child as to procure its vaccination. The trouble was to consist in the father requiring to attend a law court, and there make a declaration on oath that he seriously objected to vaccination. This was to involve some loss of time in every case, and might no doubt also involve some loss of money. In practice, however, the clause has not been administered with anything like uniformity throughout the country. In some places every facility has been given to diminish the time and trouble involved in registering conscientious objection. Mothers instead of fathers have been allowed to attend. Courts have been specially held at hours fixed to accommodate or encourage objecting parents, and the whole proceedings have been made as easy as possible, or reduced even to a farce by magistrates professing strong sympathy with antivaccinationists. On the other hand, a good many magistrates have erred in the opposite direction, and have refused to grant certificates to parents who have taken all the trouble that Parliament intended, to try to satisfy the magistrates of the reality of their objection to vaccination. Parents have been cross-questioned or bullied, and in the end certificates have sometimes been refused on the ground that the magistrates have not been "satisfied." For the proper working of the law a perfectly definite procedure should be enforced by Parliament, so that both of these faults would be avoided in future. There should be a clear statement of the hours when courts might be held, and of the forms requiring to be gone through, and of any fees exigible for certificates.

7. *Small-Pox Hospital Accommodation.*

Growing knowledge of the evil effects of small-pox hospitals on surrounding populations is not without a bearing on the question of legislation for revaccination. If vaccination and revaccination were universal there would be no need for small-pox hospitals. In the entire absence of vaccination and revaccination small-pox hospitals would be of practically no use, as epidemics would freely spread in spite of them. The present position being midway between these, small-pox hospitals do give an opportunity for treating cases of the disease whilst vaccination and revaccination are being carried out. But every epidemic of small-pox shows more and more clearly the dangers attached to such hospitals. Where they are in use on any large scale near any considerable population they are very likely, if not quite certain, to have the effect of spreading small-pox in the surrounding neighbourhood. The facts give very strong evidence that the spread is both aerial and by contact, and indeed it seems to defy every preventive measure.

If these conclusions are sound they raise some very serious questions. Where are sufficiently isolated sites for small-pox hospitals to be found? What right has a city community to determine that the residents in any particular locality within its own bounds, or in the country near it, shall be exposed to the risk? No doubt the city may say to the people of the selected locality, If you only take the trouble to get fully protected by vaccination and revaccination you will have no need to fear the propinquity of our hospital, even if it be full of small-pox patients. But, obviously, the people so addressed may retort to the city, If you all get vaccinated and revaccinated you will not require a small-pox hospital, but if you must have one then set it up among yourselves.

The financial question also is of some consequence. If in any community the majority of the people are willing to attend to their own vaccination and revaccination, and so to prevent their requiring incarceration in a small-pox hospital, why, they may ask, should they have to bear a share of the cost of building a hospital, and of nursing and maintaining therein persons who have refused or neglected to protect themselves?

From a practical point of view some heed must be given to the obvious fact that such hospitals are least harmful where the surrounding population is smallest in amount, and to evidence that small-pox hospitals are not so likely to prove centres of infection if the patients in them are very few. If vaccination and revaccination were obligatory in this country, there would be so little small-pox that very little hospital accommodation would be required, and there would be very little opportunity for the hospitals doing any harm. But

so long as vaccination and revaccination are neglected the hospital difficulty will remain, and it constitutes an additional reason for bringing legislation for revaccination into line with that for primary vaccination.

THE COMPLICATIONS OF VACCINATION.

By T. COLCOTT FOX, M.B., F.R.C.P.,

Physician for Diseases of the Skin to the Westminster Hospital, and to the Skin Department of the Paddington Green Children's Hospital; formerly Physician to the Victoria Hospital for Children and Medical Superintendent of the Fulham Small-Pox Hospital.

In a healthy subject the inoculation of pure vaccine lymph is followed by local manifestations of a very definite character, with periods of incubation, evolution, and decline, and by general symptoms, which we do not need to describe here. These symptoms, local and general, vary within certain limits, and, when they pursue a certain definite and recognized sequence the vaccinia is to be considered normal. Some variation will probably always occur, in so far as it depends on the state of the tissues of the subject, and on modifications in the activity and amount of the vaccine lymph inoculated; but a greater uniformity will be reached as the preparation of the vaccine lymph becomes perfected, and as the best method of vaccination, including after-treatment of the pocks, becomes more generally adopted. The reaction may vary considerably in intensity, and a successful revaccination in the adult is generally accompanied by more intense inflammatory phenomena than a primary inoculation in a child (Brouardel). The reaction to calf lymph is also apt to be somewhat more severe, with more local swelling, oedema of the arm, adenitis, and radiating pains.

At present it is not rare to meet with variations from the normal which must be set down as abnormal, and they chiefly depend on the condition and susceptibilities of the subject, on the quantity and quality of the virus and its contamination with undesirable organisms, on the degree of disinfection of the skin, on the method of inoculation, and on the subsequent treatment of the pocks and contamination from without.

A *Lancet* Special Commission which investigated all the glycerinated calf lymphs on the market and the Local Government Board lymph, had the satisfaction of reporting¹ "that although the lymphs then on the market differed very greatly as regards their bacterial purity, they were, taking them as a whole, eminently satisfactory." And in a further report² the Commission confirmed this conclusion, but added that "there is still room for improvement, since there is yet much diversity in respect to the degree to which extraneous bacteria are present." "The results," it is added, "of the investigation carried on by the Commission appear to indicate still more clearly that the efficacy of the vaccine is not necessarily impaired in those cases in which the glycerinization has been carried to such a point that practically all the bacteria have been got rid of."

The vagaries, anomalies, and complications of vaccination have been fully dealt with by Dr. Theodore Acland in an elaborate and scholarly essay in Professor Clifford Allbutt's *System of Medicine*, with which every vaccinator should be cognisant. His observations refer no doubt chiefly to the old system of vaccination, but are also applicable to the modern calf-lymph inoculation. The latter, whilst exciting some increased reactionary effects, eliminates almost entirely the possibility of the inoculation of such diseases, amongst others, as syphilis, leprosy, and tuberculosis.

Many of the variations in the development of the vaccine pocks are of comparatively little importance, and need only a brief reference. For example, the incubation period varies. The pocks may develop unequally, or they may be somewhat accelerated or retarded for a fortnight or even, it is said, up to thirty days. In this connexion we may note the assumption of activity under the influence of a revaccination at points where the inoculation performed a week or more previously appeared to come to nothing. The recrudescence, or relapse, or revivifying of a pock after some weeks is said by some to be not infrequent. The cause is not clear, and the occurrence may be of little moment, but has been found

associated with grave events. The contents of the pocks may remain watery, or form pus too rapidly, or become haemorrhagic; and when the latter is not due to injury these symptoms may mean contamination. Then it is not uncommon to find the pocks arising at the original sites of inoculation surrounded by supernumerary or extra vesicles, and to this we shall refer again.

In revaccination the pocks may be altered and not fully developed according to the degree of immunity possessed by the subject. The lesions may form only a pink papule perhaps more or less vesiculated, and these were denominated *vaccinoids* by Hervieux.

In America a peculiar complication known as the "raspberry sore" has been written about. P. A. Morrow, writing on the Incidental Effects of Vaccination,³ said it had been recognized from the introduction and general use of animal vaccination in America, but doubted it being a specific product of the bovine lymph, as it displayed certain points of resemblance with the red tubercle described by Bousquet occurring after the use of human lymph. It has been noted exceptionally on the calf, and is probably not infrequent in this country. The writer of the present article was alarmed by its appearance on his own arm. In the special number of the *Philadelphia Medical Journal*, November 23rd, 1901, on small-pox, the "raspberry excrescence" is mentioned by Welch and Schamberg, who say it usually appears from three to seven days after vaccination, beginning as a red elevation at the site of inoculation, quite similar to the papule of true vaccinia, but instead of advancing to the vesicular stage it remains hard, dense, bright red in colour and nodular in form, looking not unlike a small naevus. They add that it is very persistent, remaining usually weeks or months, is not followed by a scar, and does not confer immunity. F. S. Fielder says it only protects temporarily, and is evidence of a poor lymph. Morrow, however, stated that it disappeared spontaneously in four to eight weeks. In my own case the excrescence was rapidly dissipated by a mercury and carbolic acid plaster applied by Radcliffe Crocker's advice. F. G. Gardner described in these columns a case in which two of the inoculations out of four became the seat of a granuloma. Sobel⁴ draws a distinction between "exuberant granulations" and the dry exuberant raspberry growth of granulation tissue.

With regard to an excessive degree of local inflammatory reaction, we have mentioned that some excess may occur after the use of bovine lymph and in revaccinations. Idiosyncrasy also often plays a great part, and a too free use of a vaccinated arm is sometimes to blame. Impure lymph, however, and secondary infections with pyogenic microbes, due to unclean instruments, or at a later period to contact with contaminated coverings or hands, are mostly at fault. In association with these conditions, the inflammatory areolae may be very pronounced or extensive (so-called pseudo erysipelas); oedema of the arm may be pronounced, and more or less tenderness and swelling of the related glands may beset up. Glandular suppuration is rare. The confluence of pocks, too closely placed or supernumerary, or the severity of the local inflammation may lead to loss of tissue and ulceration over a comparatively large area or limited to each inoculation. If simple, this loss of tissue may soon heal, but if unhealthy the ulceration may extend deeply, be protracted, and even take on phagedenic characters. Such untoward results may affect one out of a batch of healthy operations, and is then probably due to secondary influences; or, as in the epidemic investigated by Leloir, the chancreiform ulcers may affect many of the batch, and be due to bad lymph.

Lastly, we have variations in the healing and formation of scars. Vaccination wounds should be well and firmly healed before the end of the third week. Such preventable causes as injuries dirty shields and dressings, may delay healing for weeks or months. Sometimes the state of the child is at fault. Hypertrophied scars may occur as after other wounds, but tend to flatten down in time. True keloid is rare and more troublesome. I have seen one or two cases in which there was a tendency to keloid throughout life after the formation of any scar, showing some constitutional tendency.

Amongst the complications of vaccination, eruptions on the skin attract the particular attention of the public, as in their view evidence of blood poisoning in the vicious sense. The

rare spontaneous generalized vaccinia eruption and the auto-inoculated vaccine pocks are probably the only ones peculiar to vaccination. As already stated, local supernumerary vesicles are not infrequent, and are of interest as similar to the occurrence in inoculated small-pox; but in the later a generalized eruption followed about the ninth to the fourteenth day. Very also rarely vaccination is complicated by a exanthematic generalized outburst of true pocks. Its date of appearance varies considerably, but is generally from one or two days before to one or two days after the maturity of the original pocks. A similar generalized eruption can arise from the introduction of the virus through the digestive, circulatory, or respiratory systems, as, for example, by a child sucking its vaccination pocks. The elements continue to evolve for seven, ten, or fifteen days. M. L. Heidingsfeld⁵ quotes Chauveau to the effect that generalized vaccinia occurred only 6 or 8 times in 500,000 to 600,000 vaccinations, and Bondersen reported only 3 cases out of 170,596 vaccinations in Denmark. This exanthematic generalized vaccinia must be carefully distinguished from the dissemination of supernumerary vesicles due to the auto-inoculation of the contents of the primary and subsequently other pocks in a hundred and one ways. Such a multiplication may be scanty and localized, or copious over a particular region, especially eczematous surfaces, or generalized. In this connexion Acland says that observations go "to show that under ordinary circumstances the receptivity of an individual to successive vaccinations in series gradually diminishes during the second week, and usually becomes extinct before the fourth." Cory found immunity was attained after the ninth day. In diagnosing these eruptions from herpes iris, impetigo contagiosa, and other vesicular, pustular, and bullous outbursts, let us remember that the true vaccine pocks are capable of inoculation in the animal or child.

Of the eruptions not peculiar to vaccination there is a group embracing all types, from the erythematous to bullous and haemorrhagic; and they may accompany typical local pocks. Sobel⁶ found about 2 per cent. of 4,160 cases had a generalized eruption. These eruptions are probably for the most part due to some chemical irritant, for one may meet with them on occasion in the course of almost any infection, for example, after the injection of antitoxins, serums, and physiological saline solutions (subcutaneous or intravenous) following enemata, and the administration of drugs by inunction, subcutaneously, or by the mouth. These coincident, or incidental, or indirect vaccinal eruptions fall into two categories. They may undoubtedly be directly due to the absorption of the pure vaccine virus, and are then benign, temporary, and of little importance. On the other hand, they may be due to the inoculation of impure lymph, or to the subsequent contamination of the pocks or sites of vaccination. It is obvious that the latter group may be of considerable significance. These eruptions occur from the ninth to the fourteenth days, most frequently on the tenth to twelfth, sometimes as early as the fifth, sometimes as late as the fifth week. In accepting the vaccinal origin of the late eruptions one must bear particularly in mind the adage *post hoc propter hoc*. The pathogeny of these eruptions is not well understood. They only occur in a small proportion of cases of any given infection or intoxication, and idiosyncrasy seems to play a considerable rôle. The eruption may consist of fugitive rose blotches, or it may be of the congestive rash type such as scarlatiniform, or like rôtheln or morbilliform, or of a larger macular type, often called roseola, or again of a still bolder and more pronounced inflammatory type such as we commonly include under the symptom-complex erythema multiforme. Even the extreme phases such as the so-called herpes iris and bullous erythemata may be met with. In diagnosis it should be borne in mind that a subject may be incubating one of the acute specific fevers at the time of vaccination.

Various phases of urticaria are met with in the adult, but in the child its place is most commonly taken by the closely allied lichen urticatus of Bateman or strophulus, as we prefer to call it. Our readers may be referred to Allbutt's *System of Medicine* for a description of this frequent and polymorphic eruption.

In addition to the trifling miliaria and sudamina, some papular and vesicular eruptions are occasionally met with, as after the ingestion of drugs, somewhat difficult to class

but usually of little significance. In an epidemic of septicaemia investigated by Brouardel, the local eruption was replaced by a sero-purulent dermatitis, and followed by a generalized impetiginous eruption. Temporary pemphigoid eruptions have long been noted as a rare complication, but, since the use of calf lymph, particular attention has been drawn to their occurrence, which is of a somewhat grave character, from its severity and tendency to chronicity. In the *Journal of Cutaneous and Genito-Urinary Diseases*, September, 1901, J. T. Bowen reports six cases of bullous dermatitis, and refers to other recorded cases. In three of the cases the eruption appeared within two weeks after vaccination, in one within a week, in two after a month. In none were there signs of sepsis, and in none signs of intense local reaction. According to Bowen, "the chief features that these cases present in common, and that lead to the conviction that they have a common etiology, are their occurrence in children after vaccination, their course varying from several months to several years, or perhaps longer; their uniform vesicular and bullous characters, with only occasional evidences of multiformity; the usually almost complete exemption of the trunk; the characteristic grouping about the mouth, nose, ears, wrists, ankles, and feet; and the very slight prominence of itching and other subjective symptoms beyond those common to any interference with the integrity of the skin." These cases are of course quite distinct from those of acute bullous erythema multiforme. Lately Sequeira (May, 1902) showed to the Dermatological Society of London a man who was revaccinated in three places. The vaccination ran a normal course, and completely healed by the fourteenth day. Three weeks later one spot recrudesced and ran its course again, and three weeks later again a very severe pemphigus set in. Galloway recited a somewhat similar case. The pathogeny of many cases of pemphigus and dermatitis herpetiformis is not clear, but, as Bowen says, possibly a toxin is in action on certain predisposed persons, as in the "herpes gestationis" of parturition.

Purpura is of very rare occurrence. It is a symptom with a manifold pathogeny. Acland thinks it is probably analogous to the well-known cases of haemorrhagic variola or scarlet fever, but probably it signifies a secondary infection.

A word may be said about the very rare occurrence of disseminated gangrenous lesions, the so-called vaccinia gangrenosa. This is to be carefully distinguished from the local gangrene or necrosis which sometimes occurs at the points of inoculation. Many cases of multiple gangrenous eruptions have been recorded in children and adults, and organisms isolated. Vaccinia gangrenosa may possibly be the result of a specific eruption due to an infection with a special organism, but we recognize that the varicella eruption under certain conditions in tuberculous or cachectic children may become gangrenous, and similarly we know a papulo-pustular eruption in infants which rapidly ulcerates, of all degrees of gravity, the so-called ecthyma térébrante infantile. It is possible that various eruptions may assume this ulcerating or gangrenous form when engrafted on suitable soils or complicated with particular organisms.

It is possible that impure lymph containing organisms, such as staphylococci or streptococci, may contaminate the vaccine lesions from the start, and produce grave systemic poisoning, which may be evidenced by generalized rashes, or, perhaps very rarely, vesico-pustular eruptions. Such results, however, are generally due to improper methods of vaccination, or, still more often, to secondary contamination of the points of inoculation from the subsequent treatment of the wounds. It used to be a very frequent occurrence, and one which had much to do with the prejudice against vaccination, to see impetigo and ecthyma from staphylococcus or streptococcus infection of the wounds inoculated about various parts of the body by scratching, infected dressings and clothing, and so on. If the virus be virulent, large, flat, spreading blisters may be rapidly produced to form a more or less general eruption, and grave results might follow in infants. Similarly furuncles or abscesses may result. The spread of the streptococcus pyogenes in the deeper structures causes erysipelas, which has become far less common than formerly. It is necessary to distinguish the inflammatory blush, which is often excessive, arising around the inoculated regions from true erysipelas. This blush is probably due to the irritation

of the developing pustule, but possibly may be due to extraneous pathogenetic bacteria. In considering the origin of erysipelas, the date of its appearance should be carefully observed. Acland writes as follows: "It seems probable, if one only of a number of children vaccinated from the same source develops erysipelas later than the fourth or fifth day, that the erysipelas is due to some extraneous cause, and is not invaccinated. On the other hand, if a number of children vaccinated from a common source develop before the fourth day, only one or two of the whole batch escaping, the probability is very great that the erysipelas is directly due to the lymph or to some factor at the time of vaccination." Most of the recorded cases have evidently been due to secondary contamination of ruptured pocks or torn crusts.

Tetanus is a complication of very rare occurrence in vaccination, at any rate in this country, though probably it may be more frequent in the tropics. The bacillus comes from dirt or earth, and may follow as an accidental infection of any wound. The recent occurrence in America of a group of cases of post-vaccinal tetanus has recently (May 3rd, 1902) been discussed in this JOURNAL. The infection in this group of cases was probably secondary.

Psoriasis, eczema, and strophulus are eruptions which may occur in close association with vaccination. Psoriasis is a recurrent eruption which is uncommon before the third year of life, and very rare in the first year. We do not know its cause. It may possibly be a local parasitic disease, but is probably what may be called a constitutional eruption. Many cases have now been observed in which it has arisen for the first time in the course of the vaccination process, and then some of the elements may actually be determined to the sites of vaccination. In two cases noted by Wolters there was a family history of the eruption. The pathogeny of the so-called eczema of childhood is also undetermined. It is also possibly a local parasitic disease, and is of great frequency in infants, even before they are vaccinated. A study of my cases has not convinced me that there is any direct relation between "eczema" and vaccination. Strophulus I have already referred to. It is one of the commonest eruptions of childhood, and in its production the vasomotor nervous system probably plays a conspicuous part. Undoubtedly it is very frequently excited by vaccination, as by the acute specific infections and other general states.

Finally, we come to a group of diseases, syphilis, tubercle, leprosy, which may possibly be inoculated at the time of vaccination or by subsequent contamination. Acland points out that "the facts brought before the Royal Commission (1889-1896) prove that, in England at any rate, the event is one of great rarity." Certainly I have never met with a case, nor have I heard of any of my contemporaries in London having done so. Neither have I seen in over twenty years' work in children's hospitals any suspicious cases occurring in vaccinated syphilitic children, beyond the local chancreiform ulcer of the arm. The introduction of vaccination with bovine lymph renders the invaccination of syphilis impossible, unless a syphilitic vaccinator himself contaminates the lymph or wound. As however a vaccinator should be armed with the knowledge to make a clear diagnosis, I will quote Acland's description of the sequence of events where syphilis has been invaccinated. All the points of insertion are not necessarily infected. "If the person vaccinated be susceptible to vaccination the pocks may not at first show any departure from the normal course, but in some cases the pocks abort, and the pathological process seems to be at an end until the syphilitic virus asserts itself. If the pocks be irritated, or the condition of the tissues be such as to favour suppuration, the vaccinal sore may become inflamed, suppuration may occur, and the ulcers may for a time scab over and then break down again; but in any circumstances, whether the vaccination pursue a normal or an abnormal course, a true syphilitic chancre with indurated base eventually forms at the point of inoculation." The chancre does not develop before the end of the third week, usually the end of the fourth or even fifth week. There is then the second incubation and indolent swelling of the glands, and generalization between the fiftieth and seventieth day (sixth and tenth week, Hutchinson), and the specific eruptions, and other manifestations have their well-known characters and sequence.

The possibility of the inoculation of tuberculosis is really

a much more important problem, but here the danger seems now infinitesimal when we consider that tuberculosis is rare in calves, and that lymph from a calf should not be used until the animal has been killed and proved to be free from tuberculosis. It will therefore be hardly necessary here to enter into a discussion on the possibilities of tubercle invagination under the former order of things. There is little advantage also in referring to cases of lupus vulgaris involving vaccination scars where the histories are too remote or vague to be of value. I have, however, observed three infants in whom one or more of the vaccination scars became the seat of a tuberculous patch on the healing, or very soon after the healing, of the wound. One child was inoculated with calf lymph by a very experienced vaccinator and other children vaccinated in the same batch experienced no ill-effects. Graham Little has recently published these cases in his paper on Vaccinal Lupus.⁷ Though they certainly raise unpleasant suspicions, I do not think any conclusion of scientific value can be drawn from them. The vaccination sores may have been inoculated secondarily, or a previous tuberculous centre may have existed and an embolus found its way to the scar.

With regard to leprosy, it is not proved, however probable it is, that the disease can be communicated directly by inoculation, and further by vaccination. The cases recorded in which the invagination of leprosy has been suspected will not stand investigation.

The recital of this list of possible complications, which may arise under every conceivable condition, is apt to excite a very false impression of the dangers attending vaccination, and may be taken undue advantage of to prejudice the public. Allowing for some variation in the local and systemic effects owing to the varying activity of the virus and the susceptibility of the subject, there are very few complications that it is not in our power to avert by using a pure lymph, conducting the operation in a proper manner, and preventing any secondary contamination. In terminating this sketch I will quote the following conclusion of the *Lancet* Commission, which is of great practical importance: "We are strongly of opinion that many of the bad results obtained in vaccination are due to the presence of one or other of the following conditions: Imperfect sterilization of the skin and want of protection against the invasion of the weakened and abraded tissues by extraneous organisms. We have found that, given a good lymph, the application of a plentiful supply of soap and water, a razor to take off hairs and surface epithelium, ether to remove fatty and sebaceous matter, alcohol to wash away the ether, superficial vaccination (by sterilized instruments), and protection of the vaccinated surface throughout the whole course of the local manifestation of vaccinia, most excellent results may be obtained. The best means of protecting the local lesion is the application of several folds of sterile lint containing no chemical disinfectant; that is held in position by strips of adhesive plaster; a layer of boric lint may then be placed outside this dressing, and the whole may be changed as soon as the slightest evidence of moistening by serum appears in the boric lint." By the observance of these conditions the vagaries and mishaps of vaccination will be reduced to a minimum, and the perfect result characterized by "typical vesicles, slow of development, with little inflammatory areolae, and late in coming to maturity," will be attained.

REFERENCES.

- ¹ *Lancet*, April 28th, 1900. ² *Ibid.*, June 7th, 1902. ³ *Journ. Cut. and Ven. Dis.*, vol. 1, 1883. ⁴ *Medical News*, August 11th, 1900. ⁵ *Journ. Cut. and Gen. Urin. Dis.*, February, 1902. ⁶ *Loc. cit.* ⁷ *Brit. Journ. Derm.*, March, 1901.

GLYCERINATED CALF LYMPH.

By F. R. BLAXALL, M.D., D.P.H.,

Bacteriologist to the Vaccine Department of the Local Government Board and Lecturer on Bacteriology at Westminster Hospital Medical School.

[From the Government Lymph Laboratories, Chelsea Bridge, S.W.]

THE methods employed in the preparation of glycerinated calf lymph at the Vaccine Establishment of the Local Government Board are those which our experience has shown are most conducive to the production of well developed active vaccine vesicles, and to the subsequent manipulation of these

in such a way that the vaccine is never exposed and never comes in contact with other than sterile instruments. Further, repeated bacteriological test is employed to ascertain that such lymph before issue is entirely free from harmful micro-organisms.

The Selection and Preparation of the Calf.

The calf is the most important factor in the production of good vaccine, and calves vary so enormously amongst themselves in their response to vaccination that no care and no knowledge can be too great to assist in the selection of those most suitable. After a journey calves need a rest before vaccination. They should be housed in clean, airy, well-ventilated stables, kept as far as possible at an equable temperature; they need to be fed in the manner and with the materials most appropriate to their age and condition; indeed, in this respect it is hardly too much to say that each calf requires individual treatment. The most suitable calves are those from three to six months old, with smooth supple skins, clear eyes, and, generally, in the pink of condition. They should be kept under observation for a week, the weight ascertained, and the daily temperature. Everything being satisfactory the calf is ready to be prepared for vaccination.

For this purpose it is placed on a tilting table, constructed in such a way that every part of it can be kept thoroughly clean, that no moisture (urine, washings, etc.) can accumulate on the table, and with fastenings so arranged that no cramping of limbs can occur. The lower part of the abdomen of the calf is then shaved as far forward as the umbilicus and backwards as far as the thighs. This is an operation requiring care and skill, it being important that the skin should not be cut or abraded. The size and position of the area to be shaved for vaccinating purposes must, however, be actually determined by the condition of the particular calf, by the season of the year, and so forth. Sometimes calves respond much better to vaccination at one part of their skins than at another. The shaved area is well washed, rinsed with tap water, and finally cleansed with sterilized water. The moisture from such washings is removed from the shaved area and from the adjacent hair by means of sterilized gauze sponges.

The Vaccination of the Calf.

The calf is then vaccinated with glycerinated calf lymph, introduced into the skin in parallel linear incisions by a sharp scalpel. The incisions are of such a depth that they only pass through the epidermis and lay open the rete Malpighii. Care should be taken not to draw blood, as this is very apt to prevent the formation of perfect vesicles.

The vaccination of the calf requires practice and constant care, the incisions should all be of uniform depth, and there should be no gaps. As the incisions are made, more lymph is run in along the lines by the aid of a sterilized ivory spatula. The lymph must be distributed evenly along the line. The inoculation of the incisions must be effected as soon as they are made, otherwise the lips of the wound are apt to swell and close the opening.

After vaccination the calf is removed to a clean stall and kept in such a way as to prevent any injury to the vaccinated surface. The temperature of the stable should not fall below 60° F.

Collection of the Vaccine Material.

When the vesicles on the calf have reached maturity—generally in this country 120 hours after inoculation, but sometimes before, even as early as 96 hours—the animal is again placed on the operating table and the vaccinated surface is thoroughly washed with soap and warm water gently rubbed over it by the clean hands of the operator. It is well washed with tap water, and finally cleansed with sterilized water and the moisture removed with sterilized gauze sponges.

At this stage the site of each incision should present a line of even and continuous vesiculation; but this is by no means always the case. Sometimes the vesicles have been retarded in their development and show a tendency to dry up and form crusts, or they may be over-developed and advanced or may present an irregular and ragged appearance. It is from the careful consideration and from the knowledge of the value of all these points that the quality of the lymph has to be determined.