COMPARING MANTOUX AND JET-INJECTION METHODS OF TUBERCULIN SKIN TESTING

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THE MINISTRY of Health of Vietnam has been surveying the 15 million people of that nation to detect cases of tuberculosis. Both the World Health Organization (WHO) and the U.S. Agency for International Development have provided assistance in this effort. At present, Mantoux tuberculin tests are administered, nonreactors receive bacille Calmette Guerin (BCG) vaccine, and "positive" reactors are given X-ray examinations. Persons with subsequently diagnosed tuberculosis are treated.

The recent introduction of jet-injection equipment to the public health effort in Vietnam has made possible a new intradermal injection technique. Because of a shortage of medical and paramedical manpower, it was postulated that intradermal tuberculin skin testing by jet injection might expedite mass surveys through the more efficient utilization of existing personnel. To determine the effectiveness of testing for tuberculosis by jet injector as compared with the Mantoux technique, we used as a study population the 1,478 inmates of the National Mental Hospital, Bien Hoa, Vietnam.

Inmates of the hospital, who ranged in age from 8 years to over 70 years, were given tuberculin by both methods. Tuberculin skin testing had never been performed within the institution before this trial, and the past medical history of the patients was generally unknown, although the hospital director felt that pulmonary tuberculosis was a major disease among his patients. History of BCG immunization preceding commitment to the hospital was not available.

Our primary objective was to compare results of skin test readings after mechanical injection of tuberculin antigens with those after use of needle and syringe (Mantoux method) on the same patient. If skin test readings after jet injection were discovered to be equivalent to Mantoux test results, further investigations concerning speed of administration and survey campaign organization were to be undertaken.

Procedure

The jet-injection apparatus (*A*) used in this test was a foot-powered rather than an electrically operated unit. Electrical power would not always be available in the field, and we wished to establish the reliability of the method under field conditions.

Mantoux skin tests were administered with disposable syringes. The ventral surface of one forearm was punctured for the tuberculin by needle while tuberculin by jet injection was placed on the ventral surface of the patient's other forearm. Each syringe was filled to an individual dose of 0.1 ml. and was discarded after use. The jet apparatus was set to dispense

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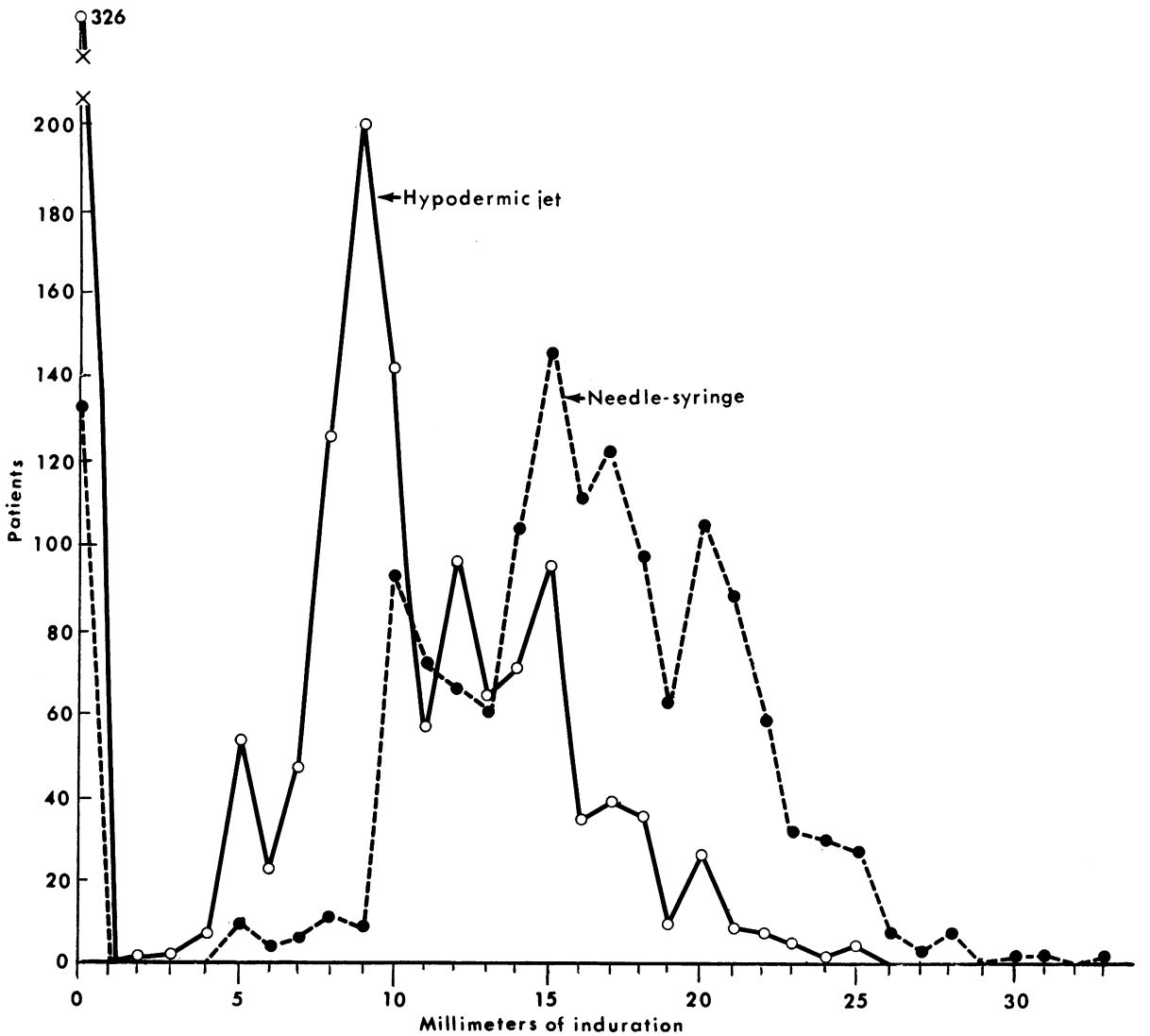
0.12 ml. On each day of testing it was calibrated before use as suggested by the manufacturer (*1*).

The tuberculin used, PPD RT–23 with Tween 80, was diluted to 1 TU per 0.1 ml. dose and packaged in 50 ml. rubber-stoppered vaccine vials for both jet injection and syringe administration. All tuberculin was from the same lot of concentrate supplied by WHO and diluted by Pasteur Institutes, Vietnam, for use in the test.

The entire survey was completed in 4 working days. Tests were given on Monday and Tuesday, followed by readings 72 hours later on Thursday and Friday of the same week. Patients from the 18 wards of the hospital were divided into 2 working days for both testing and reading and were taken from the wards in the same order for reading that had been followed in giving the tests.

Mantoux syringe-needle tests were administered by one nurse detailed from the Hong Bang National Tuberculosis Hospital staff who had had many years of experience with this technique. Jet-injector tests were administered by one nurse employed by the U.S. Agency for

Results of tuberculin tests of 1,478 Vietnamese mental patients using both hypodermic jet and needle-syringe methods, by diameter of induration



International Development who had had 1 year of experience using hypodermic jet equipment. Although each patient received tuberculin antigen intradermally in both forearms, the right arm-left arm distribution of needle or jet techniques was varied from ward to ward and noted.

One additional nurse provided by the national tuberculosis hospital read the resulting reactions 72 hours after administration. She had had many years experience doing this work, was not present during injection days, and was not aware which arm represented a Mantoux or jet test in any given patient. Procedural protocol was supervised by both Vietnamese and American medical personnel. WHO

Table 1. Correlation of reactions of 1,478 Vietnamese mental patients tuberculin tested by both hypodermic jet and needle-syringe methods

Reaction to 0.12 cc. tuberculin by hypodermic jet (diameter of induration in millimeters)

Reaction to 0.1 cc. tuberculin by needle-syringe (diameter of induration in millimeters)	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Total
0	133																													133
1																														
2																														
3																														
4																														
5	7		1	1		3																								12
6	2					1				1																				4
7	3			1		1		2																						7
8	9					3		1																						13
9	3							2	1	2			1			1														10
10	58				3	8	6	3	6	3	6								1											94
11	22				1	8	3	2	8	25	1	1	1																	72
12	25					7	1	2	10	12	5		1	2																65
13	14					3	2	4	11	19	4	1	2							1										61
14	17				2	3	3	5	19	18	20	1	6	2	5		1		1	1										104
15	20					8	2	7	28	35	21	5	8	5	3	4														146
16	5					4	3	4	10	24	20	9	14	6	8	2	2	1												112
17	2					5	1	9	14	17	20	9	14	9	3	8	3	9												123
18	4					1	1		8	14	16	5	16	8	7	10	1	1	4											96
19							1	3		12	5	6	6	3	17	4	1	5												63
20	1					1		2	6	9	12	11	9	6	11	13	5	6	7		7									106
21	1							1	1	2	10	7	5	9	6	25	8	9	3				1							88
22									4	3	2	1	4	5	6	13	3	3	11	1	1					1				58
23										1			4	1	3	4	5	4	2	2	5	2								33
24													2	3		4	3	2	5	2	5	2		1		1				30
25										2		1		1	1	4	2		1	2	7	3	3	1						28
26																1	1		1		2	1				1				7
27														1									1	1						3
28													1			1							2	1	1	1				7
Total	326		1	2	6	56	23	47	126	199	142	57	94	61	70	94	35	40	36	9	27	8	7	4	1	4				1,475

NOTE: Totals show readings for 1,475 patients. Omitted because of space limitations are 3 readings: jet 17 mm., 15 mm., and 14 mm.; Mantoux method 33 mm., 31 mm., and 30 mm., respectively.

Table 2. Comparison of positive and negative reactions to tuberculin of 1,478 Vietnamese mental patients tested by both hypodermic jet and needle-syringe methods

Jet injection	Needle-syringe		
Reaction	Positive	Negative	Total
Positive	692	2	694
Negative	607	177	784
Total	1, 299	179	1, 478

NOTE: Using 10 mm. as the criterion for positive reactions, 77 percent (607÷784) were false negatives.

criteria for administration and reading of intradermal tuberculin tests were adhered to at all times (*2*).

Results

The chart shows the distribution among patients of reactions to the two methods, plotted by size of reaction, and table 1 shows the correlation of reactions to the two tests. Fifteen subjects had greater reactions to jet-administered tuberculin when compared with their response to Mantoux technique. Only 133 patients had no reaction to needle testing, although 326 were nonreactive to jet-injected antigen.

In applying the WHO criteria (*2*) of 8 to 10 mm. of induration for the interpretation of reactions as positive, the upper size of 10 mm. has been in common use in Vietnam for the ITU skin tests employing RT–23 with Tween 80. Using the index of 10 mm. as the dividing line between positive and negative reactors, as shown in table 2, 179 patients were tuberculin negative in the needle-syringe group, and all but two of those were negative to the jet injector. However, an additional 607 were also negative by jet injector. These 607 were considered "false negatives." In other words, 607 of 784, or about three-fourths of the reactions called negative by jet injection, were positive by Mantoux.

Discussion

Ideally, results obtained by jet-injection intradermal tuberculin skin testing should closely duplicate those produced by presently accepted methods if published claims (*3*) of equivalency are to be substantiated. The reaction caused by 0.1 ml. of tuberculin antigen deposited intradermally should not vary if WHO criteria for positivity are to be used.

Dull and co-workers (*4*) in a recent study indicate that, in the absence of reasonably identical results produced by the two methods of injections, a directly comparable relationship should exist between them. Variations should be minor and consistent. In a followup study of Dull's series, Luby and co-workers (*5*), estimated the injected volume of antigen solution by weighing the liquid recoverable from skin surface and jet-injector nozzle after injection. By this method, it was determined that about 53 percent of the fluid volume delivered actually penetrated the patients' skin. Reactions produced in terms of "positivity" were not directly related to estimates of volume of antigen injected in his series.

Forearm girth, skinfold thickness, and operator experience were also reported as not affecting reaction size. Race and age are suggested as being pertinent, but it is postulated that some factor inherent in the way antigen is deposited by the jet injector is probably more important in determining reaction size. In our series of 1,478 patients, we attempted no evaluation of antigen deposition beyond checking to see if a visually satisfactory wheal was produced by both techniques on each person tested.

In analyzing our data we noted, as did Dull (*4*), resulting indurations after jet injection of tuberculin antigen tended to be smaller than those produced by Mantoux tests, with approximately comparable contours produced when results were plotted on the chart. Unfortunately, the large percentage of patients that showed no reaction whatsoever to jet-injected antigen prevents reliable revision of criteria for positivity.

Conclusions

Our impression is that hypodermic-jet intradermal tuberculin skin testing using the equipment described is not sufficiently sensitive, when compared with standard needle-syringe techniques, to warrant its use in mass surveys of populations, whether the screenees have high or low positivity rates. Some 77 percent false negatives by jet injection is too large an error to be acceptable. Additional investigation of

intradermal deposition of fluids by jet injection, both quantitatively as well as of penetration, spread, and local reaction are suggested.

Summary

Results of intradermal tuberculin skin tests using hypodermic jet equipment were compared with results obtained by the standard Mantoux needle-syringe technique in a study of 1,478 Vietnamese mental patients suspected of having a high prevalence of tuberculosis. If intradermal tuberculin skin test readings after jet injection were discovered to be equivalent to Mantoux test results, mass testing for tuberculosis would be expedited through more efficient use of existing medical and paramedical personnel.

A foot-powered jet-injection apparatus, disposable syringes and needles, and tuberculin, PPD RT–23 with Tween 80 diluted to 1 TU per 0.1 ml. dose, were used in the test. Each syringe contained an 0.1 ml. dose, and the jet apparatus was set to dispense 0.12 ml. On each day of testing the hypodermic jet was calibrated to actual quantity delivered before being used, as suggested by the manufacturer.

One nurse used the needle-syringe method, and a second nurse used the jet injector to administer the test. The right arm-left arm distribution varied from ward to ward, and patients in all 18 wards of the hospital were given tests in a 2-day period. A third nurse spent 2 days reading the reactions 72 hours later.

World Health Organization criteria of 8 to 10 mm. of induration for the determination of positive reactors were used, and procedural protocol was supervised by representatives from both Vietnamese and American medical personnel.

Using 10 mm. of induration as the lower limit of positivity, 177 patients were tuberculin negative by the Mantoux technique, and 607 were negative to jet-injected antigen. This number represents a false negativity rate of 77 percent among tests by jet injection. A total of 326 tests by jet injection were completely nonreactive, while 133 were nonreactive to Mantoux testing. This discrepancy obviates any possible revision of criteria for positivity to compensate for the generally smaller reactions found by others, as well as ourselves, to the jet-injection method of tuberculin skin testing.

Hypodermic-jet intradermal tuberculin skin tests with the equipment used in the study did not seem sufficiently sensitive, when compared with standard needle-syringe techniques, to warrant its use in mass surveys of populations with high rates of tuberculosis.

REFERENCES

(1) Scientific Equipment Manufacturing Corp.: Instructions, intradermal nozzle for Scientific's jet injection apparatus. Larchmont, N.Y. Undated.

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EQUIPMENT REFERENCE

(A) Hypodermic jet injection apparatus, Ped-O-Jet, model POJ, Scientific Equipment Manufacturing Corp., Lodi, N.J.