B.C.G. VACCINATION IN THE BRIGADE OF GURKHAS *

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SINCE early in 1952 every tuberculin negative Gurkha recruit, enlisted for service with the British Army in the Far East, has been vaccinated with B.C.G. soon after arriving in Malaya from Nepal. In this paper the results of those vaccinations are assessed by comparing incidence rates between vaccinated and unvaccinated groups during military service.

Method

Between November 1951 and November 1960, 9,501 Gurkha recruits joined the army in ten annual intakes (Table I). 3,221 recruits (34 per cent) were negative

Table 1.

Recruits tuberculin tested on enlistment (at Sungei Patani, MALAYA)

Year of enlistment	*Total tested*	*Negative and given B.C.G.*	*Positive*
1951	680	337 (49.6%)	343 (50.4%)
1952	965	341 (35.3%)	624 (64.7%)
1953	617	289 (46.8%)	328 (53.2%)
1954	536	216 (40.3%)	320 (59.7%)
1955	1,047	494 (47.2%)	553 (52.8%)
1956	886	235 (26.5%)	651 (73.5%)
1957	1,134	428 (37.7%)	706 (62.3%)
1958	1,185	108 (9.1%)	1,077 (90.9%)
1959	1,152	182 (15.8%)	970 (84.2%)
1960	1,299	591 (45.5%)	708 (54.5%)
TOTAL	9,501	3,221 (34%)	6,280 (66%)

to the tuberculin test on enlistment and were vaccinated with B.C.G. (the vaccinated group). 6,280 (66 per cent) were not vaccinated because they already showed positive tuberculin reactions on enlistment (the unvaccinated group). All recruits—vaccinated and unvaccinated—were medically examined on enlistment and had chest x-rays taken which were accepted as normal. During their army service, the vaccinated and unvaccinated were exposed to similar environmental and operational conditions, and both groups were regularly examined by mass miniature radiography as described elsewhere (Large, 1965).

The cases of tuberculosis which occurred in the two groups were studied at the Gurkha Sanatorium, British Military Hospital, Kinrara, near Kuala Lumpur, Malaya. The period of follow up was the ten years from 1st January, 1952 to 31st December, 1961 during which time every patient in the Brigade of Gurkhas with proven or suspected primary or pulmonary tuberculosis was admitted to Kinrara for investigation and treatment, wherever he may have been serving when his illness was discovered. Incidence

*Part of a Cambridge MD thesis.

rates based on Kinrara figures, therefore, provide an accurate index of the total brigade incidence of primary and pulmonary tuberculosis. Every case of extra pulmonary tuberculosis in the vaccinated was also admitted to Kinrara (a cross check against the B.C.G. cards held at Kinrara confirms this). A few cases of extra pulmonary disease in the unvaccinated may never have passed through Kinrara, however, as the rule regarding transfer there applied only to cases of primary and pulmonary disease.

Cases

These were assessed from the notes and x-rays: patients from 1958 onwards were seen personally. Only " definite " cases (from whom M. tuberculosis was isolated by culture or direct smear) and " probable " cases (who satisfied all other criteria) have been included. The cases have been classified as follows:—

1. Primary tuberculosis

   (*a*) Primary pleural effusions without radiological lung opacities. In these, the diagnosis was based on typical onset and course, the absence of other possible causes of effusion, a positive tuberculin reaction, and the characteristic straw coloured lymphocytic fluid on aspiration.

   (*b*) Cases of enlarged hilar glands together with pulmonary parenchymal foci.

2. Pulmonary tuberculosis

   Cases of progressive pulmonary disease of the adult or re-infection type, unaccompanied by enlargement of the hilar glands, but sometimes associated with small pleural effusions.

3. Extra-pulmonary tuberculosis

   Tuberculosis of other organs.

Tuberculin testing

Recruits were tuberculin tested at the training depot at Sungei Patani, Malaya in the January or February of their first year of training, having been enlisted in the previous November in Nepal. The methods used were as follows:—

For the first four annual intakes (1951-1954), the tuberculin test employed for pre-vaccination testing was the Mantoux intradermal test using 0.1 ml. of 1/10,000 Old Tuberculin (O.T.) (the equivalent of one unit International Standard) followed by a second test with 1/100 O.T. (100 Units) if the reaction to the first was negative. Results were read between 72 and 96 hours after testing. A reaction showing an area of raised induration of 6 mm. in diameter or more was accepted as positive. Simple erythema was not regarded as positive. Those negative to the second test with 1/100 O.T. were vaccinated with B.C.G. For the last six annual intakes (1955 to 1960) the Heaf multiple puncture test (Heaf 1951) using Purified Protein Derivative (PPD) in a solution containing 2.0 mg. (100,000 Tuberculin units) per ml. was employed for all pre-vaccination testing. The results were read 72 to 96 hours later. Any reaction showing more than four indurated papules was regarded as positive (War Office Memorandum on Immunological Procedures, 1956).

Positive results were graded as follows in accordance with this Memorandum:—

Grade I — 4 or more indurated papules.
Grade II — the papules have coalesced (to form a ring).
Grade III — a large plateau of induration.
Grade IV — anything greater than this (reactions showing blistering, ulceration or necrosis).

Vaccination procedure

The vaccine in use from 1951 to 1954 was Pasteur Institute freeze-dried B.C.G. (Bacille Calmette-Guerin) given by intradermal injection. After vaccination, testing for tuberculin conversion was carried out with 0.1 ml. of 1/100 old tuberculin (100 units) at eight weeks intervals, and the recruit was revaccinated if conversion had not occurred by 24 weeks. Revaccination was necessary in a number of cases, but with improvement in technique, conversion rates of 99 per cent were obtained at 17 weeks (Robinson, 1956) and these have since been maintained. Since 1955 freeze-dried B.C.G. vaccine (Glaxo) has been used for vaccination. When reconstituted, this vaccine contains a minimum of 100,000 viable organisms per 0.1 ml. dose. Post vaccination testing (by the Heaf technique) has been carried out 6 and again 12 weeks after vaccination and cases still tuberculin negative at 12 weeks have been revaccinated. Thereafter, all vaccinated men have been tuberculin tested annually and all those whose tuberculin tests have reverted to negative have been vaccinated.

Reversions to negative reactor state after apparently successful vaccination

This happened in 20 to 25 per cent of the men who were vaccinated in the 1951 and 1952 recruit intakes, reversion in most instances being observed three to six years after the original vaccination had been performed. Reversion was observed, also, but to a lesser extent (5 to 10 per cent) in the later intakes. The records show that those who reverted had very small vaccination lesions, many of these measuring only 2 to 3 mms. in diameter. This may have been due to ineffective vaccination technique or to the use of vaccine not scrupulously protected against heat and exposure to " skyshine ". All those men whose tuberculin tests reverted to negative were successfully revaccinated.

Records

A card was made out in duplicate for every recruit when vaccinated, on which was recorded vaccination details, results of post-vaccination tuberculin testing and subsequent tuberculosis history. One card was kept with the soldier's medical papers: the other was kept at the Gurkha Sanatorium, Kinrara, and in this way a central record of all vaccinated men has been maintained. The B.C.G. cards have provided a cross check of the cases occurring in vaccinated men.

Evidence of total number in the vaccinated and positive reactor groups

Records held at Kinrara show the numbers of recruits tuberculin tested each year and the numbers found on enlistment to be tuberculin negative and positive. These are the figures used in this work, and the negative and positive reactors together correspond closely to the total number of recruits enlisted each year supplied by the Officer in charge of Gurkha Records. All negative reactors were vaccinated, and nominal rolls and B.C.G. cards are held at the Gurkha Sanatorium, Kinrara. For those who were not vaccinated the numbers found each year to have been tuberculin positive on enlistment are known, but these cannot be checked against nominal rolls because none were kept.

Comparison between Vaccinated and Unvaccinated Groups

The Cases

144 cases of primary and pulmonary tuberculosis occurred during military service from 9,501 men who enlisted between 1951 and 1960 (Table 2). Of these, 50 were cases

Table 2.

Cases of tuberculosis (all forms) occurring during army service in men recruited between 1951 and 1960

	Number of Recruits	*Pulmonary Tuberculosis*	*Primary Tuberculosis*	*Total Primary and Pulmonary Tuberculosis*	*Extra Pulmonary Tuberculosis*	*Total, all forms tuberculosis*
Tuberculin negative (vaccinated)	3,221	13	5	18	4	22
Tuberculin positive (not vaccinated)	6,280	81	35	116	4	120
Not tested	—	—	5	5	—	5
Not vaccinated	—	—	5	5	—	5
		94	50	144	8	152

of primary tuberculosis (41 cases of pleural effusion and 9 cases of enlarged hilar glands with pulmonary parenchymal lesions), and 94 were cases of progressive pulmonary tuberculosis of the adult type (hereafter called pulmonary tuberculosis). 18 cases (5 cases of primary tuberculosis and 13 of pulmonary tuberculosis) occurred in the vaccinated group and 126 (45 cases of primary tuberculosis and 81 of pulmonary tuberculosis) in the unvaccinated group, of which 116 were in positive reactors, 5 in recruits who were never tuberculin tested and 5 in recruits who were negative reactors, but who developed tuberculosis before being vaccinated. In addition, 8 cases of extra pulmonary tuberculosis occurred, 4 in the vaccinated group and 4 in the unvaccinated group. These are included in the comparison which follows between the vaccinated and unvaccinated, giving a total of 152 cases, 22 in the vaccinated and 130 in the unvaccinated.

Exclusions

41 cases have been omitted, 2 from the vaccinated group and 39 from the unvaccinated group, because they were probably suffering from tuberculous disease, as distinct from tuberculosis infection, when they joined the army. A further 3 cases have been omitted: one from the vaccinated group because his vaccination was technically un-

Table 3.

Cases of tuberculosis (all forms) during army service
(After exclusion of 44 cases suffering from tuberculosis on enlistment)

	Number of Recruits	*Pulmonary Tuberculosis*	*Primary Tuberculosis*	*Extra Pulmonary Tuberculosis*	*Total*
Vaccinated group	3,221	11 (58%)	4 (21%)	4 (21%)	19
Unvaccinated	6,280	75 (84%)	11 (13%)	3 (3%)	89
		86	15	7	108

satisfactory and 2 from the unvaccinated group because they were tuberculin negative, leaving 108 cases (152 minus 44) for further study (Table 3). Of these, 19 cases occurred in the vaccinated and 89 in the unvaccinated.

Nature of disease

The type of disease which occurred in the two groups is shown in Table 4.

Table 4.

Nature of Disease

Vaccinated and Unvaccinated Cases

	Pulmonary tuberculosis	*Primary tuberculosis*	*Extra Pulmonary tuberculosis*
Vaccinated group (19 cases)	11 (58%)	4 (21%)	4 (21%) (Cervical adenitis — 1 case; Tuberculosis peritonitis — 1 case; Tuberculous of spine — 2 cases)
Unvaccinated group (89 cases)	75 (84%)	11 (13%)	3 (3%) (Cervical adenitis — 1 case; Tuberculous of spine — 1 case; Tuberculosis epididymitis — 1 case)

Comment

In the vaccinated group the proportion of primary and extra pulmonary cases was higher than in the unvaccinated group. Many primary and extra pulmonary cases in the vaccinated group were from the 1951 and 1952 intakes. It will be shown later that the vaccine used for them may have been less effective than that used for later intakes. This would explain the high incidence of disease, including primary and extra pulmonary disease, shown by the vaccinated who enlisted in these two years.

Extent and severity of disease

The cases of pulmonary tuberculosis (11 in the vaccinated group and 75 in the unvaccinated group) analysed according to cavity state, sputum state, and extent of diseases as assessed radiologically on first admission to the Gurkha Sanatorium, are

Table 5.

Type and extent of disease

Vaccinated and unvaccinated cases

Pulmonary tuberculosis only

	Vaccinated (11 *cases*)	*Unvaccinated* (75 *cases*)
Cavitated	8 (73%)	36 (48%)
Non-cavitated	3 (27%)	23 (31%)
Not known	—	16 (21%)
Positive sputum	3 (27%)	20 (27%)
Resistant organisms isolated	—	—
Radiological extent of disease*		
Minimal (one zone)	—	8 (11%)
Moderate (two or three zones)	10 (91%)	45 (60%)
Extensive (four or more zones)	1 (9%)	14 (18%)
Not known	—	8 (11%)

*After Foster-Carter et al (1952)

shown in Table 5. 73 per cent of the vaccinated cases showed cavitated disease on admission compared with 48 per cent of the unvaccinated cases. This suggests that the disease in the vaccinated was more severe than in the unvaccinated. On the other hand, only 9 per cent of the vaccinated cases showed widespread disease involving four or

more zones compared with 18 per cent of the unvaccinated cases. The sputum state was the same in both groups, 27 per cent of the cases in each group having had sputum in which M. tuberculosis was identified. The conclusion is that there has been little dissimilarity in the nature and extent of disease met with in the two groups.

Incidence

The incidence of tuberculosis according to the year of enlistment in the vaccinated and unvaccinated is given in Table 6. Since they have served in the army for varying

Table 6.
Tuberculosis (all forms)
Incidence by year of enlistment

	Vaccinated Men								*Unvaccinated (Tuberculin Positive) Men*							
Year of enlistment	No of vaccinated Recruits	No. of years during which cases occurred	Men x years observation	Pulmonary Tuberculosis	Primary Tuberculosis	Extra pulmonary Tuberculosis	Total : all forms Tuberculosis	Incidence per 1000 per annum	No. of unvaccinated recruits	No. of years during which cases occurred	Men x years of observation	Pulmonary Tuberculosis	Primary Tuberculosis	Extra Pulmonary Tuberculosis	Total: all forms Tuberculosis	Incidence per 1000 per annum
1951	337	10	3,370	4	1	3	8	2.4	343	10	3,430	7	2	0	9	2.6
1952	341	9	3,069	2	2	0	4	1.3	624	9	5,616	16	3	0	19	3.4
1953	289	8	2,312	1	0	0	1	0.4	328	8	2,624	8	2	0	10	3.8
1954	216	7	1,512	0	1	0	1	0.7	320	7	2,240	5	2	1	8	3.6
1955	494	6	2,964	2	0	0	2	0.7	553	6	3,318	13	0	0	13	3.9
1956	235	5	1,175	1	0	0	1	0.8	651	5	3,255	2	0	0	2	0.6
1957	428	4	1,712	1	0	1	2	1.2	706	4	2,824	10	0	2	12	4.3
1958	108	3	324	0	0	0	0	0	1,077	3	3,231	8	1	0	9	2.8
1959	182	2	364	0	0	0	0	0	970	2	1,940	3	1	0	4	2.1
1960	591	1	591	0	0	0	0	0	708	1	708	3	0	0	3	4.2
Total	3,221		17,393	11	4	4	19		6,280		29,186	75	11	3	89	

Incidence per 1,000 per annum from combined intakes (vaccinated men).
All forms of tuberculosis 19 cases — 1.09
Primary and pulmonary tuberculosis 15 cases — 0.86

Incidence per 1,000 per annum from combined intakes (unvaccinated men).
All forms of tuberculosis 89 cases — 3.04
Primary and pulmonary tuberculosis 86 cases — 2.94

periods of time, case incidence has been estimated from the number of " men X years of observation ". (Number of men multiplied by the number of years of service).

3,221 vaccinated men were observed for 17,393 men-years. 19 cases of tuberculosis occurred. The incidence per thousand per annum was 1.09 for all forms of tuberculosis, 0.86 for primary and pulmonary tuberculosis only. 6,280 unvaccinated men were observed for 29,186 men-years. 89 cases of tuberculosis occurred, giving an incidence per thousand per annum of 3.04 for all forms of tuberculosis, 2.94 for primary tuberculosis and pulmonary tuberculosis only.

Comment

From every intake, except that of 1956, the incidence in the unvaccinated group was higher than that in the vaccinated. In the 1953 intake, for example, it was nearly ten times as high, and in the 1954 and 1955 intakes more than five times as high. In the last

three intakes of 1958, 1959 and 1960, all the cases were in unvaccinated men and none in vaccinated men. On the other hand, the contrast was smaller in the intakes of 1951 and 1952. In these, the incidence in vaccinated men was particularly high. (2.4 per thousand per annum and 1.3 per thousand per annum, compared with rates of 0.4, 0.7, 0.7, 0.8 and 1.2 in succeeding years). The vaccinated men in these early intakes also showed a higher rate of subsequent tuberculin " reversion ", from positive to negative, than the vaccinated men of following intakes. This suggests that the vaccine used in these, the early years of the vaccination scheme, resulted in a less permanent allergy, and perhaps also a less effective immunity, than the vaccine used later. This may explain the comparatively high incidence shown by the vaccinated in these intakes.

Protection afforded by B.C.G.

Since there has been no control group of tuberculin negative unvaccinated men to compare with the vaccinated group, it is necessary to use indirect means as follows to assess the degree of protection conferred by vaccination in Gurkhas.

Of the total of 693 cases of primary and pulmonary tuberculosis from the Brigade of Gurkhas who were admitted and treated during the decade 1952 to 1961, 340 occurred in men who enlisted between 1945 and 1950 (hereafter referred to as the pre-1951 group) and 144 in men who enlisted in November 1951 and subsequently (the post-1951 group). Table 7 shows the annual incidence per thousand in these two groups, based on the

Table 7.

Primary and Pulmonary Tuberculosis
Incidence in Pre and Post 1951 groups, 1952-1961

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*
1945–1950 (Pre 1951 recruits)	5,850	10	58,500	340	5.8
1951–1960 (Post 1951 recruits)	9,501	1–10	46,579	144	3.09

strengths of recruit intakes at enlistment and the number of men X years of army service during which they were followed up. This shows that the incidence per thousand per annum in pre-1951 men has been 5.8, compared with 3.09 for post-1951 men. The difference in incidence between the two groups, 2.71 + 0.40, is statistically significant.

It is unlikely that this was due to age differences between the two groups since it has been shown elsewhere (Large, 1965) that age and length of service have not greatly affected incidence in Gurkha soldiers. The most important difference between the groups has been that all negative reactors in the post-1951 intake men were vaccinated with B.C.G. on enlistment, whereas the pre-1951 intake men include many negative reactors who were not vaccinated when they joined the army. It is probable, therefore, that vaccination has been the main factor responsible for the smaller incidence shown by the post-1951 men. It is true that other preventive measures have been more stringently enforced since the vaccination scheme began, but these have been applied to pre-1951 and post-1951 men alike and their effects would have been shown equally by both groups.

Although there has been no strictly comparable group control, it is possible to estimate the degree of protection afforded by B.C.G. in the following way. In the post-1951 group of men the incidence of tuberculosis in positive reactors is known. In the pre-1951 group, the total disease incidence (including disease in both positive and negative reactors) is known, estimated over the same period of 10 years (1952 to 1961), but since the numbers of men who were tuberculin positive or negative are not known, the disease incidence cannot be estimated for either positive or negative reactors.

However, if it be assumed that the pre-1951 men showed the same proportion of positive reactors as the post-1951 men, and if the disease incidence in positive reactors in the latter group over the 10 years 1952-1961 then be applied to the former group over the same period, it is possible to estimate the number of cases which must have occurred in positive reactors of the pre-1951 group. From this the number of cases which must have occurred in tuberculin negative, unvaccinated, men in the group can be determined.

The method involves three major assumptions. The first concerns the number of positive reactors there might have been in the pre-1951 group. There was a reactor rate of 66 per cent in the post-1951 group and in view of the fact that tuberculosis has been increasing in Nepal since the war it has been assumed that the rate in the pre-1951 group was a little lower, namely 60 per cent. This would mean that 3,300 of the pre-1951 group were tuberculin positive on enlistment. The second assumption is that over the ten year period of study the positive reactors in both pre-1951 and post-1951 groups developed tuberculosis at the same rate; and the third is that if the negative reactors in the post-1951 group had not been vaccinated they would have experience tuberculosis at the same rate as the pre-1951 negative reactors. There is little reason to doubt the validity of these assumptions since both groups were exposed to similar environmental conditions during the ten year period of study. The degree of protection afforded by vaccination with B.C.G. can now be estimated as follows.

Of the 144 cases of primary and pulmonary tuberculosis in the post-1951 group, 18 were in vaccinated men and 126 in unvaccinated men (Table 2). 116 of the cases in the unvaccinated men occurred in tuberculin positive reactors. There were 6,280 positive reactors whose length of service between 1 January 1952 and 31 December 1961 varied between one and ten years giving a total follow up of 29,186 men X years. The incidence of tuberculosis in positive reactors was thus 3.97 per thousand per annum. If this rate be applied to the estimated number of 3,300 positive reactors amongst the pre-1951 group, 131 cases must have occurred over the whole ten year period, 1952 to 1961 inclusive. Since a total of 340 cases occurred over this period from all the pre-1951 men, including negative as well as positive reactors, it follows that 209 cases must have occurred from amongst the negative reactors. It is estimated that there were 2,540 of these, so that the incidence of tuberculosis shown by the unvaccinated tuberculin negative men over the whole ten years must have been 8.2 per thousand per annum. This rate is more than nine times as high as the actual incidence of 0.86 per thousand per annum shown by the vaccinated men of the post-1951 intakes.

If the 3,221 post-1951 tuberculin negative recruits (followed up for 17,393 men X years) had not been vaccinated and had experienced the same incidence of disease as the pre-1951 tuberculin negative recruits, there would have occurred 142 cases instead of the 15 cases which actually occurred. (18, if the 3 cases with technically unsatisfactory

vaccinations are included). This represents a reduction in incidence in the tuberculin negative men of 90 per cent. This protection would apply only to the tuberculin negative recruits. In assessing the total contribution of vaccination to the reduction in disease incidence in the Gurkha brigade as a whole, the incidence in positive reactors must also be considered. 116 cases occurred in positive reactors. If none of the tuberculin negative post-1951 recuits had been vaccinated since the campaign began, the total number of cases which would have occurred in post-1951 recruits would have been 258 (142 from the negative unvaccinated group, plus 116 from the positive group) instead of the 131 cases which occurred in fact, (116 from the positive group, plus 15 from the vaccinated group). This represents a *total* reduction of almost 50 per cent in the incidence of tuberculosis in the post 1951 recruits due to vaccination of all negative reactors with B.C.G.

Discussion

In considering the subject of vaccination with B.C.G. in the Brigade of Gurkhas, there are two questions to be answered: first, has B.C.G. conferred any degree of individual protection in those soldiers who were vaccinated; and secondly, what part has vaccination played in the total preventive campaign against tuberculosis in the Brigade? Unfortunately, the absence of a tuberculin negative control group has made impossible a direct comparison of incidence between those who were vaccinated and those who were not; and the indirect methods resorted to are bound to have introduced errors of such a nature that the results cannot be taken as establishing more than presumptive evidence of the degree of protection provided by B.C.G. Nevertheless, they suggest strongly that vaccination played an important part in the smaller incidence of tuberculosis shown by those men recruited since 1951.

There is a substantial amount of evidence from other sources that vaccination protects, although the degree of protection afforded varies according to environmental and epidemiological circumstances, and it is of interest to compare the results of vaccination in Gurkhas with a few of the best controlled trials carried out in other parts of the world.

The Medical Research Council Trial (1959 and 1963) showed little doubt as to the efficacy of B.C.G. in 13 and 14 year old children exposed to a relatively high risk of tuberculosis infection in the United Kingdom, where living standards are high and the existence of low grade sensitivity to non specific organisms has never been proved. The degree of protection demonstrated (80 per cent) was about the same as that shown by Aronson, Aronson and Taylor (1958) in North American Indians with low standards of living and high tuberculosis rates, and by Rosenthal (1955, 1956) and Sergent, Catanei and Ducros-Rougebief (1956) in new born infants in Chicago and Algiers respectively. Hyge's (1956) study of an epidemic in a Danish school in which half the susceptible pupils had been vaccinated with B.C.G. showed that the incidence of tuberculosis in the unvaccinated children over the next 12 years was eight times higher than in the vaccinated children.

All these results are of the same order as those shown in Gurkhas. On the other hand, a much smaller degree of protection—only 30 per cent—was shown by Palmer, Shaw and Comstock (1958) in Puerto Rico and in the American states of Georgia and

Alabama; and Frimodt-Moller (1960) in India failed to demonstrate any protection from B.C.G. at all, but for various reasons these trials were not strictly comparable with the present study of Gurkhas.

The second aspect of vaccination concerns the part that it has played in the preventive campaign as a whole. The degree of protection afforded by vaccination is only one of several factors to be taken into account: the number of negative reactors who might be expected to benefit from vaccination, their chances of becoming infected if left unvaccinated, and the expected incidence of disease in the positive reactors who cannot, of course, be helped by vaccination are points which must also be considered.

There is evidence from the tuberculin testing of all recruit intakes since 1951, that about 34 per cent of recruits do not react to tuberculin on enlistment. Since 1944, when Aspin (1947) tested Gurkha recruits, there would appear to have been an increase in the number of positive reactors found each year. If this trend continues, as it may do if tuberculosis remains common in Nepal and the country's Health Services are not improved, there may come a time when so many young recruits are already infected with M. tuberculosis when they enlist that vaccination cannot be expected to play more than a negligible part in the preventive scheme as a whole. However, such a possibility in the distant future is insufficient reason for withholding vaccination from those recruits eligible for it now, numbering as they do some 34 per cent of each annual intake.

It has been shown that if the tuberculin negative recruits since 1951 had not been vaccinated an estimated total of 258 cases might have been expected to have developed from amongst all the post-1951 recruits (including negative and positive reactors) instead of the 131 cases which actually occurred. This represents a total reduction of incidence in the Gurkha Brigade of almost 50 per cent, due to the vaccination of all negative reactors with B.C.G. This is little less than the 59 per cent reduction in incidence which the Medical Research Council (1959) estimated could have been achieved as a result of vaccination, but it is considerably more than the 9 per cent reduction in incidence which Palmer, Shaw and Comstock (1958) estimated might have been achieved by vaccination in the U.S.A. The American figure was low because in their trial comparatively few cases occurred in unvaccinated tuberculin negative participants, and this in turn was because they were not exposed to a high risk of tuberculous infection. However, the position is very different in the Brigade of Gurkhas. Although the risk of infection is not one which can be determined statistically because serial tuberculin testing has not been possible since the vaccination scheme began, it is clear that the chances of infection must, to a large extent, depend on the prevalence of tuberculosis in the countries where Gurkhas serve. The disease is common in Malaya, Singapore and Hong Kong, and reasons have been given elsewhere (Large 1964) for supposing it to be common in Nepal, where soldiers return periodically on leave. However thorough the army's efforts may be to reduce the chances of cross infection from other people, the dangers of infection from the local population can never be avoided entirely. There is evidence from Aspin (1947) and Ingham (1960) that tuberculin conversion (from negative to positive) occurs at a great rate in Gurkha soldiers during their army service if they are not vaccinated, and the high incidence of disease in pre-1951 recruits (who must have included many negative reactors) emphasises the dangers run by tuberculin negative soldiers of becoming infected if they are not vaccinated. Under these circumstances, the 50 per cent reduction

in total incidence which has occurred in Gurkhas due to vaccination is readily understandable, and presents a formidable argument in favour of continuing to vaccinate all susceptible recruits.

There remain for discussion certain objections which are sometimes raised against the widespread use of B.C.G. The first is that a valuable case finding and diagnostic tool would be lost if everybody in the community were tuberculin positive. In the army, however, this is less important than in civilian life because so many Gurkhas are already tuberculin positive on enlistment that the scope for using the test as a case finding procedure is greatly reduced. Secondly, it has been argued (Anderson et al 1959) that vaccination does not protect against serious forms of " re-infection " tuberculosis (what has been called pulmonary tuberculosis in this paper), but only against mild and relatively insignificant forms of primary tuberculosis (effusions and " primary pulmonary infiltrates ") whose prognosis even without treatment is good. However, the results of the Medical Research Council (1959) trial showed clearly that the degree of protection from vaccination for extensive lesions was as great as for lesser lesions. In any case, the view has been taken that primary disease in Gurkhas should always be regarded as important because the outcome of primary lesions is not always benign—many progress if left untreated—nor their prognosis entirely favourable (Lincoln 1954; Bentley, Grzyboswski and Benjamin 1954; Gaisford 1955). Accordingly, Gurkhas with primary tuberculosis have received full courses of anti-tuberculous drugs, and treatment has always been begun in hospital, so that in terms of man-days of soldier service lost to the army primary disease has been as important as pulmonary disease of the adult or post primary type.

Finally, there are the dangers of vaccination to be considered. Systemic complications of vaccination have not occurred, so far as can be discovered, in the Brigade of Gurkhas. Local complications have occurred occasionally, of which ulceration and regional adenitis have been most common, but these have never required treatment in hospital nor have they prevented the soldier from carrying on with his normal duties, except on one or two isolated occasions.

It will be seen, therefore, that the objections which have been raised in some quarters against use of B.C.G. in certain communities are of small importance when weighed against the considerable advantages which have resulted from its use in the Brigade of Gurkhas.

Summary

19 cases of tuberculosis occurred in 3,221 vaccinated men who were observed for 17,393 men X years. The incidence was 1.09 per thousand per annum for all forms of tuberculosis, 0.86 per thousand per annum for primary and pulmonary tuberculosis only. 6,280 unvaccinated men were observed for 29,186 men X years. 89 cases of tuberculosis occurred giving an incidence of 3.04 per thousand per annum for all forms of tuberculosis, 2.94 per thousand per annum for primary tuberculosis and pulmonary tuberculosis only. The incidence has thus been about three times higher in those who were tuberculin positive on enlistment than in those who were vaccinated. There was no dissimilarity in the nature and severity of the disease met with in the two groups.

Every recruit intake except one has shown a higher incidence in the positive reactors than in the vaccinated men. In most intakes the incidence has been four to five times higher in the positive reactors than in the vaccinated men; but the contrast was much smaller in the 1951 and 1952 intakes probably on account of ineffective vaccine used in those years.

The incidence of primary and pulmonary tuberculosis in men enlisted between 1945 and 1950 (pre-1951 men) has been 5.8 per thousand per annum. The corresponding incidence for men enlisted in 1951 and subsequently (post-1951 men) has been 3.09. Vaccination of all tuberculin negative recruits has been mainly responsible for this difference in incidence which is statistically significant (2.71 ± 0.40).

The incidence per thousand per annum shown by all positive reactors amongst post-1951 men has been 3.97. If this rate be applied to the estimated number of 3,300 pre-1951 men who were tuberculin positive on enlistment, a total of 131 cases results. The remaining 209 cases which occurred in the pre-1951 men must have come from the estimated number of 2,540 men who were tuberculin negative on enlistment, giving an annual incidence of 8.2 per thousand. This is more than nine times as high as the actual incidence which occurred in the vaccinated men of the post-1951 intakes.

If the 3,221 post-1951 tuberculin negative men had not been vaccinated on enlistment and had experienced the same incidence of disease as the pre-1951 tuberculin negative men, there would have occurred 142 cases instead of the 15 cases which actually occurred. This represents a reduction in incidence due to vaccination of 90 per cent.

If none of the tuberculin negative post-1951 recruits had been vaccinated, the total number of cases which would have occurred in the post-1951 men would have been 258 (142 from the negative unvaccinated group plus 116 from the positive group) instead of the 131 cases which occurred in fact (116 from the positive reactor group plus 15 from the vaccinated group), this representing a total reduction of almost 50 per cent in the incidence of tuberculosis in the post-1951 men due to vaccination of all negative reactors with B.C.G.

It is concluded that the policy of vaccinating with B.C.G. all tuberculin negative recruits since 1951 has been fully justified by the results achieved.

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R.A.M.C. Prizes 1966

THE closing date for submission of entries for prizes other than those awarded on course at R.A.M. College is 31st December 1965.

The prizes concerned are :—

Leishman Memorial (medal and £30).
Alexander (medal and £100).
Parkes Memorial (medal and £50).
North Persian Forces Memorial (medal and £10).
Consultants Prize Essay (£50).

Each entry will be sponsored by the appropriate Director after submission through the usual channels to the Ministry of Defence (A.M.D.2.).

Military Essay Competitions 1965-66

THE primary purpose of these competitions is to encourage original thought and good writing on military topics of general interest. Particulars are given in D.C.I's and Notes and Information on Training Matters.

Bertram Stuart Essay Competition 1966 (sponsored by The Army Quarterly).

Prize £80. Closing date 22nd June 1966. General conditions are shown in D.C.I. (General) No. 12 of December 1964.

George Knight Clowes Memorial Prize Essay 1966.

Prizes: 1st £35, 2nd £15. Closing date 31st March 1966. General conditions are shown in D.C.I.(Army) No. 94 of 24th June 1964.

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COLONEL Robert Ollerenshaw, E.R.D., T.D., Q.H.S., B.M., M.A., M.R.C.S., D.M.R.D., F.I.I.P., F.R.P.S., A.P.S.A., M.B.K.S., has been elected President of the Institute of Incorporated Photographers Ltd. for the session 1965/66.

Andrews V.C. Picture and the Salvation Army

A COPY of the picture representing the action for which the Victoria Cross was awarded to Captain Andrews I.M.S., and which now hangs in the V.C. Room, was presented to General Frederick Coutts by the Director General on Thursday, May 27th. General Coutts who was accompanied by Commissioner T. H. Holbrook (International Secretary), Colonel D. A. Anderson (C.M.O.) and Colonel Arnold Brown (Secretary for Public Relations) of the Salvation Army gratefully acknowledged the gift which was a worthy reminder of a man whose faith and conduct was an example long to be remembered and whose memory the Salvation Army greatly cherished.

JOURNALS RECEIVED

The following Journals/Periodicals have been received and are available in the R.A.M. College Library :

Annales Chirurgiae et Gynaecologiae Fenniae; Annals of Tropical Medicine and Parasitology; Alfred Hospital Clinical Reports; Acta Biologica et Medica; Australian and New Zealand Journal of Surgery; Anais do Instituto de Medicina Tropical; Annual Report of the Institute for Medical Research for 1962; Archives of Surgery.

British Medical Journal; British Journal of Surgery; Bulletin of the Johns Hopkins Hospital; Bulletin of the World Health Organization; Boletin de la Oficina Sanitaria Panamericana; British Medical Bulletin; Broadway; Bulletin of the Calcutta School of Tropical Mecidine; Brompton Hospital Reports Vol. XXXII, 1963.

Canadian Journal of Public Health; Central African Journal of Medicine; Catalogue of World Health Organization Publications, 1947-1964; East African Medical Journal; Forsvarsmedicin; Giornale di Medicina Militare; International Civil Defence Bulletin; Indian Journal of Medical Research; International Review of the Army, Navy and Air Force Medical Services; International Register No. 7.

Journal of the Irish Medical Association; Journal of the Royal Naval Medical Service; Journal of the Sheffield University Medical Society; Journal of the Royal Army Veterinary Corps; Journal of the Egyptian Mecidal Association; King's College Hospital Gazette.

Lancet; Le Medecin de Reserve; London Hospital Gazette; Leprosy Review; Leech; Lister Institute of Preventive Medicine—Report of the Governing Body 1965.

Medical News; Medical Officer; Medical Journal of Australia; Medical Bulletin of the U.S. Army; Medical Digest; Medecine Tropicale; Medico-Legal Society Journal; Manchester Medical Gazette; Military Medicine; Medicine, Science and the Law; Military Review; Montreal Medical; Medicine Today and Tomorrow; Militar Halsovard; Midland Medical Review.

National Library of Medicine News; New Zealand Medical Journal; National Defense Medical Journal; Newcastle Medical Journal; Pathogens, Parasites and Predators of Medically Important Arthropods; Practitioner; Proceedings of the Royal Society of Medicine; Polish Medical Science and History Bulletin; Pakistan Armed Forces Medical Journal; Quarterly Journal of Medicine.

Royal Society of Health Journal; Revista de la Asociacion Medica Argentina; Revista do Servico Especial de Saude Publica; Revista del Viernes Medico; Revue des Corps, de Sante des Armees; Report on the Health of the Army 1963—Part I Statistical Tables.

South African Medical Journal; St. Bartholomew's Hospital Journal; Scottish Medical Journal; South African Journal of Laboratory and Clinical Medicine; South African Journal of Medical Sciences; South African Journal of Obstetrics and Gynaecology; South African Journal of Radiology.

Transactions of the Royal Society of Tropical Medicine and Hygiene; Tropical Diseases Bulletin; Transactions and Studies of the College of Physicians of Philadelphia; Vierteljahrsschrift fur Schweizerische Sanitatsoffiziere; W.H.O. Chronicles and Reprints; W.H.O. Reports—Nos. 302, 303, 304, 305, 307 and 308; Yale Journal of Biology and Medicine.