'HEAF' MULTIPLE PUNCTURE TUBERCULIN TEST

A COMPARISON WITH INTRADERMAL TUBERCULIN P.P.D. IN THE CAPE COLOURED SUBJECT

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Tuberculosis is at the present time the major Public Health problem in the Union of South Africa, particularly amongst the non-White sections of the population in the wetter coastal regions with a winter rainfall.

Despite the progress which has been made since the introduction of the modern antibiotics and chemotherapeutics, the incidence of tuberculosis amongst the Cape Coloured section of the population of the Western Cape has remained high. It has, therefore, been decided to introduce BCG vaccination into the anti-tuberculosis campaign, in the hope that it will reduce the incidence at least of the primary types of the disease.

An essential part of any BCG vaccination scheme is the preliminary tuberculin testing of those members of the community to whom BCG is to be offered, and one of us (F.K.M.) was greatly impressed during a WHO Fellowship visit to the Northern Ireland Tuberculosis Authority, in 1956, with the potential advantages of the 'Heaf' Multiple Puncture[1] apparatus in arranging a tuberculin survey under conditions such as those found in the Cape Division. The Heaf test is easily performed and painless to the patient; the antigen is comparatively stable and inexpensive; and the reading of the test is so simple that any intelligent person can easily be trained to undertake it without significant observer error.

A search of the literature showed that the Heaf test has been extensively studied amongst White populations and to a lesser extent amongst the African Bantu,[2-4] but no detailed study of the test appeared to have been made in the Cape Coloured. Before introducing the test, therefore, it was considered essential to ascertain whether it was reliable in the Cape Coloured group, and it was decided to compare the results of the Heaf test with the intradermal test, using Tuberculin PPD in a group of Cape Coloured children. It was desired to establish whether or not the test was reliable in the Cape Coloured; whether any abnormal reactions such as hyper-keratinization cones, described by Greening[2] in the Northern Rhodesian Bantu, occurred; and incidentally to ascertain the best time for reading the test.

Subjects

The trial was conducted at a Cape Coloured primary school at Bishop Lavis Township, in the Cape Peninsula near Cape Town, where, by arrangement with the principal, parental permission was obtained to submit 180 apparently healthy children of both sexes, aged between 10 and 15 years, to the test. The trial involved 4 separate visits to the school and, owing to the fairly high absentee rate at Cape Coloured schools, only 156 of these children were seen on all 4 occasions.

Materials

The Heaf test was performed with the Heaf Multiple Puncture apparatus using 'protoderm' containing PPD, 2 mg. per ml., equivalent to 100,000 u. OT per ml. (obtained from Messrs. Allen & Hanbury).

The intradermal test was performed with first and second strength tuberculin PPD (Messrs. Parke, Davis & Co.). The first-strength dose of 0·1 ml. contains 0·00002 mg. of PPD, equivalent to 1 TU. The second-strength dose contains 0·005 mg. of PPD, equivalent to 250 TU. per dose. New tuberculin syringes were used, separate syringes being kept for the two strengths of PPD. The tuberculin solution for the test was freshly prepared immediately before use.

Method

First visit. At the first visit the Heaf test was performed on the anterior aspect of the right forearm. After preliminary cleansing with acetone, a drop of 'protoderm' was applied to the skin with a flame-sterilized platinum loop. The base of the Heaf apparatus was applied to this drop, turned slightly to secure spread and the trigger released. After each application the base of the apparatus was dipped in spirits and flamed.

At the same session, after preliminary cleansing, 0·1 ml. of first-strength PPD was injected intradermally into the anterior aspect of the left forearm.

Second visit. 48 hours after the first visit both the Heaf and PPD reactions were read. All subjects showing a negative reaction to the PPD test (5 mm. or less) were given intradermally a second-strength dose of PPD, approximately 50 mm. distal to the site of the previous injection in the left forearm.

Third visit. On the 5th day, i.e. 72 hours after the second visit, the Heaf and second PPD tests were read.

Fourth visit. On the 7th day, the Heaf test was read a third time.

Method of Reading

(*a*) For the intradermal test, the mean diameter of the induration was measured with a rule and recorded.

(*b*) For the Heaf test the following criteria were adopted:

First-degree positive (+): A ring of 4 or more indurated discrete papules.

Second-degree positive (++): A ring of coalescent papules.

Third-degree positive (+++): A plateau of induration.

Fourth-degree positive (++++): An indurated plateau with vesication.

Doubtful reactions. It became apparent during the tests that a further category of doubtful positives should be recorded. Reactions were labelled 'doubtful' when there was a minimal induration of a less degree than a first-degree positive. A significant proportion of doubtful positives became definitely positive at succeeding visits.

RESULTS

Children who were absent at one or more of the visits were eliminated and the results recorded concern only the 156 children who were seen on all occasions.

Heaf test. The results are shown in Table I. It is noteworthy that every positive to the Heaf test remained a positive throughout the period of observation. Of 15 doubtful readings at the second visit, 5 were (+) at the third visit and remained (+) at the fourth visit. The remainder were obviously negative by the fourth visit. Three children who were

TABLE I. INTENSITY OF HEAF REACTIONS IN 156 CHILDREN

Days	–	±	+	++	+++	++++
2	69	15	42	21	9	0
5	68	6	29	32	17	4
7	68	3	41	35	5	4

negative at the third visit were (+) at the fourth visit. It was also noteworthy that the number of fourth-degree positive reactions was exceedingly small and even these reactions did not cause any particular subjective discomfort.

Intradermal test. In Fig. 1, curve 1 shows the extent of reaction 48 hours after administration of first-strength PPD, and curve 2 shows the readings 72 hours after the administration of the second-strength PPD to the 108 children who

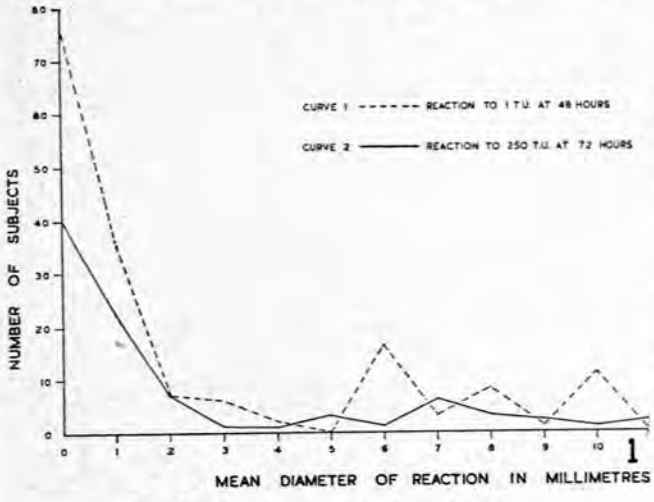

Fig. 1. Reaction to intradermal PPD.

showed a negative reaction to the first test dose. Although the numbers are small, curve 1 indicates that the critical degree of reaction above which the test could be regarded as positive was 5 mm. and, although curve 2 is much less definite, this standard was adopted in all readings.

Comparison between Heaf and Intradermal Tests

Table II compares the Heaf reaction and the reaction to the 1-TU intradermal test in the 156 children who completed the tests. It will be noted that all subjects showing a positive

TABLE II. DEGREE OF REACTION TO 1 T.U. INTRADERMAL PPD READ AT 48 HOURS, COMPARED WITH HEAF REACTION READ AT 7 DAYS

Intradermal PPD		Heaf Reaction					
Reaction in mm.	Number	–	±	+	++	+++	++++
0	69	46	2	14	6	1	—
1	26	19	1	4	2	—	—
2	7	2	—	3	2	—	—
3	4	1	—	3	—	—	—
4	2	—	—	2	—	—	—
5	—	—	—	—	—	—	—
6	16	—	—	7	9	—	—
7	2	—	—	2	—	—	—
8	6	—	—	1	5	—	—
9 or more ..	24			5	11	4	4
	156	68	3	41	35	5	4

reaction of 6 mm. or more to 1 TU also showed a positive Heaf. On the other hand of the 108 subjects showing a negative reaction to the intradermal test with 1 TU (5 mm. or less) 37 showed a positive reaction to the Heaf test at 7 days.

Table III compares the Heaf readings with the reaction to 250 TU of 108 children who were negative to 1 TU. All subjects exhibiting a positive reaction to 250 TU also exhibited

TABLE III. DEGREE OF REACTION TO 250 TU INTRADERMAL PPD READ AT 72 HOURS, COMPARED WITH FINAL HEAF REACTION READ AT 7 DAYS (POSITIVE REACTORS TO 1 TU PPD EXCLUDED)

Intradermal PPD		Heaf Reaction					
Reaction in mm.	Number	–	±	+	++	+++	++++
0	42	42	—	—	—	—	—
1	20	19	1	—	—	—	—
2	7	6	1	—	—	—	—
3	—	—	—	—	—	—	—
4	1	—	—	1	—	—	—
5	3	1	1	1	—	—	—
6	1	—	—	1	—	—	—
7	6	—	—	5	1	—	—
8	3	—	—	2	1	—	—
9 or more ..	25	—	—	16	8	1	—
	108	68	3	26	10	1	0

a positive reaction to the Heaf test. Of 73 subjects showing a negative reaction to 250 TU at 72 hours, 2 showed a positive Heaf at 7 days (these 2 children had reactions of 4 mm. and 5 mm. respectively to the intradermal test but were recorded as negative as the induration failed to pass 5 mm.).

CONCLUSIONS

As was expected, the intradermal test using 1 TU of PPD was found to be unreliable and useful only as a screening test to avoid exposing hyper-tuberculinized subjects to unnecessarily severe reactions to 250 TU. On the other hand, there was a very close correlation between the Heaf test and the intradermal test using 250 TU of PPD, and it was therefore concluded that for practical purposes the Heaf test could be regarded as being as reliable as the latter test. Despite the preliminary screening with 1 TU of PPD, 12 subjects had more or less severe reactions to 250 TU (15 mm. or more) and several of these children suffered considerable discomfort. These same children suffered little or no discomfort from their positive Heaf reactions.

The positive Heaf readings were found to remain positive until the seventh day. In fact, as has been indicated, 3 readings became positive on the seventh day which had been negative at the fifth day. It was accordingly concluded that the optimum day of reading the Heaf test was the seventh day.

DISCUSSION

Before the introduction of any new procedure into a Public Health service, it is essential to establish as far as is reasonably possible that it is both reliable and safe. Within the limits of the small numbers involved in this trial, and bearing in mind that the Heaf test has successfully passed investigation in other communities, it is felt that the Heaf test can now be accepted as both effective and safe in the Cape Coloured group. In fact, our experience confirms the findings of Rathus[5] that the Heaf reaction produces less subjective symptoms than the intradermal test on the other arm. It might be objected that results have been compared of tests carried out on different sides of the body, but Gillis and Stradling[6] showed that the Heaf reaction is equal on both forearms and it seems reasonable, therefore, to infer that a Heaf reading on one forearm can be compared with an intradermal reading on the other.

The ease of reading the Heaf test has been commented upon. There are obvious advantages of being able to train lay persons to read the test and it is noteworthy that Carstairs[7]

introduced self-reading cards in his series and was satisfied with the results.

There is apparently no general agreement on the relative sensitivity of the Heaf test. Stewart and Carpenter[8] and Irvine[9] concluded that it was approximately equal to 10 TU of PPD. Briggs and Smith[10] regarded it as slightly more sensitive than 10 TU. Heaf[1] and Low[11] compared the test with 100 TU. The present small series would appear to indicate that it is comparable with 250 TU.

No hyper-keratinization cones were encountered during the course of this trial, nor has this complication been observed in considerable subsequent work with Cape Coloured patients. The induration at the site of the test disappeared fairly rapidly after the seventh day but it was noted that pigmentation of the site of puncture persisted in some cases for many months.

SUMMARY

1. A comparison is presented of the observations made on 156 Cape Coloured school children between the ages of 10 and 15 years who were subjected simultaneously to an intradermal tuberculin test using PPD and to the Heaf test using Heaf's Multiple Puncture apparatus.

2. The Heaf test gave results as reliable as those achieved by the intradermal test using 250 TU of PPD.

3. It was found that reading the Heaf test on the seventh day was quite reliable and probably preferable to earlier reading.

4. The Heaf test is easily performed, rapid, painless, and very suitable for mass testing of children. It is cheaper for mass work than the intradermal test using PPD.

5. No abnormal reactions other than persistent pigmented spots and occasional capillary bleeding were encountered and positive reactions resulted in little inconvenience to the patient.

6. There appeared to be no contra-indications to the use of this test in the Cape Coloured community.

Our thanks are due to the Principal of the Bishop Lavis Primary School for permission to carry out this trial and to the Health Committee of the Divisional Council of the Cape for permission to publish the results. Our special thanks are due to the Council's Medical Officer of Health, Dr. J. P. de Villiers, whose encouragement and support of any measure likely to assist in the combating of tuberculosis in the Council's area has been a source of inspiration to us.

REFERENCES

1. Heaf, F. (1951): Lancet, **2**, 151.
2. Greening, C. L. (1955): Cent. Afr. J. Med., 25.
3. Henshaw, J. E. (1955): West. Afr. Med. J., **4**, 175.
4. Stott, H. (1955): Tubercle, **36**, 119.
5. Rathus, E. M. (1956): Med. J. Austral., **1**, 696.
6. Gillis, S. and Stradling, P. (1957): Tubercle, **38**, 107.
7. Carstairs, L. W. (1955): *Ibid.*, **36**, 34.
8. Stewart, J. and Carpenter, R. G. (1955): *Ibid.*, **36**, 387.
9. Irvine, K. H. (1955): *Ibid.*, **36**, 21.
10. Briggs, I. L. and Smith, C. (1957): *Ibid.*, **38**, 107.
11. Low, E. (1956): *Ibid.*, **37**, 102.