

Jet Injector Tuberculin Skin Testing Compared with Mantoux Method

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A NOZZLE designed for intradermal injection has made the U.S. Armed Forces' jet injector gun practicable for tuberculin testing of children. Fed from a multidose vial and loaded and cocked by two strokes of a foot pedal, the portable jet injector gun fires a metered dose of tuberculin at a maximal pressure of 1,300 pounds per square inch. After passing through a sapphire jewel orifice, the tuberculin traverses the specially designed nozzle pressed against the child's forearm and penetrates his skin tangentially (A).

The jet injector method of tuberculin skin testing is fast and almost painless. An experienced

nurse can test about 600 children per hour with the jet injector gun without danger of inadvertent cross-infection. In early studies (1-3), testing with the jet injector gun yielded results comparable with those obtained by syringe and needle.

Recent reports, however, have questioned the accuracy of the jet-injected tuberculin test. Feigenbaum and co-workers (4) cited a high percentage of erroneous responses to jet injected tuberculin among South Vietnamese mental patients. And in a study of Georgia school children, Luby and co-workers (5) and Dull and associates (6) noted a significant variation between responses to jet injected and syringe and needle injected tuberculin PPD (purified protein derivative). They reported that, on the average, only 53 percent of the tuberculin ejected by the jet gun penetrated the skin. But they considered the placement of the antigen within the skin, which they believed differed from that of the Mantoux test, primarily responsible for the altered reactivity.

Our report concerns the reliability

of reactions to jet injected tuberculin. With a sample of 48 junior high school students, we studied the reliability of jet injected tuberculin PPD in producing reactions of 5 mm. or more as compared with syringe and needle injected tuberculin PPD. For the study, the jet injected dose was standardized so that each jet injected tuberculin test produced an intradermal wheal comparable to that usually produced by syringe and needle.

Materials and Methods

The commercially available jet injector gun, foot powered, with intradermal nozzle (A) was tested to find the tuberculin dosage needed to produce an intradermal wheal of 8 mm. in the longest diameter. The 8-mm. diameter was selected because it corresponded to that of the Mantoux tuberculin test. We found that the jet injector gun produced an 8-mm. wheal when set to dispense 0.14 ml. of tuberculin PPD-S in a concentration (B) of 5 TU (tuberculin units) per 0.1 ml.

The jet injector gun set to dispense 0.14 ml. of tuberculin PPD-S at each firing was then

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used to give intermediate-strength tuberculin tests to 1,321 boys and girls attending a New Orleans junior high school. Each jet injected tuberculin test was placed on the flexor surface of the student's left forearm midway between the wrist and elbow. If the intradermal wheal produced by the jet gun did not approximate 8 mm. (7-9 mm.) in longest diameter, the test was repeated at a distal site.

Only 10 tests had to be repeated. In each instance the jet injector gun had produced an intradermal wheal that was less than 10 mm. in diameter. The second test, however, was satisfactory in all 10 students.

Two days later, all but 90 of the students tested were examined; and the 48 students, aged 12 to 18 years, whose reactions to jet injected tuberculin measured 5 mm. or more in longest diameter were given intermediate-strength Man-

toux tuberculin tests on the flexor surface of the right forearm. According to the accepted multiple-dose technique, a carefully cleaned sterile glass syringe fitted with a platinum needle was used to inject 0.1 ml. of tuberculin PPD-S into the most superficial layer of the student's skin. Unsatisfactory tests were repeated at a distal site.

Two experienced nurses from the health department of New Orleans gave the jet injected tuberculin tests and used dividers and a ruler to measure to the nearest millimeter the intradermal wheals produced and the reactions obtained. They also gave the Mantoux tuberculin tests, but two other experienced nurses from the health department examined and measured the Mantoux reactions. In addition to the supervising physicians, the other survey personnel included two health department officials who were familiar with the jet injector apparatus and

helped the nurses load, cock, and fire the jet injector gun, and two clerks who kept records identifying each student, the type of tuberculin test, and the result.

Results

Jet injector testing. With few exceptions, the jet injector gun produced intradermal wheals that were more sharply defined, blanched, and persistent than those produced by the syringe and needle technique. Student acceptance was notably good; most boys and girls seemed interested in, rather than frightened by, the jet injector apparatus.

Tuberculin reactions. The results of retesting with syringe and needle 48 jet injector tuberculin reactors having indurations of 5 mm. or more were as follows:

	Syringe and needle (Mantoux)	
	< 10 mm.	≥ 10 mm.
Jet injector gun		
5-9 mm.-----	5	6
≥ 10 mm.-----	1	36
Total students-----	6	42

With syringe and needle (Mantoux) test reactions of 10 mm. or more as the standard for a positive tuberculin test, the responses to jet injected tuberculin were false-negative in six students, false-positive in one, correct-negative in five, and correct-positive in 36.

The syringe and needle technique often produced the largest reaction (fig. 1). The sample median for the jet injected tuberculin test was 13.5-mm. range $P(12 < M < 14) = 0.9706$, and that for the syringe and needle injected tuberculin test was 15-mm. range $P(14 < M < 17) = 0.9706$.

A scatter diagram (fig. 2) was the best means of relating reactions to the two techniques. Eight students, one-sixth of the sample, had the same reaction to both

Figure 1. Reactions to intermediate strength PPD-S among 48 students

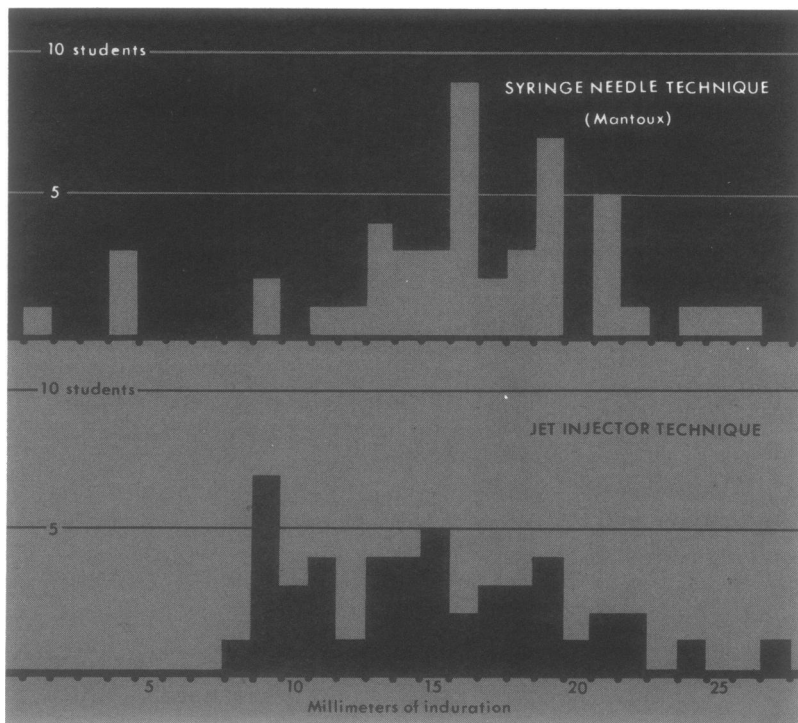
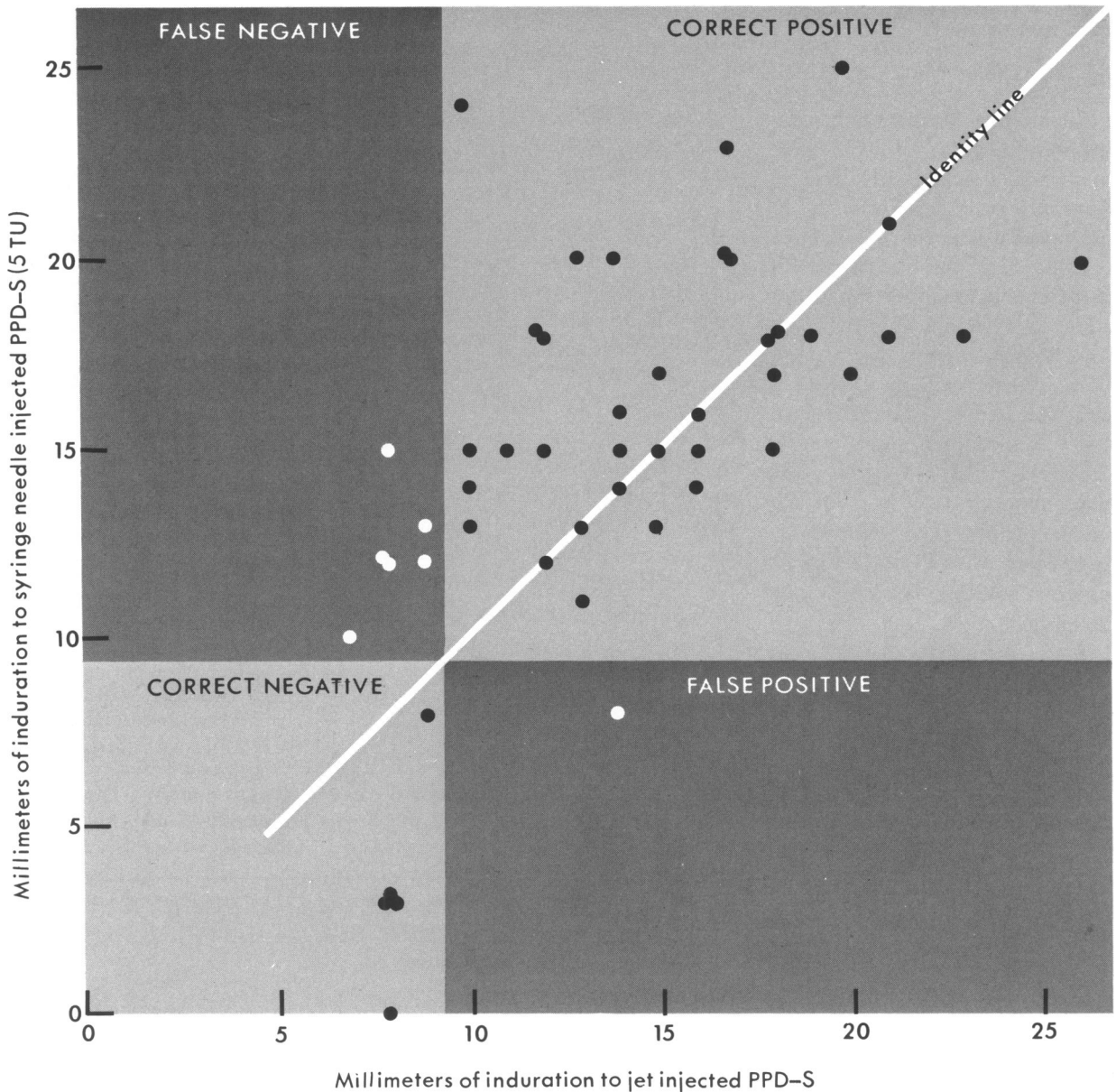


Figure 2. Reactions to jet injected and syringe and needle injected tuberculin PPD-S among 48 students



syringe and needle and jet gun injected tuberculin PPD-S. The results can be seen along the 45° identity line in figure 2. This figure also demonstrates a region of critical error, delineated by the 10-mm. threshold, for the jet injected tuberculin test. In this region lie the responses (false-negative to jet injected tuberculin)

of six of the 11 students whose jet injector reactions were between 5 and 10 mm.

Figure 2, however, mainly illustrates the high positive correlation between reactions to the two techniques. Of the 37 students with jet injector reactions of 10 mm. or more, 36 also had syringe and needle reactions of 10

mm. or more. Calculating the rank order coefficient for the sample

$$\begin{aligned} \rho &= 1 - \frac{6\sum D^2}{N(N^2-1)} \\ &= 1 - \frac{3,672}{110,544} = 0.967 \end{aligned}$$

also indicated that students whose reactions to jet injected tuberculin PPD-S were 10 mm. or more had a high probability of responding

to syringe and needle injected tuberculin PPD-S with reactions of 10 mm. or more.

Discussion

The results of this study confirmed the observations of Feigenbaum and associates (4) that responses to jet injected and syringe and needle injected tuberculin PPD-S sometimes varied significantly in the same student. In this study, as in theirs, the jet injector technique usually produced a more sharply defined, persistent, and blanched intradermal wheal than the syringe and needle (Mantoux) test. Whether the placement of the jet injected antigen in the skin was entirely responsible for its altered effect in some students remains to be established.

Since part of the jet injected tuberculin did not penetrate the student's skin or penetrated too deeply to produce a satisfactory wheal, the jet injector gun used for this study had to be calibrated. Once calibrated, however, the in-

jector gun, without further adjustment, consistently produced satisfactory intradermal wheals.

Nonetheless, retesting the students who reacted to jet injected tuberculin PPD-S with syringe and needle injected tuberculin PPD-S showed that the jet injector responses of 5 through 9 mm. were not reliable. Six of 11 students with jet injector reactions of 5 through 9 mm. had positive Mantoux tests with indurations of 10 mm. or more. On the other hand, there was only one false-positive jet injected tuberculin test. With this one exception, students with jet injector reactions of 10 mm. or more also had positive Mantoux responses. For practical purposes, jet injector reactions of 10 mm. or more were reliable as compared with Mantoux reactions of 10 mm. or more.

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SUPPLY REFERENCES

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THOMPSON, DORIS, H. (City of New Orleans Health Department), and **GREENBERG, HARRY, B.:** *Jet injector tuberculin skin testing compared with Mantoux method. HSMHA Health Reports, Vol. 86, April 1971, pp. 381-384.*

With a sample of 48 junior high school students, a study was made of the reliability of jet gun injected tuberculin PPD-S in producing reactions of 5 mm. or more as compared with syringe and needle injected tuberculin PPD-S. The dosage of jet injected tuberculin was standardized for the study so that each jet injected tuberculin test produced an intradermal wheal comparable with that produced by syringe and needle.

It was found that when set to dispense 0.14 ml. of tuberculin at each firing, the jet gun used in the study produced intradermal wheals comparable with those produced by the syringe and needle injection of 0.1 ml. of tuberculin (Mantoux test). With few exceptions, the jet injector gun produced intradermal wheals that were more sharply defined, blanched, and persistent than those produced by

the syringe and needle technique. Acceptance by the students was notably good.

The results of the study showed that reactions of 5 mm. or more to jet gun injected tuberculin PPD-S were not reliable as compared with syringe and needle (Mantoux) reactions. Six of 11 students with jet injector reactions of 5 through 9 mm. had positive Mantoux tests (indurations of 10 mm. or more). There was only one false-positive jet injected tuberculin test, however. Of 37 students with jet injector reactions of 10 mm. or more, 36 also had syringe and needle (Mantoux) reactions of 10 mm. or more. Positive reactions (indurations of 10 mm. or more) to jet gun injected tuberculin were reliable as compared with positive reactions to syringe and needle injected tuberculin.