

## TOOLS AND TECHNIQUES IN SMALLPOX VACCINATION

by

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There is no excuse for not using the very best available tools and techniques in performing vaccination. Throughout years of vaccination practice, the medical profession has employed a variety of different methods for vaccination. Modern practice has discarded most of these. The purpose of this paper is to discuss the most commonly used tools and techniques, their advantages and disadvantages.

### Pins and Needles

These have been in use since the earliest days of the history of vaccination and in some countries were until recently the only available tools for vaccination. They are cheap, readily available and can be flamed easily in the field after use. However, it is not possible to use them for multiple puncture vaccination as this would be hazardous and it is recognized that scratch vaccination produces a much lower incidence of vaccination takes than multiple puncture vaccination. Furthermore, glass rods or droppers are needed for transferring the vaccine from the vial to the skin which is not only troublesome but wasteful of vaccine.

### Rotary Lancet

This now abandoned instrument was formerly widely employed in India and Pakistan. Studies, however, have shown that take rates obtained are significantly lower than by multiple puncture vaccination. The difficulty of sterilizing the instrument has led to many secondary infections and the violent reactions and ill effects induced by vaccination by means of this tool readily explain the objection of many communities to smallpox vaccination.

### Jet Injector

The jet injector is a relatively new tool and several models have been developed and subjected to field tests. Some have proved to be cumbersome and difficult to operate; some have failed to produce take-rates of acceptable level; some have depended on electric power, thus limiting their use; and some have proved too

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fragile for routine field use.

Amongst jet injectors, the Ped-o-jet is the only one in routine use which gives satisfactory results and which has proved sufficiently durable. It is powered by a hydraulic system operated by foot. It injects the vaccine through a very small orifice into the superficial skin layers. It has been in wide use in West African programmes, in Brazil and in the Congo.

Its advantages are:

**Speedy vaccination:** one is able to perform up to 1 000 vaccinations per hour. An average of 3 000 to 5 000 vaccinations per day have been reported in some eradication programmes. The problem, however, has been to assemble sufficient numbers to permit maximum use of the injector.

The injected dose of vaccine is 0.1 ml and 25 cc or 50 cc vials are sufficient for 250 or 500 vaccinations without changing vials. As the vaccine is diluted by about a third, there is a saving in vaccine.

High take-rates are invariably observed, comparable to those obtained in multiple puncture vaccination.

Unfortunately there are disadvantages to the jet injector:

In contrast to the needles whose use can be taught to ordinary vaccinators, the handling of the jet injector demands special skill and understanding. Mechanical aptitude is desirable to permit minor repairs to be undertaken.

Maintenance of the injector requires special care and spare parts must be stocked. These are reasonably expensive and must be ordered well in advance.

Major repairs cannot be performed under field conditions, and more elaborate tools as well as more highly skilled mechanics must be available.

It is expensive.

Special vaccine is required in terms of purity and bacterial count. If the vaccine is not totally free from particles, the nozzles will clog repeatedly, resulting in difficulties in field operation.

The use of the ped-o-jet can only be justified where and when vaccinees can be gathered in an orderly manner and in large numbers. It is useful for large schools, institutions, army camps, market areas, etc. Its use in house-to-house operations is neither economical nor practical.

## Bifurcated Needle

Although introduced for use only in 1968, the bifurcated needle has now been adopted for use by all endemic countries. This tool is a very simple two-inch stainless steel needle with a small fork at one end. When inserted into the vial of reconstituted vaccine, it retains between its forks one droplet sufficient for performing one vaccination.

Never before were so many advantages grouped in a single vaccination tool: durability, saving in vaccine, ability to induce a high proportion of satisfactory takes, simplicity in field use and very low cost.

### Durability

The bifurcated needle was originally intended to be used only once and then discarded. Considering the number of vaccinations to be performed in the global eradication programme, and the quantity of needles required, studies were carried out to test the durability of the needle and the possibility of its being used several times.

In a field trial in the United Arab Republic, by Shafa, one needle was used 172 times. In this trial, flaming was used as the means of sterilization. The frequency of takes in a group of revaccinees was observed: a greater proportion of successful takes was in fact noted among the second half of the group vaccinated, attesting to the fact that the needle can be used effectively many times, undoubtedly increasing with the skill of the vaccinator.

In another study by Shafa in a group of primary vaccinees where boiling was used as a means of sterilization, each needle was successfully used for 46-47 times and would still have been good for many more vaccinations. Similar studies have been carried out in Kenya. Ladnyi reports 90 vaccinations with a single needle and still the needle could have been used for more. Both autoclaving and boiling were used for sterilization. Metallurgical testing carried out in Geneva indicates that the needle could withstand the heat of alcohol flaming for at least 50 times when exposed for three seconds each time, without any changes occurring in its "hardness index".

### Saving in vaccine

In many cases only about 25 to 30 vaccinations are being performed from a vial containing 100 conventional doses when a dropper is used. Because the needle holds a very small, yet sufficient quantity of vaccine between its forks, an amazing saving of vaccine is possible. The amount taken up by the needle is less than 0.0025 ml, in comparison to conventional methods which employ at least 0.01 ml of vaccine per vaccination.

In an experiment by Shafa using a "50 dose" vial of vaccine (0.5 ml), over 500 vaccinations were performed. Similar observations were reported by investigators in India.

### Satisfactory take-rates

In planned studies carried out with this tool, several investigators (Millar, Zikmund, Ladnyi, Huisman, Meyer and Shafa), using freeze-dried vaccine of standard potency, obtained take-rates of 98% to 100% in primary vaccinees and 56% to 76% in revaccinees. Other tools have invariably shown lower take-rates. In these studies, the multiple puncture technique was compared with multiple pressure and linear scratch.

### Number of insertions

Because the needle is forked, 15 strokes means, in fact, 30 insertions, thus increasing the probability of successful takes.

### Cost

One thousand of these needles cost only US\$ 5.00. Considering that over 100 vaccinations can be successfully performed with each needle, the cost per vaccination is almost nil.

### Simplicity in field use

The need for simplicity is obviously an important consideration in vaccination campaigns. A sufficient number of clean needles can be provided to each vaccinator every day to permit the use of one needle for each vaccinee thus saving the time and equipment required for sterilization in the field.

### Capsule Containers

Special plastic containers designed for the bifurcated needles allow about 200 needles to be carried in a compact practical form, a sufficient number for the day's work of one vaccinator in the field. The needles used each day are an indication of the number of vaccinations performed and may substitute for manual recording of numbers of vaccinations. The capsule container also permits easy sterilization of used needles after work in the field. The capsule containing the used needles may be boiled in any available pot of water and vaccinators thus are not obliged to carry sterilization equipment. A vaccinator in house-to-house activities need only carry one container with a sufficient number of needles for his day's work, one container for collecting the used needles and a vial of diluted freeze-dried vaccine.

### Techniques of Vaccination

It is evident that the technique used in vaccination has a great influence on the result achieved. The preferred technique is one that can be easily taught to vaccinators, produces little trauma, induces the highest possible proportion of takes and is accepted by the public. At present only the multiple puncture and jet injection techniques are recommended. The previously prevalent linear scratch method, while simple enough, produces an unsatisfactorily low proportion of takes. The multiple-pressure method on the other hand, produces a satisfactory proportion of takes but is difficult to teach vaccinators to do properly.

The multiple puncture technique is the simplest to teach. Because the needle moves perpendicularly, the penetration of the superficial layer of skin is almost a certainty, thus permitting insertion of the vaccine. A trace of blood should appear at the vaccination site as an indication that vaccination has been sufficiently vigorous. The take rate is not reduced even if frank bleeding occurs. Care should be taken in vaccination to grasp the arm firmly as children may move their arm away if it is not held firmly during the act of vaccination.

The multiple puncture technique has been extensively field-tested. Comparing the rotary lancet and multiple puncture methods in revaccinees in India, Nath and Rao obtained 75% positive reactions with the multiple puncture method against 42% with the rotary lancet. Both techniques were performed in the same group of 153 subjects. In a study by Ladnyi in Kenya, 112 primary vaccinations were performed with the multiple puncture technique and the same number with the scratch technique. The results, read after seven days, showed 100% take-rates with the multiple puncture technique and 98% with the scratch method. In 334 revaccinees, the take-rates for multiple puncture and scratch were 60.9% and 57.9% respectively.

Clearly, the multiple puncture technique performed with the bifurcated needles is the method of choice for smallpox vaccination and thus is highly recommended by WHO.

ANNEX 1

MULTIPLE PUNCTURE VACCINATION - PRACTICAL CONSIDERATIONS

In using the bifurcated needle in the multiple puncture technique of vaccination, a few points based on field experience are worthwhile noting.

1. It is most advantageous, in general, to boil rather than to flame the needles. However, if flaming is used for sterilization, the needle should be passed through the flame three times, then the needle should be allowed to cool for five seconds before its insertion in the vial of vaccine.
2. After boiling, the plastic container containing the needles should be left overnight to dry. Wet needles have a tendency to stick together and do not come out of the container one by one as they should.
3. Make sure that all needles are placed in the container with the forked ends downwards.
4. The upper hole of the container should be neither too tight nor too wide in order to allow easy release of the needles one by one.
5. When withdrawing the needle from the vial, make sure that its tip does not touch the neck of the vial as this may cause the droplet of vaccine to fall back into the vial.
6. Before vaccinating, one should look through the forks of the needle to make sure that a drop of vaccine is between the forks. If no vaccine is retained by the needle, the fork should be reinserted into the vaccine.
7. The site chosen for vaccination should always be the same, to facilitate subsequent assessment. Most programmes use the upper left deltoid region.
8. It is important that the wrist of the vaccinator rests on the arm of the vaccinee whilst vaccinating. This allows the punctures to be concentrated on a smaller skin area.
9. It is not necessary to first apply the vaccine to the skin before beginning the strokes with the needle.
10. The appearance of a trace of blood at the vaccination site is a sure sign that virus has been introduced into the skin. If no blood appears, vaccination should be repeated. At times, it may take from 10 to 15 seconds for blood to appear at the vaccination site.
11. No skin preparation is recommended. Thus, no alcohol, ether, acetone, soap, etc. should be provided or used. As it is only recently that this approach has been introduced, the medical profession may raise some questions. Reasons for this procedure thus should be explained to them.