

ESSENTIALS OF VACCINATION;

A COMPILATION OF

FACTS RELATING TO VACCINE INOCULATION AND
ITS INFLUENCE IN THE PREVENTION OF

SMALL-POX.

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*These pages are respectfully inscribed to
Dr. Frank P. Foster, of New York City, in
appreciation of his many scientific and prac-
tical labors in the cause of Vaccination.*

P R E F A C E .

This little volume is, of course, not intended to be a comprehensive treatise on Vaccination; but I believe that a careful compilation of the more essential facts relating to this all-important subject will not prove unacceptable to the profession.

This conviction is strengthened by the knowledge that much of the literature bearing on Vaccination in its modern aspects, especially Animal Vaccination, is more or less inaccessible to the general reader.

As the practical administration of Vaccination in America differs to some extent from the customs prevailing in Europe, it will be found that this fact has been given due consideration.

I have availed myself freely, and in many instances literally, of the labors of eminent vaccinologists in this country and abroad; but I believe that due acknowledgment has been made in every case.

W. A. H.

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ESSENTIALS OF VACCINATION.

CHAPTER I.

HISTORY OF VACCINATION.

Inoculation for Small-Pox.—A crude theory of preventive viruses, the highest development of which we have but to-day witnessed at the hands of Pasteur, has perhaps been in existence for many centuries ; at any rate, the practice of inoculating for small-pox boasts of a somewhat remote antiquity. It is said that this operation was employed in China and India as early as the eleventh century. Dr. George Gregory* states that about the year 1703, rumors of the great success of this operation attracted the attention of Timoni, a Greek physician, a graduate of Oxford. Further observation having convinced him of the importance of the method, in 1713 he wrote an account of inoculation to an English correspondent, which was

* Cyclop. Pract. Med., vol. iii, p. 748; London, 1835.

afterward published in the Philosophical Transactions. In 1715, Dr. Pylarini, the Venetian consul at Smyrna, published an account of it at Venice; a notice of this work also appeared in the Transactions. These favorable reports were corroborated by Mr. Kennedy, an English surgeon, who had traveled in the East, in an Essay on External Remedies, published in London in 1715. These important facts were quite forgotten in England till attention was again called to the subject by the famous letter of Lady Mary Wortley Montague, dated April 1, 1717.* While all praise is due to that distinguished woman for her acute intellect and great moral courage, her daughter affording the first example of inoculation in England, it should not be forgotten that the practice had been first urged by medical men.†

Jenner and Vaccination.—It is quite probable that the prophylactic influence of

* Letters of the Right Hon. Lady Mary Wortley Montague; Leipsic, 1835.

† As there are certain circumstances that might arise in which inoculation would be necessary (see Trousseau, Clin. Med., and Marson, Reynolds' System), it will not be amiss to state that the variolous lymph should be taken when *limpid*, on about the fifth or sixth day of the eruption, selected from a mild case, and put into the arm in but one place.

vaccinia against variola has been matter of tradition among the common people. Humboldt* declares that among the mountaineers of Mexico this knowledge has long been known and acted upon. Sülzer, in 1713, and Sutton and Fewster, in 1765, are said to have first called attention to this property of vaccine in Europe.† In 1791, a school-master of Holstein, named Plett, is reported as having inoculated three children with vaccine virus. There is no sort of question that Benjamin Jesty, "an honest and upright man," a farmer of Gloucestershire, vaccinated his wife and two children in 1774.‡ But all these circumstances detract nothing from the glory of the scientific discoverer and systematic promoter of vaccination. Edward Jenner was born at the vicarage of Berkeley, in Gloucestershire, on the 17th of May, 1749. While engaged as an apprentice to Mr. Ludlow, of Sodbury, the attention of Jenner was frequently attracted to a popular belief, current in the neighborhood, that cows were

* Ziemssen's *Encyclop. Pract. Med.*, vol. ii, p. 401; New York, 1875.

† Ziemssen, *loc cit.*, and Hebra, *Dis. of Skin*; London, 1866

‡ Trousseau, in his fascinating chapter on Vaccination, gives a full history of Jesty's connection with the subject.

subject to an affection called the cow-pox, which was sometimes contracted by the milkers, who, in consequence, acquired an immunity from small-pox. On one occasion a young woman came into the surgery for advice while the subject of variola was being discussed. Upon hearing the conversation, she exclaimed: "I cannot take that disease for I have had cow-pox." This incident created a deep impression upon young Jenner's mind. Afterward, when he became a student of Hunter's, he mentioned these various circumstances to the master, but met with little encouragement from him. It is not necessary to follow step by step the road pursued by Jenner till he reached the ultimate goal of his immortal discovery. The story has been repeated many times.* Suffice it to say that when he settled in practice in Gloucestershire (1775), he discovered many persons insusceptible of variolous inoculation. On the other hand, there were others who had apparently suffered from cow-pox, but who afterward received small-pox in the usual way. After many difficulties and much painstaking research, he ascertained that the

* See Baron's *Life of Jenner*, 2 vols.: London. 1828

cow was subject to a number of eruptive disorders, which had all received the name of cow-pox. He then came to understand the apparent contradictions in the results of inoculation. (After learning to distinguish between true and spurious vaccinia, it occurred to him that the cow-pox presented successive stages, and that it was only at one period of its course that its virus was prophylactic against small-pox.) Finally his philosophic mind reached the conclusion that it might be possible to propagate the disease by inoculating first from the cow and then from one human being to another. On the 14th of May, 1796, Jenner vaccinated his first patient. James Phipps, aged eight years, was inoculated with matter taken from the hands of Sarah Nelmes. He passed through the disease in a satisfactory manner, and was tested on the 1st of July following by small-pox inoculation, without effect. Jenner's first essay was published in London, in June, 1798, and was entitled "An Enquiry into the Causes and Effects of the Variolæ Vaccinæ, a disease discovered in some of the western counties of England, particularly Gloucestershire, and known by the name of cow-pox."

As a matter of course, the early career of vaccination met with much bitter opposition, not only from the laity, but also from medical men. However, in spite of all drawbacks, the cause advanced with rapidity. Jenner states that in 1801 more than six thousand persons had been vaccinated, the greater number of whom had been tested by inoculation, and exposed to the infection of small-pox in every way that could be devised, without effect. In our modern estimation of the value of vaccination, these early rigorous experimental tests should not be forgotten. Vaccination was introduced into America by Dr. Waterhouse, of Cambridge, in 1796, the year of Jenner's first vaccine inoculation. That physician's observations and the works of Coxe and Scofield may be yet read with interest and profit. Thomas Jefferson was an ardent advocate and promoter of the new practice. In 1800, vaccination was introduced into France. Dr. Luigi Sacco, of Milan, was an early worker in the same field, and made many investigations into the pathology of cow-pox and the analogous pox of other animals. Dr. De Carro, of Vienna, was an active propagator

of the new doctrine on the continent of Europe. After many difficulties, vaccine was transported to various quarters of the globe, and the art of vaccination became general over the civilized world. Dr. Jenner died in 1823. In addition to the names mentioned above, no sketch of the history of vaccination would be complete without reference to the works of Woodville, Pearson, Dunning, the originator of the words *vaccination* and to *vaccinate*, Ring, Robt. Willan, and a host of others among the early, and Ceely, Bousquet, Steinbrenner, Hering, Marson, Simon and Seaton among the comparatively recent investigators.

Animal Vaccination.—In our own day a new page in the study of vaccination has been unfolded, which, perhaps, affords some problems not yet thoroughly solved. By animal vaccination, in the true sense, is to be understood, according to Dr. Martin,* the inoculation of a young selected animal of the bovine species, from an original spontaneous case of cow-pox, from this others, and so on in a continuous series. He calls the

* Trans. Am. Med. Ass'n, vol. xxviii, p. 196, 1877.

lymph secured in that way "heifer-transmitted cow-pox virus."

Before the year 1866, outside of Italy, the practice of calf-to-calf vaccination was nowhere pursued, and, in fact, was practically unknown.* In that country, at a very early date, animal vaccination had been advocated. Although the modern era of animal vaccination may be said to have owed its birth to the address delivered by Dr. Palasciano to the Medical Congress at Lyons; it was not till the discovery of the case of cow-pox at Beaugency that this mode of practice received the tremendous impulse which has ended in establishing it in many countries, and almost exclusively in America. In 1870, Dr. Henry A. Martin, of Boston, the indefatigable and able promoter of the science and art of vaccination, secured from Depaul virus taken from the 258th, 259th and 260th of his continuous series from the heifer of Beaugency. It is safe to say that there exists very little, if any, long-humanized vaccine lymph in the United States to-day, the current stocks being either bovine or virus of recent removes.

* See Martin, *loc. cit.*, and De Wolf, *Chicago Med. Jour. and Exam.*, May, 1881.

CHAPTER II.

VARIOLA IN ANIMALS.

General Considerations.—Many animals, such as the ox, the horse, the sheep, etc., suffer from contagious eruptive disorders, which present many features common to the small-pox of man, and to the variola of each other; but notwithstanding these general points of resemblance, a closer scrutiny will discover features of radical difference, both in their natural history, modes of origin and diffusion, and also in their mutual protectiveness. For instance, while sheep-pox is self-protective, it is not antagonistic to human variola, as is cow-pox, nor can it be conveyed by ovination to other animals, or man. Upon the other hand, the virus upon which it depends is volatile like that of human variola, as well as transmissible by inoculation; the contagion of cow-pox and horse-pox being probably transmitted only in the latter way. Vaccinia will not protect the sheep from his pox nor does it produce anything but a local effect on

that animal, while it engenders systemic effects upon man, the horse, and the goat. The vaccine disease in man and in the cow is a strictly local affection, but in the horse it is apt to be a generalized disorder.* In the early days of vaccination, experimental inoculations were made in various directions, in the hope of discovering protective viruses analogous to that of vaccinia.† There still remains much conflict of opinion in regard to all of these questions. The relationships of these various disorders to each other and to human variola, are matters of deep scientific and practical interest, which, however, will not admit of discussion here, but will be, in part at least, subject of inquiry in another chapter.

Natural Cow-Pox.—Cow-pox, the variolæ vaccinae of Jenner, is a disease of the most vital interest to the human race, and worthy of close study by the practical vaccinator.

Definition.—Cow-pox may be defined as a specific eruptive affection, characterized

* Fleming, *Human and Animal Variolæ*, *Lancet*, vols. i and ii, 1880.

† Luigi Sacco, *Trattate di Vaccinazioni*, etc.; Milano, MDCCCIX.

by a period of incubation, and the subsequent appearance of lesions, which are successively papular, vesicular and pustular, and normally confined to the teats and udder. It occurs sporadically or as an epizootic.

History.—It is probable that the cow-pox has been known from time immemorial, and it certainly had been observed in Europe before Jenner's day; but it was not till that great man's announcement of its prophylactic power, that the disease aroused the attention of the world, and eager search was everywhere made for it. In England in the vale of Aylesbury, and in the classical vale of Gloucester, it has been frequently observed, although a recent writer* states that the affection has rarely prevailed in the first-named place of late years. Spontaneous (so-called) cow-pox is, so far as our knowledge goes, a rare disease in America. Cases have been reported, however.† In Germany, where in certain states its discovery was stimulated by government bounties,

* Newham, *Lancet*, June 4, 1881.

† See De Wolf, *loc. cit.*, and Martin, *Boston Med. and Surg. Jour.*, Aug. 11, 1881.

numerous announcements were made at various periods of its appearance. It has been said that the much less frequent occurrence of vaccinia nowadays is due to the fact that the milkers who were formerly the active agents in its dissemination are no longer susceptible of its influence, from having undergone vaccination. According to Dr. Seaton, who was an ardent advocate of the identity of cow-pox with human variola, its diminution is ascribed to the much less diffusion of small-pox. Cow-pox has most frequently manifested itself in May and June, though it has been observed by the late Mr. Ceely in all seasons, except midsummer. It occurs much more often in a sporadic way, and in solitary instances, than as an epizootic. Mr. Fleming* ridicules the notion that milch cows only are capable of contracting the disease; he declares that the male sex offers no bar to its morbid influence.

Symptoms and Course. † The period of in-

* Loc. cit.

† For a full description of cow-pox in its various phases, the reader is referred to the unrivaled papers, beautifully illustrated, of Robert Ceely, in the *Trans. Prov. Med. and Surg. Ass'n*, vols. viii and x. These rare books are in the Surgeon General's library at Washington. In Seaton's *Handbook* a full account, taken from Ceely, is also to be found.

cubation is from three to four days; in some cases, from five to eight. About four days from the date of invasion the parts become hot and tender, and small red papules make their appearance on the part of the udder near the base of the teats, and also on the base of the teats. After three or four days the papules assume a vesicular character and take on umbilication. A dusky, yellowish point at the apex of the papule gives the first indication of beginning vesiculation. The vesicles gradually increase, and in three or four days more attain their full development. The vesicles vary in size from a pin's head, in which case they are perhaps the result of auto-inoculation, up to that of a sixpence, or dime; but more generally are of the dimensions of a pea or horse-bean. Their size is generally determined by their number. At the base and neck of the teats the vesicles are usually circular, while on the body of the teats they are generally oval; but they may also be oval on the udder, and on the teats they often run together. They have a metallic, glistening luster. By the eighth or ninth day a pale rose or light damask areola appears around them. Between

the tenth and twelfth days the disease has reached its full development ; the areola extends to a width of four or five lines, and the surrounding cellular tissue becomes deeply infiltrated. The hitherto clear lymph becomes opaque, and by the twelfth day, desiccation has begun, which is completed in five or six more days. The crusts, which are of a brownish-black color, fall off between the twentieth and twenty-third days.

These stages may be more or less abridged or lengthened by various circumstances, such as arise from handling the parts, or from auto-inoculation, pressure on the part of the animal, etc. The physical character of the lesions may also be altered from the same causes.

Mr. Ceely has called attention to the fact that the cow is subject to a number of other disorders, which should be carefully differentiated from vaccinia. He enumerates the following affections :

“Inflammation and induration, sometimes suppuration of the cutaneous follicles at the base of the teats; small, hard knots, cutaneous or sub-cutaneous, in the same locality, about the size of a vetch, a pea, or even larger, which often remain indolent for a time, at length become red, vesicate, enlarge, suppurate and burst, attaining not infrequently the size of a walnut, or more, occasionally affecting the hands of the milkers, and often

the other cows milked in the same shed by the same hands; an eczematous eruption, with intertrigo on the udder and near the roots of the teats; warty growths of two kinds: one consisting of long, narrow, pendulous and linear shaped prolongations, easily removed and often detached; the other of short, thick, compact, broad elevations, lighter in color, generally, than the ground from which they rise, of various sizes, from that of a pea to that of a horse-bean; frequently very numerous on the teats, where they are often bleeding and partially detached. *The yellow pock*—a pustular eruption resembling ecthyma on the teats and udders, succeeded by thin, dirty brown or black irregular crusts. *The bluish or black pock*—Bluish, or black, or livid vesications on the teats and udders, followed by thin, dirty brown or black irregular crusts and some degrees of intertrigo on the interstices near the bases of the teats. *The white pock*—a highly contagious disease among milch cows and to the milkers, quickly causing vesications and deep ulcerations; often, or almost always, confounded by them with the true vaccine, and certainly not readily distinguishable in all its stages by better informed persons than milkers." Trans. Prov. Med. and Surg. Ass'n, vol. viii, p. 297.

Finally, as is well known, the vaccine disease may be induced in the ox tribe by inoculation with virus derived directly from other cows laboring under the natural, casual, or inoculated form of the disease; with the virus of horse-pox (equination); with virus which, originally derived from the cow or horse, has become humanized by passing through the human system (retro-vaccination), or lastly, with the virus of human small-pox (variolation).

Horse-Pox.—In a historical and scien-

tific way, horse-pox possesses an interest next to that of vaccinia in the cow. Jenner was convinced that vaccinia in the cow was always induced by the disease known as the grease in the horse. In his famous "Enquiry" he stated that "in this dairy country a great number of cows are kept, and the office of milking is performed indiscriminately by men and maid servants. One of the former having been appointed to apply dressings to the heels of a horse affected with the malady I have mentioned (grease), and not paying the proper attention to cleanliness, incautiously bears his part in milking the cows with some particles of the infectious matter adhering to his fingers. When this is the case, it frequently happens that a disease is communicated to the cows, and from the cows to the dairy maids, which spreads through the farm, until most of the cattle and domestics feel its unpleasant consequences. This disease has obtained the name of cow-pox." From the fact that a local affection of the horse was confounded with the true equine pox, the result of experimental inoculations proved of a negative sort, and the existence of horse-pox was de-

nied. As early, however, as 1801, Dr. Loy, of Pickering, made the proper differentiation between the two disorders, and confirmed so much of Jenner's assertion as related to the possibility of the one animal contracting the disease from the other. Viborg, a Danish veterinarian, is said to have succeeded also in producing vaccinia in a cow with matter taken from a horse.

But it has been only in comparatively recent years that the early experiments of Loy and others have been confirmed; particularly by the French physicians and veterinarians, Pichot, Maunoury, Lafosse and Bouley.* While these various researches have abundantly demonstrated that the equine pox may produce vaccinia in the cow, it is also apparent, as the result of further observation, that Jenner was wrong in assuming that the disease in the latter was acquired in no other way. As a matter of fact, the two diseases may originate quite independently of each other; cow-pox occurs where there is no possible contact with horses, and horse-pox where there is no possible means

* Trousseau, Clin. Med., vol. ii; Philadelphia, 1869.

of contagion from cows.* The eruption in the horse is apt to be generalized, occurring on the skin of the trunk and legs, as well as upon the nasal and buccal mucous membranes. According to Raynaud,† the horse is subject to an eruption similar in appearance to true horse-pox. It is more or less developed on the trunk and limbs, but sparing the mucous membranes. The liquid of these vesicles is not inoculable.

Sheep-Pox.—*Variola ovina*, or sheep-pox, is one of the most fatal diseases of animal life; in this respect it differs from the variolæ of the horse, ox, etc., and most resembles the variola of man. The vesicles, however, are unlike those of human small-pox, being unilocular and without umbilication. According to Chauveau its contagion is very active, especially as compared with that of vaccinia, infecting with a hundred times more activity than the latter.

The possibility of inoculating the human subject with sheep-pox has been largely de-

* E. Hering, Ueber Kuhpocken an Kühen; Stuttgart, 1839; and Fleming, loc. cit.

† Recherches expérimentales sur l'infection et l'immunité vaccinales, par le docteur, M. Raynaud, Gazette Hebdomadaire, Nos. 29, 31, 32; 1879.

nied, notwithstanding the alleged successes of the early Italian vaccinator, Sacco. Mr. Ceely and Mr. Marson made numerous experiments in this direction, all which resulted in failure, except one, that at the best was regarded as equivocal, and susceptible of other explanation.* K rner,† however, reports two cases which apparently prove that the human subject may be ovinated, although it is not stated that they thereby gained vaccinal or variolous immunity. Inoculations of sheep with the virus of their own pox, produce in them a mild form of the disease which procures a complete immunity against further attacks; but inoculations of vaccine lymph or the lymph of human variola give negative results, the sheep being as susceptible as ever of sheep-pox.

Other animals, goats, swine, the dog, the camel, etc., have a variola of their own. It is said that the disease in the camel is communicable to man, and is protective against

* The lancet had been previously employed for vaccination.

† Quoted by Fleming, loc. cit., p. 375. I would also refer the reader to this writer for details of ovination of other animals.

small-pox. Fowls are also subject to a variola, which is sometimes very fatal.*

* For observations on variola in pigeons see *Die Praxis der Naturgeschichte, Dritter Theil*; Weimar, 1882, p. 142; and also *Archiv. Gén. de Méd*; August, 1881, p. 245.

CHAPTER III.

NATURE OF VACCINIA.

The Relationship of Cow-pox and Horse-pox to Human Variola.—Jenner entertained the idea that the grease of the horse was the source of variola in the cow and in man. While the hypothesis as to the equine origin of small-pox has been generally dismissed from consideration, there are many who contend that cow-pox, horse-pox and human variola acknowledge one common specific infection. Others again have declared such a position to be totally untenable. The most notable attempt towards the solution of these vexed questions was made by a commission appointed by the Academy of Sciences, of Lyons, under the presidency of M. Chauveau. Briefly stated, the experiments instituted were as follows: The virus of small-pox was inoculated on a number of animals, horses and cows, which was followed by no constitutional symptoms, but by the local appearance, corresponding to the site of puncture,

of small red pimples. This papulation was more marked in the horse than in the cow. At no period of their existence did they exhibit any tendency to secretion, but disappeared about the twelfth day, leaving a small, blackish crust at the point of insertion. With some serous exudation obtained by *scraping* the papules thus produced, inoculations were made on children, which resulted in local vesicles followed by the general eruption of variola. Numerous other experiments were made, of which our space forbids further detail, all tending to confirm the commission in the belief that "small-pox in its passage through the system of a cow is not transformed into vaccinia; it remains small-pox, and returns to the original state of small-pox when re-introduced into the human species." These views have been generally accepted on the continent of Europe in late years. Mr. Fleming in his recent able essay on "Human and Animal Variolæ," adopts the conclusions of Chauveau, and adduces other evidence, such as prevalence of cow-pox where human variola is unknown, etc., in support of his position. Certain learned vaccinologists in our own

country sustain the theory of non-identity.* On the other hand, many experiments are recorded, which in spite of the negative results just quoted, would seem to conclusively demonstrate the identity of small-pox and vaccinia. In 1802, Gassner inoculated eleven cows with variolous matter, and succeeded in producing on one of them a characteristic vaccine vesicle, from which he vaccinated four children, from whom, in turn, seventeen others were successfully inoculated.

In 1830 Dr. Sonderland excited variola in cows by enveloping them in infected bed-clothing. In a few days the animals manifested the usual symptoms of cow-pox, and the vesicles thus produced gave rise to genuine vaccine vesicles when introduced into the human system. In 1836 Dr. Thiele succeeded in inducing vaccinia in cows by variolation. The lymph thus generated was successfully used in vaccination, and many subsequently had their immunity tested by variolous inoculation and exposure to small-pox. But his further assertion that he could

* T. F. Wood, *Chicago Med. Jour. and Exam.*, October, 1881; *N. C. Med. Jour.*, February, 1882.

produce cow-pox without the intervention of the cow at all, by simply *diluting small-pox virus* with warm milk, was received with incredulity; and it is to be observed that Seaton has omitted all mention of it, fearing no doubt to weaken the cogency of his argument for identity by admitting such an apparently irrational statement. The reader of to-day will readily see that Thiele was really, perhaps, anticipating Pasteur's researches on the attenuation of viruses.* In 1839 Robert Ceely, of Aylesbury, directly inoculated two storks with small pox virus, and from the vaccine vesicles which resulted, originated a stock of variola-vaccine lymph which was used on many children.

But the most remarkable and convincing experiments in this direction are those of Mr. Badcock, a druggist, of Brighton. About forty-five years ago, having experienced an attack of post-vaccinal small-pox, it occurred to him that a more vigorous stock of lymph could be procured by passing the virus of human variola through the cow. Although repeatedly failing afterwards, his first variolation of a cow was successful.

* W. B. Carpenter, Nineteenth Century, October, 1881, p. 551.

From this inoculation a child was successfully vaccinated, and from this child others, and so on through a long series. During the course of twenty years he attempted variolation on two hundred cows, but such is the great difficulty of the operation that he succeeded in producing typical vesicles on but thirty-three animals. He found the thinly haired skin near the vulva the most favorable point for inoculation. It is said that Mr. Badcock himself has vaccinated more than 30,000 persons with this lymph, and that for more than forty years several hundred practitioners have been using it without causing anything but typical vaccinia from its employment.*

It is therefore assumed that Chauveau's experiments produced nothing but local papules, and that when recourse was had to them for material for experimental purposes, the operator merely collected the same variolous virus that had been inserted a few days before. The English experimenters took lymph from their variolated cows only on the appearance of vesicles, and made no attempt to gather serosity from abortive

* Brit. Med. Jour., November 26, 1881.

papules, which they regarded merely as the result of local inflammation. It is quite possible that had they used material from such papules, the same results, production of small-pox, would have occurred to them as to the members of the Lyons' commission.

There are several other points of view from which this subject may be considered, but the limited space at disposal precludes a further discussion. It seems to me, however, that although there are many apparently conflicting statements yet to be definitely settled, the direct positive results obtained by Ceely and Badcock, not to mention the earlier experimenters, oblige us to acknowledge that under certain conditions, the variolation of kine gives rise to phenomena possessing all the specific characters and protective properties of vaccinia. It only remains to add that the researches of Pasteur on the attenuation of viruses lends the strongest scientific support to the results of clinical experience. The time may even arrive when the inoculation of attenuated variola virus will supersede altogether the use of vaccine lymph.

Contagium of Vaccine Virus and Mode of Infection.—Numerous observers have demonstrated the existence, in the vaccine lymph, of fine molecular bodies, which are presumed to be the vehicle of the contagion; others have regarded them as mere chance products.*

Bristowe has remarked that it is not improbable that the specific poisons of the various infectious fevers pass into the system through the portals of the lymphatic system.† Recent investigations into the morbid anatomy of hydrophobia point to the same conclusion.‡ I have elsewhere § expressed my belief as to the manner in which the syphilitic virus gains access to the system, and in the same paper I stated my conviction that the lymphatics played the same role in vaccinia. Since then we have been put into possession of the exquisite experiments of

* For references consult Ziemssen's *Encyclop.* vol. ii, p. 381, Am. edit.; Piffard, *Dis. of Skin*, 1876; *Proc. Med. Soc. Co. of Kings*, October, 1880; and Neumann, *Lehrbuch der Hautkrankheiten*; Wien, 1876.

† *Treatise on the Theory and Practice of Med.*, 1876.

‡ Jennings, *Lancet*, January 21, 1882, p. 102.

§ *Lymphatic Theory of Syphilitic Infection*, N. Y. *Med. Jour.*, December, 1877.

Raynaud,* which would seem to establish the fact of lymphatic absorption of vaccine virus beyond question. I am not aware that his positions have been disputed or overturned. As it is impossible here to record his experiments at length, I have thought it advisable to append his conclusions in a note.†

* Gazette Hebdomadaire, No. 29, et seq., tome xvi, 1879.

† Conclusions of M. Raynaud's "Experimental Researches on Vaccinal Infection and Immunity":

1. The vaccinal pustule. The evolution of this pustule is not indispensable in order to secure immunity; for this is secured even, when after subcutaneous inoculation, the development of the pustule is prevented.

2. The nervous system. A. The nervous system has nothing whatever to do with the evolution of the phenomena of vaccinia; the infection developing itself fully, even after the nerves distributed to the inoculated region have been previously divided. B. This interruption of the nervous current does not even sensibly alter the gradual evolution of the pustule.

3. The blood. A. Vaccinia is never produced by the subcutaneous inoculation of vaccinal blood; hence this operation is not susceptible of practical application. B. Transfusion of large doses of vaccinal blood is most always followed by no appreciable effects; the animal still remaining susceptible of vaccinia. C. Under certain circumstances, however, transfusion may produce vaccinal immunity, although no exterior phenomena have taken place. D. Immunity secured in this way is not transmissible by a second transfusion. E. After consideration of the above facts, there is very little probability that it is by means of the blood that the vaccinal virus is generalized through the entire economy.

4. The lymphatic vessels. A. The subcutaneous inocula-

Whether the virus of vaccinia is capable of passing through the septum of the maternal and foetal vascular systems, or, in other words, whether it is possible to render the foetus *in utero* insusceptible of small-pox by

tion of lymph from a vaccinated region and taken from beyond the nearest ganglion, has met with the same negative results as the hypodermic inoculation of vaccinal blood. B. On the other side, I produced horse-pox, by injecting into the blood of a horse a few grammes of this lymph. C. Hence this lymph may be virulent, provided it be used in rather large doses.

5. The lymphatic ganglions. A. A fact until now overlooked is that in a normal vaccination there is always engorgement of the nearest ganglion, which deserves the name of vaccinal bubo. This bubo is indolent and without inflammatory reaction. B. The inoculation of the juice obtained from this ganglion, at whatever time it may be taken, never produces vaccinia. C. It is possible then, that traces of virulence be found in the lymphatic system between the inoculated region and the nearest ganglion. From the (*A partir de*) ganglion on, no trace of virulence can be detected. D. This fact is of such a nature as to cause us to look upon the ganglions as being endowed with an elaborating power in regard to the disappearance of the virulence and the appearance of immunity. These phenomena are simultaneous and correlative. E. The experiments giving this hypothesis a high degree of plausibility, are those which enabled me to dissociate the absorption of virus and vaccinal infection. The one is not the necessary consequence of the other. This dissociation has been obtained by the experimental suppression of ganglionic intervention, either by extirpating the ganglions under certain determined conditions, or by causing the virus to enter a lymphoid organ having no connection with the ganglions, e.g., the anterior chamber of the eye. F. The immunity obtained by the injection of the virus directly into the veins does not prove against this elabo-

vaccinating the pregnant mother, is a question which has not yet received a definite answer. Therefore I shall not enter upon its discussion here.*

rating role of the ganglions, for being vascular organs they are constantly bathed in blood. G. It is certain, that the vaccine virus inoculated into the skin loses its inoculability in passing through the nearest lymphatic ganglions, thus establishing between it and the inoculable material of charbon a fundamental difference, which is very important with reference to the general theory of viruses.

* The experiments bearing upon this question are very contradictory. In the first place, Bollinger (Sammlung. Klin. Vortr., No. 116) suggested, as the poison of small-pox was known to be capable of transmission from the mother to the foetus, a similar condition might exist in regard to vaccinia, and that the frequent insusceptibility of infants of vaccinia might be due to the revaccination of their mothers during pregnancy. The results of some experiments on sheep pointed in the same direction. Rickett inoculated about 700 pregnant ewes during the last four to six weeks with *variola ovina*. Their lambs were inoculated when from four to six weeks old with good sheep-pox virus; no result followed in any case, while thirty-six other lambs treated in the same way had fine pustules. Induced by these considerations, Burckhardt (Deutsches Arch. f. Klin. Med. Band xxiv) made some experiments on the pregnant human female. He vaccinated twenty-eight pregnant women, but, owing to circumstances, only eight of the children born to these women could be employed for experimentation. Four children were vaccinated whose mothers had not been inoculated during pregnancy, and in every case with successful result. With this same lymph he vaccinated the eight children of the revaccinated mothers. The results were: The children of four women, whose revaccination had been successful during pregnancy, were found to be insusceptible. The children of two of the women, whose revaccination during pregnancy

had been only partially successful, were also found to be insusceptible. Of the two children whose mothers had been unsuccessfully vaccinated, one was vaccinated successfully, and the other failed. Gast's researches (Berl. Klin. Woch. No. 5, 1880) gave quite different results. He inoculated pregnant women in the seventh, eighth, and last months of gestation, the latest about ten days before confinement. These revaccinations were partly normal, partly modified, and partly negative. The children of these women were afterward vaccinated with the result of producing typical results in all, whether the mothers had been successfully inoculated or not. It is stated that very young infants are much more difficult to vaccinate than older children, which, together with bad lymph and faulty technique, would account for the failures. Pasteur's latest researches also bear on this point. A lamb, the offspring of a sheep that had been "protected" by charbon vaccination, when inoculated with the same virus, expired within twenty-four hours (Med. Times and Gaz., February 4, 1882). Finally, Bollinger's analogy drawn from the fact that variola in the mother is capable of transmission to the fœtus, also, perhaps, admits of another explanation; for it is not absolutely certain that the fœtus is infected through the mother's blood (Ziemmsen's Encyclop., vol. ii, p. 327). Kassowitz's studies on hereditary syphilis are not without interest in this connection.

CHAPTER IV.

VACCINIA IN THE HUMAN SUBJECT.

Symptoms and Course.—Vaccinia is never acquired by the human subject, except as the result of inoculation.

Usually at the close of the third day after the inoculation of vaccinia upon a previously unvaccinated subject, a slight elevation of the skin may be felt or seen at the site of operation. On the fourth day papulation is well marked. On the fifth day vesiculation has commenced, and by the sixth day, a distinct vesicle has been developed, cellular in structure,* of a bluish-white color, and presenting a characteristic raised edge and a central cup-like depression. This vesicle gradually enlarges, and on the eighth day attains its greatest perfection. At this date, a few hours earlier or later, a specific inflammation of the skin, called the areola, forms about the base of the vesicle, and the vesicle and areola continue to in-

* The structure of the successive vaccinal lesions is the same as in variola.

crease for the next two days. The areola, which was but a few lines in width at first, enlarges to the dimensions of two inches or more, and is of a deep red color, and hot and tender to the touch, and accompanied by swelling and induration of the subjacent cellular tissue. On the tenth day, when the inflammation has reached its acme, local disturbance, heat, itching and tenderness are marked, and more or less febrile reaction, occasionally out of proportion to the local dermatitis, is manifest. Sometimes the contiguous lymphatic glands are obviously enlarged and sensitive.*

After the tenth or eleventh day the pustule, for such it has become, begins to dry in the center, the areola grows narrower, and gradually disappears, and the swelling and induration of the tissues materially abates. Desiccation of the pustule steadily progresses, and by the fourteenth or fifteenth day a dark mahogany-colored scab has formed, which falls off between the sev-

* Raynaud (loc. cit) states that there is constantly found in young children, from the fifth to the seventh day after vaccination, indolent, pea-sized glands, which roll under the finger, and can always be detected. They are to be looked upon as indicating the specific infection of the system.

enteenth and twenty-fifth days. The separation of the crust reveals a cicatrix, which is vascular at first, but finally assumes a dead-white color. This scar is generally circular, depressed, and marked with minute pits, and occasionally radiated.

Mr. (now Sir) E. Wilson recapitulates thus: First two or three days, *incubation*; fourth day, *papular*; fifth to eighth, *vesicular* (*umbilication*); eighth day, *areola*; ninth to eleventh days, *pustular*, *umbilication* lost, *areola* enlarged; fifteenth to seventeenth days, period of separation. The phenomena of successful vaccination, as described by different observers, suffer certain slight deviations from the course here portrayed. This is undoubtedly due to the variations in the quality and vigor of the lymph employed, to the condition of health, of the person vaccinated, the state of the weather, season of the year, mechanical interference, etc.

Normal Deviations.—Although in no way a deviation from the normal course of vaccinia, it should not be forgotten that the lesions will differ in appearance according to the method of performing the inoculation.

When vaccination is done by scarification or somewhat extensive abrasion, several vesicles may be developed, producing a compound vesicle, followed by an irregular cicatrix. A small straw-colored scab is also sometimes seen over the center of a vesicle which contains none of the virus, when the method of scarification has been followed. (J. Lewis Smith.)

According to Dr. F. P. Foster, if the pock have been produced by long humanized virus, it will reach its acme by the eighth day; but if bovine virus have been employed, the vesicle will go on increasing in size for several days longer.

Retardation in the course of a vaccination is not an uncommon occurrence. The vesicle may be delayed a day or two in its progress; an eight day vesicle may be no larger than is one ordinarily on the sixth, and the areola may be delayed to the tenth day or later.

A relatively long period of *incubation* is frequently observed. This fact I have been particularly struck with after the use of dry bovine virus. My friend, Prof. I. E. Atkinson, of Baltimore, informs me that he has no-

ticed the stage of papulation to be postponed from five days to a week. Afterward, however, the disease runs a normal course.

Seaton has ascribed this delay to the use of dry lymph, which after being put in the skin simply waited solution to be absorbed. This explanation is undoubtedly correct, and if it hold good for humanized lymph, such as was used by Seaton, it is doubly true of bovine albumen, which is far more insoluble.

The *constitutional symptoms* are sometimes very slight. The febrile reaction, the test of systemic infection, differs in different subjects, and is undoubtedly more or less intense according to the activity of the lymph employed. The contiguous *lymphatic glands* are sometimes much enlarged; but suppuration is rare, and when it occurs is apt to be due to the natural or acquired unfavorable condition of the patient.

Bryce's Test—If vaccine virus be reinoculated on the fourth, fifth or sixth day after a primary vaccination, the vesicles of the second insertion are hurried forward so as to overtake the first crop, and the whole come to maturity together. The second

crop are not more than one-fourth the normal size, and the areola surrounding them is likewise much diminished. If no acceleration of the secondary vesicles be observed, it is to be considered that the first vaccination failed to infect the system. The second is then to be looked upon as the primary affection, which in turn should be tested by a third, and so on. The practical carrying out of this procedure would be a matter of great difficulty, even if the theoretical deductions to be drawn from it did not admit of question.

Vaccinia after Small-Pox.—It has sometimes been observed that vaccinia, more or less normal in its course, will occur after small-pox. I have noticed this quite a number of times in persons who had undergone variolous inoculation in their youth. Recently, I saw quite a characteristic revaccination result in a medical man, who had suffered small-pox in Vienna, in 1876. The literature of vaccination will afford numerous instances of such an occurrence. It is to be observed, however, that the small-pox has

been experienced, in most cases, many years before.*

Vaccinia Revived.—Some curious instances of the revival of dormant vaccinations have been reported. Mr. Shepherd (*Lancet*, June, 1881, p. 978), records the case of a nurse whom he vaccinated on the right arm unsuccessfully in four places, four years before. Lately he again vaccinated her on the left arm in four places, producing one well-marked vaccine pustule. In a few days the four places on the right arm threw out distinct areolæ, and showed tolerably characteristic marks of successful revaccination.† A case is mentioned by Sir Thos. Watson of a little girl who was vaccinated in infancy, and in whom the spots became well developed pustules during an attack of influenza, fourteen years afterward. Mr. Byerly relates an instance where the virus remained dormant for two months before taking. Other instances have been published.

Insusceptibility of Vaccinia.—It must be admitted, both from analogy and actual

* For cases and references see *New York Med. Record*, July 5 and 26, 1879.

† *London Med. Rec.*, July 15, 1881.

experience, that some persons, at one time or another, are insusceptible of vaccinia ; but this condition of system must be exceedingly rare. Inefficiency in the operation of vaccination, or some fault in the quality of the lymph employed, generally lies at the bottom of such inaptitude.

CHAPTER V.

ABNORMAL MODIFICATIONS AND COMPLICATIONS OF VACCINIA.

Spurious Vaccinia.—It has been seen that a vaccination may be regarded as running a normal course, although in some of its stages more or less retardation, or slight acceleration, may occur; but in other instances the departure from the customary phenomena of the eruption is widely marked. Now, while some of these forms of irregular vaccinia are perhaps protective—for small-pox is nevertheless small-pox in spite of perfectly analogous local modifications—it is an eminently safe rule to assume that the vaccination has been ineffectual unless it has developed a characteristic vesicle and well-formed areola, running a fairly typical course. Any doubt as to the genuineness of a vaccinal result should always be put to the test of a revaccination.

A so-called spurious vaccinia may take on one of the following aspects: 1. Red tubercles, the size of peas, appear at the

seat of vaccination. These tubercles afterward suppurate. Hebra says they correspond to ordinary follicular furunculi. The prevalent notion that these tubercles appear only after the use of bovine virus, is incorrect, for this irregularity was observed years before the introduction of animal vaccination. 2. In other instances the vesicle commences with much itching and irritation; it is not umbilicated, but acuminated or conoidal, and contains straw-colored, or opaque, instead of clear lymph; the areola is completed by the fifth or sixth day, and begins to decline on the eighth day, the scab falling off by the tenth day. 3. Instead of the usual papule or vesicle, a bulla containing a transparent fluid and having a reddened margin, may develop. Troublesome ulceration sometimes arises beneath the crusts, which are formed after the rupture of the blebs. 4. A crop of herpetic vesicles, preceded by shivering, may appear about the third day after vaccination. These soon burst, and the exuded fluid gives rise to an eczematous eruption, the skin becoming hard and œdematous. Intolerable itching accompanies the vesicles, and the ax-

illary glands become enlarged. 5. Occasionally, vesicles which have apparently run a normal course up to the eighth or tenth day, suddenly rupture, and ulcers, that spread both superficially and deeply, make their appearance. They cause pain or itching, and are accompanied by much constitutional disturbance.

Erysipelas after Vaccination.—Erysipelas is a comparatively rare, although one of the most serious complications of vaccinia or rather of vaccination. Dr. Ballard makes a wise distinction between erysipelas *after* vaccination and erysipelas *from* vaccination. He points out that the disease may occur as a consequence of the prevalence of general erysipelas, or may be due to sanitary defects in the house of the patient. Dr. J. Lewis Smith* observes that the vaccination acts often merely as an exciting cause, not from any deleterious property in the virus itself, but just as an equal degree of inflammation might be produced from a cut, burn or other indifferent agency. On the other hand, the virus itself may be the direct exciting cause. Vaccinal erysipelas may com-

* Dis. of Children.

mence immediately after the operation, or it may wait upon the development of the vesicle, or be delayed until the fall of the crust. Its symptoms and course require no particular description.

Excluding those cases of erysipelas in which the vaccination has been merely an accidental factor, it is stated that the disease is prone to occur from use of revaccination lymph, from spurious primary cases, or from lymph taken at too late a period of the vesicle, or finally from lymph which has become partially decomposed. It should not be forgotten that erysipelas after vaccination is of exceedingly rare occurrence, much rarer than after small-pox in former days.

Influence of Mechanical Interference.—The course of the vaccine vesicle is sometimes interfered with by mechanical influences, such as scratching, rubbing of the clothes, etc. The inflammation under these circumstances is apt to be increased, and supuration may occur. The scab which results is composed of large yellowish crusts unfit for use in vaccination. It is quite possible that in this case the protective influence of the disease is not decreased, but a safe prac-

tice would be to revaccinate after such an untoward event.

Glandular Involvements, etc.—Inflammation and suppuration of contiguous lymphatic glands are sometimes an annoying, although not generally a serious complication. Hebra* states that occasionally swelling of the parotid and submaxillary glands occurs after vaccination, attended with rather abundant salivation. In children of a vitiated constitution, when the inflammation surrounding the vesicle has been intense, circumscribed abscesses may occur. Mr. Savory† reports a case of pyæmia following about the ninth day after vaccination, which resulted in death. Dr. Day‡ records the case of a patient who had wasting of the deltoid, and paralysis of the arm, which he regarded as consequent upon vaccination.

Otitis Media Suppurativa after Vaccination.—My friend Prof. H. N. Spencer, the distinguished otologist, of this city, has given me the notes of six cases of suppurative ear trouble, which were apparently the result

* *Dis. of Skin*, New Sydenham Soc., vol. i, 1866.

† *St. Bartholomew's Hosp. Rep.*, vol. xv, p. 263, 1879.

‡ *Dis. of Children*; Phila. 1881, p. 98.

of vaccination. These cases occurred this winter during the general vaccination and revaccination, in persons who had never suffered before from any similar disorder. The affection was of a violent character, just as in scarlet fever, etc., and made its appearance in one case three days after vaccination, in three cases on the tenth day, and in two cases between the tenth and fifteenth days (exact date unknown). The persons affected were all adults, and had been the subjects of revaccination.

Vaccinal Eruptions.—It is an old observation that certain *acute* eruptive disorders sometimes occur in the course of a vaccinia. I quite agree with Behrend* that they do not owe their existence to any specific action of the vaccine virus, but that they are perfectly analogous to the exanthemata following the internal administration of drugs: in neither case possessing any constancy of expression, but differing in different individuals. As these cutaneous manifestations may occur at any period between the operation of vaccination almost to the date of separation of the crust, I ap-

* Arch. Derm., October, 1881.

prehend that they are excited by one of several causes: First, the irritation of the skin caused by the act of vaccinating. Second, the presence of vaccine virus circulating in the blood. Third, the direct absorption of septic material during the period of suppuration. As in medicinal rashes, we must acknowledge an individual idiosyncrasy in their production. According to my own observation these vaccinal eruptions have almost invariably appeared after the ninth day of vaccination. As regards the roseola vaccinia, Hebra places it between the third and eighteenth day. Behrend makes two distinct periods for vaccinal eruptions, of which the first begins on the second day at the latest, and the second on the eighth day. The most common eruption met with is roseola, which first shows itself near the point of vaccination, thence gradually spreading over a large extent of surface (Hebra) or occurring as a macular exanthem appearing evenly distributed over the body, imperfectly distributed on the extremities and entirely sparing the face (Behrend). A minute description of the various vaccinal eruptions, although of great interest

to the dermatologist, would be out of place here. Therefore, it will suffice to say that bullous and vesicular eruptions, urticaria, and the eruption of erythema multiforme have been recorded. I have been particularly struck with the prevalence of erythema multiforme during the past winter, which was undoubtedly consequent upon vaccination. I have notes of several cases of ecthyma and one of herpes zoster, occurring several weeks after the fall of the scab, directly over and about the vaccinated region. Ceely and Gregory have seen vaccinia attended with purpura.

These manifestations are all benign in character, and always end in complete recovery; but a cutaneous complication of considerable more gravity is described by Hutchinson* and Stokes,† under the name of vaccinia gangrænosa. In Mr. Hutchinson's case, the child from whose arm the lymph was taken was apparently healthy, and three other children vaccinated from the same source showed no unusual symptoms. On the eighth day the vaccinated

* British Med. Jour., December 13, 1879.

† Dublin Med. Jour., June 1, 1880.

spots had risen, as usual, but the child's body presented an eruption, which was first mistaken for variola. Three days later the vesicles of the eruption were surrounded by large red areolæ which developed into gangrenous patches. The child died three weeks after vaccination. The vaccination scars were normal. In Mr. Stokes' case, purple and black spots appeared within forty-eight hours after vaccination, which subsequently became gangrenous. The vaccine vesicles ran a normal course. The child recovered.

Eczema after Vaccination.—In eczematous subjects the operation of vaccination is apt not only to aggravate an existing eruption, but also to arouse a latent predisposition to the disease. In these cases, however, the vaccination acts merely as an exciting agent, just as eczema is often produced in those predisposed to it by piercing the ears for ear-rings, etc. Most of the instances of so-called scrofula after vaccination are merely examples of eczema thus aroused.*

Generalized Vaccinia.—So-called su-

* Mr. Tait has reported, on the other hand, cases of long standing eczema in children, where the vaccination apparently provoked rapid cures.

pernumerary vesicles, which are the result of accidental inoculation during the operation of vaccination, or from the subsequent transfer of lymph to abraded surfaces, are not uncommon. The existence, however, of true eruptive vesicles, the "vaccine généralisée" of the French, admits of serious question. Vaccinators of very large experience have never seen such an occurrence. Doubtless the significance of certain accidental vesicular eruptions has been misinterpreted. Of course, the true test would be their capacity, upon inoculation, of producing normal vaccine vesicles. Ceely remarks that it is rare to see them upon parts to which lymph might not have been directly applied. He further states that it is not absolutely necessary that the skin should have been visibly abraded. It is but just to observe that M. Hardy, the distinguished dermatologist, is reported as saying at the recent Medical Congress, that generalized vaccinia is common. I have seen cases that were supposed to be instances of true eruptive vesicles, that a careful examination proved to be merely the result of auto-inoculation.

Vaccinal Syphilis.—Numerous instan-

ces of the transmission of syphilis by the operation of vaccination are recorded. Viennois* is of the opinion that it is the blood drawn in collecting the lymph which is responsible for the contagion and not the lymph itself.† According to Keyes‡ vaccinal syphilis yields the most convincing proof that heterologous diseases upon a syphilitic person do not contain the poison in their secretions. Inherited syphilis sometimes develops after vaccination, the operation merely hastening into activity the latent trouble. Again the vaccination may not possess even this causal relation, the syphilis being upon the point of outbreak at the time of the vaccine inoculation.§ The appearance of the

* Arch. Gén. de Méd., June, 1860 (quoted by Bumstead & Taylor).

† This fact is supported by the statement of Willan that the variolous pustule may be developed within the margin of the vaccine vesicle, and matter taken from it produce small-pox, while fluid taken from the opposite edge of the vesicle communicates cow-pox. (Vaccine Inoculation, p. 6, Note, quoted by Seaton).

‡ The Venereal Diseases; N. Y., 1880.

§ An instance is recorded, where for some reason a proposed vaccination was postponed; in the interval the infant developed an inherited syphilis. In this case, as in all other troubles that happen to appear after vaccination, the parents would have been only too happy to have availed themselves of a convenient scape-goat for their own infirmities.

constitutional symptoms of syphilis within a few days or weeks after vaccination would render it probable that the disease was already latent in the system, the period of syphilitic incubation being considerably greater. Mr. Hutchinson, while admitting that the pure lymph of a vaccine vesicle is perhaps never the vehicle of contagion, thinks that it is sufficient to let the vesicle draw or weep, in order to engage in the secretions corpuscular elements of the blood, and tissues.* Where the vaccine crust is used, which always contains a portion of the true skin, the only guarantee for safety would be in the condition of the child from whom it was taken. Even with our present facilities for obtaining virus direct from the calf, it should not be forgotten that syphilis may be conveyed by using an *infected* instrument.

My friend, Dr. Robt. W. Taylor,† of New York, has pointed out in a very forc-

* It is still believed by some that, in these cases, the blood is not the only vehicle of contagion, and that epidermic scales, or leucocytes, or the secretions of an ulcer underlying the vaccine vesicle (Reinecker) may also be responsible. Bumstead & Taylor, *Veneral Diseases*, 1879 p. 433.

† Arch. Dermatol., vol. ii, 1876; and Bumstead & Taylor, loc. cit., p. 434.

ble manner the dangers of this practice. In the case reported by Taylor, a number of persons were vaccinated in succession using the same scarificator without cleaning it. An infant, who was vaccinated immediately after a young prostitute affected with syphilis, developed a chancre at the point of inoculation, which was followed by the usual general lesions. The vaccine employed was in quill form and furnished by the Board of Health.*

Influence of other Diseases on Vaccinia.—It has been observed that if a vaccination have been successfully performed during the incubation stages of certain diseases, e.g., measles, scarlatina, chicken-pox, and the early or febrile stage of whooping cough, and the vesicles do not reach their period of areola before the particular affection manifest itself, it will frequently happen that the areola will not form till the disease has subsided, sometimes for two weeks or more, or it may not form at all. On the contrary vaccinia has frequently been seen

* On this subject, consult F. P. Foster in the *Am. Jour. Syph. and Derm.* 1870-1871 and vol. iv, 1873.

running its course along with these affections and uninfluenced by them.*

The respective influence of small-pox and vaccinia upon each other is of much interest and of vital importance practically. When, to quote Dr. Seaton, vaccination has been performed on any one who is incubating small-pox, if the incubation of that disease be so far advanced that the small-pox manifest itself within two or three days of the vaccination, no vaccine vesicles will rise, but small-pox only will be developed. Under these circumstances variolous vesicles will often be met with on the vaccinated spots. But if the incubation have been less advanced, and the cow-pox have taken local effect before the small-pox symptoms set in, the further progress of the vaccination may, or may not, be retarded. Very frequently the two diseases may be seen going on together.† If, however, the cow-pox vesicles had not reached the stage of areola before the small-pox set in, no influence will be exert-

* See ref. in Seaton's Hand Book, p. 87. Dr. J. Lewis Smith (*Dis. of Children*, p. 208) states that the paroxysmal cough of pertussis is arrested by vaccinia, to return when the pock begins to desiccate.

† Loc. cit., p. 88.

ed on the course of the small-pox; if, on the other hand, the areola be fully formed around the cow-pox vesicles before the small-pox symptoms appear, the vaccination will, according to its date, either arrest the small-pox at its premonitory stage or alter and modify the course of the eruption.

Causes of Vaccinal Irregularities and Complications.—In the foregoing sections mention has been made of some of the causes of irregular and complicated vaccinia, and in a chapter to follow the question will be still further discussed. It will be sufficient to say here, that in some cases no particular cause can be assigned for these untoward results. The virus may be all that could be desired, the person vaccinated apparently in perfect health, and others inoculated from the same virus may present typical features, yet the vaccinia fails to run a normal course. In most instances, however, these anomalies are capable of direct explanation. Excepting those cases where there is an individual predisposition to eruptive disorders, epidemic influences, etc., the fault generally lies with the source of lymph supply, the condition of the person vaccinated, or in the

manner of operating.* After all, the deviations from the usual course of vaccinia are very rare. In the words of Dr. Thin, the overpowering arguments in favor of vaccination are not weakened by such exceptional cases; and as their occurrence does not escape the notice of the public, the legitimate influence of the medical attendant can only be strengthened by his being able to admit and explain their existence.†

* During the late war, especially in the South, the spurious results of vaccination were of frequent occurrence. Prof. Joseph Jones, as a consequence of his investigations on Spurious Vaccination in the Confederate Army, arrived at the following conclusions as to its causes: 1. Lowered vitality—scorbutic condition. 2. From abnormal lymph, from persons previously vaccinated or having eruptive diseases. 3. Scabs or lymph undergoing decomposition, long carried about the person. 4. Mingling vaccine virus with that of true variola, as in persons having varioloid. 5. Virus from persons having erysipelas, pyæmia, gangrene, and suppurating wounds. 6. Lymph, scabs, etc., from persons suffering from syphilis. Quoted in the Proc. Med. Soc. Kings Co., October, 1880.

† Edin. Med. Jour., December, 1881.

CHAPTER VI.

REVACCINATION.

Course of Revaccination.—When a person who has undergone a successful primary vaccination, is again submitted to the operation, there will be either no result; or a modified effect, running an irregular and eccentric course, will follow; or, less usually, the normal course of the regular vaccinia will be observed.

The results of vaccination in a small number of persons, even in recently vaccinated children with good scars, are quite typical.* In the majority, however, the effects are exceedingly irregular; in some instances papules, with some effort at vesiculation, occur; in others acuminated vesicles, with hard and irregular areolæ, arise, the whole process, including the fall of the scab, being completed by the eighth day. Meyer † proposes to classify the results obtained in re-

* This statement, so far as regards children, is made on Seaton's authority. I have never witnessed it.

† Vierteljahr. f. Derm. u. Syph., v. Jahrg., 1879, 2 u. 3 Heft.

vaccination as follows: 1. Those in which the pustules* run the course of primary vaccinia, or else do not reach their acme before the fifth day. 2. Those in which they reach their acme by the fourth day. 3. Those in which the pustules reach their acme on the second or third day. 4. Irregular manifestations (scales, scabs), or else none at all—negative results.

Severe constitutional symptoms are much more frequent after revaccination than after the primary vaccination, and, so far as my own experience goes, certain forms of vaccinal eruptions are much more common. I am quite convinced that during the prevalence of variola epidemics, the susceptibility of vaccinia is increased, and that it is then not uncommon to produce some degree of result, when at other times the issue would be negative.†

What Constitutes a Revaccination?

What is to be considered a vaccinal effect

* It should be borne in mind in reading foreign literature that the vaccine vesicle is generally called a pustule.

† As it is claimed (Gregory) that puberty, inflammatory diseases, change of climate, etc., revive the predisposition to variola, the same conditions may produce analogous results for vaccinia.

after a revaccination, is a question that has been variously answered. I exclude of course those cases where a tolerably normal vesicle and areola are developed; but refer particularly to slight dermatitis, infiltration of the skin, more or less developed papules, and abortive vesiculation. Niemeyer's* investigations, which I have frequently verified, are quite pertinent to this question. He had the opportunity of following day by day the effects of revaccination on five hundred recruits. The number of men who developed normal pocks was proportionately small, but the number where there was no result was equally slight. In most cases a few days after the vaccination, there were redness, infiltration of the skin, papules, vesicles, etc. Among the latter class, in many cases, eight days after the operation, the inflammation had run its course, and if unwatched during the interval, they would have been classed among those where the vaccination had no effect. These inflammations, he continues, may have been the result of the wound from the lancet, of scratching, or of the foreign body introduced under the

* *Textbook Pract. Med.* vol. ii, p. 556; New York.

epidermis; but at the same time it was possible that they were due to incomplete vaccinia running a rapid course, and holding the same relation that varioloid does to variola,—vaccinoid. To determine this point he first vaccinated a number of persons with the contents of blisters and pustular eruptions, and in none of them was the result produced. He also vaccinated others in whom the phenomena mentioned above had been observed, and in these also he failed to get similar effects.

How often should Revaccination be Performed.—The idea that the disease vaccinia, once typically received, exhausts all future susceptibility of small-pox, finds no acceptance at the present time, although a fixed article of faith in the early days of the practice. There is no reason to doubt that the most perfect vaccination loses its effect in the course of years. There is equal reason to believe, however, that the value of the protection afforded is in direct proportion to the thoroughness of the vaccination and to the quality of the lymph employed. As this last proposition will be thoroughly discussed in a subsequent chapter, I shall

content myself with certain facts as they now obtain, and not as they may perhaps be under more efficient vaccination with animal virus.

In the first place, as frequently referred to in former sections, all doubtful primary vaccinations should be put to the test of revaccination. It is the moral duty of the medical man to see to it that the operation has been surrounded with all possible safeguards. Again, if the amount of vaccinal effect produced be not so great as was expected, or if the vaccine scars lack the appearance of genuineness, or if, while typical in character they are deficient in quantity, I can see no objection to a further vaccination. But assuming that the primary vaccination was normal in all respects, the important question still remains to be answered, How often should revaccination be performed? Seaton* in his excellent treatise, tells us as the result of the experience of many observers, that every person should take care to be revaccinated about, or soon after, the period of puberty. He states that under ordinary circumstances the age of fifteen is the best

* Loc. cit. p. 305.

time for it to be done, since experience has shown that the most danger to be dreaded from post-vaccinal small-pox is from the age of fifteen to twenty-five. In girls, in whom the changes connected with puberty occur early, the revaccination may be correspondingly anticipated. Dr. Welch,* of the small-pox hospital in Philadelphia, regards revaccination at the age of puberty of extreme importance; but also states that when there is danger of infection it is wise to revaccinate all persons who have been vaccinated more than five years.

From my own experience, and after careful survey of the whole question, and in view of the general inefficiency of vaccination, and especially from the fact that individuals undoubtedly vary as to the immunity granted by vaccinia; I should say that under danger of infection, revaccination should be performed even if a few months only had elapsed from the date of the previous inoculation; and moreover I am constrained to agree with Trousseau who recommends that vaccination be repeated as often as once every five years; for if this practice be un-

* Phila. Med. Times, August 13, 1881.

necessary it is at all events free from objection. Finally, it may be stated that those most experienced in the use of true bovine virus claim that an adult revaccinated with animal lymph will be as fully protected against small-pox for the rest of life as, "if he or she had twice had that disease." (Martin).

CHAPTER VII.

MERITS OF DIFFERENT KINDS OF VACCINE VIRUS.

General Considerations.—It has been shown in another chapter that vaccine virus may be produced in a variety of different ways. For practical purposes we are concerned only with that kind which is the result of the inoculation of a series of human subjects with vaccine lymph, or with that other kind, called by Dr. Martin, "heifer-transmitted cow-pox virus," the animal lymph of European writers, which has never passed through the human organism. In this country, where vaccination with bovine virus is almost the universal rule, the relative merit of animal and humanized lymph has lost much of that burning interest, which still attaches to it in Europe, and especially England, where the so-called Jennerian lymph finds many staunch, and perhaps bigoted, defenders; still the subject is one of much scientific and practical moment, and will require somewhat detailed consideration.

Has the Prophylactic Power of Vaccinia Degenerated?—The fact that vaccine virus, which has gone through many successive transmissions (cultures) from its original source, undoubtedly *loses much of its prophylactic influence, would seem to be well established.* If the question be examined statistically, we shall find that the fewer removes that the lymph had undergone from its original fountain-head in the cow, the more marked was the freedom from post-vaccinal small-pox; while as time rolled on and the lymph became weakened by innumerable transmissions, the frequency of post-vaccinal variola correspondingly increased.

In 1802, about four years after Jenner had made public his discovery, a committee of the House of Commons thoroughly investigated the subject, with a view of determining his claims to a national reward, and succeeded in finding only two cases in which small-pox had occurred after properly performed vaccination. A number of special inquiries made in immediately succeeding years gave the same general results. Even as late as thirteen years after the practice had been introduced, no fatal case of post-

vaccinal small-pox had been recorded. In Copenhagen, at the time a city of over one hundred thousand inhabitants, where vaccination was universally practised, not a single death from small-pox was recorded during the thirteen years, 1811-23. In Anns-pach, Bavaria, with a population of about three hundred thousand, no death from small-pox took place in the nine years, 1810-18. Of more than two and a half millions of people vaccinated in France between the years 1804 and 1813, only seven were known to have contracted variola.

With these facts in view, it is not at all surprising that Jenner should have dreamed of the possibility of exterminating small-pox from the face of the earth; and it is well known that up to the close of his life (1823) he resolutely opposed the idea of the decay of the vaccine influence by the lapse of years, and proposed a number of theories to account for the fact which each day was becoming more apparent, viz.: the more frequent occurrence of post-vaccinal small-pox.

But even before Jenner's death, small-pox after vaccination was becoming more frequent and more fatal, and this frequency and fatality

have steadily increased. Thus, in France, from 1819-35, there were registered 5,467 cases of small-pox after vaccination, of which fifty-one were fatal. In Switzerland, 4,211 cases occurred between the years 1822-32, with ninety-two deaths. Several epidemics occurred in Copenhagen, from 1825-35, in which it is noted that there were 3,093 post-vaccinal cases, and sixty-six deaths.

Further statistics could be adduced to prove the greater frequency and fatality following the use of long-humanized virus; but I shall bring to an end this part of our inquiry by appending the conclusions reached by Dr. Cameron in his able and exhaustive essay on this subject : *

1. That the protection against small-pox afforded by the vaccine lymph in use in this country (England), though still great, has become much less than it was when the lymph had undergone comparatively but few transmissions through the human subject.

* *Fortnightly Review*, May, 1881. I am indebted to this article for much material, also to the able paper on vaccination by Prof. C. A. Lindley, M.D., in the Fourth Annual Report of Connecticut State Board of Health, 1882.

2. That the number of cases of small-pox occurring per million of vaccinated persons is very much greater than that shown in the records of vaccinated populations in the earlier part of the century.

3. That the death rate in recorded cases of post-vaccinal small-pox has progressively increased in all cases, with and without marks, from 1.75 per cent in 1819-35 to over 10 per cent in 1870-79, and in cases with marks from 6.9 per cent in 1831-51 to 9.2 per cent in 1870-79.

4. That this increase in mortality has been remarkable in the best vaccinated classes of cases, the death rate in cases with three or more cicatrices in 1870-79 being twice what it was in 1852-67; and the death rate in cases with three or more good cicatrices in 1870-79 being thrice what it was in 1852-67.

5. That the proportion in which vaccinated children are attacked and cut off by small-pox has alarmingly increased, being many times greater during the last decade than it was thirty or forty years earlier; and,

6. That while the death rate in small-pox occurring in unvaccinated persons has varied in the different groups recorded, and was ex-

ceptionally high in 1870-79, the progressive advance of mortality in post-vaccinal small-pox is not to be attributable to epidemic influence, being equally observed in successive groups of cases in which the mortality from natural small-pox shows a diminution.

Examined from another point of view anyone can satisfy himself of a marked difference, both local and constitutional, which will be exhibited according as the operation of vaccination has been performed with long humanized lymph or with the fresher bovine virus. The Jennerian lymph will produce a vaccinal lesion which will run through its various stages much more rapidly, and the whole process, including the fall of the crust, will have been accomplished by the fourteenth or seventeenth day. On the contrary, the march of the vaccinal process after the use of animal lymph is much more deliberate, and the crust rarely falls before the twenty-first day, and frequently not till a longer period. In brief, the often deprecated "violence" of bovine virus gives us the best assurance that we are dealing with a stock that has lost none of its pristine vigor, and which most corresponds in its sev-

eral phenomena to the vaccinations of the early Jennerian days.

The Disadvantages of Humanized Virus.—The gravest charge that could be brought against humanized virus has been considered in the preceding section, namely, that when long humanized it loses much of its power of granting immunity against variola. But even if this objection were not valid, there are a number of others of serious importance. It has been found in England, a country where vaccination is compulsory, and where the means of carrying out the practice are arranged upon the most comprehensive scale, that sole dependence upon human vaccine, particularly during epidemics, sometimes places the authorities in difficult and dangerous straits. If "vaccine famines" are possible in Great Britain, how much more likely would they be in countries where there exists no State provision for the proper cultivation and dissemination of humanized lymph.*

* For a full consideration of all the points bearing on this question, with which, however, the American reader is interested in a historical and scientific, rather than in a practical way, I would refer to Martin's valuable paper, already freely quoted, in the *Trans. Am. Med. Ass'n* for 1877.

It seems to be quite universally acknowledged that erysipelas occurs with unusual frequency after the use of humanized lymph, and if it can be established that the bovine virus is free from this serious disadvantage, no one should hesitate to encourage its general use.

No one denies that syphilis has been transmitted, or rather inoculated by vaccinating with humanized virus, and this deplorable fact, rarely as it has occurred, brings us to one of the most important disadvantages of virus which has passed through the human system, viz: that its employment has destroyed public confidence in vaccination.

The Advantages of Bovine Virus.—
Relying upon the statistical information which has been presented, showing the infrequency and small mortality of variola in the early history of vaccination, that is, in the days when humanized lymph had undergone but few transmissions from the natural disease in the cow, the conclusion would seem to be fully warranted that frequently renewed bovine virus would afford an equal protection in our day. M. Warlomont* strongly

* Brit. Med. Jour., November 12, 1881.

reiterates the assertion made by him as to this matter some years ago. He states that out of more than ten thousand children vaccinated at Brussels with animal vaccine from 1869-70, not one case has to his knowledge been reported as having been attacked by the terrible epidemic that ravaged Europe soon after. He has made a number of appeals for information as to cases of variola after animal vaccination, but so far without result. Others have made similar requests, and have offered large rewards for such information, but without avail.

It has been repeatedly urged by some that bovine virus "does not take well." Without any reference to individual success, which of course depends altogether upon personal skill and experience, we have recently been put in possession of certain statistics, which show that in experienced hands animal vaccination gives, to say the least, as good a percentage of successes as can be exhibited by vaccination done with ordinary current lymph by equally skilled vaccinators. Dr. Warlomont* writes that when calf-lymph is inoculated direct,

* *Loc. cit.*

taken from good pustules at the proper age, no other failures are known but those resulting from the manipulations of the operator. Out of three hundred children thus vaccinated by himself, not one puncture failed to produce a good pustule. When preserved vaccine was used in primary vaccination the successes were at the rate of ninety-six per cent.; and in revaccinations at the rate of sixty-two per cent. Dr. Martin, in this country, reports his successes in revaccination to be "exactly seventy-three per cent. at the first attempt;" and if those cases which fail to be affected at the first trial are twice more attempted, the result is raised to a fraction over eighty per cent. Dr. Browning gives his percentage of successes in upwards of one thousand vaccinations and revaccinations as 97.13 per cent. He states that Dr. Renner's percentage of successes is 98.3.*

Mr. Ernest Hart,† in a recent address on animal vaccination, presents some further statistics, which were supplied him by Dr. Carstan, of The Hague, as follows:

* *Med. Times and Gaz.*, February 25, 1882.

† *Brit. Med. Jour.*, November 26, 1881.

“ In 1869, when animal vaccination was begun in Rotterdam, there were sixty-seven failures out of 542 operations; last year (1880) there were only four failures in 2727 operations, whilst in 1563 of these the full amount of ten vesicles was obtained. At Amsterdam, there were nineteen failures in 1879—when animal vaccination was started—out of 626 operations; whilst during the last six years there has been but one single failure out of a total of 14,849 operations. Similar experience comes from The Hague, Utrecht and Haarlem; and the gross total of all the vaccinations performed in Holland with animal lymph, including all the early efforts, shows that out of 60,754 operations only 720, or little more than one per cent., have been unsuccessful.”

“ Testimony such as this,” says Mr. Hart, “ and on so large a scale, shows indisputably that the allegations made against the taking power of calf lymph have no foundation in fact.”

The rather enthusiastic claim made for animal lymph, that erysipelas is never known to occur from its use, and further that it may indeed be looked upon as a prophy-

lactic against that disease, I think is subject to criticism. The prime fact remains, however, that while erysipelas was only too frequent an accompaniment of humanized virus vaccinations, it is rarely attendant upon properly performed operations done with carefully selected bovine virus. I am convinced that those having experience with both kinds of lymph will unquestionably confirm this statement.

Above all, the assurance that it is not possible to convey syphilis by means of animal vaccination, gives the practice a value which is paramount. There is neither scientific nor practical evidence that any of the diseases of animal life have ever been inoculated by means of bovine virus. Finally, one of the greatest advantages of animal vaccination lies in the fact that any quantity of vaccine lymph may be produced at will.

Disadvantages of Bovine Virus.—The disadvantages which may arise from the use of bovine virus can be summed up in one word—the lack of proper supervision over its cultivation. If all “propagators” were as skilled and honest as we know some of them to be, the necessity for legal control of some

sort would not be demanded ; but it is a notorious fact that bovine virus cultivation is carried on, in some instances, in a manner so ignorant that it would be amusing if it were not criminal. It is no doubt true that various untoward results, such as erysipelas, local inflammatory neoplasms, ulcerations, and even tetanus,* have followed the use of "commercial" bovine virus, especially during the past winter ; but it should be remembered that if proper discretion be exercised in the selection of animal lymph such unfortunate consequences would be averted. Moreover, it should not be forgotten that such ill effects, and worse, are known to have followed the employment of humanized vaccine. The distressing experience of the confederate army, referred to in a preceding section, could hardly have occurred under the use of bovine virus. The acknowledged disadvantages of animal vaccination could be quickly remedied if the national or state boards of health had power to control its application.

* *St. Louis Courier of Med.*, April, 1882.

CHAPTER VIII.

METHODS OF OBTAINING AND STORING VACCINE VIRUS.

Propagation of Bovine Virus.*—The practice of propagating bovine virus is not the simple matter that business cupidity would make it; but, on the contrary, requires great technical skill, knowledge and perseverance on the part of the physician, by whom alone such work should be undertaken. The essential features in the proper and safe carrying on of animal vaccination are as follows: 1. To use for the purpose carefully chosen healthy calves of a suitable age and trustworthy pedigree. 2. To keep them in separate stalls in well ventilated and drained stables. 3. To so arrange their diet as to guard against intestinal or other derangements. 4. To protect the inoculated parts from all contact with decomposing ma-

* For much valuable information in regard to the practical details of animal vaccination, I am indebted to Dr. Frank P. Foster, of New York. I have also drawn largely on the admirable report of vaccine farms made by Dr. James Law to the National Board of Health, in their Bulletin for April 1, 1882.

nure or fæces. 5. The taking of the lymph at the proper period, and from unbroken vesicles. 6. The thorough purification of the material upon which the virus is to be stored, and its subsequent protection, both before and after charging, from flies and other insects. Law objects to the practice of taking calves indiscriminately for the purpose of inoculation, and suggests that the best interests of vaccination would be served if the progeny of vigorous and sound animals only were used, and for this purpose recommends that a large breeding herd be kept on hand under the supervision of an accomplished veterinarian.* The same observer warns against the preference given for calves of the Jersey breed, that stock being particularly prone to tuberculosis. I believe that calves between three and six weeks of age are the most suitable for vaccination; but some experienced vaccinators employ calves somewhat older—six to eighteen months—they being more independent as to diet, and said to give a larger yield of lymph.

* In Holland a veterinary surgeon is attached to every *part* *vaccinogene*.

After the calf selected has been fastened down on a properly constructed table, the part to be operated upon should be washed with a weak thymol or carbolic acid lotion, and then shaved, and subsequently re-washed with the antiseptic solution. The lower third of the belly is usually chosen for lymph insertion, but from the liability of the parts to exposure, to pressure and friction, and danger from contact with urine and fæces, it has been suggested by Dr. Law that the dorsal rather than the ventral surface be selected.* In all cases it is well to protect the inoculated parts with a canvas cover. Not more than sixty or seventy finger-nail-size, very superficial, abrasions are usually made.

According to Dr. Foster,† “ the incubation varies from three to six days. The stage of vesiculation follows a rapid course—frequently the calf will seem to show no sign of success on the seventh day, and on the following day the efflorescence is at its height. Incrustation begins speedily, and the crusts soon

* The objection that the animal would lick the inoculated surfaces of the back, Law states could be prevented by applying *beads* around the neck, as in blistered horses.

† Personal communication.

mature. The vesicle is not usually so pronounced as in the human subject, and it is never surrounded by an areola. The crusts are seldom characteristic (owing perhaps to traumatism). The temperature rises about two degrees at the height of the disease, but otherwise there is seldom any sign of fever. A calf's normal temperature is one hundred degrees."

Some difference of opinion exists as to the proper time for taking the lymph. Dr. Foster considers the lymph to be good as long as it is clear. Others claim that the earlier it is secured the better. It has been said that the virus is most intense from the third to the seventh day. Dr. Browning,* an English vaccinator, writes that the vesicles should be opened as soon as acumination is observed, up to the fifth day, inclusive. Dr. Griffith † declares that up to the seventh day the unbroken vesicle contains no superadded products, and will induce uncomplicated vaccinia; but that at a later period the ruptured vesicle becomes the nidus of septic and other bacteria. Un-

* *Med. Times and Gaz.*, February 25, 1882.

† Quoted by Dr. Law., *loc. cit.*

der favorable circumstances it is possible to charge from two to four thousand points from the yield of one heifer; but when to collect, and how much to collect, are often matters of individual experience as applied to particular cases. It is manifest that only clear lymph, taken from unbroken vesicles, should be employed, and from animals which exhibit no abnormal symptoms.

Collection and Storage of Bovine Virus.—The methods of collecting and storing animal lymph vary somewhat, and will require a brief description. The custom which prevailed at Milan of cutting out the pustule and using the whole mass for vaccination has been very justly condemned. It is difficult to understand how so reckless a proceeding should ever have been tolerated. Dr. Browning advises that the vesicle be pinched up with forceps. Any colored exudation or serosity that exudes is wiped off, and the vesicle is removed with a broad double-edged scalpel, and drained by slight pressure on to a piece of glass. The dry scab is left alone for fear of septism, but the pool of lymph running from it is “microscoped” and used as necessary. At one of

our most trustworthy vaccine establishments it is the custom to first remove the crusts that form over the patches, to seize the vesicle between the blades of a pair of long dressing forceps, and as soon as the lymph begins to exude, to charge the points on both sides. Others claim to collect the lymph on the points without pressure. At one establishment the lymph is said to be collected in small bottles without pressure, and the points are afterwards dipped into these, thus obtaining the mixture of lymph from the various inoculated patches.

Some excellent authorities on animal vaccination, among them Martin and Foster,* claim that the presence of blood in the lymph is of no importance; others urge that all specimens of virus should be free from blood corpuscles. Generally speaking, admixture of blood with animal lymph must be regarded as objectionable; but in the hands of honest and experienced propagators, who select healthy calves and attend faithfully to all the details of the practice, I should look upon the presence of blood as not particularly contra-indicated, aside from the fact that it

* Proc. Med. Soc. King's Co., October, 1880.

is practically very difficult to avoid it. The case is very different with humanized virus.

Bovine virus may be variously stored for preservation and use. The crust may be used, or the lymph may be preserved between glass plates, in capillary tubes, or dried upon quill slips and ivory points. I have the authority of Dr. Foster for the statement that bovine crusts are almost wholly worthless, which agrees entirely with my own experience. It is a difficult matter to obtain crusts that are free from blood, pus, and casual impurities of all sorts. Upon the Continent and in England glass squares are sometimes used. I am not aware that this method is practiced here. Most of our vaccinators also discard the capillary tubes. This most excellent method for the long preservation of humanized lymph has been found unsuitable for bovine virus. Dr. Warlomont* however, claims excellent results with them when prepared in the following manner: The lymph is first collected in large glass tubes, two or three millimeters in diameter; after a short interval of time, it is deposited in a capsule of glass or por-

* Brit. Med. Jour., November 12, 1881.

celain, when it separates itself into a clot surrounded by serum. When all the serum has been thoroughly pressed out and the clot reduced to its minimum, the liquid thus obtained is introduced into its permanent depository, which is closed up with a preparation of paraffine or asphalt. If the vaccine be not required for immediate use, a very small quantity of distilled water is added, with about one-tenth part of glycerine, to prevent any consecutive changes. If the virus is to be used very soon after it is put up this addition will not be necessary.

Quill slips and ivory points are the favorite method for preserving dry lymph. The first-named are preferred by many propagators, the ivory points being considered too porous, absorbing too much lymph on the one hand, and giving it up too meagerly on the other. My personal preference is for the well-prepared ivory points, since they are also very convenient and cleanly for use in vaccinating; besides I have not failed to get a good percentage of successes from their employment. The essential thing to be attended to, whichever be selected, is to see to their thorough purification before their coating

with lymph, and their prompt drying and seclusion from extraneous influences afterward.*

Lymph in the dry state, provided it be kept in a cool place, may retain its infectious qualities for a long period; but as a rule slips are valueless after a week or ten days, and if carried about in the pocket or other warm place rapidly deteriorate. Finally, it should be stated that direct vaccination from the calf with living lymph should be practiced when practicable, as it holds about the same relation to safety and efficiency as does arm-to-arm vaccination in the human subject.

Methods of Obtaining Humanized Virus.—It is obvious that the same rules hold good for the human vaccinifer as for the calf, namely, that the vaccine lymph or crust should be taken only from such subjects as are healthy and born of healthy

* Patent lymph cones, of which I have no personal experience, are said to be both fraudulent and dangerous. Microscopical examination of the mass which they contain shows them to be made up of animal and vegetable debris of various sorts. Prof. Lindsley states that he has been informed that an amount of "consolidated solid lymph," enough to make one of these cones, could not be produced for more than one hundred times the price named in the advertisement. Very serious results are reported as having occurred from their use.

parents. As a matter of course, the virus should be the product of perfectly normal vaccinia, *occurring in a child not previously vaccinated.** Lymph may be taken, so far as effectiveness is concerned, as soon as the vesicle will yield it; it is best taken, and can be gotten in largest quantities, when the vesicle is fully formed, but before the areola appears, or within a very few hours of its commencement, which in regular cases is the day week of the vaccination. The most experienced vaccinators are agreed that lymph should not be taken at a later age of the vesicle, for while it will yield it in greater abundance, it does not take with certainty, and according to Seaton and others is more apt to lead to erysipelalous and spurious results. Good lymph is more or less viscid, and not thin and serous. For the purpose of obtaining the lymph, the vesicle, being cellular in structure, should be opened by a number of minute punctures on its surface, and not around the base, for fear of blood admixture. If by inadvertence any blood be

* The italicized caution would seem unnecessary, if the writer were not familiar with instances of vaccination done with the products of revaccination in adults.

drawn, this should be allowed to coagulate and carefully removed before any lymph is taken. On no account should the vesicle be pinched or squeezed to obtain a greater supply.* In America the majority of practitioners have been in the habit of using the spontaneously separated crust for vaccination. According to Scofield,† Mr. Bryce was the first to recommend the scab as a substitute for the lymph.

Various Modes of Storage of Humanized Virus.—Vaccine virus from the human subject may be preserved for use between glasses, in capillary tubes, upon points, and in the crust. For immediate use it is sometimes the custom for practitioners to coat the points of their lancets with lymph, but the practice is not commended if there should be a delay of more than a few hours. The vaccine bottle, a small phial with a glass stopper, made in such a manner that its inner surface projects into the bottle in the form of an oblong plate of glass, on which the lymph is collected, is also employed for immediate use. Or the lymph may be col-

* Seaton's Handbook, pp. 123, 124.

† Pract. Treatise on Vaccinia or Cow-pock; New York, 1810.

lected between plates of glass, one of which may if desirable contain a cup-like depression at its center.

Seaton mentions to condemn the proposition which has been made of keeping lymph liquid by mixing it with glycerine. He says that aside from the manifest objection to using anything but pure and unmixed lymph, he knows that this practice has given rise to a large relative amount of failures. Curschmann,* on the contrary, declares that the lymph and glycerine mixture appears to keep quite as well as the unmixed lymph, and asserts that the certainty of result is not at all less than after the use of pure lymph. Müller, who introduced this method, usually mixes the lymph carefully with two parts of glycerine and two parts of distilled water (by means of a small brush in a watch glass), and preserves the liquid in air-tight capillary tubes. This mixture, according to Müller, can be still further diluted (one to eight) without perceptible deterioration. Reiter has obtained a feeble action with dilutions of one part lymph to two hundred of water. I cannot help regarding any at-

* Ziemssen's Cyclop. vol. ii, p. 413, Am. Edit.

tempt at lymph dilution as highly pernicious, and calculated to lead to much present and future mischief.

A very common method of preserving humanized lymph is by means of the capillary tubes, and for long storage they offer many advantages.*

Thoroughly coated ivory points and glasses are also recommended.† Dr. Pott‡ speaks highly of lymph preserved in capillary tubes, which has been rendered aseptic by equal parts of a three and one-half per cent solution of boracic acid, while lymph treated in a similar manner by a five per cent solution of carbolic acid, gave negative results.§ After filling and securely

* For a full account of the methods of employing the capillary tubes, consult Dr. Husband, as quoted by Seaton in his *Hand-book*, and by Heath in his *Minor Surgery*.

† To insure success with dry lymph, humanized or bovine, requires that the material upon which it is stored should be very heavily charged.

‡ *Jahrb. f. Kinderheilk*, xvii, Bd. 2 u. 3 Heft.

§ Pott also employed a salicylic solution (1 to 300). According to the *Brit. Med. Jour.*, April 22, 1882, Pott's results coincide with the more extensive experiments of Braidwood and Vacher, although he fails to give his methods of procedure. Braidwood and Vacher have insisted on the great importance of using special instruments for each set of experiments; on the necessity of testing the efficacy of the vaccine itself before drawing inferences from its action when mixed with antiseptic

sealing capillary tubes, Dr. Benoit,* puts them into test tubes filled with lard, so as to cover them. They are then kept in a cool place till used.

The humanized crust, the usual method of preserving vaccine virus employed in the United States, while far inferior in my judgment to other preparations of vaccine, must also be regarded as dangerous, con-
solutions; on the influence of lengthened contact with the anti-septic, especially in the case of carbolic acid; and on the falsity connected with the ordinary manner of conducting such experiments by inoculating a subject on the one arm with vaccine and on the other with the experimental fluid. In their second report they state "that a saturated solution of salicylic acid does not impair the efficacy of the vaccine contagium;" and that a saturated solution of boracic acid "impairs the vitality of vaccine contagium little if at all, even after having been kept some days in contact with the contagium particles." On the other hand (in their first report) their conclusions in regard to the influence of carbolic acid on the vitality of vaccine were, "(a), that the immediate inoculation of a mixture of vaccine and a moderately strong solution (1 to 20 aq.) of carbolic acid succeeds in a certain number of instances; (b), that such a mixture, preserved for some time, seventeen days to six weeks, fails to produce vesicles," and that the mixture of vaccine with stronger solutions of the acid, and likewise with carbolate of glycerine, "destroys the efficacy of vaccine." They have further distinctly proven that antiseptics in the gaseous state are much more potent destroyers of the vitality of vaccine than are such in solution or in fluid form. These reports were made to the Scientific Grants Commission of the British Medical Association.

* *Lyon Med.* June 5, 1881.

taining of necessity blood cells and necrosed tissue. In England, where vaccination with humanized lymph has been carried to the highest perfection, the use of the crust or scab is condemned. The American resort to the crust I think has been a matter of necessity rather than choice, but nevertheless it has led to much inferior vaccination. During the small-pox epidemic of ten years ago, I had an abundant opportunity of satisfying myself that Europeans generally were infinitely better vaccinated than our own countrymen, and the conclusion seems justified that the use of the crust was largely responsible for our inadequate protection.

CHAPTER IX.

THE OPERATION OF VACCINATING.

General Considerations.—Simple as the operation of vaccinating seems to be, as a matter of fact it requires considerable technical skill in its performance, and an amount of theoretical and practical knowledge of the subject, which is but rarely appreciated either in or out of the profession. "If," declares Mr. Marson, "a little operation—little apparently in practice, but very important in its results,—well performed, can save many lives, as most certainly it can, and prevent much suffering and sorrow, it should surely always be done with the greatest care, and in the best known way. The success of all operations depends on nice care and management. Operations for hernia and stone, for instance, if roughly, carelessly, and badly done, end badly; so it is with vaccination; and, so far as the public is concerned, it is quite as objectionable to them, no doubt, to die of small-pox because they have been carelessly and badly

vaccinated, as it would be to them to die of hernia or of stone, because the operations for these complaints, respectively, had been badly performed. In the latter case the day of retribution would occur immediately; in the former, unfortunately for its correction, it is delayed for perhaps twenty years or more; otherwise it would soon be set right. The operation, as an operation, has not been properly estimated from the first introduction of it in England, and it should be looked upon as a blot on our polity that vaccination has been worse performed, generally, in England, its birth place, than in any country in Europe." *

This state of affairs of late years has undergone great improvement in England; but I doubt if there is a civilized land where less is known of the theory and practice of vaccination than in America. The reasons for this are several. There is no doubt that in the early days of the practice, there was a greater knowledge of the subject everywhere; the works on vaccination of Coxe and others show that it was fully appreciated

* Art. Small-pox, Reynold's System of Med., p. 150, Am. Edit.

and understood in the United States. In the lapse of years, however, the great discovery became so much a matter of fact, that it no longer aroused the absorbing interest so universal at its inception. In England, an official inquiry made in 1859, developed the fact, as stated by Seaton, that matters of the utmost practical importance, which had been published years and years before, were unknown to a large majority of vaccinators; such, for instance, as the proper time to take lymph, the influence of the quality of vaccination on the small-pox death rate, etc. In this country, where there is no national recognition of the practice, where vaccination from arm-to-arm is comparatively unknown, and that from the scab very nearly general, it results, as a matter of course, that the knowledge of the vaccinal process, necessitated by the English and continental methods, is not widely diffused.* Druggists, midwives, and lay persons of all descriptions finding that medical men make light of this truly momentous operation, usurp the functions of physicians; and the consequence of the whole matter is that human life is jeopard-

*The subject is criminally neglected in our medical schools.

ized, and the beneficent science and practice of vaccination are fallen into a certain amount of disrepute.

Vaccination being determined upon, there are a number of matters to be duly considered before the operation is begun, viz :

Condition of the Person to be Vaccinated.— Under ordinary circumstances the individual to be vaccinated should be in good health. It has been shown that acute febrile processes markedly interfere with the normal course of vaccinia, but on the other hand certain chronic maladies offer no bar to vaccination. I am satisfied from personal observation that the presence of syphilis in the system does not contra-indicate the operation. The same experience is also said to hold good for scrofulous subjects. Intestinal and cutaneous affections decidedly contra-indicate vaccination. It is well known that Jenner laid much stress on the fact that herpes, eczema and intertrigo prevented the normal reception of the vaccine influence. The nomenclature of the eruptions he specified may, with our present dermatological knowledge, be subject to some criticism ; but I am fully satis-

fied in my own mind, that the general rule as to avoiding the performance of vaccination during the eruption of cutaneous diseases, is one that is not lightly to be disregarded, although there are undoubtedly many exceptions to it. Besides, certain eruptions, such as eczema for instance, are certainly aggravated by vaccination.

It is said that pregnant women should not be subjected to vaccination; but the opinions of the best authorities are against such conclusions. Gast, who vaccinated a large number of pregnant women at various stages of gestation, did not observe any untoward results from the practice.

The rules as to the selection of individuals to be vaccinated are necessarily modified by circumstances; if, for example, a patient be exposed to the risk of infection by small-pox, it is a plain duty to vaccinate in spite of any contra-indication.

Age.—A child born in the midst of small-pox contagion should be vaccinated at once. I have seen the happiest results from such a procedure. As young children are the chief sufferers from small-pox—English statistics showing that one-fourth of all fatal cases

occur in the first year of life—it is clear that vaccination should not be delayed beyond a reasonable period. In large cities, where variola is more or less prevalent at all times, vaccination is demanded at a comparatively early age—a month to six weeks,—provided there is no good reason for a longer delay.* It may be stated as a general rule that when the health of the child permits, the operation should be performed about the age of three months. As has been pointed out,† this time of life is particularly suitable from the fact that it anticipates the period of dentition, which with its attendant irritations and derangements might seriously interfere with the normal development of the vaccinia.

Circumstances which Demand the Immediate Performance of Vaccination.—It has already been stated that under danger of infection no age should be exempt from vaccination. It sometimes happens that small-pox breaks out in a household where there are a number of unprotected or imperfectly protected persons. The question then arises: Will it be of any avail to vaccinate individuals who have already been

* Seaton, loc. cit., p. 118. † Lindsley, loc. cit., p. 128.

exposed, for a greater or lesser period, to the variolous contagion?

This matter has been so well put — and in a manner that so exactly coincides with what my own experience leads me to believe to be true—by Seaton and Marson, that I am constrained to present their observations as fully and literally as space will allow. At once and without any delay, says Seaton,* the vaccination of all such persons should be performed; the loss of a day may be the sacrifice of a life. It does not follow, he continues, that because a person has been exposed to the infection of small-pox, he has therefore received infection, and the vaccination may be in time to prevent the infection altogether; but, supposing that before the vaccination is performed the variolous infection has actually been taken up by the system, unless that infection have so far got the start that the small-pox symptoms appear before the vaccination reaches the stage of developed areola, the vaccine process will nevertheless either prevent or modify the small-pox eruption; if, on the other hand, the variola manifest itself before

* Handbook of Vaccination, p. 119.

the vaccination has reached its protective stage, *the stage of areola*, the vaccination, though it will have done no good, will have done no harm—the small-pox will go on as though it never had been performed. As the incubative period of small-pox is twelve days, while the time required to bring the vaccinia to the stage of areola is only nine days, vaccination performed any time within the first three days will reach areola soon enough to produce its protective power; after this, whatever the local success of the vaccination, no constitutional effects will be imparted. The late Mr. Marson, than whom no one could speak with greater authority, put the matter in this way: * Suppose an unvaccinated person to inhale the germ of variola on a Monday; if he be vaccinated as late as the following Wednesday, the vaccination will be in time to prevent small-pox being developed; if it be put off until Thursday, the small-pox will appear, but will be modified; if the vaccination be delayed until Friday, it will be of no use, it will not have had time to

* Small-pox, Reynold's Syst. Med. vol. 1, p. 154, Am. Edit.

reach the stage of areola, the index of safety, before the illness of small-pox begins.

The idea which I believe was first suggested by Eichhorn,* and now and again revived, that small-pox could be modified by the free inoculation of vaccine matter after the disease had developed, does not seem to me tenable, whether considered from the standpoint of theory or actual experience. In quite a number of observations made by myself upon this subject, I do not remember to have seen the slightest influence exerted upon the variola by the vaccine inoculation. If vaccinia and variola are identical in nature, as I believe they are, such practice would be highly unscientific.

Performance of the Operation.—The proper performance of vaccination requires a consideration of the best methods of preparing the virus for insertion, and the best way of inserting it under the epidermis.

A. Preparation of the virus.—If liquid lymph be used, whether direct from the human or bovine vaccinifer or preserved in tubes or otherwise, no preparatory steps are necessary other than taking it up on a clean

*Rayer on Dis. of Skin. Am. Edit., 1845, p. 157.

instrument, and inserting it into the cutis in the manner that has been determined upon. If the vaccine crust be employed a small portion should be carefully reduced to powder and then made into paste with water. The solution thus prepared should be used with a free hand. Lymph that has been preserved by storing on quill or ivory points or between glasses, requires a certain amount of preliminary care before insertion; it is necessary that the virus be rendered liquid, "revived," before insertion is attempted. This is best done with a minute quantity of cold water. This precaution is doubly necessary when bovine virus is employed.

B. Methods of Inserting the Virus.—The main object in view in vaccinating is to see that virus is applied in such a way that it will be most readily absorbed into the system. To this end various methods of insertion have been recommended and practiced. The two most common modes of procedure are by puncture and scarification.*

If puncture be determined upon, the patient's arm should be grasped by the

* Application of a vesicant and by hypodermic injection have also been mentioned, but are not to be recommended.

left hand of the operator, so as to render the skin tense, and a sharp, perfectly clean, well-charged lancet should be introduced by valvular puncture, from above downward, so that the lymph may gravitate into the wound. The lancet should be held at an angle of about 45 degrees, and made to penetrate the cutis. It is recommended that when puncture is employed it is advisable to make each puncture a double one. // A modification of the puncture is by tattooing. ¶ Another modification of puncture is by first smearing the lymph over the arm and then ripping up the cuticle with the point of a not very sharp lancet. The method by scarification consists in making a number of single or double scratches, // or abrading the skin by a series of closely set parallel lines, /// or by a further series of cross scratches. ■ Indeed, the cuticle may be abraded in any way that will safely and thoroughly expose a sufficient absorbing surface. The favored mode of operating in this country and latterly in England, is by the more certain and effective method of scarification. It is undoubtedly to be preferred to all other procedures.

I do not believe that any special contrivances for effecting vaccination are necessary; a good lancet that is kept scrupulously clean, and used for no other purpose, being all sufficient; but my own preference is to use for each case a separate ivory point or quill upon which the lymph is stored.

If a lancet be employed it should be thoroughly cleansed before being used upon another person. The chief points in successful vaccination, especially animal vaccination, are to first revive the lymph and then to rub it gently but thoroughly into the abraded surface, and above all to use it with a lavish hand.*

Vaccinations are generally performed in too hurried a manner; on the contrary the vaccinator should proceed with the utmost care and deliberation. My habit is to work the lymph into the wound until dry, and not leave the absorption to chance. In vaccinating we should endeavor to go deep enough to cause a slight oozing but not a flow of blood, and any superfluous blood should be wiped away before applying the lymph. The

*The habit of using one point or quill for two persons is both filthy and dangerous.

usual place selected for vaccination is upon the left arm at the insertion of the deltoid and along its posterior border. The several punctures or abrasions should be made at some little distance from each other.

It has been found by abundant observation that both the quality and the quantity of the vaccination bear a vital relation to subsequent protection from small-pox. Marson's famous table giving the results of his observations on nearly 5,000 post-vaccinal cases of variola, which occurred in the twenty years—1836 to 1855, inclusive—testify in a striking manner to the truth of this assertion :

Classification of Patients Affected With Small-Pox.	No. of Deaths Per Cent. in Each Class Re- spectively.
1. Unvaccinated - - - - -	35
2. Stated to have been vaccinated, but having no cicatrix - - - - -	23.57
3. Vaccinated—	
<i>a.</i> Having one vaccine cicatrix -	7.73
<i>b.</i> Having two vaccine cicatrices -	4.70
<i>c.</i> Having three vaccine cicatrices -	1.95
<i>d.</i> Having four or more vaccine cicatrices - - - - -	0.55
<i>a.</i> Having well-marked cicatrices -	2.52
<i>β.</i> Having badly-marked cicatrices	8.82
4. Having previously had small-pox -	19

It will therefore be seen that not only

should the vaccination be well done, but the system should at the same time be thoroughly infected.

The practical question then arises, How many punctures should be made, if that be the method followed, or what should be the number or area of the abrasions if scarification be practised? Seaton says that in vaccinating by puncture *not less* than five should be made at a distance of one-half inch from each other. Marson always made six punctures. In some countries ten to sixteen punctures, five to eight on each arm, are advised. Of course, where abrasions of the cuticle are resorted to, the area of the inoculation is to be considered rather than the number of individual marks to be produced. As pertinent to this point I shall quote from a paper by Dr. J. B. Russell, of Glasgow. "The number of vaccine marks can have no meaning, excepting so far as they indicate in a general way the quantity of lymph introduced into the system. It cannot be that the same quantity of lymph introduced into four spots successfully, confers more immunity than if introduced into one spot successfully, or that by

dividing a cicatrix into four, its productive value is increased. Hence, I am inclined to think that the local and permanent phenomena which would best indicate the quantity of lymph introduced, and consequently show even more striking relations to the mortality, would be the superficial area of good vaccine cicatrices. It seems evident from Marson's description of his mode of vaccination that he would produce four good vaccine marks whose united area would probably little exceed one vaccine mark such as is left by the operation as practised at our public vaccine stations at Glasgow."

It is stated by Dr. Bridges, in an official report to the English Parliament, that the vaccination department now requires as a test of efficient vaccination, that the united area of the cicatrices should amount to half a square inch. It is no doubt true that vaccination done with bovine virus does not require the amount of local effect made necessary by the use of long humanized vaccine lymph* ; but as the reaction from

* Dr. Cameron has published tables showing that small-pox mortality has progressively increased in the best class of cases—cases amply vaccinated and with good scars—under the use of long-humanized lymph.

one abrasion is no greater than from three, safety and efficiency would demand the larger number under any circumstances, or their equivalent in area.

Inspection of Results.—Vaccination having been duly and properly performed, it is the duty of the medical man to see that the disease thus produced runs a normal and typical course. Nothing could be more unfortunate than an inefficient primary vaccination; for a false security is thereby engendered, which may not only be disastrous to the individual, but will necessarily bring the cause of vaccination into disrepute. The subsequent course of a vaccination should be watched with the same care and anxiety as the after treatment of any of the major operations of surgery. The physician should impress upon his patient the necessity for this watchfulness, and explain that a sore arm does not necessarily mean protection against small-pox; but that vaccinia runs a certain typical course, the various stages of which can only be properly appreciated by expert knowledge. The English vaccination laws require that a vaccination should always be duly inspected, the period for such

inspection being established at the eighth day. Seaton urges that the patient should also be seen on the eleventh and twelfth days, so that we may be assured that the stage of areola, "the index of safety," has been passed in a satisfactory manner. At any rate the vaccinator will have done but half his duty, who fails to have his patient return on at least the day week from the day of vaccination.

CHAPTER X.

EXAMINATION OF THE OBJECTIONS TO VACCINATION.

General Considerations.—It seems scarcely credible to the well-informed mind that any one should question, or even for a moment doubt, the rich blessing that the practice of vaccination has conferred upon the world; yet we hear it gravely charged that vaccination does not afford protection against small-pox, and that its inoculation has entailed innumerable miseries upon the human race.

All that is claimed for vaccination by its warmest advocates is that, "*duly and efficiently performed,*" it will either altogether prevent or materially modify small pox, and that by the exercise of ordinary skill and care, the operation will not be followed by any harmful consequences. The space at command forbids the consideration of the many wild and baseless assertions which have been uttered by that class of people opposed to everything established. With the general

statement, however, that, after nearly a century of severest trial, vaccination stands to-day an assured fact in the estimation of the scientific world, I shall proceed to consider the question from the only two stand-points at all worthy of serious attention, viz : Does efficient vaccination and re-vaccination protect against small-pox? and, Does the operation of vaccination introduce into the system other diseases than vaccinia?

Protection Afforded by Vaccination against Small-Pox.—The present generations have no conception of the horrors of small-pox as it existed uncontrolled by vaccination. Macaulay, the great English historian, comparing the ravages of small-pox at the close of the 17th century with the ravages of the plague, says: “The havoc of the plague had been far more rapid, but the plague had visited our shores only once or twice within living memory, but the small-pox was always present, filling the church-yards with corpses, leaving on those whose lives it spared the hideous traces of its power, turning the baby into a changeling at which the mother shuddered, and making the eyes and cheeks of the betrothed maiden

objects of horror to the lover." The disease attacked the mighty as well as the lowly; it spared neither the palace nor the hovel. Mary, the wife of William III, died of small-pox, as did his father and mother, his uncle, the duke of Gloucester, and his cousins, the eldest son and youngest daughter of James II. In the court of Austria, Joseph I succumbed to it, to which list may be added "in the course of the 18th century, besides him, two empresses, six archdukes and duchesses, an elector of Saxony and the last elector of Bavaria." A dauphin of France died of variola in 1711 and a king of France in 1770, besides a queen of Sweden in 1741 and an empress of Russia in 1727. Such deaths occurring at the present day would fill the world with horror and consternation. Those who escaped with their lives were maimed and disfigured. Large numbers of the deaf and blind owed their misfortune to small-pox. The annual mortality of small-pox in England was about 3,000 to every 1,000,000 of inhabitants. In France 30,000 persons perished annually of variola. It is stated that within the years 1783-99 one-tenth of the total mortality at

Berlin was due to small-pox. In a single year, about 1560, De la Condamine declares that it destroyed in the province of Quito more than 100,000 Indians. In 1721, one-half the population of Boston was attacked with small-pox, one-thirteenth of which died.

Such facts and figures could be largely multiplied from accurate historical data, but there is little dispute about their correctness; the deductions to be drawn from them are questioned by the so-called anti-vaccinators.

Small-pox is to-day, among unprotected persons and communities, as virulent and destructive as in the past. We have numerous records of epidemics among unvaccinated people, which show that the disease has lost none of its malignancy.

In seeking to inform ourselves as to the protection from small-pox afforded by vaccination, it should never be forgotten that the practice gained its first foothold in public and medical estimation through the *experimentum crucis* furnished by direct inoculation. So confident were the early disciples of vaccination as to its protective influence that they did not hesitate to inoculate with small-pox virus, and otherwise expose to its infec-

tion, those who had been successfully vaccinated. Nearly all of the early cases were thus tested.

Although it has been shown in another section that the prophylactic influence of vaccination is not so great as in former years, the causes for this diminution have also been indicated and its remedy pointed out; but even with this decay of vaccine influence, together with the careless manner in which the operation is generally performed, universal and extended experience furnishes an overwhelming argument for the practice, and the farther back we extend our inquiries the more convincing are the proofs. For example, in Sweden, before the introduction of vaccination, the annual death rate from small-pox was 2,050 out of every million of population, while during the 40 years, 1810-50, it was but 158; in Westphalia, where the deaths from small-pox were formerly 2,643 per million, between the years 1816-50 it fell to 114; in Bohemia, Moravia, and Austrian Silesia it was reduced from 4,000 to 200; in Copenhagen from 3,128 to 286; and in Berlin from 3,422 to 176. In Annsbach,

Bavaria, with a population of over 300,000, all thoroughly vaccinated, no deaths from small-pox occurred between the years 1810-18. During Mr. Marson's term of thirty years in the London Small-pox Hospital, 15,000 cases of variola were under his charge, and his statistics prove that the unvaccinated died at the rate of thirty-five per cent, while the presumably vaccinated died at the rate of $6\frac{1}{2}$ per cent.

When small-pox prevails in a community where some are protected and others unprotected, the influence of vaccination is most strikingly shown. Thus in the Island of Bombay, for the years 1848-53, the small-pox deaths among the general population, the majority of which was unprotected, were 5.8 per cent of the mortality from all causes; but among the European residents, mostly protected by vaccination, the small-pox deaths were for the same periods but 1 per cent of the deaths from all causes. In observations made for twenty-one years on four millions of people in Bohemia, it was discovered that the death-rate among vaccinated persons who contracted small-pox was $5\frac{1}{16}$ per cent, while

on the other hand, the mortality among the unvaccinated who contracted small-pox was 29½ per cent.

Dr. Buchanan,* Medical Officer of the Local Government Board (England), has published a memorandum, dated June 3, 1881, with the object of showing the proportionate prevalence of small-pox, and the proportionate mortality caused by it among the vaccinated and unvaccinated, respectively. The Registrar-General had for the previous year recorded all the information obtainable on the subject, returning only the cases certified to by registered practitioners, and dividing the London mortality returns into three classes, namely, the vaccinated, the unvaccinated and those cases where it was not stated if the deceased had been vaccinated or not. It was shown that there died in London from variola during the 52 weeks 1,532 persons of all ages, of whom 325 were certified to have been vaccinated, 637 as not vaccinated, and 570 belonging to the "not stated" class. In the

* *Med. Times and Gaz.*, June 18, 1881. The memorandum was published as a parliamentary paper. The facts above are taken from an editorial in the journal quoted.

tabulated statement which follows, the "not stated" deaths are set aside. Dr. Buchanan gives the grounds upon which he calculates that the vaccinated persons of all ages living in London in the twelve months concerned were 3,620,000, and the unvaccinated of all ages 190,000 in number, and he deals with the mortality from small-pox in these two classes respectively. He also examines in the same way the small-pox death-rate of persons under twenty years of age, and of those under five years. The results are as follows :

Comparative small-pox death-rates among Londoners, vaccinated and unvaccinated respectively, for the 52 weeks ended May 29, 1881 :

Death-rate of people of subjoined ages.	Per million of each age of the vaccinated class.	Per million of each age of the unvaccinated class.
All ages	90	3,350
Under twenty years	61	4,520
Under five years	40½	5,950

In order to view the question from all possible sides, Dr. Buchanan also adds that if it could be imagined that all the "not stated" deaths were of unvaccinated persons, the respective rates of all-age small-pox mortality would be 90 for the vacci-

nated and 6,350 for the unvaccinated; for those under 20 years of age the rates would be 61 for the vaccinated, and 7,428 for the unvaccinated, and for those under 5 years, 40½ for the vaccinated, and 9,300 for the unvaccinated; while, on the other hand, if it could be imagined that all the "not stated" deaths were of vaccinated persons, the rates of all-age mortality would become 247 for the vaccinated and 3,350 for the unvaccinated; under 20 years of age 260 for the vaccinated and 4,520 for the unvaccinated; and among those under 5 years of age, 334 for the vaccinated and 5,950 for the unvaccinated. Thus, from whatever standpoint the matter is examined, the advantage of the vaccinated over the unvaccinated is made manifest, although this advantage would have been exhibited in a still clearer way if the Registrar-General's returns had noted the character of vaccinations, and the thoroughness with which they had been performed.*

* The Med. Times and Gaz., commenting editorially on the facts and figures given above, says: "It will be noticed that the table given above shows that among the *vaccinated* the rate of mortality from small-pox is half as much again where persons up to 20 years of age are included as it is in children

By thorough vaccination is meant a primary vaccination "duly and efficiently" performed, both as to quality and quantity, and no less efficient revaccination.

Nothing short of this is to be considered adequate vaccination, and any figures purporting to show the failure of vaccination as a preventive of small-pox are valueless unless it can be proved that these prerequisites of efficient prophylaxis have been fully carried out.

Marson's table, already quoted, shows the value of *efficient* vaccination in a way that cannot be questioned. Observations made by Drs. Seaton and Buchanan during the small-pox epidemic in London, in 1863, on

under 5 years; and that the all-age mortality is again half as much again as it is where only persons up to 20 are taken. Among the *unvaccinated*, on the contrary, the mortality-rate is at its maximum during childhood, and diminishes as life advances. The explanation of this appears to be that the protection afforded to the vaccinated by vaccination diminishes with age, while among the unvaccinated the liability to death from small-pox diminishes with age; they have had small-pox, perhaps, and recovered from it, or they are less exposed to it, or with advancing age the susceptibility to the contagion diminishes." These figures demonstrate in an incontrovertible way the value of infant vaccination, and the necessity for revaccination. Some tables published in the *Boston Medical and Surgical Journal*, February 10, 1881, are worth consulting in this connection.

upwards of 50,000 school children, exhibit from another point of view the necessity of having regard to the *efficiency* of the vaccination in estimating the protection which it is capable of affording. They give the following results of their inspection.

Some of the children examined had never been vaccinated; the large majority had been vaccinated in various manners and degrees. Of every thousand without any mark of vaccination they found that no fewer than 360 had scars of small-pox; while of every thousand who presented evidence of vaccination only 1.78 had such traces. Upon further classification as to the *kind* of vaccination they noted the following facts:

Classification of Children Examined.	Proportion Marked With Small-pox Per 1000 Children in Each Class Respectively.
1. Having no vaccine marks	360
2. Vaccinated—	
<i>a.</i> Having one vaccine cicatrix	6.80
<i>b.</i> Having two vaccine cicatrices	2.49
<i>c.</i> Having three vaccine cicatrices	1.42
<i>d.</i> Having four or more vaccine cicatrices	0.67
<i>x.</i> Having cicatrix or cicatrices of bad quality	7.60
<i>y.</i> Having cicatrix or cicatrices of tolerable quality	2.35
<i>s.</i> Having cicatrix or cicatrices of excellent quality	1.22

On taking the extremes it appeared that of children having four or more perfect vaccine marks, only 0.62 per thousand had any trace of small-pox, while of those who had a single bad mark, 19 per thousand were disfigured by small-pox scars. They conclude, therefore, that as against small-pox of such extent as to leave any traces, the best vaccination had been upwards of thirty times as protective as the worst. In addition, Dr. Seaton declares that the numerical statement is far from expressing the whole difference; for while the small-pox left but very slight traces on those who had been vaccinated, and especially those who had been well-vaccinated, a large proportion of the unvaccinated were seriously disfigured, and in some instances the disease had caused permanent blindness or deafness.*

It is not now claimed that a single vaccination is a sufficient protection against small-pox for the rest of life—repeated observation has taught the necessity for revaccination at stated intervals; but systematic revaccination, thoroughly performed, almost completely extinguishes the suscepti-

* Reynold's System Med., p. 169, Am. Edit.

bility of small-pox in a large number of people.

Nothing more clearly exhibits the efficacy of proper vaccination and revaccination — it is difficult to dissociate the two — than the medical history of the Franco-Prussian war. At that time, according to Dr. Welch,* small-pox prevailed to an alarming extent, and both armies were fully exposed to the contagion; but the German mortality was only 263 men, while the French loss was 23,468, although the latter army was at no time more than half the size of the former. The explanation of the marked difference in the small-pox mortality of the two armies lies in the fact, as pointed out by Dr. Welch, that in no country is vaccination carried on with greater care and thoroughness than in Germany. Almost every infant is vaccinated within a year after birth, and revaccination is usually performed about the twelfth year. Every soldier is vaccinated upon entering the army, and if the operation fail it is repeated again and again until some result is obtained, or the surgeon is satisfied of vaccinal insusceptibility. In the French

* *Phila. Med. Times*, August. 13, 1881.

army neither vaccination nor revaccination was compulsory; in fact, the whole military establishment was practically unprotected from variola.

Mr. Marson states that very few persons have been admitted into the London Small-pox Hospital who acknowledged to an effectual revaccination, and these few have had small-pox in a very mild form. For over thirty years he revaccinated all the nurses who came to live in the hospital, and who had not had small-pox, and not one of them contracted the disease during the stay there. Dr. Welch says that very few persons have ever been admitted into the hospital under his charge who presented evidence of having been successfully revaccinated, and these few have had the disease in so mild a form that death has never occurred among them. During the last ten years no person entering the hospital in an official capacity, physicians, nurses, etc., who had taken the precaution to be revaccinated, has contracted small-pox, while a few in whom revaccination had been omitted have taken it.

Similar facts and statistics could be multi-

plied indefinitely, and those desirous of further information are referred more especially to Simon's "Papers Relating to the History and Practice of Vaccination," and Mr. Hart's excellent compilation, "The Truth about Vaccination"; but enough has been supplied for the purposes of this chapter.

Although common observation and irrefutable experience have long since recognized in vaccination an invaluable protection against small-pox, the brilliant researches of Pasteur upon the prevention of chicken cholera and charbon have placed the practice of vaccination, in its broadest sense, upon a basis of scientific security, which nothing can overturn. However, years before Pasteur's discoveries were made known, it was practically demonstrated that sheep could be protected from sheep-pox by the inoculation of the virus of that disease, and this fact was recognized and made use of by practical men, just as the stock raisers of France are now seeking protection against splenic fever, because common sense and business acumen suggest the practice.

While "anti-vaccinists" are constrained to allow, which they cannot well help with

the historical data before them, that small-pox prevailed to a much greater extent in past generations than now, and that for certain reasons its virulence has much diminished, they assign as a cause for this diminution the influence of better modes of life, improved hygiene, etc.,—small-pox, according to them, originating *de novo* as the result of insanitation. This unscientific hypothesis, besides ignoring the universally acknowledged contagiousness of variola, sparing none, whatever the hygienic surroundings, unless protected by vaccination, does not take into account the fact, as pointed out by Martin,* that small-pox did not make its appearance in Europe and America† for many centuries, although all the factors, insanitation, etc., existed in a more marked degree than now. But one of the most striking illustrations of the invalidity of this argument, and incidentally of the power of vaccination over variola, is supplied by the state of affairs which ob-

* North Amer. Rev., April, 1882.

† Small-pox appeared first in Germany toward the end of the 15th century, in England about 1241, and was conveyed to America soon after the discovery of the new world, where it was totally unknown before.

tained at Andersonville, a military prison in the South, during the late war. It is said that small-pox was twice introduced into Andersonville, where nearly 60,000 prisoners were confined under the most unfavorable conditions, but owing to the thorough re-vaccination of the soldiers at the date of enlistment, not more than a dozen deaths occurred.

Alleged Dangers of Vaccination.—

It has been urged by anti-vaccinists that the practice of vaccination has brought a multitude of ills upon the world, which are far more disastrous than small-pox. It is claimed that it has (*a*) produced new diseases, (*b*) that it has led to an increase in the mortality of existing diseases, (*c*) that glandular and cutaneous diseases may be invaccinated, (*d*) that syphilis may be invaccinated, and (*e*) that certain diseases of animals may be conveyed by bovine vaccination.

So far as the first allegation is concerned it may be dismissed without comment as being utterly preposterous and unfounded. The whole idea is based upon the grossest misconception of pathological laws. As a medical writer has said, when vaccinia is in-

oculated it produces vaccinia and nothing else. No disease is more frequently inoculated than syphilis, but no one ever claimed that its introduction into the system caused anything else but syphilis and its sequelæ.

The second allegation is equally without basis of fact, but as statistics have been brought to its support, one word of explanation may be necessary. It has been claimed that certain diseases, such as measles and scarlet fever, have become more frequent and more malignant since the introduction of vaccination. This statement possesses "some semblance of truth ; but if we remember that small-pox was, and is, extremely fatal in childhood, it can be readily understood that vaccination, by diminishing small-pox mortality, leaves a larger number to be attacked by other diseases. "Vaccination," says Seaton, "does not profess to make mankind immortal; it saves from small-pox and its sequelæ, and from nothing else; and everybody whom it saves therefrom lives to die of some other cause at some future period. One might as well argue on such grounds against saving a man from drowning.

One disease especially, scrofula, which

vaccination is declared to have increased, has been notably diminished since its introduction ; for scrofulous and tubercular affections were well recognized as the most dreaded and frequent sequelæ of small-pox. Dr. Farr, the eminent statistician, is authority for the statement that the mortality from fever has progressively subsided since 1771, and moreover that the deaths from small-pox, scarlatina and measles now are only half so great as the mortality formerly occasioned by small-pox alone.*

The occurrence of cutaneous and glandular diseases following vaccination has been much insisted upon by anti-vaccinists. That certain trifling eruptive disorders sometimes follow as a consequence of the act of vaccination no one is disposed to deny, and that latent eczema is occasionally roused into activity in the same manner is equally true ; but even these accidents are rare, as can be attested by any dermatologist, and in the main are of a benign character, and might as readily have been provoked by any other exciting cause. The

* McCulloch's Descriptive and Statistical Account of the Brit. Empire, 4th Edit., Vol. II, quoted in Seaton's Handbook.

cases of vaccinia gangrænosa mentioned in a preceding chapter, were perhaps really the result of vaccination, but not necessarily of competent vaccination. They afford no valid argument against the practice, since evil results may ensue upon any, ill-performed, or even well-performed, act in life. The honest advocate of vaccination has nothing to conceal.

The production of glandular diseases by vaccination, as asserted by anti-vaccinists, is readily explained by those cases of eczema, which may or may not have been provoked by vaccination, where the lymphatic glands become sympathetically involved. In former times, and not uncommonly in our own day, eczema was looked upon as an expression of the scrofulous diathesis, with which, by the way, it has no relation; and its more or less frequent coincidence with vaccination, most children being vaccinated, and a large proportion being subjects of "milk crust," naturally gave rise to the erroneous idea that scrofulous and glandular affections were in some way dependent upon vaccination.

The possibility of transmitting syphilis

by vaccination has been amply demonstrated, and that, too, by scientific advocates of vaccination. That so prevalent a disease should occasionally be inoculated in vaccination is not to be wondered at; but it is perfectly safe to say that syphilis has been less frequently conveyed in vaccination than through the medium of kissing, infected drinking-glasses, pipes, children's whistles and the other innumerable ways in which it may be propagated. Vaccination in itself is not to blame for the transmission, but in nearly all instances its improper performance. Unquestioned cases of vaccinal syphilis are exceedingly rare, for many vaccinators of life-long experience have never met with an example of it. Proper care and discrimination in the selection of virus would make this unfortunate accident well nigh impossible, and if animal lymph were exclusively employed, altogether impossible.

There is no evidence that any of the diseases of cattle have ever been communicated to man in animal vaccination. The experiences of the most eminent specialists in this direction, notably Warlomont and Martin, supply no such instance. Veterinarians tell

us that by unusual negligence such diseases as epizoötic eczema and perhaps anthrax might be communicated. Whether bovine tuberculosis may be communicated through vaccine lymph or the accidental admixture of blood with the lymph cannot be affirmed, neither can it be absolutely denied. M. Warlomont sums up the whole question in a happy and practical manner, as follows: "Thus it may be affirmed that neither syphilis nor tuberculosis nor anthrax nor any diathetic disease can be inoculated into the human race by animal vaccination. This however is dependent upon one condition, which is that the vaccine, whether living or preserved, should be taken from a healthy animal and collected at the required moment. This is the A B C of the whole question."*

Absolute protection against small-pox does not exist, for either natural small-pox or the inoculated disease may be followed by subsequent attacks; therefore, it cannot be expected that vaccination will prove a more effective preventive of small-pox than small-pox itself; but the practice of vaccination affords, when *duly and efficiently per-*

* *British Med. Jour.*, November 12, 1881.

formed, which means, of course, that the operation be done in the best manner, with the best lymph, and sufficiently often, a protection that is practically absolute.

No one would wish to deny that vaccination, as ordinarily administered, has its drawbacks, and even its dangers; but compared with the millions of cases in which favorable results are obtained, and having in view the ends to be attained, the disadvantages are most trifling. Were we, says Curschmann, to neglect vaccination on this account it would be about as wise as to refuse to travel by the railroad for fear of possibly running off the track.

Every unbiased mind must acknowledge the blessing that vaccination has been to the human race, and our constant effort should be, while reforming such evils as may exist, to so extend its practical usefulness that in the course of time, the noble dream of Jenner—the total extinction of small-pox — may be realized.

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