first year of service, and fewer admissions in the following years. Since age and length of service cannot be held responsible for the contrast in incidence between the pre-1951 and post-1951 intakes, the explanation I have already given, that the post-1951 recruits were vaccinated on entry, would seem more probable.

Incidence in recruits

The high incidence in the first year of army service is further demonstrated in Table 4, which shows the incidence (based on admissions) of primary and pulmonary

TABLE IV
Primary and Pulmonary Tuberculosis in each year of service
(Combined 1951 to 1960 intakes)

Year of service	*Number of recruits*	*Cases*	*Incidence per* 1,000
First	9,501 (1951 to 1960 intakes)	46	4.9
Second	8,202 (1951 to 1959 intakes)	21	2.6
Third	7,050 (1951 to 1958 intakes)	22	3.1
Fourth	5,865 (1951 to 1957 intakes)	13	2.2
Fifth	4,731 (1951 to 1956 intakes)	14	2.9
Sixth	3,845 (1951 to 1955 intakes)	15	3.9
Seventh	2,798 (1951 to 1954 intakes)	6	2.2
Eighth	2,262 (1951 to 1953 intakes)	2	0.9
Ninth	1,645 (1951 to 1952 intakes)	5	3.0
Tenth	680 (1951 intake)	0	0.0

tuberculosis in each year of service of the combined 1951 to 1960 intakes. The incidence per thousand in the first (or recruit) year of service was 4.9. This was higher than in any subsequent year of service, and significantly higher than in the remaining years of service together. The reasons for this high incidence in recruits are discussed in detail elsewhere (Large, 1964), and it is suggested that many recruits who develop tuberculosis, usually primary tuberculosis, early in their service do so as a result of infections acquired shortly before they arrive at the recruiting depots where they enlist. If recently infected recruits could be recognised and treated before they develop the signs and symptoms of overt disease, not only would first year incidence fall but there would be a gradual decline in the rates shown by the brigade as a whole.

Unit incidence

The number of admissions from each of the eight Gurkha rifle battalions has varied considerably from year to year, due mainly to the vagaries of MMR examinations, but over the decade as a whole the total admissions from each battalion were remarkably similar (lowest 60; highest 77). There has been little difference between the numbers admitted from battalions recruited in Eastern Nepal (7th and 10th Gurkhas; 290 cases) and the numbers from the Western Nepal regiments (2nd and 6th Gurkhas; 263 cases). Units have moved about during the review period between Malaya, Singapore and Hong Kong, but no relationship was discernable between the number of admissions from units and their sojourn in any particular area.

Future trends in incidence

The size and structure of the Brigade of Gurkhas is such that under normal circumstances only enough recruits are enlisted each year to make good the losses due to retirement. The normal period of service is 15 years and although a few N.C.O.'s and Gurkha officers continue to serve for longer periods it is true to say that over 90% of the personnel of the brigade are replaced over a period of 15 years. By the end of 1966, therefore, the brigade will be made up almost entirely of officers and men who will have enlisted in 1951 or subsequently, and all negative reactors, will, therefore, have been vaccinated on enlistment (and will have been revaccinated if annual testing has shown their tuberculin allergy to have waned). As the numbers of post-1951 men in the brigade increase, so the overall disease incidence in the brigade should decline until the time is reached, by the end of 1966, when the incidence for the brigade as a whole should reach the level already shown by the post-1951 men—that is 3.09 per thousand per annum. This rate is still high compared with the rates incurred by troops of other nationalities serving in the Far East (Large, 1964). For British and Commonwealth troops, for example, the annual admission rate between 1952 and 1961 never rose above 1.3 per thousand in any one year and the annual figure was more usually between 0.5 and 0.9. If the Gurkha brigade remains at its present strength, about 46 new cases of primary and pulmonary tuberculosis can be expected to occur annually unless certain changes are made in the tuberculosis control scheme as it used to exist during the decade 1952-1961.

Epidemiology of tuberculosis in Gurkhas

An analysis of tuberculosis incidence in post-1951 Gurkhas (Large, 1964) has shown that most cases in the 1952-1961 decade occurred in those men who were already tuberculin positive on enlistment. By contrast, there were very few cases amongst vaccinated men. If this trend continues, it is estimated that of the 46 new cases to be expected each year after 1966, no fewer than 40 to 41 will occur in positive reactors and only 5 to 6 in vaccinated men. (There should be no tuberculin negative reactors because all negative recruits since 1952 have been vaccinated on enlistment) Clearly, therefore, efforts to reduce future incidence should be directed mainly towards the positive reactors.

These men carry with them when they join the army latent and clinically undetectable lesions which later break down to cause overt tuberculous disease. Such break-

down can come about either as a result of re-infection acquired from other infectious sources (exogenous infection) or through the endogenous progression of the latent lesions themselves. It has been shown (Large, 1964), that breakdown was commoner in those men who had reacted strongly to tuberculin on enlistment than in those who had reacted weakly, and, further, that breakdown was due to exogenous infection in only 25% of the cases whereas in the other 75% it was endogenous in origin. Thus infection from others has probably not been the major cause of overt disease in positive reactors. Nevertheless, it has accounted for one in four of the cases which occurred, as well as for the cases which occurred in vaccinated men, so that it is important to recognise the common sources of infection and deal with them whenever possible.

Many Gurkha soldiers are probably re-infected in Nepal itself when they return there on leave once every three years. Tuberculosis is known to be quite common in Nepal today and the conditions in Gurkha homes and along the main routes into the mountains where Gurkhas live are highly conducive to the spread of infectious disease. Re-infection acquired in this way is difficult to prevent, but at least it can be recognised quickly if it occurs, and this is being done by x-raying all soldiers on their return to units after leave. Infectious Gurkha wives may also transmit the infection to their husbands if, as has happened in the past, they are allowed to leave Nepal to join their husbands serving abroad without prior medical examination and x-ray. This should never be allowed to happen. Infection can also be acquired by Gurkhas from civilians in the countries where they serve and from untreated infectious cases in other soldiers. Both these sources are comparatively uncommon, the former because Gurkhas keep themselves to themselves when abroad and rarely mix with the local people, the latter because the control scheme in the Brigade of Gurkhas has been very effective in detecting and isolating infectious cases as soon as they occur.

Endogenous exacerbation of pre-existing but hitherto undetectable lesions has been the cause of overt disease in most of the tuberculin positive men who have developed progressive tuberculosis. If such breakdown could be prevented or reduced, the incidence of overt tuberculosis in the Brigade of Gurkhas would inevitably fall. It is usually held that "stress" factors such as undernourishment, mental and physical strain, intercurrent infection and unsatisfactory housing and living conditions—factors, that is to say, which lead to a lowering of bodily resistance—determine the onset of endogenous breakdown. As already explained, these aspects of prevention have been, and are being, fully taken account of in the army, yet tuberculosis incidence in Gurkhas remains high. Might it not be the case, therefore, that resistance itself is low in the Gurkha or that it is easily depressed by stress factors? This immediately raises the question of native resistance and its level in Gurkhas.

Native resistance

Individual, natural (or native) resistance to tuberculous infection varies from race to race. It is well known that American negroes, for example, are particularly susceptible to tuberculosis whereas amongst the white races of America, Jews are relatively immune. It is known too that the races who show most susceptibility are those who, like the Nepalese, lack the centuries of experience of contact with tuberculosis which in most Western countries has raised the natural resistance of their peoples to a high

degree. Aspin (1947) applied this conception of racial lack of resistance to Gurkhas and I think it can still be applied today (Large, 1964) despite the fact that the disease is probably commoner in Nepal than it used to be. The subject of racial resistance is a very complicated one, especially in Ghurkas because we do not yet know the true position in Nepal itself, but having examined other possible causes for the continuing high tuberculosis incidence in the Gurkha brigade it is hard to resist the conclusion that racial susceptibility, in the sense that many Ghurkas possess low levels of natural resistance, must have been one of the main factors responsible for the progression of the latent foci which tuberculin positive Gurkhas carry with them when they join up. If so, the control scheme must be modified to take account of this susceptibility.

Some two thirds of the Ghurkas who join the army nowadays are already tuberculin positive on enlistment. These men have been able to stabilize their primary lesions, and any foci disseminated from them, to the extent that they are radiologically and clinically undetectable when they join the army. Obviously, therefore, they cannot entirely lack the ability to resist tuberculous infection. Yet at some later date many of these latent foci progress, this reflecting a situation in which resistance has to some extent been overcome by the invasive power of the bacilli already in the body. Measures additional to those at present used in the control scheme are, therefore, required which will permit individual resistance to regain its ascendency over bacterial virulence so that the stability of the primary lesions can be maintained.

With this end in view, prophylactic courses of oral Isoniazid have recently been recommended for, and are being given to, all recruits who react strongly (Heaf Grades III or IV) on joining the army, as well as to those who on retesting show definite evidence of tuberculin conversion, provided that they show no radiological or clinical evidence of active tuberculosis at the time. There is much evidence to show that Isoniazid given alone in daily doses over a period of a year or more is a cheap, safe and practical form of prophylactic therapy which does not interfere with the individual's normal routine of life, and which can be effective in controlling primary infection and in preventing progressive tuberculosis (Zorini, 1958; Dormer and Wood, 1960; Groth-Petersen, Gad and Ostergaard, 1960; Comstock, 1962; Ferebee, Mount, Murray and Livesay, 1963). A detailed account of the methods employed in this experimental trial of prophylactic Isoniazid in Gurkha soldiers is outside the scope of this work, but preliminary reports about its effects on incidence, not only in the first year of service but in later years also, have been very encouraging.

Conclusions and Recommendations

The tuberculosis control scheme in the Brigade of Gurkhas has resulted in a progressive decline in the annual tuberculosis rates since 1957, and this is likely to continue until 1966. Thereafter, if the incidence is to be further reduced the control scheme must be modified to deal, first, with the high rate shown by recruits in the first year of service and, secondly, the high endogenous breakdown rate incurred by men with positive tuberculin reactions on enlistment. Both problems can be dealt with by recognising those at risk at the earliest possible moment and taking appropriate steps to prevent the emergence of overt disease.

It is recommended, therefore, that all Gurkha recruits be tuberculin tested as soon

as they join the army, in Nepal if possible instead of 6 weeks later in Malaya as hitherto. The strong (Heaf Grades III and IV) reactors should receive careful surveillance during their first year of service and be given courses of prophylactic oral Isoniazid for 18 months in addition.

Minor modifications in the control scheme are recommended as follows: first, the elimination of many unnecessary "contact examinations;" secondly, the more vigorous application of measures to identify infectious cases amongst civilians working in army camps; thirdly, the medical and radiological examination of wives and families in Nepal before they leave that country to join their husbands overseas.

Summary

The curative and preventive aspects of the tuberculosis control scheme which has been used in the Brigade of Gurkhas since 1951 are described. The effects of good treatment have been shown by a recent decline in mortality and morbidity amongst pensioners.

The preventive aspects of the tuberculosis control scheme have included tuberculin testing of all recruits; the vaccination of negative reactors with BCG; the regular examination of all soldiers by MMR; the immediate notification, isolation and treatment of cases; and the identification and surveillance of "contacts."

The value of each measure has been assessed and the part each has played in the control scheme as a whole has been discussed.

Mass miniature radiography has been an especially valuable aid to early case detection particularly since Gurkhas are very slow to report their symptoms.

The number of case detections resulting from the existing "contact procedure" has been small, possibly because infection from one soldier to another has been uncommon in the Brigade of Gurkhas.

The supervision of the cured case is assuming an increasingly important role in the control scheme now that soldiers are being returned to duty while still under treatment instead of being invalided to Nepal as in the past.

The incidence of tuberculosis, based on admissions to hospital, in the Brigade of Gurkhas over the ten year period 1952 to 1961 shows a steady decline over the last 5 years; this is attributed to the combined effects of the various preventive measures. By 1966 it is estimated that about 46 fresh cases of tuberculosis will occur annually but no further decline is anticipated unless changes are made in the tuberculosis control scheme.

The most important of these changes is that a prophylactic course of oral Isoniazid should be given to all Gurkha recruits showing strongly positive tuberculin reactions on enlistment. It is important that those at risk should be recognised as early as possible and recruits should, therefore, be tuberculin tested in Nepal instead of in Malaya as hitherto.

REFERENCES

ASPIN, J. (1946). *Tubercle* (*Lond.*), **27,** 25.
ASPIN, J. (1947). *Tubercle* (*Lond.*), **28,** 129 and 123.
COMSTOCK, G. W. (1962). *Amer. Rev. Resp. Dis.*, **86,** 810.
CROFTON, J. (1960). *Brit. med. J.*, **2,** 679.

REFERENCES—continued.

DORMER, B. A. AND WOOD, M. M. (1960). *Lancet*, **2**, 837.

FEREBEE, S. H., MOUNT, F. W., MURRAY, F. J. AND LIVESAY, V. T. (1963). *Amer. Rev. Resp. Dis.*, **88**, 161.

GROTH-PETERSEN, E., GAD, U., AND OSTERGAARD, F. (1960). *Amer. Rev. Resp. Dis.*, **81**, 643.

HEAF, F. R. G. (1956). *Brit. med. J.*, **2**, 1383.

INGHAM, F. J. (1960). *J. roy. Army med. Cps.*, **106**, 68.

LARGE, S. E. (1964). *Tubercle (Lond.)*, **45**, 321.

LARGE, S. E. (1965). *J. roy. Army med. Cps., In the press.*

MACKAY-DICK, J. (1960). *J. roy. Army med. Cps.*, **106**, 28.

ZORINI, A. O. (1958). *Dis. Chest*, **33**, 1.

R.A.M.C. CHARITABLE FUNDS

UP to the present Officers have been invited to subscribe to the R.A.M.C. Officers' Benevolent Society at £1 1s. 0d. per annum and the R.A.M.C. Fund (Officers' Branch) at £1 per annum.

Since the beginning of 1964 most of the objects of the Officer's Branch have been taken over by the H.Q. Officers' Mess Club Fund, so that subscriptions to the R.A.M.C. Fund (Officers' Branch) are no longer required. In order to give better support to the Charitable Funds, a Covenant Scheme has been put into operation.

This Scheme asks for a donation of £2 to the R.A.M.C. Fund General Relief Branch by Covenant for a minimum period of seven years. The income tax on this is reclaimed by the Fund and of the total £1 1s. 0d. is paid to the R.A.M.C. Officers' Benevolent Society.

The new covenanted subscription will be directed firstly in support of the R.A.M.C. Officers' Benevolent Society (established in 1820) which exists "to afford relief to those orphans of commissioned officers who may be left under circumstances of peculiar distress or who may be enabled by a small addition of means at a certain period of their lives to procure a better education than their limited means will allow." The funds of the Society are administered by a committee of subscribers, all being serving or retired Regular Officers, meeting quarterly to make grants which are reviewed annually. This committee also administers other funds not directly affected by the new subscription.

Secondly, the new subscription will be directed to support the General Relief Branch in its work of relieving distress among men, women and children of the R.A.M.C. The Branch also makes grants to ensure the admission of men, women or children to suitable institutions and schools and is administered by a committee of "all ranks," Regular, T.A., serving and retired, meeting monthly. Urgent cases are dealt with by the Chairman and Secretary of the R.A.M.C. Charitable Funds Office at 83 Cambridge Street, London, S.W.1.

Forms of covenant may be obtained from the same address.

While this appeal is primarily directed to serving and newly commissioned officers, it is hoped that retired officers will wish to participate in view of the increased income to the Funds which the scheme makes possible.