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Smallpox vaccination is one of the most effective weapons of preventive medicine. It consists of the inoculation of vaccinia virus, which produces in the vaccinated individual a benign disease that immunizes against smallpox.

#### Age at which vaccinations should be performed

1. Primary vaccination. Primary vaccinations should be made during infancy, between the first and sixth month of age. There are numerous advantages in primary vaccination during the first months of life: early protection against the disease; reactions usually are milder than at other ages; complications are less frequent; the probability of local trauma is smaller, owing to the limited mobility of infants; subsequent revaccinations cause less intensive reactions; and the resulting scar is smaller.

If the primary vaccination has not been given at the age indicated above, it should be performed at any other age.

2. Revaccination. Immunity afforded by vaccination is lost by different individuals at different rates. As a general rule, revaccination every five years is advised and, most especially, at the age of entering school.

In the event of an epidemic, the entire population should be vaccinated or revaccinated, regardless of the time which has elapsed since the previous vaccination.

#### Site of vaccination

The vaccination should be applied to the lower part of the deltoid region, preferably of the left arm. Vaccination on the leg should be avoided since this region is more exposed to contamination and traumata, and circulation is less active; thus, local and general reactions are more likely to occur and cicatrization is slower.

#### Cleansing the skin

For cleansing the skin the use of either ether or acetone is recommended, since both evaporate quickly. Alcohol should not be used because, if any residue remains on the skin at the time the vaccine is applied, it might inactivate the virus. The vaccinator may also cleanse the skin with water and soap, in this case making certain that the site is thoroughly dry before applying the vaccine.

Method of vaccination

The purpose of vaccination is to introduce vaccinia virus in the deeper layers of the epidermis. There are various acceptable methods, the scratch and the multiple-pressure techniques being those more commonly used.

The multiple-pressure technique has the advantage of being painless, causing very little trauma and producing very few local reactions or septic complications. A drop of vaccine is placed on the skin at the site of election. Using his left hand, the vaccinator keeps the skin of the arm taut; taking a sterile vaccinating needle with a good point (the needle being similar to those used in sewing but preferably without the eye), he holds it tangentially to the skin surface and moves it rapidly up and down to make some 25 to 30 pressures over an area not more than 3 millimeters in diameter on which the vaccine was placed. The longitudinal axis of the needle should always be at a perpendicular angle to the pressing motion of the needle.

The needle point should not penetrate the skin, but each pressure should pull a fraction of the epidermis over the point of the needle, carrying the virus to the deeper layers. The needle should be lifted from the skin after each pressure and the operation should take only from 5 to 10 seconds. (See Figs. 1 and 2.)

If the skin has not been unduly irritated in the preliminary cleansing and if the needle has been kept in the correct position, the vaccination will not be painful, it will not produce bleeding, and the irritation caused by the small trauma will disappear within a few hours.

When the scratch technique is chosen, a needle similar to the one recommended for the multiple-pressure technique, or a vaccinostyle, can be used. A single or a double superficial scratch of about 4 millimeters in length should be made through the drop of the vaccine, and the vaccine rubbed in with the side of the needle or vaccinostyle.

When using a vaccinostyle, this should be sterilized in the blue portion of a flame and allowed to cool before further use. It is recommended that at least two vaccinostyles be available for each vaccinator. When needles are employed, a sterile needle should be used for each vaccinated individual, leaving the used

needle to be sterilized at a central station and not by the vaccinator himself. This ensures good sterilization and is less time-consuming for the vaccinator; it has also the added advantage of permitting control of the number of vaccinations made by each vaccinator by counting the number of used needles returned by him.

A well-performed vaccination should not draw blood.

Excess vaccine can be removed with a sterile swab (without antiseptics), the residue being allowed to dry on the skin.

No dressing should be used. During the vesiculation phase it is best to keep the lesion uncovered and dry to promote rapid formation of a crust and avoid maceration and rupture of the vesicle. If the lesion is large and some type of protection becomes necessary, it is preferable to attach a fold of sterile gauze to the inside of the clothing that comes in contact with the lesion.

#### Reactions caused by smallpox vaccine

A technically correct application of a potent vaccine should give a reaction. There are three types of reactions:

1. Primary vaccination reaction. This reaction is observed in persons who have not been vaccinated previously, or in those revaccinated in whom the immunity conferred by the primary vaccination has disappeared. On the fourth day after the vaccination, a papular response becomes evident at the inoculation site and increases in size until at the end of three days it turns into a vesicle filled with a whitish liquid. This vesicle enlarges and the lesion achieves its greatest intensity by the ninth or eleventh day. Thereafter a scaly scab is formed; this separates about the twentieth day, leaving a white, pitted scar. Together with these local reactions, there are usually some symptoms of general reaction such as cophalea, fever, nausea or vomiting, and in some cases tumefaction of regional glands.
2. Vaccinoid or accelerated reaction. This type of reaction indicates partial protection and occurs in revaccinated persons or in those who have had smallpox. The evolution of the lesion is similar to that described above but occurs in a shorter time. The papule appears on the second or third day and the lesion acquires its greatest intensity between the fourth and seventh day. A vesicle usually forms in the centre of the lesion.

3. Immediate reaction (formerly called immunity reaction). This reaction occurs in previously vaccinated individuals. It is a sensitivity reaction to the virus and although it can be observed in persons having a high degree of protection, it is not evidence of immunity. It may result from the use of inactive lymph, and smallpox cases have been observed in individuals who had shown this type of reaction a short time before when revaccinated. For this reason, the term "immunity reaction" should be discarded. The maximal diameter of the erythema is reached within 24 to 48 hours. There usually appears a small papule which does not evolve until it forms a vesicle. This reaction should not be confused with the slight traumatic reaction caused by the needle.

Complete absence of reaction means a failure of the vaccination, either because inactive vaccine was used or because an incorrect vaccination technique was employed.

In Summary: The Primary, accelerated or vaccinoid, and immediate reactions are each characterized by the different periods of incubation and by the time required for their complete evolution. (See Fig. 3.)

#### Observation of the reaction

The best method is to read the reactions at two different times, preferably on the third and seventh days. In this way, the type of reaction produced by the vaccination can be determined with accuracy.

During a mass vaccination campaign, it will not be necessary to observe the reactions of all the persons vaccinated. It will suffice to make the reading of results in 10 per cent. of the primary vaccinations made, in order to maintain control over the quality and state of preservation of each batch of vaccine used and over the technical accuracy of the vaccinators in applying the vaccinations. Since these are primary vaccinations, it will be sufficient to make the observations on the seventh or eighth day.

#### Complications

Postvaccinal complications are not frequent. The following conditions, however, may be observed:

Secondary infection: This is easily prevented through use of correct vaccination techniques.

**Accidental inoculation:** Secondary pustules may result from accidental inoculation, frequently by scratching. Such lesions may appear on any surface of the body and may be either single or multiple. They evolve parallel with the initial inoculation.

**Generalized vaccinia:** In this case, the spread of the virus is haematogenous. In a large number of cases studied, the lack of neutralizing antibodies in the patients' blood was demonstrated. In such cases, an immunoglobulin injection is recommended or, in the lack of this agent, serum obtained from recently vaccinated persons may be used.

**Postvaccinal encephalitis:** Cases of postvaccinal encephalitis have been observed only in certain countries. To prevent this possible complication, it is recommended that children be vaccinated before reaching school age, preferably during their first year of life.

In this respect, it should be mentioned that in the mass vaccination campaigns conducted in Mexico, Peru and Venezuela, where millions of individuals were vaccinated, no cases of postvaccinal encephalitis were reported.

#### Contra-indications

The most important contra-indications to vaccination are diabetes and skin lesions, particularly generalized eczema. It is also wise to postpone the vaccination of fever patients, and children who have been exposed to some infectious disease. Pregnancy, after the third month, is not considered a contra-indication. Among expectant mothers vaccinated during the first three months of pregnancy, some authors have reported a significant increase in foetal deaths.

#### Types of vaccine

In the majority of countries, the vaccine used is glycerinated lymph from calves. However, other animals are also used to produce vaccine lymph. At present, the use of vaccine prepared in chick embryo is becoming widespread.

Both the vaccines produced in calves and those prepared in chick embryo may be in liquid or dry form. Although more difficult to prepare, the dry vaccines have the advantage of being more resistant to heat. The vaccination techniques described above will be used also in the application of dry vaccine, which should be previously diluted in accordance with the instructions accompanying it.

### Preservation of vaccine

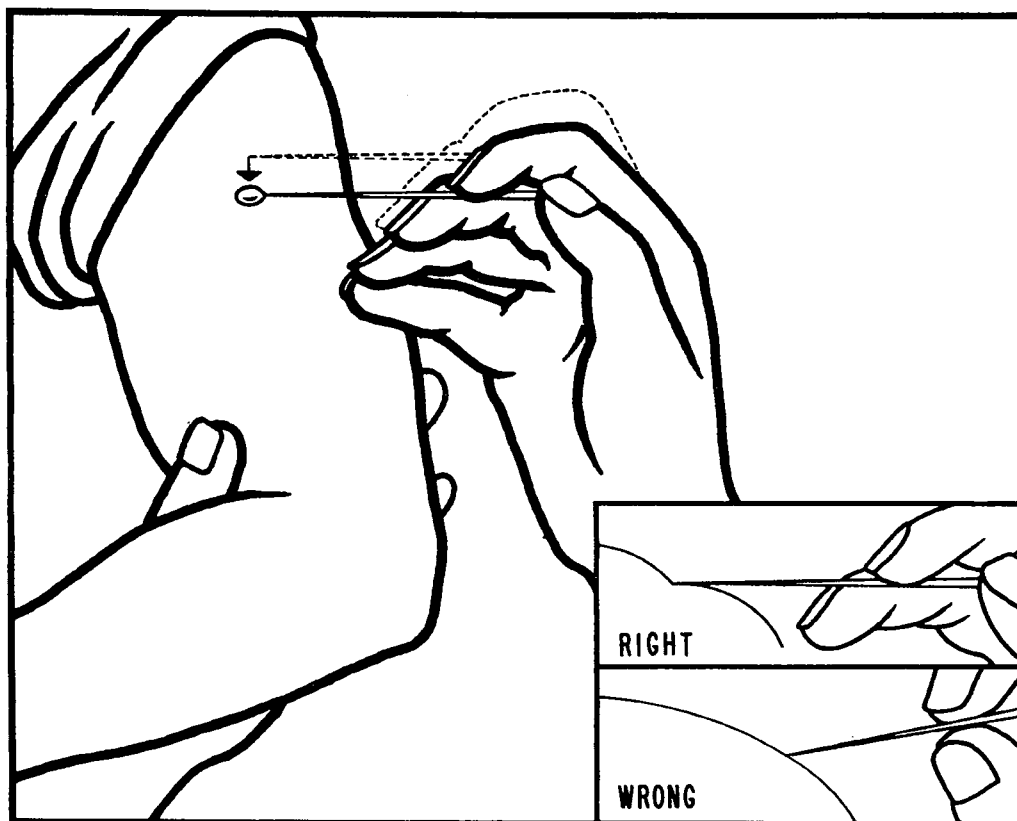
Glycerinated lymph. This vaccine should be kept at temperatures under  $-10^{\circ}\text{C}$  (freezer). It maintains its activity at from  $4^{\circ}$  to  $5^{\circ}\text{C}$  for a variable period of time, depending upon its quality and the initial concentration of the virus. At room temperature, the virus rapidly becomes inactivated. Within 24 hours, 90 per cent. or 100 per cent. of its activity can be destroyed. Iced thermos containers should be used in transporting the vaccine.

Dry vaccine. This is much more resistant to heat. Although variations can occur in different batches, the vaccine can be expected to maintain its potency for several months at room temperature in tropical regions. Nevertheless, it is recommended that this vaccine be kept in a refrigerator or in a cool place as long as possible.

### International certificate of vaccination

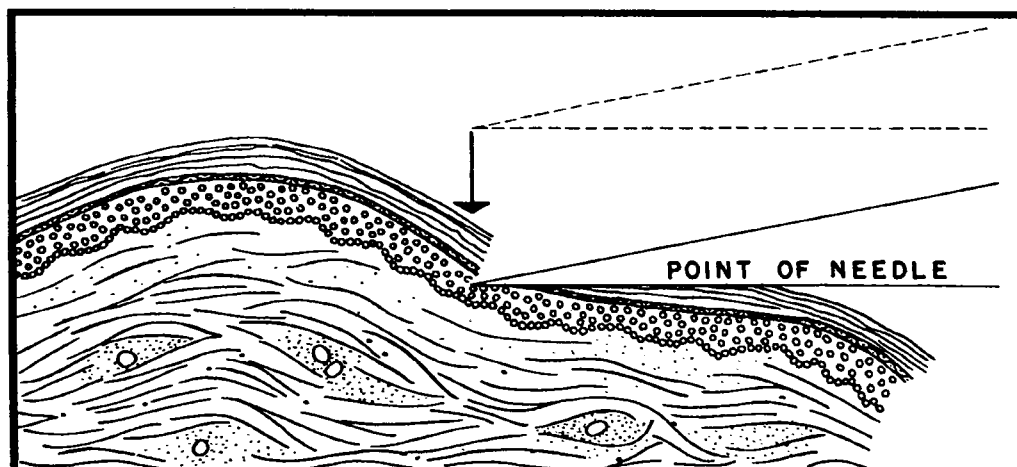
The international certificate of vaccination against smallpox remains valid for a period of three years, beginning eight days after the date of a successful primary vaccination or, in the event of a revaccination, on the date of that revaccination.

Fig. 1



THE MULTIPLE-PRESSURE METHOD OF VACCINATION,  
FIGURE SHOWING THE UP-AND-DOWN MOTION  
OF THE NEEDLE IN APPLYING VACCINATION

Fig. 2



DIAGRAMMATIC SECTION OF SKIN, SHOWING THE MOTION OF THE  
NEEDLE TO THE POSITION OF PRESSING AGAINST SKIN SURFACE  
AND ENTERING IT SLIGHTLY

Fig. 3

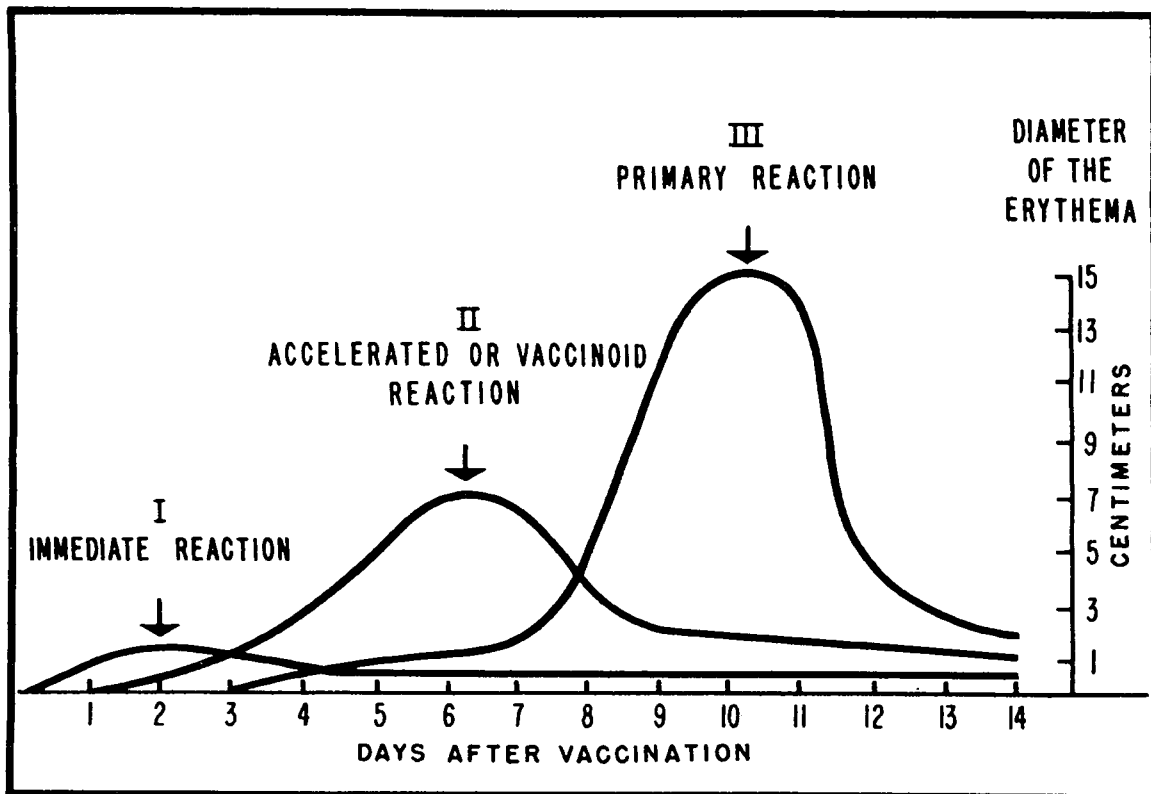


DIAGRAM SHOWING THE THREE TYPES OF REACTION PRODUCED BY VACCINATION - HEIGHT OF CURVES INDICATES DIAMETER OF THE ERYTHEMA

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