Statistics of inoculations with Haffkine's anti-plague vaccine, 1897-1900 : compiled from records in the Plague Department of the Secretariat and the Plague Research Laboratory, Bombay / by W. B. Bannerman.

STATISTICS

OF

INOCULATIONS

WITH

HAFFKINE'S ANTI-PLAGUE VACCINE,

1897-1900.

Compiled from Records in the Plague Department of the Secretariat and the Plague Research Laboratory, Bombay,

BY

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STATISTICS OF INOCULATIONS WITH HAFFKINE'S ANTI-PLAGUE VACCINE.

The experience of plague and measures for its management acquired in Bombay during the past three years has demonstrated that the ordinary means used for "stamping out" the disease have not met with the success hoped for. It appears to be a fact that, in a large town, once the disease has taken root, it will re-appear year after year, and that its virulence will, for a long time, show no sign of diminution, as is the case with some other epidemic diseases. If the disease then cannot with certainty be "stamped out," the only other resource left is to try to render the people of the infected town immune to plague, so that, though living with the cause of the disease all round them, they may remain free from attack. It is only necessary to refer to the effects of vaccination for small-pox, to make it clear that it is not impossible to immunise a population, so that, though the exciting cause of a disease may exist in nature all around, yet cases of that disease are comparatively rare. It is a well-known fact that diseases, such as small-pox, typhoid fever, cholera, &c., appear as a rule only once in the same individual, and a person who has recovered from an attack of one of these has the comfortable conviction that in all probability he will not suffer again. He or she has become "immune" to that disease. The causes of immunity are not yet properly understood, and several conflicting hypotheses have been advanced to explain the matter; all of them extremely complicated, and none quite satisfactory. This is not the place in which to argue for one or the other of these, nor is it necessary to enter into a discussion of theoretical considerations. What is attempted in the following pages, is to set forth in an unbiassed manner the results following on a practical application of anti-plague inoculation to various communities throughout India. The figures themselves are placed before the reader, and a sufficient account of the methods used in their collection is given to enable anyone to judge for himself of the effects actually produced, and as to the trustworthiness or otherwise of the statistics.

As the results of three months' labour at the life-history of the plague bacillus, Haffkine informed the Government of India, in a letter dated 16th January 1897, that he had been able to prepare an inoculation fluid, which promised, on the analogy of the results obtained previously by Pasteur in connection with anthrax and rabies, and by himself in the case of cholera, to produce in the human organism a considerable resistance to plague. The now well-known effect on human beings he described from its action on himself, as he had been inoculated with a dose which turned out to be 4 times stronger than that now fixed as the standard. Shortly afterwards, 77 leading citizens of Bombay were inoculated to demonstrate publicly the complete harmlessness of the operation. The preparation of the prophylactic is detailed in the *British Medical Journal* for May 1897, and the *Indian Medical Gazette* for June 1897, and though many improvements have since been introduced in its manufacture, the principles as therein laid down, remain unaltered. The first trial of the prophylactic on a plague-stricken community was made in the Bombay House of Correction at Byculla. Plague broke out there on the 23rd of January 1897, 9 attacks with 5 deaths occurring between that date and the 29th of the same month. On the 30th of January, 6 more cases, of which 3 proved fatal, occurred. In the afternoon of that day inoculation was offered to the prisoners, and about half the population of the jail volunteered. Three of the inoculated developed plague the same evening, and all of these died. These cases manifestly had plague in their systems already—in fact, one actually had a visible bubo at the time of inoculation—and are therefore excluded from the following table of results obtained in the two groups of "inoculated" and "uninoculated". The difference between these two groups began to be manifest within 24 hours of the time of inoculation, and continued till the close of the epidemic.

Dates.	Classification.	Daily strength.	Cases.	Deaths.
1st day	*Uninoculated* ...	*177*	*2*	*1*
	Inoculated	151	1	0
2nd day	*Uninoculated* ...	*172*	*1*	*1*
	Inoculated	150	0	0
3rd day	*Uninoculated* ...	*173*	*1*	*1*
	Inoculated	146	0	0
5th day	*Uninoculated* ...	*171*	*1*	*1*
	Inoculated	146	0	0
6th day	*Uninoculated* ...	*169*	*2*	*1*
	Inoculated	146	0	0
7th day	*Uninoculated* ...	*169*	*5*	*1*
	Inoculated	146	1	0

Thus in an average uninoculated population of 172, there occurred 12 cases, with 6 fatalities, while in an inoculated group living in exactly similar circumstances, and averaging 147 in numbers, there were only 2 attacks and no deaths at all.

This result, having become known, naturally encouraged the inhabitants of Bombay City to apply for inoculation in large numbers, and during the course of the season of plague prevalence, *i.e.*, up to October 1897, altogether 8,142 persons were operated on. The following table shows that those inoculated belonged to all castes and ages:—

Sex and Age distribution.

Adult males	5,259
,, females	1,668
Children of 10 years and under.	1,079
Unclassified	136

Race distribution.

Parsees	3,414
Brahmins	298
Kshatriyas	486
Vaisyas	219
Sudras	805
Other Hindu Castes	339
Mahomedans	1,478
Europeans	467
Native Christians	414
Jews	84
Japanese	2
Unclassified	136

In this early period in the introduction of inoculation, it is probable that cases of plague appearing among those inoculated were promptly reported to the Laboratory staff, as the whole medical profession in Bombay were watching its effect with the keenest interest.

The reported number of attacks and deaths among the 8,142 inoculated persons may therefore probably be taken as fairly accurate. Eighteen cases of undoubted plague were thus reported and investigated by officers of the Laboratory. Of these 2 died and 16 recovered. The two former were ascertained to have had the signs of the disease on them at the time of inoculation, and therefore may be left out of account, as the operation does not profess to be curative in this sense.

These encouraging results have since been confirmed by numerous observations made in plague-stricken localities, and a short account of the principal operations will now be given. The instances chosen are those in which the figures given may be regarded as reasonably accurate, and in certain cases perfectly so; and where the groups of inoculated and uninoculated were living in similar and therefore comparable conditions in each case. Many other communities in various parts of India have been operated on (as many as 1,628,696 doses having been issued from the laboratory up to December 1900), but owing to various causes, accurate observations were not obtained. In all cases without exception there has resulted a striking reduction of plague mortality, and also a markedly favourable effect on the case incidence has been produced.

1. *Mora.*—In the middle of March 1897, in the village of Mora to the south of Bombay Harbour, in Uran Municipality, with a population of about 1,000 inhabitants, 419 were inoculated. Only 7 of these were attacked by plague, and all recovered. In the uninoculated portion of the population, according to information furnished by the local Pársis, 26 cases occurred, of whom 24 died.

2. *Daman.*—This town, situated in Portuguese territory to the north of Bombay, and in constant communication with it by sea, was affected in February 1897. The infection is believed however to have been brought from Bulsár, or by sea from Karáchi, as cases were first reported among arrivals from the former place, and in the fisher community who were in close connection with sailors from the latter port. By the end of the month a considerable exodus had taken place, and by the 30th of March, when a cordon was placed round the territory by the Bombay Government, it is estimated that 2,000 of the inhabitants had fled. The disease reached its climax in the middle of April, when as many as 80 corpses were buried in one day, began to decline towards its close, and became insignificant towards the end of May. After the closing of the cordon round the town the population remained stationary as regards immigration and emigration. The original population of the affected villages of Daman was 10,900, but as 2,000 fled before the closing of the frontiers, and 670 died of plague before the inoculations began, the figures to be dealt with are thus reduced to 8,230. The inoculations began on the 23rd of March, and were performed in 3 series on the following dates, 23rd to 26th March, 17th April to 2nd May, and 21st and 23rd May. Altogether 2,197 persons were operated on in Daman up to the date of the investigation, carried out in the end of May 1897 by Major Lyons, I. M. S., President of the Government Committee for Investigation of Bubonic Plague in Bombay.

The results obtained by a careful house-to-house visitation and classified by periods were as follows:—

Note.—In the following tables, the total numbers shown as inoculated are progressive, *i.e.*, the numbers for the second period *include* those for the first period; and those for the third period include the numbers for both first and second periods. Deaths are of course deducted in each case, The number of *cases* of plague among the uninoculated could not be ascertained.

		Inoculated.				Not Inoculated.		
	Operators.	Numbers.	Cases.	Deaths.	Percentage of Mortality.	Numbers.	Deaths.	Percentage of Mortality.
1st Period, 23rd March to 16th April.	Dr. Kalapesi	846	17	3	0·4			
	Dr. Poiares	171	6	3	1·8			
	Total ...	1,017	23	6	0·58	7,213	716	9·9

Dr. Poiares used the same vaccine as Dr. Kalapesi, but gave smaller doses, so his results were not so good. *If the 1,017 inoculated had suffered in the*

same proportion as the uninoculated, they should have had 101 deaths instead of 6—a difference of 94·06 per cent.

2nd Period, 17th April to 21st May.	Inoculated.				Not Inoculated.		
Operators.	Numbers.	Cases.	Deaths.	Percentage of Mortality.	Numbers.	Deaths.	Percentage of Mortality.
Dr. Kalapesi	1,372	52	18	1·3			
Dr. Poiares	267	12	9	3·3			
Total ...	1,639	64	27	1·6	5,869	674	11·5

The vaccine used for the second series was much weaker than that previously employed, as the laboratory was unable in this initial stage to meet the increasing demands which arose on all hands. The results obtained therefore were less successful as one would naturally expect. *If the inoculated had suffered in the same proportion as the uninoculated, they should have had 188 deaths instead of 27—a difference of 85·6 per cent.*

3rd Period, 22nd to 31st May.	Inoculated.				Not Inoculated.		
Operators.	Numbers.	Cases.	Deaths.	Percentage of Mortality.	Numbers.	Deaths.	Percentage of Mortality.
Dr. Kalapesi	1,906	1	1	0·05			
Dr. Poiares	258	3	2	0·8			
Total ...	2,164	4	3	0·14	4,643	93	2·0

If the inoculated had suffered in the same proportion as the uninoculated, they should have had 43 deaths instead of 3—a difference of 93 per cent.

Taking the period as a whole, the following is the result obtained :—

2,197 inoculated had 36 deaths, or 1·6 per cent. of mortality.

6,033 not inoculated had 1,482 deaths or 24·6 per cent. of mortality.

As many familes in Daman were entirely inoculated, and so had no uninoculated individuals living with them for comparison, it was found necessary to compare the whole inoculated population with all those not inoculated remaining in the town. But if those houses be singled out in which only a portion of the inhabitants had been inoculated, the following result is obtained in 62 such cases :—

	Numbers.	Cases.	Deaths.	Percentage of Mortality.
Inoculated...	250	50	20	8·0
Not Inoculated	124	54	37	29·8

If the 250 inoculated had suffered to the same extent as the 124 uninoculated, they should have had 75 deaths instead of 20—a difference of 73·3 per cent.

From the above it would appear that uninoculated individuals living in the same houses as those inoculated are a source of danger to them, and therefore inoculated people are advised to see that those in immediate contact with them, (*i.e.*, family and servants) are likewise operated on. It is just as much a duty to the public to be inoculated during plague prevalence, as to be vaccinated when small-pox appears in the neighbourhood.

A striking illustration of the effect produced by the inoculation of an entire community is afforded by the history of this epidemic among the Pársi inhabitants of Daman. The Pársi community of Lower Daman numbered 306. Of these, 277 were inoculated and 29 were not. The following shows the attacks and deaths in the two groups. No death from any other cause than plague occurred in this community during the epidemic :—

	Numbers.	Cases.	Deaths.	Percentage of Mortality.
Inoculated	277	8	1	0·36
Not Inoculated	29	4	4	13·8

If the inoculated, who were living in precisely the same social conditions as the uninoculated had been affected in the same proportion, they should have had 38 deaths instead of only one, a difference of 97·4 per cent.

It should be noted that the solitary case of death among the inoculated Pársis, had pain in the groin and fever at the time of inoculation—in fact, was suffering from plague already manifest,—and therefore could not be expected to derive benefit from the prophylactic.

3. Lanowli.—A small hill-station and railway depôt at the top of the Bhor Ghât was the scene of the next demonstration. During the season, *i.e.*, April and May 1897, plague first appeared here, and about 20 cases occurred; then the disease subsided, but only to re-appear in epidemic form after the onset of the monsoon, at a time when, owing to the departure of summer visitors, the population numbered only about 2,000. Operations were begun towards the end of July, in C and D Wards of the town, these having been chosen by the local Plague Committee for trial. A census having been made, inoculations were begun on 24th July 1897, and continued daily, as opportunity arose, among the friends and neighbours of those attacked. A daily house-to-house inspection was kept up in these wards for weeks after this, and the figures given below show the result obtained.

Table showing the incidence of Plague in C and D wards of Lanowli in 1897. Days showing no occurrences are omitted :—

Date.	Uninoculated.			Inoculated.		
	Population.	Cases.	Deaths.	Population.	Cases.	Deaths.
24th July 1897 ...	711	4	4	45	...	...
25th do. ...	636	5	5	116	...	...
26th do. ...	621	4	3	126	...	...
27th do. ...	568	2	2	175	...	...
28th do. ...	544	3	3	197	...	...
29th do. ...	472	2	1	266	...	...
30th do. ...	460	6	4	276	...	...
31st do. ...	430	3	2	300	1	1
1st August 1897 ...	398	8	6	328	3	2
2nd do. ...	373	8	6	342	3	1
3rd do. ...	341	1	1	363	1	...
4th do. ...	336	3	2	366	1	...
5th do. ..	331	1	...	368	1	...
6th do. ...	329	3	1	367	...	...
8th do. ..	323	1	...	370	...	...

Date.	Uninoculated.			Inoculated.		
	Population.	Cases.	Deaths.	Population.	Cases.	Deaths.
9th August 1897 ...	322	1	1	370	...	...
10th do. ...	320	1	...	371	1	...
11th do. ...	319	1	1	370	...	..
12th do. ...	318	1	...	370	1	1
13th do. ...	316	1	1	370	...	...
14th do. ...	315	1	...	370	...	...
17th do. ...	314	1	...	370	...	...
19th do. ...	313	1	1	370	1	1
20th do. ...	312	1	...	369	...	...
22nd do. ...	311	6	5	369	...	...
23rd do. ...	305	...	...	369	1	1
26th do. ...	305	1	1	368	...	...
3rd September 1897.	304	1	1	368	...	...
4th do. ...	303	1	...	368	...	...
6th do. ...	302	1	1	368	...	...
7th do. ...	301	3	3	368	...	...
13th do. ...	298	1	1	368	..	...
23rd do. ...	297	1	1	368	...	...

Taking the average daily strength of the two groups and comparing them, it is seen that 377 uninoculated had 78 cases with 57 deaths, while 323 inoculated had 14 cases with 7 deaths. *If the inoculated had suffered in the same proportion as the uninoculated, they ought to have had 49 deaths, instead of 7—a difference of 85·7 per cent.*

4. *Kirkee.*—Plague broke out here in the artillery cantonment, situated 4 miles from Poona; and the followers of the four batteries stationed there suffered severely. These men were living with their families in lines on a sloping plain, under Military discipline, and in circumstances far superior, in a sanitary sense, to those of the average villager. When the disease appeared the lines were isolated, so that none could enter or leave without the knowledge of the Military. A special hospital was erected close by, where all sick persons were sent as they were discovered by the search parties of European artillerymen, who visited each house thrice daily. It is therefore probable that all cases of plague were promptly discovered and removed to hospital, and in each case the usual disinfection was thoroughly and systematically carried out. Yet, in spite of all this, it was found that, in those not protected by inoculation, one out of every 6 of the population was attacked, and 2 out of every 3 attacked, died. The epidemic was therefore a severe one. The population of the lines numbered 1,530; and out of these 671 volunteered for inoculation. At the close of the epidemic the plague hospital admission and discharge book was examined, and compared with the register of those inoculated, when the following result was got. The population operated on being under Military discipline, and confined to their lines makes the accuracy of the figures undoubted.

	Numbers.	Cases.	Deaths.	Percentage of Mortality.
Inoculated	671	32	17	2·5
Not inoculated	859	143	98	11·4

Here, then, is seen a body of people divided into two groups by the fact that one had undergone inoculation and the other not, *but differing in no other way*, reacting towards plague in such a markedly different manner that the conclusion is forced on one that the inoculation must be the cause. Seeing the absolute similarity of conditions, *the 671 inoculated should have had proportionately 112 cases and 77 deaths if they had remained as susceptible to the disease as their uninoculated brothers, sisters, parents, wives, husbands, children; but*

instead of that they had only 32 cases and 17 deaths, or a reducton in the death-rate of 77·9 per cent. This death-rate would doubtless have been still further reduced but for the fact that a very much weakened vaccine had to be used, owing to the demand having got beyond the resources of the Laboratory at that time.

5. *Belgaum.*—Plague cases began to appear in Belgaum—a town of 40,700 inhabitants—in October 1897, 5 deaths being reported in that month. In November 111 deaths occurred, 156 in December, 226 in January, and 50 in February 1898, after which an insignificant number of attacks took place, till in May the epidemic ceased. The 26th Regiment of Madras Infantry were, during this period, living in lines close to the Cantonment and City, and suffered similarly. The first reported case among them took place on 12th November, when Sepoy 2224, Govindaswamy, was brought to hospital and died the same day. Next day another sepoy was attacked and also died. On the 15th a drummer was seized, and on the 17th the disease appeared among the followers. By the 21st, 13 attacks had been reported from the lines, 4 of these being among sepoys. On the 22nd November the companies most severely attacked were moved out into camp, and by the 28th the whole Regiment, families, and followers had left the lines. These were then disinfected by washing with perchloride of mercury solution, whitewashing, and removal of tiles from the roofs. During this transition period 15 persons were seized, 6 of them being sepoys. In the ten days following removal to camp, 13 sepoys and 20 among the families and followers were attacked. Then removal from the infected locality had its usual effect: the cases gradually became fewer, and ceased by the end of the year. The following table summarises the events of this period, *i.e.*, 12th November to 31st December 1897:—

Among Sepoys,	34	cases,	with	22	deaths	= 64·7	per cent.	of mortality.
„ Women,	20	„	„	10	„	= 50·0	„	„
„ Children,	16	„	„	9	„	= 56·25	„	„
„ Followers,	8	„	„	8	„	= 100 0	„	„
Total ...	78	„	„	49	„	= 62·8	„	„

At the request of Major Forman, R.A.M.C., Senior Medical Officer of the Station, an officer of the Plague Research Laboratory (Major Bannerman, I. M. S.), was sent to Belgaum, and commenced operations there on 24th December. No difficulty was experienced in persuading the men to consent to inoculation when it was explained to them that they would be free to return to their houses in the lines after being operated on. General Rolland, Commanding the District, and formerly Colonel in this very Regiment, was the first to be operated on, and his example, combined with that of the Officer Commanding, and their Medical Officer, who were all operated on in front of the men, sufficed to convince the sepoys of the harmlessness of the operation, and the only difficulty that then remained was to perform the operation fast enough. All the men off duty that day in the Hindalgi Camp (229) were operated on during the morning, and allowed to return to their lines next day. Those in other camps and the families were speedily inoculated and allowed to return also. The return was complete by the 30th December. A few more inoculations continued to be done up to 6th January 1898 among followers and children, but the community was practically completely inoculated by the end of the year. The total operated on was 1,665, out of a population of 1,746 living in the lines at that date. The 81 not operated on were infants, women far advanced in pregnancy, and the sick in hospital chiefly, though one solitary sepoy has, up to the present time, refused to submit to operation.

After this date 2 cases occurred in January, the sufferers being a European officer and a sepoy, both employed in disinfection work in the town; they had been inoculated and both recovered. No cases were reported for the next 6 months, though, as shown above, the epidemic was at its height in the neighbouring City and Cantonment in January, and the men were allowed freely to go to these places after inoculation. That this practical immunity of the Regiment was not

due merely to the disinfection of the lines will be mainifest to anyone studying the occurrences during the second epidemic from July to December 1898, now to be described.

The second epidemic in Belgaum town began in June, reached its height in October, and thereafter declined till January 1899, when it ceased. The table given below shows the number of deaths from plague (the attacks were, of course, many more, but no accurate figures are forthcoming on this head) reported in the City and Cantonment, month by month, contrasted with the attacks and deaths in the Regiment.

Dates.	Deaths reported from City and Cantonment.	Attacks in the Regiment.	Numbers of those attacked who died.
June 1898	14	.....	.....
July „	215	1	1
August „	304	2	1
September „	698	2	1
October „	999	4	2
November „	275	2	1
December „	65	1	.....

From the above it is manifest that the numbers attacked and the subsequent fatalities in the Regiment kept pace exactly with the severity of the epidemic in the neighbouring town, rising and declining with it. The conclusion is therefore inevitable, that the same infection that was producing such havoc in the civil population was equally present in the lines of the military, yet *they suffered in proportion from 10 to 31 times less month by month during the course of the epidemic*. In the City and Cantonment 2,570 persons died of plague, or 1 in every 17 of the population, while in the sepoys' lines, with a population of 1,801, but 6 died, or at the rate of 1 in every 300 only. It has been shown how heavily the Regiment suffered during the first epidemic, why, then did they not again produce cases to the same extent during the more severe second visitation? The only measures taken by the authorities were, placing the Cantonment and City "out of bounds" for the troops after 4th July, and disinfection of the few huts that became infected. But both these measures had been taken in the first outbreak and had proved totally inadequate to stay the ravages of the disease, until the men were removed from the infected locality. A very practical answer to this question was given by the sepoys themselves, who volunteered to undergo a second inoculation, which was duly carried out during July and August. Practically no one was left in the lines unprotected by inoculation, so that a comparison cannot be made with an unprotected population living in precisely similar circumstances as was possible in the first experiment in the Byculla Jail, for instance, yet, in the opinion of the sepoys and their officers, there is no doubt that the inoculation saved them. Nine out of the 12 cases of plague in the Regiment occurred in the persons of inoculated people, and 3 among non-inoculated. Of the former, 6 recovered and 3 died, among the latter all died. The history of the 3 un-inoculated persons is interesting. The first case was that of a sepoy who was believed to have already suffered from plague in the first epidemic, and who was not inoculated on the presumption that he would prove immune. From a study of the history of his case as recorded in the hospital case-book, it appears probable that a mistake in diagnosis had been made, during the hurry and stress of the first epidemic, and that the man had not suffered from plague previously. The second case occurred in the person of a sepoy's wife who had just joined her husband and who was attacked before she could be inoculated. The third was a European Officer who probably trusted to the comparative immunity of his race, and had therefore omitted to protect himself.

6. *Major Forman's statistics.*—Two very striking instances brought to notice by Major Forman, R. A. M. C., Senior Medical Officer at Belgaum, may here be stated. The men of the Army Hospital Corps, with their families, numbering 83 individuals, were living close to the European Military Hospital under con-

stant supervision. All but 3 of them submitted to inoculation on December 23rd, 1897, and the following shows the incidence of plague in the two groups :—

	Population.	Cases.	Deaths from Plague.
Inoculated	80	.....	.....
Not inoculated	3	2	2

In January 1899, when a third epidemic of plague visited Belgaum, this group of persons, who then numbered 84, were inoculated again, 7 excepted, with the following result :—

	Population.	Cases.	Deaths from Plague.
Inoculated in 1899... ...	77	2	2
Inoculated in 1897 but not again in 1899	2	...	...
Not inoculated	5	1	1

As these people were living isolated from others, and under daily medical supervision, errors of diagnosis are practically excluded, and the results recorded may be taken as accurate.

The second instance noted by Major Forman is from his own compound, being from the body of his private servants and their families. They were all inoculated, with the exception of Govind's child and Rajah, on 23rd and 24th December 1897, and the following are the details of events up to August 1899 :—

Names.	Whether attacked by Plague.	Remarks.
Anthony, butler ...	No. ...	Left Belgaum some months after ; now in Burmah.
Juan do. ...	No. ...	Still withtMajor Forman in Belgaum. Have been inoculaed twice since.
Do. wife	No. ...	
Do. daughter ...	No. ...	
Do. do. ...	No. ...	
Sundaram, chokra ...	No. ...	Do. do.
Bullock-coach driver...	No. ...	Do. do.
Tom, cook	No. ...	All alive in Belgaum. Now cook with 21st Pioneers.
Do. wife	No. ...	
Do. father	No. ...	
Do. 5 children ...	No. ...	
Joseph, cook's matey .	No. ...	Still alive in Belgaum.
Dusrut, syce	No. ...	Went to his village about 4 months afterwards. Present state unknown.
Do. 2 wives ...	No. ...	
Govind, syce	No. ...	Both in Belgaum now and well.
Do. wife	No. ...	
Do. child	Yes. ...	Parents refused to have child inoculated. It died of plague in end of January 1898. Was treated in hospital by Major Zimmermann, R.A.M.C.
Tulsi, sweeper ...	No. ...	All in Belgaum now and well. Her husband, a cantonment sweeper, who was not supposed to live in the compound, but probably came at nights, was not inoculated, and died of plague 3 months after.
Do. 2 children ...	No. ...	

Names.	Whether attacked by Plague.	Remarks.
Sattu, gardener ...	No. ...	Still in Belgaum and well. This man lost his father, wife, sister-in-law, and 2 children from plague. None of them, except himself, were inoculated. He was living with them at the time in the city.
Puniah do. ...	No. ...	Still in Belgaum and well.
Madah, washerman ...	No. ...	Lost his sister and brother from plague some time afterwards. They were not inoculated, and he was living with them.
Rajah, waterman ...	Yes. ...	He was not inoculated, threw himself into a well and was drowned. He was believed to have been delirious from plague fever at the time.
Lingapah, tailor ...	No. ...	Still alive in Belgaum. Lost his mother and brother and brother's wife and children from plague. They were not inoculated, and he was living with them.

Note—The 5 last named lived sometimes in the compound and sometimes not. The tailor spent the day at Major Forman's house, but went home at night.

The above may be arranged in tabular form as follows :—

	Population.	Cases.	Deaths from Plague.	Remarks.
Inoculated	28	.....	.....	
Not inoculated ...	2	*2	*2	* One was possibly not a case of plague (Rajah) but at the time was thought to be so.

7. *Umerkhadi Jail, Bombay.*—Plague appeared in this jail in the end of December 1897. Three prisoners took the disease and subsequently died. Then on 1st January 1898, inoculation was offered to the prisoners, who all, 401 in number, declared themselves willing to undergo the operation.

It was resolved, however, for the purposes of demonstration, that only one-half of each group of prisoners should be operated on. These consisted of groups of prisoners sentenced to simple imprisonment or to hard labour, civil debtors, undertrials, convict warders, cooks and female prisoners. As each group was brought forward, the individuals composing it were seated in rows, and every second man or woman was chosen for operation. Two prisoners only, refused to allow inoculation. No distinction was made between the groups of inoculated and uninoculated prisoners; they had the same food and drink, the same hours of work and rest, and the same accommodation. After this, plague cases appeared at intervals for a space of 30 days and were distributed as follows. During this time an almost equal number of releases took place in the two groups, and the average daily strength exposed to the disease up to the end, was 147 inoculated, and 127 not inoculated :—

Average.	Population.	Cases.	Deaths.	Remarks.
Inoculated ...	147	*3	...	* The disease was so mild in these cases that the hospital authorities were doubtful whether they were cases of plague.
Not inoculated ...	127	10	6	

8. *Undhera.*—Plague broke out in this agricultural village, which is situated 6 miles from Baroda, in the end of December 1897. According to a census taken by the Baroda authorities on 5th January 1898, there were 1,031 souls in the village. Between that date and 12th February, when the inoculations were performed, 76 persons died of plague, 10 had left the village, and 5 were born, thus leaving 950 persons alive on the latter date. This is equivalent to a death rate of 766 per mille per annum, and will serve to show how virulent the epidemic was. On 12th February the village was visited by Mr. Haffkine, Major Bannerman, Indian Medical Service, the chief plague authorities of Baroda State, and some half-dozen local medical men, and by them inoculation of 513 of the inhabitants was carried out the same day. By reference to the census papers the whole of the inhabitants were called out house by house, and the half of each household inoculated. In this way an endeavour was made to inoculate half the men, half the women and half the children in each family, and to arrange that a fairly equal proportion of the sickly looking should be placed in each division. That the division effected was a fair one will be manifest from the following table, which shows the sex and age distribution of the inhabitants of the 28 houses in which plague cases occurred after the inoculation:—

Ages.	Inoculated.		Not inoculated.	
Five years and under ...	Males ... 4		Males ... 5	
	Females ... 9	= 13	Females ... 5	= 10
Between 6 and 59 years inclusive ...	Males ... 34		Males ... 18	
	Females ... 20	= 54	Females ... 33	= 51
Sixty years and over ...	Males ... 3		Males ... 1	
	Females ... 1	= 4	Females ... 2	= 3
Total ..		71		64

An investigation as to the results of the inoculations in Undhera was made on 4th April 1898 by Surgeon-General R. Harvey, M.D., C.B., Director-General, Indian Medical Service, Mr. Haffkine, Major Bannerman, I. M. S., and Captain Dyson, I. M. S., with the aid of the local authorities of Baroda. Each house in which a plague case had occurred since the 12th February, was visited, and the occurrences among the members ascertained by personal inquiry from the survivors, by reference to the hospital register, and from the census papers, in which the doses of prophylactic administered had been entered. The following is the result of this investigation. The plague continued in the village for 42 days after the inoculations were performed, and affected 28 families.

Among the inoculated.

(*a*) There were no deaths from causes other than plague.

(*b*) There were no deaths during the first 3 days after inoculation, the first fatality being recorded on the 21st, 8 clear days after.

(*c*) From the 15th February till the end of the epidemic there were 8 attacks of plague, of which 3 had a fatal termination.

Among the uninoculated.

(*a*) A child aged 1 year, died of bronchitis on 21st February 1898.

(*b*) Three died of plague during the first 3 days following the inoculation, and are therefore omitted from the calculations as having been attacked before the inoculations were carried out.

(*c*) From the 15th of February till the end of the epidemic, 27 more attacks of plague occurred, of whom 26 died.

One of the three fatal cases among the inoculated had no interval between the inoculation fever and the manifestation of plague; the others had apyretic intervals of 6 and 8 days respectively.

The events in each of the 28 families were noted on separate investigation sheets, in which the names of every member present at the time of inoculation were entered as either "inoculated" or "not inoculated." The occurrences in each household being entered in each sheet below the names, it was then easy to compile the following table :—

Ward No.	House No.	Inoculated.			Not Inoculated.		
		Number inoculated in the family.	Number of Attacks.	Number of Deaths.	Number not inoculated in the family.	Number of Attacks.	Number of Deaths.
1	2	3	4	5	6	7	8
1	8	4	...	...	1	1	1
1	63	3	...	...	2	1	1
1	67	3	...	...	2	1	1
2	24	1	...	...	1	1	1
3	1	2	...	...	2	1	1
"	15	2	1	...	3	...	...
"	20	3	1	...	4	1	1
"	29	3	...	...	2	1	1
"	39	4	1	1	3	1	1
"	42	1	...	...	2	1	...
"	48	5	...	...	3	1	1
"	49	1	...	...	5 . .	1	1
4	7	1	1	...	1	1	1
"	8	2	1	...	1	...	...
"	10	4	1	...	1	...	...
"	12	2	...	...	2	1	1
"	13	2	...	...	1	1	1
"	18	3	...	...	2	2	2
"	26	1	...	...	2	2	2
"	30	1	...	...	3	1	1
"	31	4	1	1	2	...	...
"	34	2	...	...	3	1	1
"	35	1	1	1	1	1	1
"	53	2	...	...	2	1	1
"	80	4	...	...	4	1	1
"	84	5	...	...	5	2	2
"	89	2	...	...	1	1	1
"	90	3	...	...	3	1	1
	Total ...	71	8 (11·3%)	3 (4·2%)	64	27 (42·2%)	26 (40·6%)

The 71 inoculated members of the affected families had therefore 8 attacks, of which 3 proved fatal, while the 64 not inoculated in the same families had 27 attacks with only one recovery. *If the inoculated had suffered to the same extent as their uninoculated relatives, they should have had 29 deaths from plague, instead of 3 only.* The proportional number,—29—is reduced by 26, which is equal to a diminution of 89·6 per cent. of mortality attributable to inoculation.

The subjoined figures show the number of days which elapsed between the dates of inoculation and the occurrence of a death from plague in these families. The large figures refer to the number of days after the date of inoculation, the smaller ones to the number of deaths on those days :—

In the inoculated, deaths took place . . . . . 9^1 . . . 12^1 and 14^1 . . . . . .
In the uninoculated " " " . . . . . 3^2, 4^1, 5^3 . 7^2, 8^3 . 10^3, 11^3, 12^3 . . 15^1, 16^1, . . 19^1, 20^1, 21^1, . . 24^1 . . . . . 32^1 . . . and 42^1 days after inoculation.

Eight days, therefore, elapsed after operation before any deaths occurred among the inoculated, while during this time 11 deaths from plague were registered among the unprotected. The inoculation acted again at once, or at least within the time necessary for the subsidence of the general reaction due to the operation, just as it did before in the Byculla Jail.

The following table shows the occurrences arranged according to sexes :—

	Inoculated.		Not inoculated.	
	Numbers.	Deaths.	Numbers.	Deaths.
Males	41	3	24	7
Females	30	.....	40	19
Total ...	71	3	64	26

If the population be divided and arranged in 3 groups according to age, we find that the following was the incidence of plague in each :—

Ages.		Population.	Number of Cases.	Number of Deaths.
Five years and under	Inoculated ...	13	1	1
	Not inoculated ...	10	3	3
Between 6 and 59 years, inclusive.	Inoculated ...	54	5	2
	Not inoculated ...	51	22	21
Sixty years and over	Inoculated ...	4	2	.....
	Not inoculated ...	3	2	2

From the above account of the way in which this demonstration was carried out, it will be evident that the conditions approached very nearly the strictness of a laboratory experiment, and the results obtained may therefore be accepted with confidence.

9. *Khoja Community, Bombay City.*—H. H. Sir Sultan Shah, Aga Khan, K.C.I.E., the head of the Khoja Community, was one of those who early in the history of inoculation was convinced of its efficacy. Acting on this conviction he opened an inoculation station in March 1897 at Love Lane, where many of his followers were operated on. On the re-appearance of plague, he again, on 27th December 1897, opened this private station at Khusiru Lodge, Mazagon, and retained the services of Dr. J. B. DeQuadros to inoculate all who applied. From this date to 20th April 1898 inclusive, 5,000 Khojas were inoculated there, and 184 at other places in Bombay, so that a total of 5,184 of the community were operated on. Those inoculated at the time of the previous epidemic (March, April, May, 1897) are not included in the above numbers, unless they presented themselves for re-inoculation during the period of the second epidemic in 1897-98. As the operations extended over 16½ weeks, it is necessary to take the average number for comparison with the uninoculated portion of the community, and this is found to be 3,814 persons. In the beginning of 1898 a careful census of the Khojas in Bombay was taken by order of His Highness, which showed that 9,350 Khojas were in the city at that time. But as a certain number of families had left the city through fear of plague, a calculation was made from the average number of deaths registered in the burial book of the Jamát Khána* for the five years previous to the appearance of plague, and it was decided that 13,300 should be taken as representing the total Khoja population. This exaggerated number, ⅔ more than that found at the census, is taken so as to avoid the risk of increasing unduly the death-rate among the uninoculated, when making the subsequent calculations. It is found then that there were during this period in Bombay 3,814 (average) inoculated, and 9,516 (purposely exaggerated) uninoculated Khojas. Between 27th December 1897 and 20th April 1898, there were 184 deaths in the Khoja community. Of these 6, including 2 from plague, were in those inoculated in 1896-97 and not re-inoculated since; 7 deaths, including 3 from plague, occurred in the 5,184 inoculated, or re-inoculated during the above period, and 171 deaths took place among the uninoculated.

* The Jamát Khána is the central meeting place of the Khojas, for religious and social gatherings, and here a register of all burials in the community is kept by the officials who perform the last rites.

Calculating from the normal average death-rate during these months among the community for some years previous to the plague epidemic, it appears that one should expect 102 deaths from natural causes, but as 184 deaths were actually recorded, it may fairly be assumed that the 82 extra deaths were due to plague. Of these 82 plague deaths, 3 occurred in those inoculated between 27th December 1897 and 20th April 1898, 2 in those inoculated during the previous epidemic, and 77 among the uninoculated. These details were carefully ascertained by a house-to-house visitation conducted by Mr. Haffkine personally, by examination of the burial book at the Jamat Khana, and by the inoculation documents in the Laboratory. The distribution of deaths in the two groups is shown below.

	Population.	deaths from plague.	Deaths from other causes.
Inoculated...	3,814	3	4
Not inoculated	9,516	77	94

Admitting that not more than 77 deaths among the uninoculated were due to plague, and *supposing that the inoculated had remained after operation as susceptible as before, they ought to have had proportionately 31 deaths from plague instead of 3 only; or a difference of 90·3 per cent. in favour of the inoculated.*

10. *Hubli.*—Plague appeared in this mercantile town of 50,000 inhabitants in the end of 1897. It then disappeared for a time, only to break out once more on the approach of the monsoon. "The average rainfall between April and October amounts to more than 28 inches. Under these circumstances, although a large and weather-proof health camp had been prepared for emergencies, complete evacuation of the infected town-site was impossible, and the attempt to effect it would have led to the severest hardships and to the immediate spread of the disease into surrounding villages and districts." It was for this reason, as Mr. Cappel, the Collector—whose words have just been quoted—remarks, that inoculation was tried so extensively, being the only feasible measure under the circumstances. As Mr. Cappel further remarks:—"Inoculation seems therefore to be pre-eminently adapted for large towns and industrial places at all times, and in the rains it is, so far as present experience shows, the only method of staying the disease which can be relied on."

The enormous numbers inoculated, and the size of the town itself, precludes any such great accuracy of figures as was attained in the small village of Undhera, for instance, but still the following figures from Captain Leumann's Report to Government may be taken as substantially correct. The inoculations were begun on the 11th of May 1898, and between that time and 27th September, 38,712 persons were operated on:—

Dates.	Actual population of Hubli as per weekly census.	Numbers not inoculated.	Numbers inoculated.	Plague deaths among not inoculated.	Plague deaths among inoculated.
11th May to 14th June 1898 ...	Fell from 50,000 to 47,427	44,573	2,854	47	1
Week ending 21st June „ ...	47,082	41,494	5,588	22	3
„ 28th „ „ ...	47,485	39,042	8,443	29	1
„ 5th July „ ...	46,537	36,020	10,517	55	6
„ 12th „ „ ...	46,518	33,255	13,263	34	6
„ 19th „ „ ...	45,240	29,716	15,524	82	7
„ 26th „ „ ...	43,809	24,112	19,697	100	15
„ 2nd Aug. „ ...	43,707	21,031	22,676	140	16
„ 9th „ „ ...	42,768	15,584	27,184	272	19
„ 16th „ „ ...	40,441	10,685	29,756	386	61
„ 23rd „ „ ...	39,400	6,367	33,033	371	41
„ 30th „ „ ...	38,210	4,094	34,116	328	28
„ 6th Sept. „ ...	38,382	2,731	35,469	227	34
„ 13th „ „ ...	38,408	1,116	37,292	138	46
„ 20th „ „ ...	39,142	937	38,205	106	35
„ 27th „ „ ...	39,315	603	38,712	58	20

Discarding the figures in the first row as being only approximate, the average population for 15 weeks under "Not inoculated" and "Inoculated" respectively is as in the following table, where also the occurrences in each group are shown :—

	Average population.	Deaths from plague.	Percentage mortality.
Inoculated	24,631	338	1·3
Not inoculated	17,786	2,348	13·2

In other words, 1 in every 72 of the inoculated population died, while 1 in every 7 of the uninoculated succumbed to plague; giving a reduction of mortality of 89·6 per cent. in favour of the inoculated.

11. *Southern Mahratta Spinning and Weaving Company's Mill.*—The experience in this Company's mill at Hubli should be an object lesson to all mill-owners in plague-stricken towns. On the 21st of June 1898 there were 1,173 mill-hands on the muster rolls. The table below shows the events as ascertained at the close of the epidemic.

Population.		Deaths from plague.	Percentage of mortality.
Inoculated twice	1,040	22	2·11
Inoculated once only	58	8	13·79
Not inoculated	75	20	26·66
Total ...	1,173		

If the 1,098 inoculated persons had remained as susceptible to plague as the 75 not inoculated, they ought to have lost 293 by death instead of 30 only, a difference of 89·7 per cent. in favour of the inoculated.

12. *Employés of the Southern Mahratta Railway, Hubli.*—These persons were living in barracks, and in the Railway yard apart from the general population of Hubli town. They were under close daily inspection by English officials, who formed a committee for this purpose, with Dr. Chenai as their medical adviser. The results given below may therefore be regarded as accurate to a high degree, the numbers dealt with not being excessive, and the supervision strict. Inoculation was begun early in June 1898, and after its introduction plague cases appeared on 29 different dates between 11th June and 6th October of that year.

The actual occurrences are shown in the following table :—

Dates on which occurrences happened.	Inoculated.					Not inoculated.			Total population living in Railway yard.
	Once.	Twice.	Total.	Attacks.	Deaths.	Population.	Attacks.	Deaths.	
June 11 ...	41	0	41	...	...	1,794	2	2	1,835
„ 29 ...	439	235	674	...	...	1,243	2	1	1,917
July 5 ...	385	471	856	...	...	1,063	2	2	1,919
„ 9 ...	365	552	917	...	...	1,063	1	1	1,980
„ 11 ...	365	552	917	...	...	1,129	1	1	2,046
„ 13 ...	337	597	934	...	...	1,125	2	2	2,059
„ 14 ...	335	603	938	...	...	1,120	1	1	2,058
„ 19 ...	344	821	1,165	...	...	880	2	1	2,045
„ 20 ...	344	821	1,165	...	...	880	2	2	2,045
„ 21 ...	344	821	1,165	1	...	881	2	2	2,046
„ 22 ...	344	821	1,165	...	...	882	1	1	2,047
„ 23 ...	344	821	1,165	...	...	886	2	1	2,051

Dates on which occurrences happened.	Inoculated.					Not Inoculated.			Total population living in Railway yard.
	Once.	Twice.	Total.	Attacks.	Deaths.	Population.	Attacks.	Deaths.	
August 4 ...	297	880	1,177	...	...	862	3	...	2,039
„ 5 ...	297	880	1,177	...	...	827	2	1	2,004
„ 6 ...	297	880	1.177	...	...	827	1	...	2,004
„ 9 ...	297	880	1,177	...	...	834	2	...	2,011
„ 10 ..	215	965	1,180	1	...	831	...	...	2,011
„ 12 ...	215	968	1,183	...	...	829	2	...	2,012
„ 21 ...	245	1,132	1,377	2	...	619	2	1	1,996
„ 22 ...	234	1,146	1 380	...	...	618	1	...	1,998
„ 23 ...	151	1,231	1,382	1	...	615	...	...	1,997
„ 24 ...	224	1,253	1,477	1	...	520	...	...	1,997
„ 25 ...	210	1,272	1,482	...	...	516	1	1	1,998
„ 26 ...	287	1,277	1,564	2	1	418	...	...	1,982
„ 30 ..	292	1,354	1,646	1	1	333	...	...	1,979
September 1 ...	342	1,375	1,717	1	...	261	1	1	1,978
„ 21 ..	64	1,697	1,761	...	...	102	1	1	1,863
October 6 ...	134	1,713	1,847	1	...	31	...	...	1,878
„ 9 ...	84	1,723	1,807	...	...	65	1	1	1,872
Total attacks and deaths				11	2	...	37	23	

The above table may be summarised as follows; only premising that 2 deaths from plague in the uninoculated, which occurred in persons who were not permanent residents of the yard, though temporarily living there at the time of attack, are deducted :—

	Numbers.	Attacks.	Deaths.
Twice inoculated	990	6 (0·6%)	1 (0·1%)
Once „	270	5 (1·8%)	1 (0·3%)
Not inoculated	760	35 (4·6%)	21 (2·7%)

In the above table, average populations have been taken in each case, as the numbers present varied on each date when plague appeared; the numbers inoculated steadily increasing while those not inoculated decreased correspondingly.

If the 1,260 inoculated had suffered to the same extent as the 760 not inoculated they ought to have had 58 cases and 34 deaths, instead of 11 and 2 respectively. The number of cases therefore appears reduced by 81·03 per cent. and the deaths by 94·1 per cent.

13. *Dhárwár Jail.*—In October 1898 plague appeared in this jail, as well as in the town of Dhárwár situated in the Southern Deccan.

The population of the jail varied from 360 to 380, but on the date of inoculation it was 374. Before inoculation was performed 5 cases of plague, of which one was imported, and 4 in old residents of the jail, occurred, all ending in death. After inoculation of the entire jail population, only one case followed two days after operation, but he recovered.

14. *Broach.*—A town of 40,168 inhabitants situated on the sea-coast 200 miles north of Bombay. Owing to the advent of plague, and consequent flight of many of the inhabitants, only about half were found present when a census was taken on 16th March 1899. The average population for the previous six months is estimated by those on the spot as 27,000, and this number is therefore adopted for statistical purposes, in the figures given below, which are taken from a report submitted by Dr. Burjorji Sorabsha, the medical officer employed by the Parsi Panchayat to perform inoculation among the members of their community.

The table below shows at a glance the events in the two sections :—

Population.		Cases.	Deaths.
Inoculated ...	... 1,970	6 (0·3%)	4 (0·2%)
Not inoculated	... 25,030	564 (2·2%)	460 (1·8%)

If the inoculated had suffered in the same proportion as the uninoculated, they should have had 44 cases with 36 deaths, instead of 6 and 4 respectively. *The number of cases amongst the inoculated appears therefore to have been reduced by 86·3 per cent. and the number of deaths by 88·8 per cent.*

Taking the Parsi community by itself we find that during the period from October 1898 to March 1899, they numbered on an average 1,843 persons, of whom 1,080 were inoculated. The following occurred :—

Population.		Cases.	Deaths.
Inoculated ...	... 1,080	2 (0·2%)	1 (0·1%)
Not inoculated	... 763	9 (1·2%)	5 (0·6%)

If the inoculated Parsis had suffered in the same proportion as those not inoculated, they should have had 12 cases with 7 deaths, instead of 2 and 1, respectively. Inoculation appears therefore to have reduced the number of cases by 83·3 per cent., and the deaths by 85·7 per cent.

Another community which shows striking results from inoculation is that of the tailors of Broach. These numbered 225, and were all living in a camp outside the town, under similar conditions as regards dwellings, mode of living, etc., Of this community 90 were inoculated, and 135 remained uninoculated. The following table shows the incidence of plague among them.

Population.		Cases.	Deaths.
Inoculated ...	... 90	0	0
Not inoculated	... 135	10 (7·4%)	6 (4·4%)

15. *Dhárwár*—A town of some 32,000 inhabitants situated in the Southern Mahratta Country, 13 miles from Hubli, and the head-quarters station of the Southern Mahratta Railway. Plague broke out here during August 1898, and inoculation work was begun almost at once by the Civil Surgeon, Lieutenant-Colonel Davidson, I. M. S., and afterwards continued and practised on a large scale by Dr. Miss Corthorn, who was sent there on special duty, and from whose report the following figures are taken. During the 12 weeks covered by this report, from September 2nd to November 16th 1898, the population actually residing in the town numbered on the average 21,088, the rest having fled to the fields or jungle in the neighbourhood. Of these persons, 2,367 were operated on once, and 1,864 twice; while 16,848 remained uninoculated.

The table below shows the incidence of plague among the inoculated and uninoculated :—

Average population present.		Cases.	Deaths.	Case incidence.	Case mortality.
Inoculated	... 4,231	129	54	3·04%	41·8%
Not inoculated	... 16,848	1100	889	6·5%	80·8%

If, therefore, the inoculated had remained as susceptible to plague as their fellow townsmen they should have shown 270 cases with 223 deaths, instead of 129 and 54, respectively. The number of cases therefore appears reduced by 52·2 per cent., and the mortality by 75·7 per cent.

Owing to the careful way in which the records of the inoculation work were kept it is possible to pronounce an opinion on the effect of inoculation on those actually in the incubation stage of plague. In Dhárwár 74 individuals developed plague within 10 days of operation. As 10 days is generally admitted to be the limit of the incubation period, we may assume that many of these persons had already the plague germs in their bodies at the time of inoculation. The following statement shows that the death-rate at no time exceeded that among the uninoculated population (80·8%) and was generally very much below this. It is evident then that inoculation of persons incubating plague, does not do any harm, but on the contrary increases their chance of recovery.

	Cases.	Recoveries.	Deaths.	Percentage of Mortality.
Inoculated with plague actually developed ...	5	4	1	20·0
Developed plague on day of inoculation	5	3	2	40·0
„ „ within 2 days of inoculation ...	13	9	4	30·7
„ „ „ 4 „ „ „	7	2	5	71·4
„ „ „ 6 „ „ „	19	8	11	57·8
„ „ „ 10 „ „ „	25	21	4	16·0
Total within 10 days of inoculation ...	74	47	27	36·5

16. *Gadag.*—A town in the Dhárwár District of some 23,000 inhabitants. Plague appeared here shortly after Dhárwár itself was attacked. From Dr. Miss Corthorn's report of her work there, the following information has been obtained.

In the 28 weeks from 18th November 1898 to the end of May 1899, which is the period dealt with in the report, the incidence of plague was as follows:—

Average population.	Cases.	Deaths.	Case incidence.	Case mortality.
Inoculated once, 1,365	32	14	2·3%	43·7%
„ twice, 11,639	161	69	1·4%	42·8%
Not inoculated, 4,163	278	216	6·6%	77·7%

If the 13,004 inoculated had suffered to the same extent as those not inoculated, they ought to have had 868 cases with 674 deaths instead of 193 and 83, respectively; a reduction of 77·7 per cent. and 87·6 per cent. respectively.

17. *Belgaum Cantonment.*—A severe epidemic broke out in Belgaum Town and Cantonment in April 1899 and continued throughout May, June, July and August. In the Cantonment inoculation was vigorously pushed by the local Plague Committee, who carefully watched and recorded the results. These are given in the table below, which has been compiled from the Belgaum Collector's weekly report to Government:—

Week ending	Number inoculated during the week.	Total Population...9,543. A Inoculated. B Uninoculated.		Weekly numbers of		
				Cases.	Deaths.	
12th May 1899 ...	...	9,543	A 1,230	14	8	
			B 8,313	34	19	
19th do. ...	898	"	A 2,128	10	4	
			B 7,415	17	6	
26th do. ...	451	"	A 2,579	5	3	
			B 6,964	31	19	
2nd June 1899 ...	231	"	A 2,810	3	...	
			B 6,733	27	21	
9th do. ...	199	"	A 3,009	10	3	
			B 6,534	32	21	
16th do. ..	165	"	A 3,174	1	3	
			B 6,369	45	26	
23rd do. ...	74	"	A 3,248	2	...	
			B 6,295	34	19	
30th do. ...	113	"	A 3,361	1	2	
			B 6,182	33	22	
7th July 1899 ...	310	"	A 3,671	3	1	
			B 5,872	47	34	
14th do. ...	648	"	A 4,319	4	1	
			B 5,224	71	50	
21st do. ...	1,151	"	A 5,470	6	4	
			B 4,073	51	33	
28th do. ...	1,254	"	A 6,724	4	3	
			B 2,819	30	36	
4th August 1899 ...	1,145	"	A 7,869	4	2	
			B 1,674	24	15	
11th do. ...	313	9,052*	A 8,182	12	3	* Cause of decrease probably flight.
			B 870	18	15	
18th do. ...	546	8,674*	A 8,048	5	3	
			B 626	6	6	
25th do. ...	Only 2 cases and 2 deaths in the whole Cantonment.					
1st September 1899...	77	8,947	A 8,590	3	...	
			B 375	1	1	
8th do. ...	134	9,064	A 8,749	...	...	
			B 315	5	3	

Taking the average population for each of the groups, the following summary of the above is obtained:—

		Cases.	Deaths.	Percentage mortality on average population.
Average inoculated population present throughout the epidemic.	4,842	78	40	0·83
Average uninoculated do. do. ...	4,558	506	346	7·59

If therefore the inoculated had suffered to the same extent as the uninoculated, *they should have had 537 cases with 367 deaths instead of 87 and 40, respectively.* The number of cases therefore appears to be reduced by 83·8 per cent., and the deaths by 89·1 per cent.

18. *Artillery Followers, Belgaum.*—Major Forman, R.A.M.C., sends the following particulars relating to the inoculation of the Native Followers of the 49th Battery, Royal Field Artillery, who since plague broke out have been under medical inspection twice daily.

These people, numbering 334, reside in lines ¾ mile from the nearest bazár. Plague appeared on the 31st of May 1899, and between that date and the 7th

of July there were 23 cases of plague with 17 deaths among those not inoculated. Inoculation was begun on the 5th of June and carried on as follows :—

5th	June	1899,	10	inoculated.
17th	„	„	6	„
21st	„	„	22	„
26th	„	„	36	„
30th	„	„	42	„
3rd	July	„	56	„
6th	„	„	67	„
10th	„	„	49	„
15th	„	„	23	„
		Total	311	

Neither attacks nor deaths have taken place among the 311 inoculated, up to date (10th September 1899), and they are still kept under medical inspection twice daily.

19. *Mauritius.*—The following account of inoculation work in the Island of Mauritius is compiled from the report submitted by Captain J. S. Stevenson, I. M. S., to the Director, Medical and Health Department, there, and published by command of His Excellency the Governor of Mauritius.

The mortality in Port Louis (population 54,000) was above the average death-rate of the past ten years from the end of March 1899 till the beginning of November of the same year. Inoculation was introduced in May, but people did not come forward in large numbers till the end of June, at which time plague deaths were numerous in the town. The table below, compiled from Captain Stevenson's report, relates to the period from 1st July to 30th December 1899 inclusive, " a period which corresponds to the most serious rise in the plague death-rate and its gradual decline to normal." The figures cannot be used as an *exact* demonstration of the effect of inoculation, for no census of the population was taken, several thousand people had left the town, and concealment of cases to a large extent prevailed. Nevertheless, as an indication, they are interesting.

Population.	Plague attacks.	Plague deaths.
Inoculated ... 6,816	66 (0·96%)	38 (0·55%)
Not inoculated ... 47,184	826 (1·75%)	708 (1·50%)

If the inoculated had suffered to the same extent as the uninoculated, they ought to have had 119 cases with 102 deaths instead of 66 and 38 respectively; a reduction of 44·5 per cent. in the case of attacks and 62·7 per cent. in the case of deaths in favour of the inoculated.

Although in Port Louis, as a whole, accuracy was not attainable, yet in certain small groups of persons it was found possible to observe events so closely that reliable data are forthcoming.

Mauritius Dock Camp.—In this camp live Madrasis and Indian Musalmáns brought to the island under a labour contract. They live in a dozen or more barrack-like buildings placed close together, and covering 5 or 6 acres of ground. Some of these dwellings are double-storied, but all are dark, ill-ventilated and insanitary, and 12 families inhabit each block.

The first case of plague occurred on 6th July 1899 and the last on 21st November.

Inoculation was begun on 1st July and was rapidly completed, almost all the people submitting on account of the privileges offered. At the end of Sep-

tember about 90 of these people went to an evacuation-camp. Up to this time the following had occurred :—

Population.		Plague attacks.	Plague deaths.
Inoculated ...	423	13 (3·01%)	6 (1·38%)
Not inoculated ...	13	7 (53·8%)	6 (46·1%)

If the inoculated had suffered to the same extent as those not inoculated, they ought to have had 228 cases with 195 deaths instead of 13 and 6 respectively; a reduction of 94·2 per cent. in the attacks and of 96·9 per cent. in the deaths. By the end of September plague had almost ceased in the vicinity of this camp, and only one more case occurred in an uninoculated individual. None of the inoculated contacts developed plague, and on no occasion did more than one case occur in any one room. Captain Stevenson remarks on this and says, "I do not see that this result can reasonably be put down to anything but the fact that these contacts were all inoculated."

Engrais Mauricien Camp.—"This camp held 70 men and 82 women and children. Thirty of the men and 6 of the women and children were inoculated in July. Plague attacked the camp in October and 13 cases occurred in the first fortnight of that month, none of whom had been inoculated. The camp was then evacuated and its inmates inoculated with the exception of 37 individuals."

The following table shows the events both before and after evacuation. The number of deaths is not reported :—

Population.			Plague attacks.
Inoculated	...	Before evacuation ... 36	.....
		After evacuation ... 115	4 (3·4%)
Not inoculated	...	Before evacuation ... 116	13 (11·2%)
		After evacuation ... 37	4 (10·8%)

Of the four inoculated cases, one developed symptoms one day and another three days after operation.

Albion and *Colonial Dock Camps.*—In these camps the whole of the inhabitants were inoculated, and there is therefore no unprotected population living under the same conditions for comparison. It is not then possible to say what would have happened had the inhabitants not been inoculated. In the Albion Dock Camp with 500 inhabitants there were 12 cases of plague with 6 deaths, or a percentage of 2·4 and 1·2 respectively. In the Colonial Dock Camp with a population of 70 there were 10 cases of plague with 7 deaths, or 14·2 and 10 per cent. respectively.

Several interesting examples are given in this report of the effect produced by the inoculation of the coolies working on the sugar estates. The result was invariably good, and it is therefore only necessary to refer briefly to the more striking examples.

L'Espérance Estate.—Attached to this sugar estate is a camp of over 1,100 persons. On October 2nd a case of plague was discovered and on the 5th of the same month 159 of the inhabitants were inoculated. No more could be operated on as the stock of vaccine in the island was exhausted. Before the new supply arrived in the course of six weeks the following had occurred :—

Population.		Plague attacks.	Plague deaths.
Inoculated	159	4 (2·5%)	1 (0·6%)
Not inoculated ...	956	68 (7·0%)	54 (5·6%)

If the inoculated had suffered to the same extent as the uninoculated, they ought to have had 11 cases of plague with 9 deaths, instead of which they had 4 and 1 respectively; a reduction in favour of the inoculated of 63·6 per cent. for attacks and 88·8 per cent. for deaths.

On November 17th a new supply of vaccine having arrived, the remaining coolies were operated on, and the epidemic ceased. Whereas in the two weeks preceding the final inoculation 7 and 8 cases of plague had occurred respectively, in the two following weeks 2 cases and 1 case appeared among the uninoculated remnant of about one dozen. No more cases have since occurred there. Two other sugar estates gave similar results, the disease stopping whenever inoculation was complete.

Shoenfeld Estate.—A case of plague was found here on 15th October. During the third week in November there were 5 cases, and it appeared certain that an epidemic was commencing similar to the one in the neighbouring estate of L' Espérance. On 14th November inoculation was begun and rapidly completed. The last case of plague occurred on the 20th November; there had been 10 cases, all ending in death and all among the uninoculated.

Union (Ribet) Estate.—Between November 30th and December 5th, 12 cases of plague suddenly occurred, of which 66 per cent. proved fatal. The whole camp of 420 persons was then inoculated, and no further cases occurred. In these two last-named estates evacuation was not resorted to.

20. *Ahmednagar District.*—The villages dealt with in the following summary are all situated within a few miles of Ahmednagar, the chief town of the district of that name in the Bombay Presidency. The information was compiled by Mr. F. G. H. Anderson, Indian Civil Service, First Assistant Collector of Ahmednagar, who submitted an interesting report on the matter, which was published by the Bombay Government. Plague appeared first in Arangaon, 4 miles south of Ahmednagar, in May 1899, and gradually spread through the neighbouring villages and cantonment. As the monsoon rains were nearly due, inoculation was resorted to instead of evacuation, and 5,648 persons were operated on, out of a population of 11,287 in the affected villages.

As soon as plague appeared a complete census of the village was made by house-to-house inspection by a special staff working under Mr. Anderson's directions. Strangers coming to the village were liable to detention, and were included in the census lists, and no one was allowed to leave on pain of prosecution. Thereafter a daily roll-call was taken morning and evening, and thus a complete check was kept on the inhabitants.

The inoculated were granted certain concessions, the chief of which was that they were not turned out into camp if cases occurred in the block or street in which they lived. As pointed out by Mr. Anderson, this resulted in the greater and longer exposure of the inoculated to the local poison throughout the epidemic; for the uninoculated were at once removed to camp and compelled to live outside the village when a case occurred in their neighbourhood. As regards the classes of people inoculated, Mr. Anderson says, he "is able in the case of these villages to vouch personally for the fact that the inoculated, if anything, belonged to the lower and poorer classes, as, for instance, at Nepti, where the inoculated were almost all Mahárs."

Two possible sources of error are pointed out, *viz.*, (*a*) concealment of cases and deaths, and (*b*) concealment of flight of the people. But "as the inoculated "were not subjected to the same rigours as the uninoculated, they had less "reason both to conceal their cases and to run away; moreover, it is notorious "how prompt the neighbours are to call loud attention to the cases among the "inoculated. Hence, even if we admitted (which we do not admit) that the "figures might contain some errors, those errors would be such as to make the "number of the uninoculated population greater and of the cases occurring "among them less than it really was, and so the error would conceal the full "extent of the protection afforded by inoculation. As we have ready to hand "the name, age, sex, caste, and all other particulars, and whether he was present "or not at every day's roll-call, for every inhabitant counted in the census from

"the day of the outbreak up to the date of this memorandum [24th October "1899] the writer does not admit there is any appreciable error in these statistics. "In some of the villages the number of the residual population at the end of "the outbreak has been further tested and tallied and found not to throw the "least suspicion on the records."

The method of calculation adopted by Mr. Anderson is as follows:—"A "number of protected and a number of unprotected persons live for a day in "the infected area, and the question is, which class shows the higher rate of "attack and death from plague. If the number is not the same, as will "usually be the case, then we must multiply the number of protected by the "number of days they have lived in the village, and similarly with the unpro- "tected: thus the product will give the number of daily units of each class: "these units divided by the number of attacks and deaths from plague among "that class give the daily rate of attack and death as 1, in so many units."

The unit in fact is 1 (person) × 1 (day).

As the result of the labour of the census parties Mr. Anderson was able to compile tables showing day by day the progress of plague in each village, and the events happening in the groups of inoculated and uninoculated respectively. From these he compiled the following summary:—

Village.	Period and its characteristics.	Inoculated.				Uninoculated.			
		Units.	Attack.	Death.	Death-rate 1 in—	Units.	Attack.	Death.	Death-rate 1 in—
Arangaon ...	9th May to 14th June disease slowly spreads till it gets epidemic and inoculation begins; 37 days ...	24	...	...	...	37,945	11	8	4,743
	15th June to 31st August plague gets worse till at last inoculation is resorted to freely; 78 days ...	18,940	4	2	9,470	59,937	40	28	2,140
	1st to 30th September inoculation general and plague disappears; 30 days	22,119	7	4	5,530	7,364	23	12	613
	Total, 145 days ...	41,083	11	6	6,847	105,246	74	48	2,192
Vakodi ...	3rd July to 15th August outbreak controlled by evacuation till it gets severe; 44 days	...	...	...	...	38,663	14	10	3,865
	After 15 cases in 2 days the people take to inoculation, 16th August to 5th September; 21 days	2,218	...	...	...	15,860	36	28	566
	6th September to 12th October inoculation stamps out plague which becomes sporadic; 38 days ...	26,116	8	2	13,090	5,992	4	1	5,992
	Total, 102 days ...	28,334	8	2	14,162	60,515	54	39	1,551
Nepti ...	6th July to 13th August inoculation declined; 39 days	66	...	...	...	43,848	50	38	1,154
	14th August to 13th September epidemic dies out through evacuation; 31 days	7,377	6	2	3,687	26,500	19	16	1,656
	Total, 70 days ...	7,443	6	2	3,721	70,348	69	54	1,302
Valunj ...	Little inoculation, disease very virulent 1st to 28th August; 28 days.	497	3	2	249	17,923	53	49	365
	9th August to end of epidemic 14th October inoculation stamps it out; 47 days	20,920	5	5	4,184	7,362	24	24	306
	Total, 85 days ...	21,417	8	7	3,060	25,295	77	73	345
Nimblak ...	From 25th August to 13th October the disease still rages and people take very little to inoculation; no fair trial; 50 days	2,269	9	2	1,135	37,329	56	34	1,098
Bhirgar ...	From the time when plague began to be epidemic (7th September) to 19th October period of 43 days ...	31,338	7	5	6,267	148,300	59	47	3,155

Village.	Period and its characteristics.	Inoculated.				Uninoculated.			
		Units.	Attacks.	Deaths.	Death-rate 1 in—	Units.	Attacks.	Deaths.	Death-rate 1 in—
Nagardevala.	24th September to 7th October plague increasing and rather virulent and no inoculation; 14 days ...	...	...	...	...	15,460	30	24	644
	8th October to 13th inoculation started but epidemic still goes on ..	1,384	...	...	...	5,105	25	21	243
	Total ...	1,384	...	...	...	20,565	55	45	457
	(Please note that after 13th October large numbers of the Nagardevala people have been inoculated; and up to date (19th) there has been one non-fatal case among the inoculated and 5 cases and 9 deaths among the remaining uninoculated. Therefore the above figures do not yet show the enormous amount of protection afforded.)								
Darevadi ...	11th September to 13th October. Here inoculation was started the very day that cases were first discovered; 33 days	10,396	18	5	2,079	6,852	47	33	206

"The remaining village, Hingangaon, is peculiar; it was surrounded by plague, and on 31st of August 12 persons came to get inoculated, it having up to that time not been discovered that there was any plague there: this strange behaviour makes it probable there was, as of the 21 persons 2 developed plague almost at once and died within 48 hours; and a third was attacked, but not fatally, afterwards. To complete the first summary however these figures will be included and discussed below.

Village.	Period and its characteristics.	Inoculated.				Uninoculated.			
		Units.	Attacks.	Deaths.	Death-rate 1 in—	Units.	Attacks.	Deaths.	Death-rate 1 in—
Hingangaon.	Scarcely any inoculation from 2nd September to 13th October; 44 days	453	3	2	226	34,635	62	42	824

"The following table sums up the occurrences in the above villages:—

Villages.	Inoculated units.				Uninoculated units.			
	Total.	Cases.	Deaths.	Death-rate 1 in—	Total.	Cases.	Deaths.	Death-rate 1 in—
Arangaon	41,083	11	6	6,847	105,246	74	48	2,192
Vakodi	28,334	8	2	14,162	60,515	54	39	1,551
Nepti	7,443	6	2	3,721	70,348	69	54	1,302
Valunj	21,417	8	7	3,060	25,295	77	73	345
Nimblak	2,269	9	2	1,135	37,329	56	34	1,098
Bhingár	31,338	7	5	6,267	148,300	59	47	3,155
Nagardevala	1,384	...	...	...	20,565	55	45	457
Darevadi	10,396	18	5	2,079	6,852	47	33	206
Hingangaon	453	3	2	226	34,635	62	42	824
Grand Total ...	144,117	70	31	4,648·9	509,085	563	415	1,226·7

"Now the meaning of the above is that, assuming that the exposure of the inoculated units was just the same as that of the uninoculated units, then the inoculated had a daily plague death-rate of 1 in 4,648·9 while the uninoculated had a daily death-rate of 1 in 1,226·7; or, if the inoculated had not been protected, they would have presumably died at the same rate as the others and lost 117·6 lives instead of 31; so that by inoculation 86·6 lives were saved, or a percentage of 73·6.

"When we recall that as a fact the inoculated were more exposed and that it was those who had had deaths in their families and close neighbourhoods who were most ready to try the protection, the real truth is that they were protected much more than 73·6 per cent. But even if their greater exposure is disallowed, still we have the incontrovertible fact that they lost 73 per cent. less lives from plague than the uninoculated."

The only case in the series given above in which a doubtful result is shown is the village of Hingangaon where out of the 12 persons inoculated 2 developed plague within 48 hours and subsequently died. The fact that these 12 persons

applied to be inoculated before it was known that plague was in the village, and before, therefore, any effort had been made to induce the inhabitants to be operated on, is strong presumptive evidence of the existence of undetected plague there.

It is probable then that these two children (aged 9 and 5 years) had been exposed to plague infection, and that the prophylactic was not in their case given early enough to produce abortion of the disease. The presumption that the inoculation caused the attack is out of the question, as the vaccine does not contain living plague germs.

Mr. Anderson finally sums up his report in the following words:—

"Out of 5,648 persons inoculated the writer has seen a few, perhaps 4, cases of rather badly swollen arm: none of them have resisted treatment or led to any worse effects. Had these accidents been many times as frequent, it would be a cheap price to pay for so many saved lives.

"The lesson of the figures is that plague can be effectively stamped out by inoculation; plague seems like a forest fire, it sweeps along destroying dry grass and bushes, and is stayed when it comes to the green: the inoculated are the green bushes: so long as they are few in number, some are caught up in the general conflagration, but as soon as the inoculated are in the majority, the fire dies down and splutters out. Consider the following figures for the four villages where more than half the people got inoculated:

Village.	Date on which the inoculated were in majority.	Date on which plague ceased to be epidemic.	Interval in days.
Vakodi ...	6th September 1899.	6th September 1899.	*Nil.*
Arangaon ...	6th September 1899.	13th September 1899.	7
Darewadi ...	20th September 1899.	27th September 1899.	7
Valunj (badly infected) ...	1st September 1899.	12th September 1899.	11"

The Government of India, wishing to collect, and submit to examination, the many facts concerning plague collected by medical men and others throughout the country, and having reference to various matters regarding the origin, dissemination, prevention and combating of plague epidemics, appointed for this purpose the Indian Plague Commission, consisting of—

T. R. Fraser, M.D., LL.D., F.R.S., Professor of *Materia Medica*, University of Edinburgh, President of the Commission.

Members ...
- J. P. Hewett, C.I.E., I.C.S., Secretary to the Government of India in the Home Department.
- A. E. Wright, M.D., Professor of Pathology in the Army Medical School, Netley.
- A. Cumine, I.C.S., a Senior Collector in the Bombay Presidency.
- M. A. Ruffer, M.B., Head of the Quarantine Board of the Egyptian Government.

C. J. Hallifax, I.C.S., Secretary to the Commission.

The principal questions, about which the Government of India desired that evidence should be collected were—

(1) the origin of the different outbreaks of plague;
(2) the manner in which the disease is communicated:
(3) the effects of curative serum; and
(4) the effects of preventive inoculation.

The members of the Commission reached Bombay on the 25th November 1898, and at once began the work of examining witnesses put forward by the various local Governments throughout India, as well as any of the public who expressed a desire to give evidence. Their tour extended throughout the Bombay Presidency, the Province of Mysore, the Deccan districts of Madras, the State of Hyderabad, the Central Provinces, the Lower Provinces of Bengal, the North-West Provinces and the Punjab. In short their tour was co-extensive with the territory which had up to that time been invaded by plague. The witnesses examined during this extended tour comprised not only civil and military officers of Government of all grades who had any experience of plague and plague measures, but medical men and laymen from the non-official classes, both European and Native, and also *hákims* and *vaids* well versed in the ancient medical lore of the East. The Commission left India on 25th March; had several sittings in London, where further evidence was collected, and they are still engaged (December 1900) in arranging the voluminous

evidence collected, and compiling their report. Considering, however, the practical importance of speedily making a pronouncement on the subject of inoculation, they have submitted a preliminary report on "Haffkine's Anti-Plague Inoculation," which will form the fourth chapter of the completed report. After a rigorous criticism of all the statistics laid before them by the various witnesses—and most of which have been included in the preceding pages—and after excluding all data, which seemed to them liable to any objection, the commissioners arrive at the following conclusion, which they formulate thus :—

"In every case, except that of Bulsár, inoculations had a considerable effect in warding off plague attacks from the inoculated, and that in every case, without exception, they rendered attacks among the inoculated less fatal than attacks among the uninoculated."

On the main point at issue, *i.e.*, the practical utility of Haffkine's anti-plague vaccine, the plague Commission thus agree with the conclusions (*a*), (*c*) and (*d*) on page 36. For the details on which differences have arisen and which it would be out of place here to discuss, the reader is referred to the report itself, Chapter 4 of which, dealing with inoculation, has already been published in *Supplement to the Gazette of India* for February 1900.

With regard to the case of Bulsár, additional information has been obtained locally, through the kindness of Khán Bahádur P. H. Dadachanji, Assistant Surgeon in charge of Bulsár dispensary, who did a large number of the inoculations himself, and who kept records of the occurrences subsequently.

The following is the account of what actually occurred :—

21. *Bulsár.*—A town near Surat, in the Bombay Presidency, with a population of 14,472. Inoculation was begun here early in 1898 by Assistant Surgeon Dadachanji, from whose figures the members of the Indian Plague Commission compiled the following information. The operations were confined to four wards of the town, and the following advantages were allowed to the inoculated : they were not segregated, and were allowed to treat the sick in their own homes, or in special houses set apart for this purpose in each quarter. The table below shows the events in each ward.

Population taken into account.			Plague Attacks.	Plague Deaths.	Case Mortality.
Dheberwad ...	Inoculated ...	170	4 (2·4°/₀)	1 (0·6°/₀)	25·0 per cent.
	Not inoculated...	10	0	0	.....
Taiwad ...	Inoculated ...	490	65 (13·3°/₀)	23 (4·7°/₀)	35·4 per cent.
	Not inoculated...	9	4 (44·4°/₀)	2 (22·2°/₀)	50·0 „
Machiwad ...	Inoculated ...	97	8 (8·2)°/₀	3 (3·1°/₀)	37·5 „
	Not inoculated...	8	1 (12·5°/₀)	1 (12·5°/°)	100·0 „
Ghanchiwad...	Inoculated ...	261	7 (2·7°/₀)	4 (1·5°/₀)	57·14 „
	Not inoculated...	35	4 (11·4°/₀)	4 (11·4°/₀)	100·0 „
Total ...	Inoculated ...	1,018	84 (8·2°/₀)	31 (3·0°/₀)	36·9 „
	Not inoculated...	62	9 (14·5°/₀)	7 (11·3°/₀)	77·7 „

If the inoculated had suffered to the same extent as the uninoculated; they should have had 148 cases with 115 deaths, instead of 84 and 31 respectively; a reduction of 43·2 per cent. in the case of attacks and of 73 per cent. in the case of deaths, in favour of the inoculated.

With reference to the above the following is quoted from the report of the Indian Plague Commission :—

"It is to be noted that all the plague occurrences entered in this table occurred after the completion of inoculations. It is further to be noted that the population under observation does

not include the whole of the population of the wards. Mr. Dadachanji has, in his figures for the population under observation, left out of account 110 people out of the total population of the four wards, as 62 of these were children under two, 30 had had plague during a previous outbreak, and 18 were attacked by plague in the outbreak under consideration before inoculations were completed. Lastly, it is to be noted that the number of uninoculated persons who came under observation amounted to no more than 62. This number is so small that we may assume that it consisted in large part of persons who remained uninoculated because they were unfit for inoculation. The mortality among these might naturally be expected to be higher than in a normal community. As a matter of fact, we find that from May to December 1898 the 62 uninoculated lost 8 persons on account of deaths from general causes while the 1,018 inoculated lost 10.

"As far as we have been able to judge, Mr. Dadachanji's figures have been carefully collected. A census of the town was taken at the end of 1897, and a complete census of the inoculated wards was taken again at the time of inoculations. A list of the inoculated and uninoculated inhabitants was posted up on the door of each house, and each house is said to have been visited daily by a medical officer who had orders to satisfy himself regarding every person living in it, and to call out the inhabitants daily for inspection. In this manner the number of plague cases and deaths, and their distribution between the inoculated and the uninoculated were ascertained.

"It will be seen from the table that the effect of anti-plague inoculation manifested itself here especially in the reduction of case mortality. When we take into consideration the fact that the uninoculated were a sickly community, we see that it is probable that inoculation exerted little, if any, effect in warding off plague attacks."

The conclusion arrived at by the Plague Commission, as expressed in the last sentence, is seen to be founded on the *sickly state* of the uninoculated community, a condition of affairs which, presumably by a slip, they "assume" in one paragraph, and assert to be a "fact" in the next one.

On this point further local enquiry has thrown some useful light. Through the kindness of Assistant Surgeon Dadachanji it has been found possible to ascertain the proportion of sick people among the uninoculated, and to exclude this disturbing element from the comparison now to be made.

The following table shows the distribution of the sick and healthy in the various streets and the reason for the non-inoculation of the 62 persons now under consideration :—

Name of Street.	Reason for non-inoculation as noted at time of operation.						Total.
	Healthy, but absent on duty or business.	Healthy, but cause of absence not noted.	Pregnancy.	Puerperal state.	Old age.	Sickness.	
	1	2	3	4	5	6	
Dheberwad ...	4	1	1	...	2	2	10
Taiwad	2	...	5	...	1	1	9
Machiwad... ...	4	...	1	...	2	1	8
Ghanchiwad ...	22	3	3	1	2	4	35
Total ...	32	4	10	1	7	8	62

Among the 32 in the first column, 8 were policemen or railway servants on duty; the rest were away on private business and are stated to be healthy. Those in the second column were likewise healthy. Those in the third and fourth columns cannot be designated "sickly", but they may be reckoned along with the 8 actually sick and the aged, as being perhaps specially susceptible to disease on account of their physical condition. If those in columns 3, 4, 5 and 6 be deducted, we may consider the remainder to be as healthy as the average inoculated population, and we find then that there were 36 undeniably healthy people and 26 sickly or in exceptional states of health. The following table shows how plague affected the persons belonging to these two groups :—

Name of Street.	Name of non-inoculated persons.	State of health as recorded at the time of inoculation.	Result.
Dheberwad ...	Nil.	.....	.....
Taiwad	1. Havaboo ...	Pregnant	Recovered.
	2. Fatma ...	Do.	Died.
	3. Aisaboo ...	Do.	Do.
	4. Amanboo ...	Old	Recovered.
Machiwad	5. Devji... ...	Healthy; absent at work...	Died.
Ghanchiwad	6. Havli ...	Pregnant	Do.
	7. Kasam ...	Healthy; absent at work...	Do.
	8. Moosa ...	Do. do. ...	Do.
	9. Kasi	Do. do. ...	Do.

The above may be summarised as follows :—

	Cases.	Deaths.
Healthy ... ... = 36	4	4
Sickly ... ... = 26	5	3

If the 36 healthy uninoculated persons be compared with the 1,018 inoculated, the following table may be constructed :—

Population.	Cases.	Deaths.	Case mortality.
Inoculated, 1,018	84 (8·2 °/₀)	31 (3·0 °/₀)	36·9 per cent.
Not inoculated, 36	4 (11·1 °/₀)	4 (11·1 °/₀)	100·0 „ „

If the inoculated had suffered in the same proportion as the healthy uninoculated, they ought to have had 113 attacks with 84 deaths instead of 84 and 31 respectively; a reduction of 25·6 per cent. in the case of attacks and of 63·1 per cent. in the case of deaths in favour of the inoculated.

Thus, when the "sickly" are excluded from the calculation, a reduction of the attack-rate *in favour of the inoculated* is seen. The smallness of the reduction in this case should not be adduced as an argument to show the little effect of the prophylactic, for such small numbers as are found here on the uninoculated side are always liable to have the balance destroyed by a single addition to one side or other of the account.

The Commission further compare the incidence of plague in two communities of the same caste, but living in separate parts of the town of Bulsár. The first of these was the Ghanchis (or oil-pressers), and the following is the table given by the Plague Commission as showing the occurrences in the two quarters. The population of the inoculated quarter is got by adding both inoculated and uninoculated together. The uninoculated persons in the inoculated quarter numbered 35, and they furnished one-third of the cases and half the deaths in this community; and this should be kept in mind when studying the table :—

Population.	Plague cases.		Plague deaths.	
	Number.	Percentage on population.	Number.	Percentage on population.
Inoculated quarter, 296 ...	*11	3·7	8*	2·7
Non-inoculated „ 154 ...	23	14·9	16	10·4

The results shown in the above table are very favourable, and would be even more so, if the Commission had not included the four cases among the unprotected who lived in the inoculated quarter. Assistant Surgeon Dadachanji also reports that about half the population of the non-inoculated quarter had fled to the fields, so that, as the Plague Commission remark, "the advantage in favour of the inoculated ward would be practically double that which is set forth in the table."

The other community noted by the Commission consisted of the Tais, a caste of Mussalman weavers and dyers, who lived in two quarters of the town said to be "absolutely comparable." The following table is given by the Plague Commission to show the incidence of plague in the two quarters :—

Population.	Plague cases.		Plague deaths.	
	Number.	Percentage on population.	Number.	Percentage on population.
Inoculated quarter, 499 ...	65	13·0	23	4·6
Non-inoculated „ 492 ...	65	13·2	47	9·5

The Commission wind up their discussion of results among the Tais as follows :—

"In spite of the fact that the prophylactic fluid was operative in reducing plague mortality . . . . . it appears that it did not sensibly reduce liability to attack by plague."

If the two communities had been strictly comparable such a conclusion would be justified, but the Plague Commission themselves admit that, "We have no details which will enable us to arrive at a judgment as to how far the two Ghanchi wards contained comparable communities," and we know from Assistant Surgeon Dadachanji's report that they were "about a third of a mile apart" and that the epidemic had passed over the one community before it began in the other. As regards the Tais, as the Commission themselves say, "it would appear that both wards did not suffer from plague at one and the same time, so that the figures of the two wards may relate to outbreaks of different severity."

The conclusion would appear obvious, then, that such a comparision as that instituted in the case of these two communities, should never have been made, and that any deductions drawn therefrom are of doubtful value.

22. *Chawl at Colába.*—In February 1900 a series of plague cases occurred in a "chawl" (or barrack like house) in the Colába Ward of Bombay City. The chawl was a single storey building containing 10 rooms arranged in two rows, back-to-back, separated from one another by 7-foot partitions, but having the roof-space common to all. All these rooms communicated with one another by doors, with the exception of two at one end which were self-contained, but these did not escape infection on this account. Three rooms did not furnish any cases, though some uninoculated persons were living in them. The inhabitants all belonged to a low caste of Hindus called Mángs, and would mix freely with one another.

* *N.B.*—Four of these belong to the uninoculated community.

Another building close to this was occupied by Gaolis or milkmen who belong to a higher caste. When plague broke out among the Mángs, the Gaolis noticed that rats were dying in their quarters and therefore wisely removed to the cowshed close by. They had no cases among them. Thus the isolated Máng community, numbering 61 persons, afforded a good opportunity for an exhaustive enquiry; and this was accordingly carried out by Dr. E. L. Hunt, Inspector of Inoculation, and Dr. Arjani, Section Medical Officer of A. Ward, acting under the direction of Mr. Haffkine himself. There is no doubt, therefore, of the thoroughness, or accuracy of the enquiry; for 57 out of the 61 inhabitants were either seen personally by one or other of the above named investigators, or if they had died meanwhile, the papers relating to them were secured from the adjacent plague hospital where they had been treated.

The remaining four were not seen personally, as they had left the locality, 3 having gone to Poona, and one, a professional beggar, having disappeared in the City of Bombay. Only one of these four had been inoculated, and none of them were attacked. The statements of neighbours had therefore to be accepted in these four cases; with regard to all the other 57 inhabitants, documentary evidence has been submitted to Government and published by them in full.

The first case of plague developed symptoms on the 1st of February 1900, on the 2nd of the same month 7 were attacked, on the 3rd, 6, and then one case occurred on each of the following dates, *viz.*, 4th, 5th, 7th, 9th, 10th, and 12th February. Altogether 20 attacks took place, with 12 deaths.

The inoculations had been done on various dates from 18th December 1899 to 29th January 1900. The one case among the inoculated was in the person of a female, inoculated on 18th December, and attacked on 9th February; she recovered.

The following table shows the distribution of the inoculated and uninoculated, room by room, and the occurrences in each group;—

Room Number.	Number of Inmates and whether inoculated.	Number of	
		Attacks.	Deaths.
1	*1 Not inoculated*	.....	.....
	2 Inoculated	.....	.....
2	*8 Not inoculated*	*4*	*3*
	3 Inoculated	.....	.....
3	*6 Not inoculated*	*4*	*2*
	4 Inoculated	1	.....
4	*1 Not inoculated*	*1*	*1*
	2 Inoculated	.....	.....
5	*4 Not inoculated*	*4*	*4*
	1 Inoculated	.....	.....
6	*4 Not inoculated*	*3*	*1*
	5 Inoculated	.....	.....
7	*3 Not inoculated*	*1*	.....
	3 Inoculated	.....	.....

Room Number.	Number of Inmates and whether inoculated.	Number of Attacks.	Number of Deaths.
8	*3 Not inoculated*	.....	.....
	2 Inoculated	.....	.....
9	*3 Not inoculated*	*2*	*1*
	1 Inoculated	.....	.....
10	*4 Not inoculated*	.....	.....
	1 Inoculated	.....	.....

The inhabitants of rooms 1 and 10 which adjoined one another at one end, but did not communicate directly with any infected room, may be deducted from the above, as no cases of disease occurred among them.

This leaves 8 rooms to be taken into account, and these were inhabited by 53 persons of whom 32 were not inoculated and 21 had been thus operated on. Each of the rooms contained a mixed population of inoculated and not inoculated persons—

The 32 not inoculated had 19 cases with 12 deaths.
The 21 inoculated had 1 case with no death.

If the inoculated had suffered to the same extent as those not inoculated, they ought to have had 12 cases with 8 deaths, but they only had 1 case which recovered. This is equal to a reduction of 91·7 per-cent. in the case of attacks in favour of the inoculated.

The fact that 21 of the inhabitants were away at work all day, and only returned to sleep at night, makes no difference between the two groups, for on enquiry it was found that no cases of plague had occurred in the various places where these people had worked. The infection, therefore, was localised in the chawl, and no circumstance existed that in any way favoured the one group over the other.

The following statement brings this out clearly :—

Those staying at home all day. { 16 Not inoculated had 9 cases. / 16 Inoculated had 1 case.

Those going out to work during the day. { 16 Not inoculated had 10 cases. / 5 Inoculated had 0 cases.

The uninoculated persons being equally divided between those who stayed at home and those who worked outside, and the two groups returning almost the same percentage of cases indicates that the source of infection was common to both, and must therefore have been in the dwelling house itself.

The 53 inhabitants of the above 8 rooms were distributed by age as follows :—

Up to 10 years of age ...	*11 Not inoculated had 7 cases with 2 deaths.* 4 Inoculated had 0 cases with 0 deaths.
From 11 to 50 years of age..	*20 Not inoculated had 12 cases with 10 deaths.* 17 Inoculated had 1 case with 0 death.
Above 50 years of age ...	*1 Not inoculated had 0 case with 0 death.* 0 Inoculated had 0 case with 0 death.

From the above it will be seen that the fatalities occurred mainly among those from 11 to 50 years of age; that the children also show a number of attacks, but with a smaller death-rate.

The sex distribution given below shews that the men were more susceptible to the disease than the women, but had greater power of recovery. Every one of the women attacked died, except the solitary inoculated sufferer.

Males	*21 Not inoculated had 14 cases with 7 deaths.* 6 Inoculated had 0 case with 0 death.
Females	*11 Not inoculated had 5 cases with 5 deaths.* 15 Inoculated had 1 case with 0 death.

23. *The Jewish Community at Aden.*—The Jews of Aden are a compact body, living together in Section A of that part of the settlement known as the Crater. Though Aden had no previous experience of the havoc wrought by a visitation of plague, yet, owing to the enlightened action of one or two of the leading men of this community, the majority had been inoculated, before any concessions were granted by the authorities to those operated on. It has thus once more been proved that it is by personal influence and rational explanation that communities may be persuaded to operation, not necessarily by any concessions granted by the local authorities. The first case of plague in Aden, occurred on 11th March 1900, and the last on 13th June 1900.

The following shows the rise and progress of the epidemic in the total population, and among the Jews separately :—

Among total population in March there were			32	cases ;	among Jews alone	13	cases.
„	„	in April	„	183 „ ;	„	89	„
„	„	in May	„	141 „ ;	„	11	„
„	„	in June	„	12 „ ;	„	0	„
Total for the whole population—				371* „ ;	for Jews alone	113*	cases.

It is manifest from the above that the Jews were badly infected from the beginning, and it is interesting to compare the progress of the epidemic, with the advance of inoculation among them. The epidemic reached its height on the 14th of April, when 10 attacks are recorded, and thereafter declined steadily till by the end of the month, the epidemic may be said to have ceased. Inoculation advanced rapidly after the beginning of April, and by the 13th of that month *more than half the population* had been operated on, and as more and more of the unprotected passed over to the numbers on the inoculated side of the account, so did the epidemic *pari passu* decline.

The following table, compiled by Assistant Surgeon Shapurji M. Mehta, in charge of the Prince of Wales' Charitable Dispensary, Aden, who also carried out the inoculations, will show the daily course of events :—

* *Note.*—The 113 cases include 26 concealed cases among the Jews discovered during the census. These are not included in the total number of 371, which was obtained from the Municipal register only; no census of the general population, other than Jews, having been taken.

Date.	Number of Inoculated present.	Plague Attacks.	Plague Deaths.	Number of Uninoculated present.	Plague Attacks.	Plague Deaths.
1900.						
24th March	2	...	...	2,602	1	...
25th "	2	...	...	2,602	...	1
26th "	6	...	...	2,597	1	...
27th "	6	...	...	2,595	2	2
28th "	41	...	...	2,553	...	2
29th "	41	...	...	2,551	2	...
30th "	56	...	...	2,536	...	...
31st "	56	...	...	2,536	...	...
1st April	95	...	...	2,497	...	...
2nd "	130	...	...	2,467	1	...
3rd "	150	...	...	2,439	2	1
4th "	245	...	...	2,341	3	2
5th "	358	...	...	2,227	...	...
6th "	463	...	...	2,118	4	...
7th "	465	...	...	2,114	1	...
8th "	579	...	...	1,995	5	2
9th "	728	...	...	1,844	1	3
10th "	975	...	...	1,593	4	2
11th "	1,105	2	...	1,457	4	3
12th "	1,196	1	...	1,341	2	3
13th "	1,401	...	...	1,131	5	...
14th "	1,398	3	1	1,124	7	4
15th "	1,398	3	...	1,119	3	...
16th "	1,467	1	1	981	3	6
17th "	1,461	...	...	976	2	5
18th "	1,460	1	...	975	1	1
19th "	1,457	...	...	969	4	3
20th "	1,441	1	...	966	3	2
21st "	1,440	1	...	965	1	5
22nd "	1,439	...	1	957	4	2
23rd "	1,614	...	...	781	...	...
24th "	1,622	4	1	720	2	2
25th "	1,652	2	1	673	3	2
26th "	1,685	1	...	631	...	...
27th "	1,694	...	...	603	...	1
28th "	1,689	1	2	601	1	1
29th "	1,651	...	...	588	1	...
30th "	1,642	...	...	558	1	...
1st May	1,586	...	...	503	2	1
2nd "	1,610	1	...	475	1	1
3rd "	1,545	...	...	454	...	...
4th "	1,545	...	...	428	...	...
5th "	1,545	...	...	426	1	...
6th "	1,484	...	...	400	1	1
7th "	1,489	...	...	368	1	...
8th "	1,504	...	1	353	...	1
9th "	1,492	...	...	346	...	1
10th "	1,488	...	...	341	...	...
11th "	1,489	...	...	332	...	1
12th "	1,489	...	...	332	...	1
13th "	1,494	...	...	327	...	...
14th "	1,503	...	...	318	...	...
15th "	1,490	...	...	296	1	...
16th "	1,487	...	...	288	...	...
17th "	1,493	...	...	282	...	...
18th "	1,510	...	...	259	...	1
19th "	1,509	...	...	258	1	...
20th "	1,500	1	...	252	...	...
21st "	1,511	...	...	222	...	1
22nd "	1,522	...	...	211	...	...
23rd "	1,522	...	...	201	...	...
24th "	1,525	...	...	197	...	...
25th "	1,536	...	...	186	...	...
26th "	1,536	...	...	186	...	...
27th "	1,531	...	...	186	...	...

Date.	Number of Inoculated present.	Plague Attacks.	Plague Deaths.	Number of Uninoculated present.	Plague Attacks.	Plague Deaths.
1900.						
28th May	1,534	...	...	179	...	...
29th „	1,535	...	...	175	...	...
30th „	1,536	...	...	174	...	...
31st „	1,539	...	...	170	1	...
1st June	1,553	...	...	151	...	...
2nd „	1,553	...	...	151	...	1
Total ...	...	23	8	...	83	65
Daily average ...	1,190	...	...	982	...	...

The above figures were obtained in the following way: The number inoculated day by day is taken from the inoculation register which was carefully kept from the beginning, and in which was entered the name, age, sex, caste, occupation, residence, date of inoculation, number of brew, and dose administered, nature of reaction resulting, and subsequently, date and result of attack if such occurred.

The number of the uninoculated was got from a house-to-house visitation, conducted between the 15th and 24th July, just a month after the epidemic had ceased, and when therefore events were still fresh in the minds of the people, and at the same time the fear of removal was no longer dreaded by them. This census was carried out by Assistant Surgeon Mehta, with the help of Mr. Salem Harun, a prominent member of the Jewish community, and who knew personally most of its members. As the epidemic was over, and the fears of the people quieted by the presence and assurances of one of their number in whom they could trust, it is probable that the census represents the actual course of events with great accuracy. The following information was obtained for each house:—House number; name, age, sex of each of the inhabitants; whether inoculated or not, whether attacked by plague or not, date of attack; recovery or death, whether remained at home, removed to camp, or went out of Aden, with date; and deaths from all causes.

The result of this enumeration showed that the Jews living in the Crater at the commencement of the epidemic numbered 2,614; consisting of 842 males 940 females, and 832 children under 10 years of age.

The statements respecting cause of deaths were checked by comparison with the plague hospital register, and the municipal death register. All deaths were certified by a Medical Officer, before any corpse was permitted to be disposed of, so that reasonable accuracy is thus secured. The only item remaining unchecked was the plague attacks ending in recovery, which may possibly have been successfully concealed during the epidemic. But as Mr. Mehta had gained the confidence of the people, and was assisted by a gentleman in whom the community fully trusted; and as no penalties could be feared after the epidemic was over; it is probable that very few, if any, such cases escaped enumeration. As a matter of fact 26 such concealed cases, ending in recovery, were discovered during the census operations. In the case of persons who were attacked by, or died from plague, the fact of inoculation or otherwise was always checked by reference to the inoculation register. From the above account of the way the investigation was carried out, it must be apparent that great accuracy has been attained, and the figures may be accepted as substantially correct.

As in this case inoculation was not carried out on one day, but was gradually pushed on through a lengthened period, it becomes necessary to take an *average population* when comparing the two groups of inoculated and uninoculated.

The following table has been thus compiled, to show the occurrences, using this "average population" as a basis :—

	Daily Average Strength.	Cases.		Deaths.		Case Mortality per cent.
		Number.	Per cent.	Number.	Per cent.	
Uninoculated...	982	83	8·4	65	6·6	78·3
Inoculated	1,190	23	1·9	8	0·6	34·7

If the inoculated had suffered to the same extent as the uninoculated, they ought to have had 100 cases with 78 deaths instead of 23 and 8; which is equal to a reduction of 77 per cent. in attacks and 89·7 per cent. in deaths in favour of the inoculated.

From the house-to-house investigation it was ascertained that out of 47 houses in which plague cases occurred, 31 were, at the time of the attacks, inhabited by a mixed population of inoculated and uninoculated; while 16 contained uninoculated persons only.

The occurrences in these 31 families are as shown below.

	Strength.	Cases.	Deaths.	Case mortality.
Uninoculated	179	44	29	65·9
Inoculated	246	19	8	31·2

The results shown here, when compared with those in the former table, bring out clearly once more the danger to inoculated persons arising from the presence of uninoculated members in their families. In spite of this however it is found that if the inoculated had suffered to the same extent as the uninoculated members of these houses, *they should have had 60 cases and 39 deaths, instead of 19 and 8 respectively; which is equal to a reduction of 68·3 per cent. of cases and 79·5 per cent. of deaths in favour of the inoculated.*

The next table shows the distribution of the cases with reference to the time intervening between inoculation and attack.

	Cases.	Deaths.
Attacked on the day of inoculation ...	...	...
,, one day after ,, ...	3	3
,, two days ,, ,, ...	3	2
,, three ,, ,, ,, ...	3	...
,, four ,, ,, ,, ...	...	...
,, five ,, ,, ,, ...	2	...
,, six ,, ,, ,, ...	1	1
,, seven ,, ,, ,, ...	2	...
,, eight ,, ,, ,, ...	...	...
,, nine ,, ,, ,, ...	...	...
,, ten ,, ,, ,, ...	2	2
,, more than ten days after inoculation	7	...

Mr. Mehta concludes from the above table that "partial protection is achieved after three days after inoculation, and the maximum of protection is reached after ten days"; but it is quite admissible to argue that, as the percentage of case mortality is the same on the first day and the tenth after inoculation, and shows varying results on the intermediate days, the protection really varies very little after the first day has elapsed. It is certain however that inoculation

within the incubation period, does not decrease the chance of recovery,—as has been stated by some eminent authorities,—but on the contrary diminishes the liability to death. This latter conclusion does not rest merely on this instance but on evidence that has been accumulating during the past three years, as the result of many similar investigations in all parts of the country where these prophylactic inoculations have been tried. (*Vide* Dhárwár, p. 18, *supra.*)

24. *Yeroada Jail.*—It has been on several occasions observed that when a population living more or less under control,—such as a regiment, or the inmates of an asylum or jail,—are entirely or almost all inoculated, the epidemic of plague at once stops. Again this sequence of events was witnessed lately in this large central jail situated near the town of Poona. The first case occurred on the 5th of October 1900, and the last indigenous case on the 17th of the same month. A solitary imported case afterwards occurred on the 26th October in an under-trial prisoner newly admitted from Poona where plague was prevalent.

Cases of plague occurred on the following dates, *viz.* :—

1	on the 5th October.	}	All in prisoners who had been some months in jail.
1	„ „ 12th „		
2	„ „ 17th „		
Total ... 4	cases.		

Inoculation was begun on the 10th October, and was practically complete by the 17th, when 1,658 prisoners had been operated on. Of the above 4 cases, all died but one, who had been inoculated 4 days previous to attack. The other 3 were attacked before they could be inoculated. Since then, no more indigenous cases have occurred.

From the above observations it may be taken as proved—

(*a*) That inoculation is harmless.

(*b*) That when given in the incubation stage (*i.e.*, before signs of plague are apparent) it has—in many cases at least—the power of aborting the disease.

(*c*) That inoculation confers a high degree of immunity from plague, and so reduces very greatly the number of attacks.

(*d*) That when, in spite of inoculation, a person is attacked, his chances of recovery are very greatly increased.