

than that which has never been cultivated upon other soil than that of the cow. The German Government takes this ground and sanctions its employment in its instructions upon this subject.

That method to which is now given the term animal or bovine vaccination is of later origin, and also has a more restricted application. Warlomont defines animal vaccination as "the product of natural horsepox or cowpox which has been cultivated upon heifers," and has never quitted that place (or medium) of cultivation ("n'ayant jamais quitté ce lieu de culture"). This method was practised in a limited degree as early as 1800, by Duquenne, at Rheims, and by Valentine, at Nancy. It was introduced into Naples in 1810 by Galbiati, and continued by his pupil, Negri. Both of these early experimenters occasionally resorted to retrovaccination, but Negri finally began a series of continuous vaccinations, for which he obtained his original supplies, on two different occasions, from animals found to be affected with natural cowpox.

In 1864 M. Lanoix, a French physician, visited Naples to study this method of vaccination, and thence introduced the practice into Paris in the same year. A commission was appointed by the Government in 1866, whose report favored the practice of animal vaccination, and the first virus employed by them was that which had been obtained from Naples. A new source was soon found at Beaugency, in France, in 1866, and still later another at St. Mandé, near Paris. Other cases of natural cowpox may be found detailed in an article in the *Revue d'Hygiène* (July, 1888) by Dr. A. Layet, entitled "Les Sources naturelles du Vaccin." Dr. Seaton, in his report on animal vaccination to the Local Government Board of England, made after a visit to Paris and other parts of the Continent in 1869, states that Drs. Lanoix and Chambon, who had introduced animal vaccination into Paris, "saw no advantage in keeping these two lymphs distinct, and the virus which they have employed since 1866 is a mixture of the two natural sources discovered at Beaugency and at St. Mandé."

Dr. Seaton had made an unfavorable report upon Bovine Vaccination, urging, in the first place, the difficulty of transmitting the virus from one animal to another successively; second, the great risk of failure in transmitting it from the calf to the human subject; third, the inferior preservative quality of bovine lymph.

In reply to this it may be said:
First. With reference to the facility of infecting calves or heifers continuously with vaccine lymph, Dr. Cory states, in his report to the Local Government Board in 1886, that 153 calves were vaccinated with lymph of one hundred and twenty hours' growth, and all of them proved susceptible to vaccination; 8,600 insertions were made, resulting in 8,242 vesicles (an insertion success rate of 95.8 per cent.); 94 calves were vaccinated with lymph of ninety-six hours' growth, producing 5,440 vesicles out of 5,631 insertions (an insertion success rate of 96.6 per cent.); 3 other calves were vaccinated with lymph of one hundred and sixty hours' growth in 144 places, producing 142 vesicles.

In the writer's experience not more than five per cent. of bovine animals of different ages prove refractory to vaccination, and the operation of transmitting the vaccine infection successfully from animal to animal is not, in the hands of an expert, attended with difficulty. The reasons for the comparative insusceptibility of adult animals are given elsewhere.

Second. As to the transmission of the infection from the bovine animal to the human subject (under like conditions as to the quality and freshness of the lymph used), the operation is quite as successful as with humanized lymph, and by some authorities the percentages of success are reputed as greater than with humanized lymph.

In Illinois, in 1882, out of 138,488 primary vaccinations with bovine lymph, 82.7 per cent. were typical, and out of 15,448 performed with humanized lymph, 76.9 per

cent. were typical. Dr. Cory vaccinated 4,688 persons, and of these 4,212 were successful in five places, 238 in four places, 92 in three places, 51 in two, 37 in one, and 17 were unsuccessful in the first trial. Excluding a very few who did not return for inspection, Dr. Cory's insertion success rate was 96.5 per cent., Mr. Murphy's 99.9, Mr. Stott's 90.6.

Dr. Pissin, of Berlin, in 1882, reported that he had made 12,679 vaccinations from 18 calves, with a ratio of success of 98.1 per cent. in primary vaccinations, and 91.3 per cent. in revaccinations, using scarifications only. Pfeiffer, of Weimar, obtained a success of 98.6 per cent.; Rissel, 97.8 per cent.; Reissner, 98.6 per cent., and Voigt, 99.4 per cent.

At the Hamburg vaccine establishment the ratios of reported success were as follows: In 1878, 69 per cent.; in 1879, 82 per cent.; in 1880, 73 per cent.; in 1881, 82 per cent.; in 1882, 85.4 per cent.

Weiler, on the contrary, found the humanized lymph to give better results, obtaining 97.3 per cent. in primary vaccinations with humanized lymph, and 86.8 per cent. with bovine lymph.

Third. As to the preservation of animal lymph as compared with that of humanized lymph.

1. As to its use upon calves. Dr. Cory, in the report already alluded to, made careful observations as to the preservation of lymph stored in tubes, and established the possibility of such preservation for a period of two years. His results were as follows: The lymph referred to in these observations was partly of ninety-six and partly of one hundred and twenty hours' growth, none being taken later than one hundred and twenty hours after insertion. He also states that lymph taken at a later period deteriorates more rapidly, and is apt to produce spurious results, just as happens occasionally with humanized lymph taken at a later date than the eighth day.

Number of days during which lymph was preserved in tubes before using.	Number of insertions with it on calves.	Successful insertions on calves.	Insertion success rate per cent.
2.....	3,968	3,290	84.7
4.....	1,438	1,139	79.2
6 to 8.....	255	184	72.1
9.....	431	309	71.6
11 to 12.....	337	273	70.6
14.....	263	214	81.3
16.....	288	207	71.9
17 to 46.....	639	472	73.8
53 to 93.....	445	332	74.6
100 to 200.....	388	258	66.5
200 to 500.....	104	17	16.3
500 to 600.....	135	45	33.3
600 to 700.....	82	24	29.0
816 to 858.....	72	4	5.5

2. As to its use upon the human subject. Like the former, this lymph was also of one hundred and twenty and of ninety-six hours' growth, in about equal proportions. A part was stored in tubes and a part upon ivory points, in regard to which Dr. Cory says that within four months of storage there is an advantage in points over tubes as a method of storage, and a period of one hundred and fifty-four days appears to be the longest interval that should be allowed to elapse between the taking of calf lymph on points and its use on children. For longer periods the lymph in tubes retained its powers better than that preserved upon points.

The three tables on the opposite page were the results of Dr. Cory's observations on this point.

From Italy and from France the practice of bovine vaccination extended to other countries. In February, 1865, it was introduced into Brussels by Dr. Warlomont, who employed successively lymph from the Neapolitan source, afterward from the Beaugency source, and finally from a third source obtained at Esneux. A state vaccine institute was finally established at Brussels under his charge, where the practice of bovine vaccination has

RESULTS OF VACCINATION WITH CALF LYMPH, PRESERVED ON POINTS AND IN TUBES, FOR VARIOUS PERIODS.

Mode of storage.	Time during which lymph was stored.	Aggregate number of insertions made (five to each child).	Aggregate number of successful insertions.	Percentage of insertion success.
Points.	Under 10 days	40	34	85
	10 to 20 days.	25	21	84
	20 to 50 days.	70	63	90
	50 to 100 days	70	51	73
	100 to 154 days	60	29	48
	Over 154 days	39
Tubes.	Under 10 days	75	65	87
	10 to 30 days.	25	17	68
	20 to 50 days.	65	47	72
	50 to 100 days	45	39	87
	100 to 154 days	20	17	85
	159 to 280 days	40	33	82

COMPARATIVE RESULTS OF PRIMARY VACCINATIONS WITH HUMANIZED AND BOVINE VACCINE VIRUS IN ILLINOIS (1881-82).

	Totals.	RESULTS.		
		Typical.	Modified.	Poor.
Bovine virus.....	138,488	114,605	12,295	11,588
Percentages.....		82.7	8.9	8.4
Humanized virus.....	15,448	11,893	2,275	1,280
Percentages.....		76.9	14.8	8.3
Totals.....	153,936	126,498	14,570	12,868
Percentages.....		82.2	9.5	8.3

COMPARATIVE RESULTS OF REVACCINATIONS WITH HUMANIZED AND BOVINE VIRUS, ILLINOIS (1881-82).

	Totals.	RESULTS.		
		Typical.	Modified.	Poor.
Bovine virus.....	76,154	45,187	14,010	16,957
Percentages.....		59.3	18.4	22.3
Humanized virus.....	3,250	2,206	430	614
Percentages.....		67.9	13.2	18.9
Totals.....	79,404	47,393	14,440	17,571
Percentages.....		59.6	18.2	22.2

Per cent. of vaccinations with bovine virus..... 79.2
Per cent. of vaccinations with humanized virus..... 20.8

been carried out with the greatest care, for the gratuitous distribution of lymph both of humanized and of bovine stock. The institute was established on condition that both sorts of lymph should be distributed from it. Dr. Warlomont, by the thorough character of his work as well as by his published writings upon the subject, has accomplished very much toward the general introduction of bovine vaccination.

Bovine vaccination was introduced into Berlin in 1865 by M. Pissin, and is still conducted there, and also at Vienna; the amount of bovine lymph used, as compared with the humanized, having increased rapidly from year to year since its introduction. Establishments for the production of animal lymph are now in operation at Berlin, Halle, Kiel, Kassel, Munich, Nuremberg, Dresden, Bautzen, Leipsic, Frankenberg, Stuttgart, Cannstadt, Karlsruhe, Darmstadt, Schwerin, Weimar, Bamberg, Lubeck, Hamburg, Bremen, Strassburg, and Metz. This practice has gradually made its way into other countries of Europe, and now nearly every large city has its vaccine institute or establishment for the propagation of bovine lymph. It is also in use under the auspices of the British Government in India. It was introduced into Bombay in 1881, and into Madras and Bengal in 1882, and was introduced into Japan in 1874.

The following table illustrates the rapidity with which bovine lymph has taken the place of humanized lymph in Germany since 1879:

PERCENTAGE OF BOVINE LYMPH IN USE IN GERMANY, 1879-1900.

Year	Per cent.	Year	Per cent.
1879.....	2.6	1890.....	89.0
1880.....	3.3	1891.....	96.8
1881.....	4.0	1892.....	98.5
1882.....	7.1	1893.....	98.9
1883.....	11.2	1894.....	98.9
1884.....	19.1	1895.....	99.85
1885.....	33.1	1896.....	99.88
1886.....	54.2	1897.....	99.96
1887.....	68.4	1898.....	99.72
1888.....	77.4	1899.....	99.94
1889.....	77.4	1900.....	99.94

The foregoing figures for the years 1879-87 are from the "Arbeiten aus dem Kais. Gesundheitsamte" and for the years 1889-1900 from the "Mittheilungen."

England was slow to adopt the new method of vaccination; Dr. Seaton's unfavorable report in 1869 undoubtedly delayed its introduction. This report, however, contained much valuable information upon the subject, which led to its careful consideration, and finally to its introduction under the direction of the Local Government Board in 1881, the use of either humanized or bovine lymph being optional. The experiments of Dr. Cory, establishing the possibility of the transmission of syphilis by humanized virus, even under the most rigorous conditions, undoubtedly strengthened the position of the board in introducing the bovine virus.

"As the result, however, of the findings of the Royal Commission on Vaccination," says Dr. Copeman, "legislative measures have now been introduced by which arm-to-arm vaccination will be entirely superseded, in public work at any rate, by animal vaccination, and the adoption of the use of preserved glycerinated calf lymph having been determined on, the necessity for stationary attendance will disappear, except in so far as may appear desirable for purposes of control, or in order to provide facilities for teaching."

By the term "stationary attendance" the writer refers to certain definite places and times, when and where facilities were provided for the work of arm-to-arm vaccination from healthy infants. Opportunities for vaccination upon the old arm-to-arm method were usually furnished weekly in the large cities, and about once in three months in the country districts.

In the United States bovine vaccination had been attempted on various occasions previous to its more general introduction in 1870-71. Dr. John Yale, of Ware, Mass., writes to me that in 1855, his cow "had the cowpox, a single umbilicated vesicle on the udder adjoining the teat; I took the crust, and vaccinated with it, used the matter upon calves, and so kept up a supply for years." He also stated that in 1844 he had observed cowpox in a herd of thirty cows belonging to Mr. Truman Curtis, of Torrington, Conn. The milkmaids and some of the men servants contracted vaccinia upon their hands from this herd.

In March, 1865, Dr. E. Cutter, of Woburn, Mass., detected kinepox in at least two instances in the town of Lexington, where the disease was more or less prevalent, and at times very troublesome at dairy farms. From two of these cases he vaccinated two cows, and obtained a succession of lymph, which was used to a considerable extent in the vaccination of soldiers in the Army of the Potomac, in the spring of 1865. A report was made upon these cases by Surgeon J. J. Milhau, U. S. A. (dated March 29th, 1865), who visited and personally inspected twelve of the animals thus vaccinated ("Medical and Surgical History of the War of the Rebellion," Medical Volume, part iii.).

Previous to the date referred to (March, 1865) Dr. Cutter, as stated in his report of 1872, had employed retrovaccination quite largely, and with excellent success, and in this respect had followed very much the same method which had formerly been employed by Negri, at Naples.

In 1870 Dr. Henry A. Martin, of Roxbury, Mass., imported lymph of French origin, and organized a well-equipped vaccine establishment at which a constant succession of heifers has been vaccinated since that time, the work having been continued after his death by his

sons. To him the work of successfully bringing bovine vaccination to popular notice in the United States, as a substitute for humanized vaccination, was largely due. Dr. Martin also obtained lymph from cases observed in

by contagion, such as syphilis, does not convey such germs, in any case, and gives rise only to vaccinia." The question was again fully discussed in 1864, by the same body, and it was finally admitted by the Academy

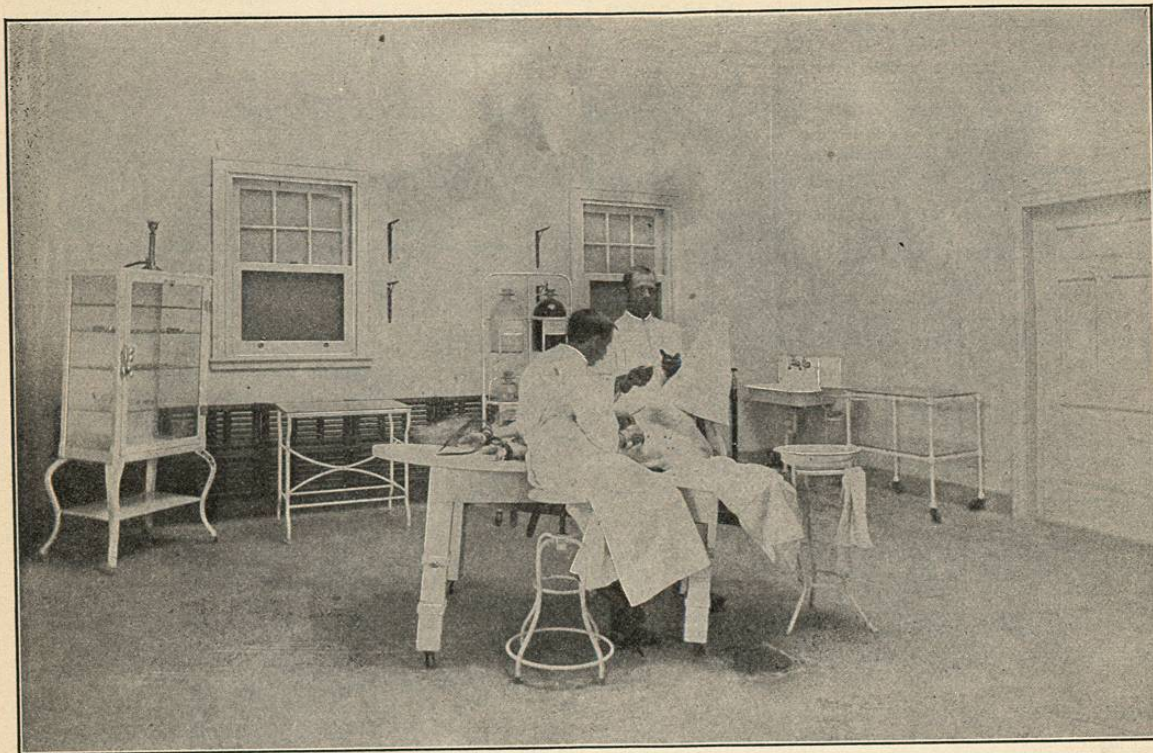


FIG. 4960.—Vaccinating a Calf. (By permission of the H. K. Mulford Company.)

the neighborhood of Boston, which was also successfully transmitted to a succession of heifers. Others soon followed him in different parts of the United States, especially Dr. Frank P. Foster, of New York, and Dr. E. L. Griffin, of Fond Du Lac, in Wisconsin.

The production of vaccine material in the United States is now (1903) mainly in the hands of a few private producers, who furnish most of the vaccine lymph used in the country. The principal producers are the H. K. Mulford Company, of Philadelphia, Parke, Davis & Co. of Detroit, Mich., and the National Vaccine Company of Washington. All of these are equipped with establishments of ample size, furnished with modern appliances, including excellent bacteriological laboratories and capable of producing vaccine material ample in quantity and reliable in quality for general use. Considerable quantities are also exported abroad for use in other countries.

At present it is safe to say that practically all of the lymph used for vaccination in the United States is of direct bovine origin—produced by artificial propagation.

There are certain advantages in the employment of animal lymph which may be detailed as follows:

The avoidance of the transmission of certain diseases common to mankind, which it has been conclusively proven may be transmitted by the process of vaccination; for while it is undoubtedly true that millions are annually vaccinated without the occurrence of a single case of such transmission, it is also true that a sufficient number of cases are on record to establish the possibility of such transmission.

The French Academy of Medicine had, as long ago as 1830, proclaimed, almost in dogmatic terms: "Vaccinate without fear, for the vaccine virus taken from subjects afflicted with complaints susceptible of communication

that vaccinal syphilis was an incontestable fact, and while it was of very rare occurrence its possibility could not be doubted. Ricord said of it: "I at first denied the possibility of the transmission of syphilis by vaccination, but facts repeating themselves, and becoming more and more confirmatory, I admitted with reserve, and even with repugnance this mode of transmission. To-day I do not hesitate to state it as a fact."

Proofs of the occurrence of vaccinal syphilis are to be found in the writings of Depaul, of Viennois, and others, where about three hundred cases are given in detail. The reported cases are mainly of French and Italian origin, those detailed by Professor Cerioli and the Rivalta cases constituting a large part of the number. While the earlier English writers have been slow to accept the possibility of such transmission, some recent experiments have apparently settled the question conclusively that the danger exists, so far as vaccination with humanized lymph is concerned, although the transmission is of extremely rare occurrence.

It is certain that hundreds of thousands of vaccinations were made every year without the occurrence of the accident in question, and hundreds of busy practitioners passed through the period of active practice, during which they were called upon to make frequent vaccinations, without meeting a single case.

Three methods have been detailed as possible for the occurrence of vaccinal syphilis:

- (1) By the mixture of vaccine lymph with the products of a syphilitic skin eruption.
- (2) By mixture with the blood of a syphilitic person.
- (3) By the use of the clear lymph of a vaccine vesicle existing on the person of a syphilitic.

With reference to the question of the transmission of

syphilis by inoculating the blood of a syphilitic upon a healthy person, there can be but little question. The question has been proven, both by observation and by experiment.

With reference to the transmission of syphilis through the medium of the clear vaccine lymph containing no blood, the experiments of Dr. R. Cory, an officer of the Local Government Board of England, established the possibility of such communication. These experiments were witnessed by a committee of experts comprising the noted surgeon, Jonathan Hutchinson, together with Drs. Bristowe, Humphrey, and Ballard (see Twelfth Report of Medical Officer of the Local Government Board of England, p. 46).

Since the introduction of animal vaccination generally into different countries, the reports of such cases have become comparatively rare, and consequently the discussion of this question has now lost much of its practical importance.

When it is remembered that at least five hundred millions of persons have undoubtedly been vaccinated since the introduction of vaccination by Jenner, the ratio of these cases of transmitted syphilis to the whole number is surprisingly small.

Another reason for the use of bovine virus lies in the facility with which an abundant supply of lymph may thus be secured for use at short notice. The occasional advent of smallpox among the crowded populations of large cities renders the production of large quantities of vaccine lymph in a brief space of time an absolute necessity.

The amount of vaccine lymph which may be obtained from one animal, as compared with the paucity of mate-

vaccine material is finally mixed with glycerin. It is, therefore, a decided advantage to be able to resort to the cow, and thus to avoid the objections which may be raised against the taking of supplies of lymph from infants. It is especially desirable, when lymph is supplied by the authorities of state and city governments, that such lymph should be of the best quality. Such authorities are under moral obligation to furnish to the people a vaccine lymph which is beyond all suspicion in the matter of freedom from contamination of disease.

These two faults, the possibility of contamination with syphilis and the relative paucity of lymph, were especially the faults of the Jennerian method of vaccination—and in animal vaccination may be found a method wherein lies the remedy for both; that is, the avoidance of syphilitic contamination and the capability of indefinite multiplication of vaccine material.

The possibility has been suggested of communication of bovine disease other than vaccinia, especially of tuberculosis of the cow. Tuberculosis is known to be inoculable, as demonstrated by Villemin, and more recently by the experiments of Koch and many other experimenters. Inoculated tuberculosis starts from the point of its insertion, as shown by experimentation upon the guinea-pig, rabbit, and other animals. It may be transmitted by means of the tubercle bacilli present in a tubercle itself, in the blood of an infected animal, or in the air exhaled from a diseased lung. Upon this point Dr. Warlomont says: "The importance of these facts as related to bovine, as well as to humanized vaccination, is worthy of consideration, and one fact should be stated at the outset, that it is impossible to inoculate tubercle by means of superficial insertion of bacilli which is the usual

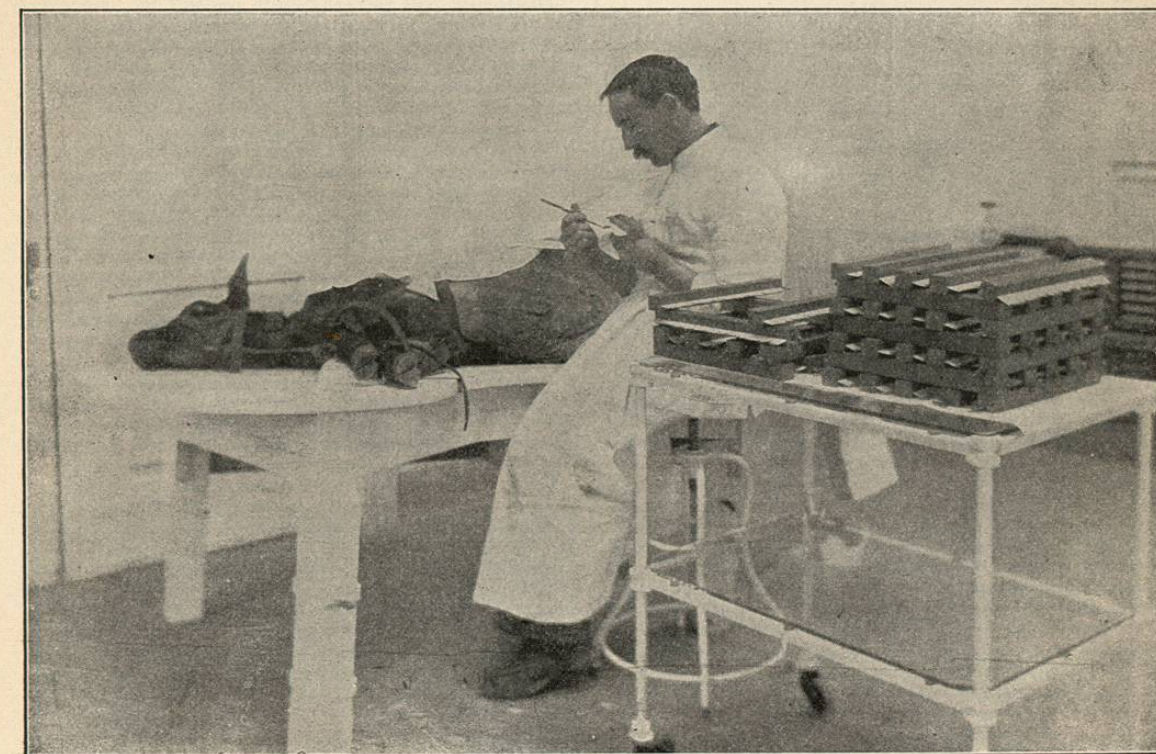


FIG. 4931.—Charging Ivory Points. (By permission of the H. K. Mulford Company.)

rial which it is practicable to obtain from a healthy infant, is very large.

From two thousand to ten thousand charges of effective lymph upon ivory points is not an unusual quantity to be taken from a single heifer, and nearly equal quantities can be procured under modern methods in which the

method of the insertion of vaccine lymph. The latter develop very slowly, and cannot, like those of splenic blood, rapidly infect a small wound. If we desire to make an animal tuberculous, we must carry the bacilli deeply into the tissues. Thus it is explained why it is that no one has been infected while making autopsies of

tuberculous subjects. Thus, *a fortiori*, is it explained why no one has ever been infected with tuberculosis through vaccination. . . . So much for theory; now for the practice. Let them show, among the millions of subjects vaccinated in the past twenty-four years, either with humanized or with bovine lymph, a single case that has exhibited, at the spot of insertion of vaccine lymph, anything that resembled a tubercle. Nothing of the kind has ever happened, although it is probable that, among so large a number of inoculated persons, some must have received vaccine from tuberculous vaccinifers."

With reference to transmission of diseases of the "charbon" type, Dr. Warlomont states that "it has been completely demonstrated that laudable vaccine vesicles would never develop in animals affected with charbon. These affections are not common in animals sold at markets or elsewhere for purposes of vaccination."

All of these difficulties, if they are worthy the name of difficulties, may be avoided by the method adopted in the best establishments at present, which consists in delivering or using the lymph from any animal for the purpose of vaccination only after such animal has been proven by autopsy to have been absolutely healthy.

Government Production of Vaccine.—The production of vaccine lymph for the use of sanitary authorities in foreign countries is very generally conducted by the governments of these countries, or under their direct supervision.

In Sweden, a central establishment at Stockholm, under the direction of the Council of Health, furnishes vaccine for the whole kingdom. In Germany all the establishments are under the general supervision of the Imperial Board of Health.

In England an establishment is maintained at London under the direction of the medical officer of the Local Government Board. In Italy there is maintained at Rome a national establishment which distributes lymph to any province which desires it. But the provinces may establish their own plants, or obtain supplies from private parties under careful restrictions.

In France vaccine is supplied by private parties, but the work has the strong support of the Academy of Medicine.

In Austria the supply is partly from public and partly from private sources.

The cities of New York and Chicago maintain vaccine plants for the public use of these cities. There can be no reasonable objection to the establishment of such plants either by a country, State, or large city. In fact, the objections which are always liable to arise in consequence of the sharp competition of private producers are thus avoided. There is also the advantage that a State in which no private establishments exist may produce its own vaccine, under its own control, and in such place as may be readily accessible in times of emergency.

The Question of the Degeneration of Vaccine.—The question whether vaccinia, in its transmission from the cow through a series of human beings year after year, loses any of its primary efficiency has been a subject of discussion since the earlier years of the present century.

Jenner did not admit such a possibility, although frequent applications were made to him, within two or three years after his discovery, for lymph "as recent from the cow as possible." A further experience of twenty years satisfied him that the hypothesis of such degeneration was groundless. He was, however, careful to require that the successive transmissions of lymph should be made through healthy subjects. In 1816 he stated that "the matter may undergo a change that may render it unfit for further use by passing even from one individual to another, and this is as likely to happen in the first year of vaccination as in the twentieth." But that with proper care and attention lymph underwent no change he considered to be proven, by the fact that the vesicles he was then producing were "in every respect as perfect and correct in size, shape, color, state of the lymph, period of the appearance and disap-

pearance of the areola, its tint, and, finally, the compact texture of the crust, as they were in the first year of vaccination; and to the best of my knowledge, the matter from which they were derived was that taken from a cow about sixteen years ago."

The argument as thus stated was, that if lymph could undergo eight hundred or nine hundred transmissions through men without giving evidence of change, it should also remain equally unchanged after an indefinite number of such transmissions, and many observers after forty years declared the same opinion.

The National Vaccine Board of England, in their annual report for 1854, declared "that the vaccine lymph does not lose any of its prophylactic power by a continued transit through successive subjects."

Seaton confirms the truth of this statement in his "Handbook," page 203.

In the United States one of the most noted instances of long-continued transmission of humanized lymph is that recorded by Dr. E. M. Snow, superintendent of health of Providence, R. I., and his successors. In a report published by Dr. C. V. Chapin in 1886 he said: "The record of the vaccine now used in the public vaccinations in this city may be traced from arm to arm by name and date continuously back to February 29th, 1868; a date fully two years before the importation of the famous Beau-gency stock of animal virus, from which the country has since been so largely supplied." He states, furthermore, that "all the traditions concerning the matter are to the effect that the virus then in use was of the stock sent to this country to Dr. Waterhouse, of Cambridge, by Dr. Jenner in the spring of 1801, with the statement that it was from his original stock."

The theory that vaccine lymph has suffered degeneration by successive transmissions through the human species is chiefly of continental origin. Many French authorities have affirmed this principle as a reason for frequently resorting to the cow for a renewed supply of lymph. Kinglake also, in England, as early as 1814, had advanced the theory of degeneration.

The Royal Academy of Sciences of France in 1838 offered a prize of ten thousand francs for the best essay on this subject, thus indicating the importance which was attached to the problem at that early day. It was not till 1845 that a report was made on the thirty-five essays received. The prize was divided between Bousquet, Fiard, and Steinbrenner, each of whom answered the question affirmatively. The Sanitary Commission of the Grand Duchy of Baden in 1817 reported in favor of a frequent resort to the cow, in consequence of the degeneration of lymph.

THE TECHNIQUE OF BOVINE VACCINATION.—The best animals for use in bovine vaccination are calves and heifers, from the age of one month to two years. Warlomont says "they should weigh at least 100 kgm. (220 lbs.), and be in good health."

The recent German regulations state that calves of "five weeks and upward are to be preferred." (Dr. Voigt, of Hamburg, employs calves from three to four months old.)

Vaillard prefers calves from two and a half to three months old, and gives as a reason the consequent avoidance of tuberculous stock. M. Leclerc, the chief inspector at Lyons, had met but five tuberculous calves out of about four hundred thousand slaughtered animals.

The stock selected for the purpose of vaccine propagation should be in perfect health, and if fatigued by long travel on the railroad, or affected with diarrhoea from improper feeding, they should be allowed to rest for a day or two until they are in good condition, before being submitted to vaccination.

The stable should be well ventilated and kept at a medium temperature. For young animals the feed should be mainly of milk, and for older animals hay and the lighter meals may be used. In Holland, the feed of calves at vaccinating establishments consists of ten litres of milk, and from two to four eggs daily, for each calf.

Older animals are often used for the propagation of

lymph with good success, and milch cows have not infrequently been employed for the purpose, such animals yielding an abundant supply of lymph, the process of vaccination apparently having no effect upon the quantity or the quality of the milk. Such animals, however, present the disadvantage of large size and consequent difficulty of management. If a large yield of lymph is not called for they may be vaccinated, and the collection of lymph may be made without laying the animal upon the vaccinating table. Another disadvantage presents itself in the fact that a small percentage of milk-giving cows, and especially of the older animals as found in farms, have usually suffered with cowpox at some period of their lives. It is useless to attempt to vaccinate such animals.

With reference to the effect of vaccination upon the value of the animal, either alive or as slaughtered for beef, the following statement from Dr. Warlomont should be received as authority. "We must, indeed, not forget that, at the latest, the animal should yield all its harvest in the course of the sixth day, and that it may be killed on the seventh, before the possible development of suppurative fever. As a matter of fact, it does not suffer in consequence of vaccination, however numerous the insertions may be. It may suffer from the fatigues and ill-treatment of the journey, from the management of the dealer, from change of stable, or from its separation from the mother, but vaccination of itself is by no means the cause of any depreciation in the animal. This may be laid down as an axiom in the matter of responsibility."

In Berlin such calves after collection of the lymph are sold to the Jewish rabbi to be slaughtered as food. A larger price is paid for them than for ordinary calves, owing to the fact that they are in excellent condition as a result of good feeding while at the vaccine station.¹²

Animals vaccinated upon the abdomen may injure the vesicles by abrasion against the floor, an accident which may be prevented by the use of Tegmin bandages. These have been introduced at some of the German establishments in recent years. Their use, however, does not appear to be universally satisfactory.

The vaccination of animals should be conducted under conditions of scientific cleanliness, such as are presented for example in Dr. Copeman's description of the plant at Cologne. These conditions apply to: 1. The construction and administration of the stabling for the calves. 2. The means for washing or bathing calves before their vaccination. 3. The construction and cleansing of the operating rooms. 4. The cleansing of the vaccinated surface of the calf with germicidal preparations and sterilized cloths before collection of lymph. 5. The use of clean sterilized outer garments by all officials concerned in the processes carried out. 6. The sterilization of all instruments employed. 7. The carrying out of the process of admixture of the lymph material or

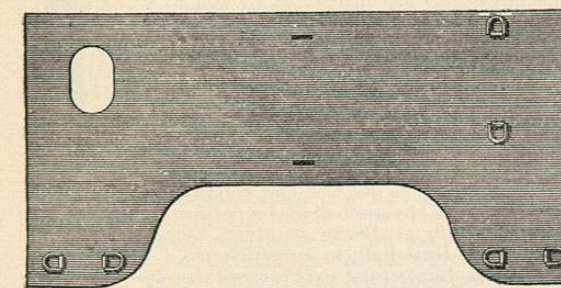


FIG. 4932.—Vaccinating Table. (From Vaillard's Manual.)

pulp with glycerin, as also its preparation and storage under conditions of laboratory freedom from extraneous organisms.

Region to be Selected for Inoculation.—Since the days of Negri, who introduced bovine vaccination, most of the

continental vaccinators have chosen the inguinal region as the point of election. Lanoix, Depaul, and Ciaudo preferred this region, including a space from 6 to 8 in. (15 to 20 cm.) square. Warlomont defines the region of

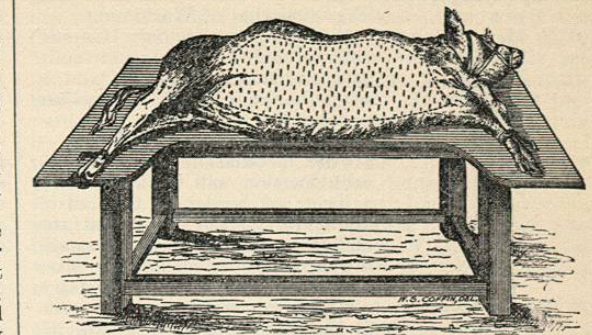


FIG. 4933.—Calf upon the Vaccinating Table. (From Vaillard.)

election as about as large as "the crown of a man's hat," and lying between the inguino-mammary region and the umbilicus.

Chambon and Vaillard define a much larger region for use, namely, the entire surface bounded by the axillary fold in front, the inguino-crural fold behind, an antero-posterior line running near the umbilicus below, and above by a horizontal line connecting the middle of the axillary fold with a corresponding point behind. Upon this broad rectangular surface may be made from one hundred and fifty to two hundred insertions of lymph.

Typical vesicles are often raised upon the escutcheon, or milk mirror, of adult animals, the disadvantage of this region lying in the risk of soiling.

For the fixation of the animal in a convenient position for the requisite operations, a tilting table will be found to be useful for all animals weighing less than 300 lbs. (140 kgm. or less). This table should be constructed of two-inch plank, strongly fastened together and provided with rings for securing the straps or thongs used for fastening the animal; one broad strap will be found useful to encircle the body. The table should be secured to the framework by four strong strap hinges. To place the animal upon it, it should be led alongside the table, secured to it firmly, and then the table should be tilted into a horizontal position and the animal more securely fastened in place. The region for vaccination is thus exposed for the necessary manipulations preliminary to vaccination. To free the animal it is only necessary to tilt the table back to the vertical position, loosening first the fetters and then the large abdominal band or surcingle. An improved table may be made by covering the plank with metal.

Other forms of tables are in use in the German establishments, some of which are made of metallic bars, having a slightly trough-shaped arrangement. In one American establishment a V-shaped trough is used for young calves, the sides being made of thick plates of glass, which may be easily cleansed. The calves are placed in this trough with their legs upward.

The shaving of the animal is a laborious task; it is usually accomplished by the use of the scissors in the first place, although the operation may be facilitated by the use of a clipper such as is used for shearing horses, if it is a good one. The parts should then be lathered with soap and warm water and carefully shaved with a razor, an operation which is by no means easy, especially if the animal be restless.

Insertion of lymph may be made by various methods, by puncture, or by scarification by a sharp lancet, or by slight incisions. In Berlin and several other German establishments long, shallow, parallel incisions are made, into which the lymph is rubbed with a spatula.

Warlomont gives careful details as to the method of

securing the animal to the table, for which purpose he employs five assistants, the duties of each being carefully defined.

Two of the forceps in common use are shown in the accompanying cuts. Fig. 4934 is that of Chambon, and Fig. 4935 that of Warlomont.

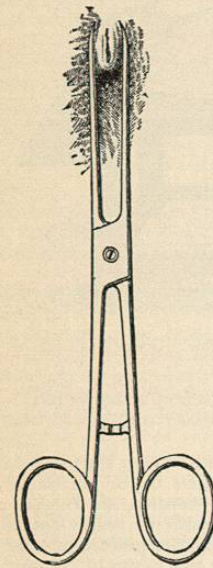


FIG. 4934.—Chambon's Expression Forceps.

A slight pressure only is necessary to hold the vesicle and facilitate the flow of lymph, and it often happens that no forceps are necessary.

The Development of the Vesicle.—If the inoculation is successful, each incision will begin to show a light red border at the end of about forty-eight hours; at the end of another day a slight swelling appears, increasing in size; and by the end of the fifth day a well-formed vesicle will be seen at the seat of each successful insertion. These vesicles are shaped according to the method of insertion. In the case of punctures they are circular, and in the case of incisions they are shaped like the half of an "elongated coffee-berry," having a cicatricial depression, surrounded by a zone of silvery white, and encircled by an outer zone of a reddish hue, the distinctness of color varying with the amount of pigmentation of the skin at the places of insertion. The swelling of the vesicle increases until about the seventh or eighth day, when the transparent zone becomes yellowish in color, and in the following days the vesicle becomes purulent, dries up, and is converted into a brown crust, which falls off from the fourteenth to the twentieth day.

According to Warlomont, if the modes of insertion by incision and by puncture be practised on the same animal, the eruption will be developed twenty-four hours later in the latter, a circumstance which may prove of advantage, by having two stages of development in the same animal, and by the consequent possibility of collecting mature lymph on two successive days if necessary.

The proper time for the collection of lymph is a period of about twenty-four hours in length, and in order to obtain lymph of the best and most efficient quality, the opportune moment for collection should be carefully studied. This moment is not of necessity the time when the most abundant flow takes place, but an earlier period. For greater clearness of expression, it is best to state the period in hours, since the expressions, third, fourth, fifth day, etc., are differently interpreted by different writers.

Negri often made use of the vesicles of three times twenty-four hours. Throughout the continent, it is common to make the collection of lymph either at the termination of three, four, five, or six times twenty-four hours. At Cologne it is the practice to vaccinate on Tuesdays and collect lymph on Fridays. The more common custom in the United States was, previous to 1890, to collect lymph at the end of seven times twenty-four hours, or on the same day of the week with its insertion; or, if the collection required several hours, to complete the operation at that time, after the method employed by Lanoix. In most United States establishments, however, lymph is now collected at an earlier date.

Collection of Vaccine Lymph.—The vesicles propagated upon bovine animals usually require more pressure, in order to obtain a supply of lymph, than is necessary in the collection of humanized virus, especially from the arms of infants, in whom the skin is tender. From these the lymph usually flows readily at the slightest puncture or incision. In bovine animals, however, having a skin

of greater thickness, considerable pressure is usually required to cause a free flow of lymph (see further statement in description of the establishment at Cologne).

Delivery of the Lymph.—A careful record is kept at each establishment of the date of sending, quantity, recipient, and other important items. By far the greater quantities were furnished in the months of May and June. The recipients were classified into public vaccinators, private physicians, and military physicians. The former class used by far the greatest quantity of lymph.

Sending and Packing of the Lymph.—The usual mode of sending lymph from the stations in the German cities is by mail in capillary tubes, usually containing about enough for five vaccinations, and in large glass tubes containing fifty or one hundred such portions. These are securely packed in wooden or pasteboard boxes, with directions for use accompanying them.

In most of the cities, test vaccinations were made upon calves for the purpose of proving the efficiency of the lymph before forwarding it. In times of unusual demand, however, this practice was omitted.

The Efficiency of the Vaccinations.—The results are stated with great care, both as to the number of persons vaccinated, and as to the number of insertions or separate scarifications made.

In Leipzig observations were made upon 22,158 primary vaccinations, in which the successful vaccinations amounted to 21,982, or 99.21 per cent.; partially successful, 145, or 0.65 of one per cent.; and unsuccessful, 31, or 0.14 of one per cent. Of the revaccinations, 15,115 out of 16,706, or 90.48 per cent., were successful.

In Hamburg, in a series of ten years the success rate of primary vaccinations was fully 99 per cent.

In the entire German Empire the success rate of primary vaccinations in 1899 was 96.1, or 1,446,914 successful vaccinations out of a total of 1,505,698.

Duration of Efficiency.—Lymph, when carefully preserved at an even and low temperature, retained its efficiency for from two to four months, and even longer.

Lymph used at stations was usually quite fresh, but private physicians often found it efficient at the age of several months. Tests were made at

Stettin of lymph, 46, 81, 102, 138, 153, 175, 178, 229, and 249 days old, and in each case it was found to be efficient. The lymph was preserved in glass tubes.

Some lymph was sent to Madras from Berlin, February 17th, 1891, and a calf vaccinated with this lymph on the 17th of March, had one hundred and one good vesicles out of one hundred and twenty-one insertions. This was also successfully transmitted from this calf to others. In some cases lymph sent to places in hot climates proved without effect.

Diseases Following Vaccination.—Vaccine physicians are instructed to make special observations upon this point. Out of the immense number of vaccinated persons in Germany, but very few cases of erysipelatous eruptions, swelling of the axillary glands, and slight skin eruptions of a temporary character were recorded, and no cases of syphilis were mentioned.

Preparation of Lymph.—The following account of the method of preparing vaccine lymph at Berlin is given by Prof. Albert Guttstadt, in an article entitled "Das Impfwesen in Preussen in 1887-88," in the *Zeitschrift des Königl. Preuss. Statistisch. Bureau's*, 1890.

The skin of the calf is first washed with warm soap and water. The incisions then show clearly, and the lymph is taken out with a sharp spoon, shaped like a potato borer.

The lymph was at first mixed with glycerin in a porce-



FIG. 4935.—Warlomont's Expression Forceps.

lain mortar, but afterward a machine was employed which was designed by the assistant, Dr. H. Döring.

This apparatus, the "Döring lymph mill" (Fig. 4936), is the result of several trials, and consists of an iron

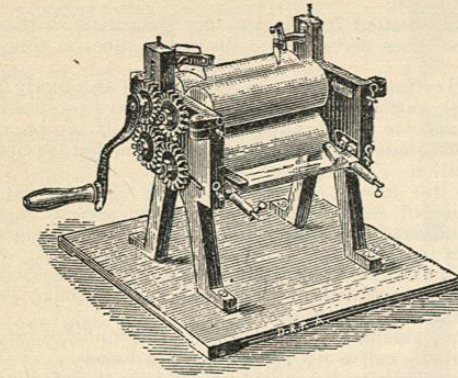


FIG. 4936.—Döring Lymph Mill.

frame fastened to an iron plate, supporting four cylinders of porcelain having roughened surfaces. These cylinders are removable, and may be sterilized.

The lymph is first mixed by light stirring with one-third of its weight of glycerin, and is then placed on the line of contact between the cylinders, a little at a time, while an assistant turns the handle. In a few moments the finely mixed lymph mass is scraped off from the last cylinder by the glass shield and caught in the dish below. After the whole mass has passed through the apparatus it is stirred with a glass rod, with the addition of more glycerin, and is passed through the mill again. It is advisable, after emptying the lymph upon the cylinders, to scrape the dish to avoid loss. The lymph is then ready for use. The loss is at the utmost 0.5 per gram. From 20 and 25 gm. of raw lymph may thus be easily prepared for use in thirty-five minutes.

The apparatus, exclusive of the plate on which it stands, is about 20 cm. (8 in.) in each dimension. Accompanying each apparatus are two rectangular dishes and glass scrapers, a spatula to collect lymph, a clamp, screwdriver, and oil can. The apparatus is sold by Julius Schober, Adalbert Street, 39, Berlin.

Another machine employed for the same purpose is that devised by Dr. Chalybäus, of Dresden. It consists of a vertical spindle revolving in a cylinder, the material for trituration being fed through a funnel at the top.

Vaccination in Japan.—Vaccination has made rapid progress in Japan since its introduction there. It appears from the government reports that calf lymph is now very largely used. The vaccine farm was at first under control of the Government, but was finally entrusted to a private association. February 16th, 1888, a commission was appointed to investigate the subject of the preservation of lymph, so that it could be distributed to distant places and still be used with efficiency.

1. **Vaccine Lymph in the Dry Condition.**—(a) On ivory points. The points in use in the United States at present are of a pretty uniform size, being about 37 mm. in length, 6 mm. in width, and about 1/4 mm. in thickness. By far the greater number are produced at several establishments in Connecticut, where bone points of the same size and shape are also made for the same purpose, at less cost. Larger and smaller sizes have also had a limited use. One end of the point is usually made square and the other end pointed, and the rounded edges near the point are often bevelled, this device having been adopted for the purpose of allowing the point to be used as a lancet (Fig. 4923).

In order to charge the points, they should be applied to the lymph exuding from the vesicle, first upon one side of the point and then upon the other, until they are quite

uniformly coated with the lymph for a distance of from 1 to 2 cm. from the point. In the case of some propagators, it is customary to allow the points to dry, and to re-charge them with lymph, either from the same or from another animal. The points should be carefully laid to dry upon the edge of any convenient place, where the charged portion may project in such a manner as to allow of its drying readily. Ivory vaccine points are adapted to use in connection with the method by scarification, rather than by puncture. As ordinarily prepared, the lymph upon ivory points will usually retain its activity, when the points are kept at an even, cool temperature of 40° to 60° F. (4° to 15° C.), for two months or more. They have been known, however, frequently to retain their activity for very much longer periods, ten months or more having been reported. Points are also charged with glycerinated lymph, and are then coated with paraffin, or protected by a shield of glass or other material.

An ingenious device was brought to notice by Dr. F. Kimball, of Andover, Mass., in 1880, for the purpose of facilitating the rapid application of lymph to ivory points when considerable quantities are required at once (see Fig. 4937). It consists of two pieces of pine wood glued together in such a manner as to allow the points to be held firmly in position while the lymph is applied. A thin shaving of uniform width is removed from one of the pieces of wood, not quite as thick as the points. Similar devices are now in use in some of the larger American establishments.

Various methods are employed for packing charged points for transportation. Those methods are best which most efficiently protect the points from the air, from moisture, and from changes of temperature. In the method employed by Dr. Martin the points are first wrapped with clean absorbent cotton, then with thin white paper, and finally are wrapped in an outer coating of thin sheet gutta-percha, which is easily made perfectly tight by a very moderate degree of heat.

(b) **Crusts.**—This method of using vaccine material has, fortunately, gone out of use in places where bovine lymph can be obtained, and it should be abandoned altogether, as relating both to bovine and to humanized lymph, since the crust consists of the products of the vaccine vesicle which have passed the period of maturity, when the clear transparent lymph has advanced to the purulent stage and the vesicle has become a pustule.

A few years since, bovine crusts were offered for sale in the shape of masses, or cones, which consisted of powdered crusts, formed into shape by the aid of pressure and other means; examination showed that these masses contained a considerable quantity of foreign material, such as might be expected to be found in the crusts formed upon animals which had not been carefully kept.

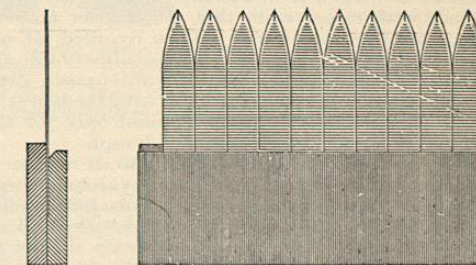


FIG. 4937.—Kimball's Device for the Rapid Collection of Lymph.

Serious results following the use of these devices soon put an end to their use.¹⁵

It is hardly necessary to allude to the fact that crusts, like other organic material, undergo rapid putrefactive changes in the presence of heat and moisture. Instances are on record of serious injury from so-called vaccinations made by the use of crusts kept dissolved in water for a considerable period.