Exposition of a method of preserving vaccine lymph fluid and active : with hints for the more efficient performance of public vaccination / by William Husband.

Fig. II.

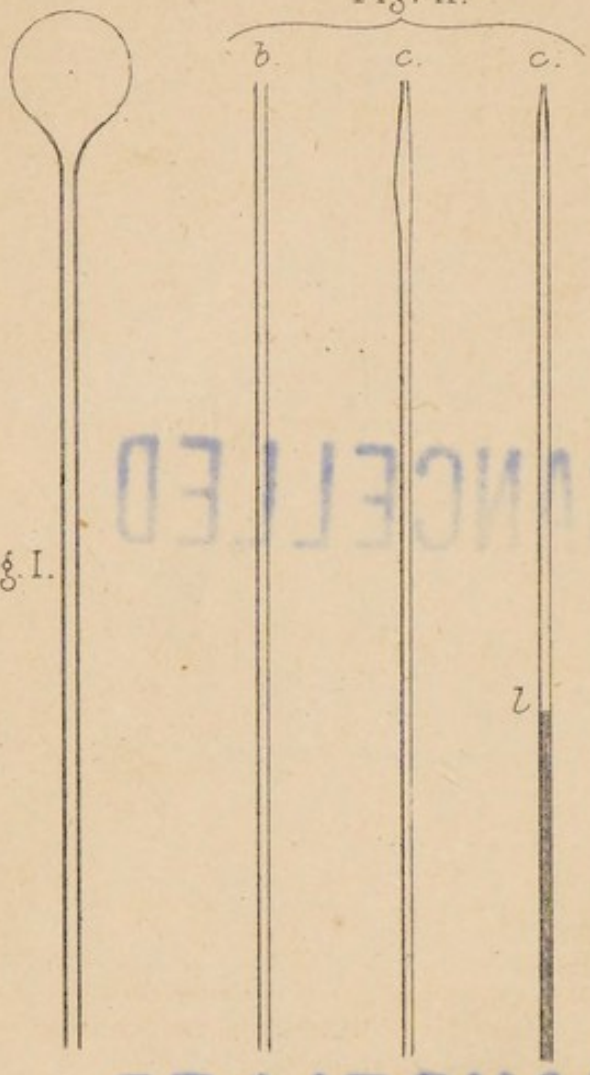


Fig. I.

Fig. III.

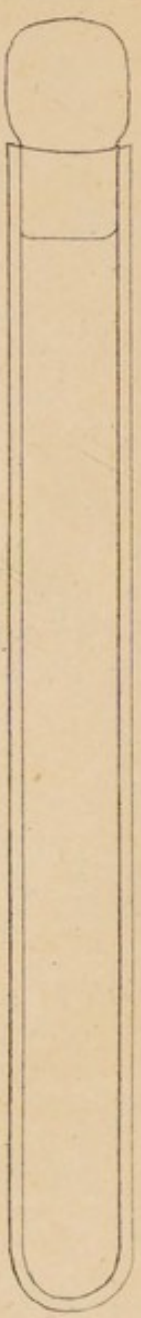


Fig. IV.

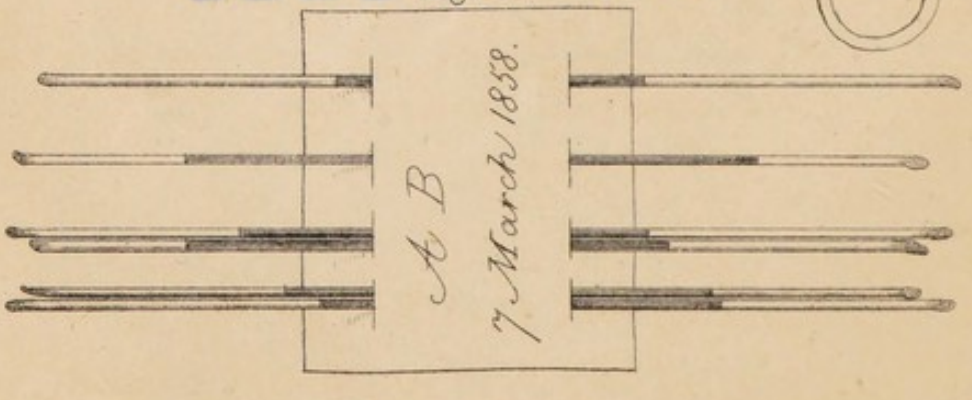
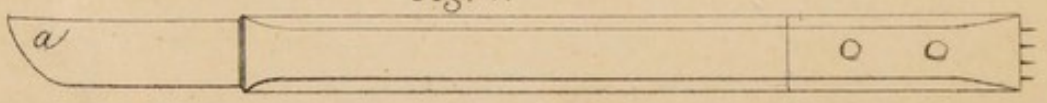


Fig. V.



W. H. Mc Farlane, Edin.r

EXPOSITION

OF

A METHOD OF PRESERVING VACCINE LYMPH FLUID AND ACTIVE;

WITH

HINTS FOR THE MORE EFFICIENT PERFORMANCE

OF

PUBLIC VACCINATION.

BY

WILLIAM HUSBAND, M.D.,

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"—— sero medicina paratur
Dum mala per longas convaluere moras."

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PREFACE.

It may be necessary to explain the circumstances which more immediately led to the publication of the following observations.

In the month of August last, Her Majesty's Privy Council deputed Mr Ceely of Aylesbury to proceed to Edinburgh for the purpose of inquiring into the mode of vaccination practised there—and more especially with reference to a particular method of preserving vaccine lymph in capillary glass tubes, to which the attention of the Council had been directed a short while before. The result of Mr Ceely's inquiry was to satisfy him that this method was eminently adapted to its purpose; and his Report has been followed by a circular from the Privy Council recommending its general adoption by public vaccinators throughout the kingdom.

The only published account of it, however, is a somewhat imperfect one, not now generally accessible, which appeared so long ago as September 1851 in the *Monthly Journal of Medical Science;* and I have therefore felt called upon to publish this exposition of the method, in order to furnish those who may be desirous of adopting it with the necessary information.

W. H.

Edinburgh, *January* 1860.

EXPOSITION

OF

A METHOD OF PRESERVING VACCINE LYMPH,

ETC., ETC.

Ever since the introduction of the practice of Vaccination, nearly sixty-four years ago, one chief obstacle in the way of the successful performance and general diffusion of it has been the difficulty of keeping vaccine lymph fresh and active for any length of time.

"Being a fluid of extreme delicacy," says the late Dr George Gregory of London, than whom no higher authority can be quoted, "and very liable to spontaneous decomposition, as well as to other changes which affect its efficacy, great difficulty has always been experienced in preserving it, and more especially in transmitting it in an active state to tropical climates."*

Hence the almost perpetual and universal scarcity of lymph under which we labour. For it is not in itself a

* *Cyclopædia of Practical Medicine*, art. "Vaccination."

scarce substance. It is produced in this and other countries in great abundance, wherever vaccination is carried on; and if we could only economise it, and save it from going to waste, it would be plentiful everywhere, in proportion to the demand for it; as plentiful in the remotest and most thinly peopled districts as in the most crowded cities. But unfortunately none of the methods commonly employed hitherto to preserve it has been found sufficient for that purpose.

With every precaution, and notwithstanding every effort, medical men are continually running short, and reduced to the necessity of borrowing from their neighbours, or of sending hundreds of miles to vaccine institutions for fresh supplies.

Some idea may be formed of the magnitude of the evil from the fact that the English National Vaccine Establishment distributed, during the ten years ending with 1857 —chiefly, of course, to medical men resident in the United Kingdom and its colonies and dependencies—not fewer than 2,000,000 charges of lymph. For several years past it has distributed upwards of 200,000 charges annually; and the demand is rising every year, and threatening to exhaust its means of supply.

Thus we find it stated, in the Report presented last year to Parliament* by the Vaccine Board, that 213,207 charges were supplied in the year 1857, in answer to 11,622 applications—of which, it may be assumed, that not fewer certainly than 10,000 were from practitioners resident in Great Britain and Ireland. The Report concludes with

* *Accounts and Papers*, Session 1857–58.

expressing a fear lest, under the present arrangement for carrying out the provisions of the Compulsory Vaccination Act, "the supply should be so far diminished as that the Board might be unable to meet the applications which are made to it. Hitherto, through the increased exertions of the vaccinators, such has not been the case; but it appears probable that it may hereafter be necessary to obtain such additional powers as would secure a supply *equal to the continually increasing demand.*"

The scarcity of lymph, therefore, as indicated by the drain upon the Central Institution, is something enormous. But when we recollect that medical men everywhere, with a few exceptions, are continually borrowing from one another, it becomes evident that the multitude of demands constantly being made for supplies is beyond calculation.

There can be no doubt whatever that the members of the Medical profession are greatly more indebted to one another, and to local institutions, than they are to the National Vaccine Establishment, great as the benefits are which that establishment has rendered to the nation and to the world at large. I mean that a very much larger quantity of lymph is given away in the course of a year, by Medical men to one another throughout the country, than is supplied to all quarters by the Central Institution in London. The moderate conjecture may be hazarded that the quantity is, at least, four times greater. This would add to the 10,000 applications made to the National Institution, 40,000 more made and responded to elsewhere, making up the number to 50,000, and would imply (what is probably short of the truth), that each of the 17,000 practitioners in the United Kingdom, on an average, bor-

rows vaccine matter about three times in a year. In a considerable number of instances, no doubt, the supply is asked for and got with little delay; but in the far greater proportion, several days, at least, must elapse before it comes to hand. All such delays are vexatious, and more or less dangerous; and the aggregate amount of delay and danger is obviously very great. An outbreak of small-pox in a town or district is often the occasion of the application for lymph. In distant parts of the country, as in the remoter Highlands of Scotland, it will take weeks for an urgent letter to reach London, and bring back the needed supply. Meanwhile the pestilence rages, and cuts off valuable lives. The antidote is not to be had. This is neither an imaginary nor a rare occurrence. It is an example of what is happening, and must necessarily happen, every day; and it seems obviously to follow, that the large annual mortality from small-pox in this country arises, in a great measure (I believe mainly), from the perpetually existing scarcity of lymph, and the ever-recurring impossibility of obtaining it without delay, when it is wanted.*

A remedy for this scarcity is therefore much to be desired, on sanitary grounds. For if we could reckon upon being provided with the means of vaccinating at all times and in all places, or could even approximate to so desirable a con-

* "The number of deaths from small-pox in England, Ireland, and Scotland during the last ten years is estimated at ninety thousand. . . . Had those ninety thousand victims been duly vaccinated, not more than five per cent would have contracted small-pox, and of these not more than five per cent would have died. We should have saved the lives of 89,675 persons during ten years." —*The Lancet*, 22d Oct. 1859, p. 418.

summation, the ravages of small-pox would be checked, and a material saving of human life effected.

Influenced by these views, I have long contemplated publishing some such exposition as the following, of a method of preserving vaccine lymph in capillary tubes, which has been for some years in common use in Edinburgh, but is as yet comparatively little known elsewhere; and I hope to be able to convince my readers, that if that method were universally adopted, it would greatly facilitate the practice of vaccination, and, by rendering vaccine lymph plentiful everywhere, would abate the mortality from small-pox by that amount of it which is occasioned by the scarcity of lymph.

The history of the origin of the method is shortly this.

In 1846 I had been making some experiments with the old methods, in the hope of finding out some effectual means of keeping up a supply of vaccine matter for my own use. Having failed with the squares of glass, I procured some of the thermometer-shaped tubes which were then used at the New Town Dispensary and elsewhere, for the purpose of sending lymph to distant parts; and it occurred to me to get rid of the terminal bulb, and to diminish the calibre and thickness of wall of the stem. The result was a true capillary tube, about three inches long, cylindrical, open at both ends, and admitting of being charged and sealed with ease and expedition. This was in the spring or summer of 1847. From that day to this I have used the tubes, to the exclusion of every other method, and have found the practice of vaccination facilitated in consequence to a degree of which I could previously have formed no conception. With the view of making observations on a large scale, I became

connected, in 1848, with the Royal Public Dispensary here, and have conducted the vaccinations at that institution ever since, with the exception of an interval of two years and a half, during which Dr M'Gilchrist occupied my place.

Before proceeding to describe the instrument farther, let me observe that it is incorrect to speak of *the tube method*, as if there were only one such. There are at least three, than which no three things passing under the same name can be more unlike in all essential respects; and, as much misapprehension has arisen from confounding them together, I cannot better introduce the description of the third, than by shortly describing, in the first instance, the other two.

I. The first is a method which long enjoyed considerable reputation in France. It was invented by M. Bretonneau of Tours, and was for a number of years extensively used and recommended by the "Comité central de vaccine," and afterwards, subsequently to 1823, by the French Royal Academy of Medicine. M. Bousquet describes these tubes as being "longs de huit à dix lignes, légèrement renflés dans le milieu et terminés par deux extrémités infiniment déliées." *

According to the *Dictionnaire des Sciences Medicales*, they are only six lines long, and one-third of a line in diameter at the thickest part. In other words, they are fusiform, tapering to a very minute point at either extremity, and are from half an inch to three quarters of an inch long. No one can read the French accounts of the mode

* Nouveau traité de la vaccine et des éruptions varioleuses, par J. B. Bousquet, de l'académie nationale de médecine. Ouvrage couronné par l'académie des sciences. Paris, 1848.

of charging, sealing, and using them, without perceiving that the whole process is beset with difficulties to such a degree, that it is matter neither of surprise nor regret that the method should have eventually proved a complete failure, and that M. Bousquet, the highest authority on the subject, should have at length pronounced against it, and in favour of the squares of glass, as simpler and more effectual.

II. The second form of tube is one with a terminal bulb. It is well known in this country, but no one ever pretended that it was adapted to everyday practice. It was invented by Mr Giraud of Feversham, who describes it in the *Medical and Physical Journal* for May 1803.

Dr George Gregory mentions it in the *Cyclopædia of Practical Medicine*, art. "Vaccination," in the following terms: "Vaccine lymph may be kept fluid in small capillary tubes having a bulb at one end (in shape like a thermometer.) They admit of being hermetically sealed." *

It was probably to these tubes that he referred, when in his evidence before a Committee of the House of Commons in 1833, he stated, in reply to the question—What is your mode of transmitting lymph to foreign parts? "We have transmitted lymph to foreign parts in tubes hermetically sealed, but it was so long and troublesome a process, that we have not practised it ourselves. We have, however,

* It is somewhat curious that the same author in his *Elements of the Theory and Practice of Medicine*, describes shortly the French fusiform tube, among other methods of preserving lymph, without mentioning the bulbed tube at all. Which of the two he preferred, I have no means of knowing; but he says nothing in commendation of either, and evidently gives the preference to the ivory points.

permitted others to arm their tubes at our establishment" —viz. the Small-pox and Vaccination Hospital. The bulbed tubes formerly used in Edinburgh were from two and a half to three inches long, and the diameter of the bulb from one-third to half an inch. Their strength and thickness of wall varied a good deal, but required to be considerable, as their form rendered them peculiarly liable to be broken.

They were charged in the following manner:—The bulb, having been heated in warm water, or over the flame of a candle, the orifice (*a*, Fig. 1) was applied to the exuding lymph, which entered as the heated air cooled; and when enough had been taken, and had passed on towards the centre of the canal, leaving a vacant space behind it, the orifice was sealed hermetically; as far as was practicable, I should add, for the glass was often so thick that an ordinary flame was not strong enough to melt it.

Some management was also required to communicate to the bulb the proper degree of heat, which was different for tubes and bulbs of different sizes; and then in proceeding to seal them, it was difficult to seize the moment when the charge had advanced a certain way along the tube, and before it approached the bulb, into which it was apt to pass suddenly, and be lost. The care required to avoid this accident, and the impossibility of sealing them expeditiously, together with the precautions necessary to be observed, in order to convey them unbroken from place to place (for they required careful packing in cotton, whether empty or charged), with other difficulties which I need not specify, were found to be insurmountable objections to their use; greatly counterbalancing the one advantage which they

possessed, of preserving the lymph fluid, and, as was understood, active.

III. The third and last form of tube is that of which I have already briefly detailed the origin, and I now resume the description of it.

It is, as I said, a simple straight tube, cylindrical, open at both ends, and of such dimensions as to fulfil the following conditions, upon which its peculiar value as a means of preserving lymph for future everyday use essentially depends. It must be—

1. In the first place, of such tenuity that it can be sealed instantaneously at the flame of a candle.

2. In the second place, it must be large enough to contain as much lymph as is sufficient for one vaccination.

3. In the third place, long enough to admit of both ends being sealed hermetically, without subjecting the charge to the heat of the flame.

4. And, in the fourth place, strong enough not to break easily in the mere handling.

There need be no difficulty in procuring tubes which perfectly answer this description; only they must be made according to a certain standard, which obviously, from the very nature of the case, is not an arbitrary one, admitting of being altered to suit the notions of different individuals, but one concerning which, within certain limits, there can be no dispute nor difference of opinion.*

* This standard is not adhered to, as it ought to be, by the instrument-makers, chiefly owing to the conflicting orders given them by different persons; and hence, large quantities of tubes are in circulation, which, being much too large to be manageable, give a quite erroneous idea of the method.

The following is the mean of several measurements which I have made of tubes differing somewhat in size, but all of them capable of containing a sufficient charge of lymph, and of being sealed instantaneously at the flame of a candle, without subjecting the charge to the heat, and also strong enough to bear all necessary manipulations without breaking :—

Average length, $2\frac{3}{4}$ to 3 inches.
Diameter, 1-28th of an inch.
Thickness of wall, 1-200th of an inch.

If any one be disposed to find fault with these measurements, and to prefer tubes half an inch longer or shorter, or otherwise of different proportions, I have no objection, provided the necessity of fulfilling the required conditions be kept in view. The tubes need not strictly and rigidly conform to the standard laid down; but they must not vary from it, except within certain limits, otherwise they become unfit for their purpose. Although their normal shape is cylindrical (Fig. 2, *a b*), some of them are more or less fusiform towards one extremity, and terminate there in a fine point, or one of the extremities may taper to a point, without becoming fusiform (Fig. 2, *c y*.) In either case, this irregularity of shape is accidental, and, as will appear presently, is no disadvantage, but rather the contrary.

Having thus described the instrument itself, I come now to the mode of using it.

The vesicles having been opened with a lancet in the usual way, the tube, held in a position more or less inclined to the horizontal, is charged by applying one end of it (the straight end, if they be not both straight, not that which

tapers to a point) to the exuding lymph, which enters immediately by the force of capillary attraction. As much lymph is allowed to enter as will occupy from about one-seventh to one-half the length of the tube, according as its capacity is greater or less. As a general rule, each tube should not be charged with more than will suffice for one vaccination.

It is now to be sealed in one or other of the following ways :—

Either, *first*, Make the lymph gravitate towards the middle, by holding the tube vertically, and, if necessary, giving it a few slight shocks, by striking the wrist on the arm or table. Then seal the end by which the lymph entered, by applying it to the surface of the flame of a candle. It melts over, and is sealed immediately. Proceed with the other end in the same way, but first plunge it suddenly—say, half an inch—into the flame, and as quickly withdraw it, till it touches the surface as before, and hold it there till it, too, melts over. If it be applied to the surface of the flame without being first plunged into it, it melts, no doubt, and gets sealed; but before you have time to complete the process, and while the glass is still soft, the heated air within the tube expands, and forms a minute bulb, which, from its tenuity, either gives way on the instant, rendering it necessary for you to break off the end, and begin anew; or, what is worse, remains entire for the time, only to break afterwards by the slightest touch. Mr Ceely has suggested that this precaution of plunging it into the flame before sealing it, besides being necessary for the reason stated, is also useful in expelling a portion of the air, and so leaving less air to be sealed up, along with the fluid lymph.

Or else, *secondly*, The charge having entered, hold the tube with the finger and thumb, covering the inner extremity *l* of the column of lymph *l y*, and protecting it from the heat, and draw nearly the whole of the empty portion *c l* through the flame, so as to rarefy the contained air, and in withdrawing it, seal the farther extremity *c*. The column now passes quickly along towards the middle of the tube, as the contained air cools, and you then, with the precaution already explained, seal the orifice *y* by which it entered.

This latter method answers especially well when the tube is below the average size, or has the form *c y*, in which the opening at *c* is so minute, that it seals over in the merest fraction of a second.

It should be observed, that in no case is a tube to be laid down until the lymph has been made to pass towards the middle of it, for the fluid concretes quickly about the orifice, and you cannot afterwards detach it, without breaking off the end, and the concrete portion of lymph with it. But if it be at once made to pass away from the orifice, by holding the tube vertically, you may lay the charge down, and take half a dozen or more in the same way before sealing them; only, if you delay the sealing process too long, more than five minutes perhaps (a delay which need never happen), the lymph within the tube is apt, from evaporation, to become adherent, especially if it be more than ordinarily viscid, or if the calibre of the tube be unusually small, and it cannot afterwards be blown out, when you come to use it.

Before concluding these directions, let me observe farther,

that if the lymph do not exude freely the tube may require to be drawn several times more or less obliquely across the surface of the vesicle, or cluster of vesicles, until a sufficient charge has entered; but generally if the exudation be copious, and a drop of some size have formed before you begin to take your supply, the orifice of the tube need not, indeed ought not, to touch the surface, but is merely to be dipped into the clear fluid; and one may commonly in this manner, from one infant's arm, charge five or six tubes in almost as many seconds, with perfectly pure and limpid lymph, which shall contain neither epithelial scales, nor pus globules, nor blood discs, and is therefore, so far, in the best possible condition for preservation.

In order to obtain the lymph from a tube for the purpose of vaccinating, the sealed ends are broken off, and the fluid contents blown out gently on the point of the lancet or vaccinator.

This description may appear to some to be unnecessarily tedious and minute. But I have endeavoured to be as concise as I could, consistently with perspicuity, and with the importance of the subject. The difficulty, however, is to convey by description an adequate idea of the facility and expedition with which these manipulations are performed. Your fingers even require training before becoming sufficiently alert to take advantage of the instantaneousness with which the law of capillarity charges the tube for you, and with which the heat of the weakest flame seals it.

No one who procures proper tubes, and gives them a fair trial, according to the foregoing directions, can fail to perceive that they furnish, beyond comparison, the easiest and most expeditious means of taking charges of lymph, for

present or for future use; I say for present or for future use, because their peculiarity is, that they are as perfectly adapted to the purposes of everyday practice, as they are for storing up lymph for long periods, and for transmitting it (as I am in the constant habit of doing) by post, or otherwise, to foreign parts. *

It is much easier, and occupies much less time, to charge a tube and seal it hermetically, than to charge two square plates of glass, and wrap them up in paper or tinfoil, or to arm one ivory point, and after allowing the lymph to dry on it, to envelop it in gold-beater's leaf, or deposit it in some suitable receptacle.

The tubes may be easily and safely sent by post in the following manner:—

A flat piece of soft fir, about three inches and a half long, an inch and a half wide, and one-sixth of an inch thick, has a narrow and shallow groove made in it about a quarter of an inch wide, into which the charged tubes, two or more of them, are placed, with perhaps a few filaments of cotton beside them to prevent motion. Another piece of wood of the same size, but which need not be quite so thick, is then laid above the groove and its contents, and the two pieces are fastened together in any way that is thought most convenient, by being tied or pinned together. Such a package resists the post-office stamp perfectly. To correspondents in the country, I generally send two or three charges; to India or other distant parts, seldom fewer than eight or ten. These ought to consist of lymph from several different sources, in order to afford several chances of success, in case some of them should prove inert.

* See Appendix A, p. 41.

The idea commonly entertained by Medical men on the subject of capillary tubes has been, that they are well fitted for conveying lymph to distant parts, but altogether unsuitable for everyday use; and the objections to them on the score of the annoyance, and loss of time, which the employment of them occasions to the vaccinator, have been regarded as far more than outweighing any real or supposed advantage which they possess over other methods, as a means of preserving lymph fluid and active.

And the prevalence of this notion has probably been the principal reason why the profession generally have been disposed readily, and without inquiry, to acquiesce in the adverse decisions which have been pronounced, from time to time, by high authorities, both foreign and British, against former tube methods, or more recently against the tube method in general, as if there were only one such. The truth is, the different methods are so totally unlike, that whereas an unfavourable judgment in the case of the French fusiform tubes, or of the bulbed tubes, even if it should be acquiesced in, and lead to their disuse altogether, would really signify little. Were the profession, on the other hand, to acquiesce in a similar condemnation pronounced upon the particular method here described and recommended, the consequences would be very different. A method would in that case be set aside, which, besides holding, as I shall show presently, the foremost rank in point of efficiency, affords such facilities to the vaccinator in his everyday duties as no other method does, and such as no one who has had experience of them will willingly forego.

But to proceed. The tubes, after being charged and sealed, may be carried in the pocket without the slightest risk of

being broken, in a glass tube (Fig. 3) somewhat thicker in the wall than a test-tube, and furnished with a common cork. I prefer, however, to carry empty tubes only in a receptacle of this kind, which contains easily from 60 to 80 of them; and for several reasons, to carry those which have been already charged, in a small box nearly four inches long, two broad, and three-fourths of an inch deep, taking care to keep each supply of lymph separate from the rest, and to affix to it its date, and generally also the name of the infant from which it was taken.

The charged tubes may be passed through a piece of soft thin writing-paper, in the manner represented by Fig. 4. If it be stiff, you are apt to break them in passing them through. But I believe few take this trouble, most Medical men here being content to mix empty and charged tubes together at random, without taking note of either date or source; evidently because they find that the date of any given charge, whether old or recent, is not an element which need be taken into account as materially affecting the chance of vaccinating with success. I found it impossible, however, without some contrivance of the kind just mentioned for distinguishing the dates, to carry on the investigations which were necessary in order to determine whether lymph preserved in this manner possesses a permanent value. And I would strongly recommend those who adopt the method to follow the same course, and never to put a charge aside without affixing its date to it. The little additional trouble required for this purpose contributes to exactitude, and will be found otherwise to be well bestowed.

That lymph so preserved possesses *a permanent value*—in

other words, that it retains its virtue unimpaired for months and years—is now well ascertained. It is a fact admitted on all hands by the members of the Medical profession in Edinburgh, and one to the truth of which many of their number are ready to testify from their own observation.

I had an opportunity, in the month of August last, of showing to Mr Ceely several perfectly successful vaccinations with lymph which had been hermetically sealed up for five, six, and seven years. Mr Ceely saw in one case the cicatrix, from which the crust had just dropped, of a vesicle produced by lymph, dated April 17, 1852—that is, seven years and three months old. He also saw vesicles in progress towards maturity, which had been produced, in two cases, from lymph dated February 2, 1853, or six and a half years old. In another case, the lymph was dated May 13, 1854, and was therefore five years and three months old; in other two cases, it was dated March 1858, and was therefore one year and seven months old; in another, September 1858, and therefore eleven months old.

I omit mentioning other cases shown to him, in which the lymph used had been kept for shorter periods. But here were seven successful vaccinations in different stages of progress, in which the lymph employed was from one to seven years old. Such an occurrence is, I suppose, unexampled in the history of vaccination. Solitary instances of the kind have happened before, and been cited as marvels. But a succession of such, occurring within the space of a few days—most of them, indeed, contemporaneously—may well fix our attention, not surely as something extraordinary and to be wondered at and forgotten, but as pointing us to results of great practical importance.

Whether success would be the rule, and failure the exception, after the lapse of such very long periods as six or seven years, I have not made a sufficient number of experiments to be able to say. Probably it would; but in truth it is far from necessary that I should be prepared with such a redundancy of proof as that would amount to. Within the limit of two years, or even upwards, I can speak with confidence, having performed numerous vaccinations with lymph kept for that length of time.

The following table gives a summary of 341* vaccinations of infants performed by me, between the years 1853 and 1856, with lymph, the greater part of which had been exposed for the sake of experiment during several hours daily for months together, to a temperature of from 80° to 90° of Fahrenheit. It is not drawn up from the Vaccine Institution register, which unfortunately has too many blank spaces in the return column to be of much use in a statistical point of view, but from the record of my own private cases; and it omits no case whatever except revaccinations, and vaccinations with fresh lymph. In every instance I observed and noted the results myself.

TABLE A.

Number of Infants Vaccinated.	Age of the Lymph employed.	Successful Cases.	Failures.	Total.
18	1 day.	16	2	18
52	1 to 8 days.	45	7	52
56	1 to 4 weeks.	46	10	56
38	1 to 3 months.	32	6	38
84	3 to 6 months.	75	9	84
53	6 to 12 months.	49	4	53
35	1 to 2 years.	32	3	35
5	2 to 2½ years.	5	0	5
341		300	41	341

* See Appendix B, p. 45.

Here, then, 341 tubes, each containing one charge of lymph, were employed to vaccinate 341 infants. They had been sealed up for various lengths of time, from one day to two years and a half, and the result was, that 300 of them succeeded and 41 failed; or, deducting the 126 cases vaccinated with lymph which had not been kept longer than four weeks; of the remaining 215, in which the lymph had been kept for periods varying from one month to two years and a half, 193 were successful, and 22 failed—that is, there was only one failure in every ten vaccinations, or the successful cases were to the failures as 9 to 1.

Now, the remarkable fact which the table brings out is this, that *the activity of the lymph*, as indicated by the probability of producing with it perfectly normal vesicles, *is not affected by the length of time it has been kept*, at least within the ample limit of two years and a half.

There does not appear to be any tendency at all to deterioration. The failures evidently do not increase in number as the lymph increases in age. Nay, I was surprised to find that the failures with the older lymph were fewer than with the more recent, and that the chance of success seemed, as the table indicates, to increase as the lymph got older. This difficulty at first puzzled me. I knew the record was accurate; but it was perplexing to find myself apparently in the unfortunate predicament of having proved too much. An explanation was necessary, and it was not far to seek.

On analysing the list of cases, I found that the more recent lymph—that, I mean, whose age did not exceed three months—had been derived from a greater number of sources than the older lymph, and that I had almost unconsciously, as well as unavoidably, acquired to some extent the habit of

selecting tubes upon which, having already tried them, I knew beforehand that I could depend. An analysis of the table will make this plain; and I would request attention to it, as it will serve, at the same time, to illustrate an advantage which is peculiar to this method, and greatly enhances its value in a practical point of view.

The 18 tubes used in performing the 18 vaccinations in the first line of the table, contained lymph from 18 different sources—that is, no two of them were charged from the same infant's arm. Two of the 18 failed.

Of the 52 vaccinations in the second line, 42 were performed with lymph from 42 different sources, and of these 37 succeeded and 5 failed; while 10 were performed with lymph taken from five different sources—two charges from each source—and of these 8 succeeded and 2 failed, these two having been performed with the same lymph. Here I might have avoided the second failure by avoiding the lymph which had failed the first time.

Of the 38 in the fourth line, 32 were vaccinated with lymph from 32 different sources, and of these 28 succeeded and 4 failed. The remaining 6 were performed with lymph from 3 different sources—two from each source—and of these 4 succeeded and 2 failed. Here, again, the two that failed were performed with lymph from the same source, and, as before, one of the failures might have been avoided.

Of the 84 vaccinations in the fifth line, performed with lymph from three to six months old, in 15 the lymph was from 5 different sources—three from each—and of these 15 succeeded and none failed.

In 8 it was from two different sources—four from each,

and of these 4 succeeded and 4 failed—the four that failed being all performed with the same lymph.

Here three failures might with attention have been avoided. It was evidently a waste of time to vaccinate so often as four times with this lymph. One unsuccessful trial with it ought to have led me to suspect the virtue of the tubes that were left. A second should have satisfied me that they were good for nothing.

Again, in six of the 84 cases, six tubes were used, all containing the same lymph—that is, lymph taken from the same infant, and all these were successful, clearly indicating, that to have succeeded with one or two tubes is a security for the virtue of all the other charges taken from the same source.

Of the 53 vaccinations, again, in which lymph from six months to a year old was employed, in 13 it was from 13 different sources, and of these 10 succeeded and 3 failed; in 12, it was from 4 different sources, and of these 12 succeeded and none failed: 8 were performed with lymph from one and the same source, and the whole 8 succeeded. This last instance is worthy of attention. It is one of many which have frequently occurred to me, and may be described generally—thus:

I charge eight tubes from an infant's arm. Several weeks or several months pass. I then vaccinate with one of them successfully, and now I have acquired a certain amount of confidence in the other seven. A second and a third succeed after the further lapse of weeks or months. The remaining five have now an ascertained value; for they contain part of the identical lymph which the three first contained, and they were sealed up in the same manner, and

under the same conditions. I now know that their contents may be relied on. Though I keep them for weeks or months longer, it does not signify. They are more valuable to me than even fresh lymph which I have not tried, for in the ascertained activity of the first, or of the first two charges, I have a guarantee for the activity of all the rest.

I would not throw away eight charges of lymph because one of their number failed; for the cause of failure might not be in the lymph itself, but in the operation, or in the insusceptibility of the patient, or in some other circumstance.

But in vaccinating a second time with the same lymph, I should do so with some suspicion; and if I failed again, I would be inclined to mark the remaining ones as inert, and avoid using them for the future.

Such is the explanation of the apparent superiority which the table indicates of the older lymph over the more recent —a superiority which would not have existed had I either taken the tubes entirely at random, in which case the average general success would have been somewhat reduced, or else proceeded systematically, both with recent and with older lymph, on the principle of preferring that which actual trial had proved to be trustworthy; in which case the general average would have been higher.

Before leaving this part of the subject, let me give one extreme case by way of illustration.

On the 18th of August last, I vaccinated A B, aged 3 months, from a tube dated February 2, 1853—that is, 6½ years old. There was only one tube of the set left. I blew out half of its contents, and resealed the other half. The vaccination was successful. Four days afterwards, August 22, I vaccinated another infant with the remainder, very

confident that if I failed it was not because the lymph was inert. The success of this second vaccination proved that my confidence was well founded, for I obtained a large cluster, and an ample supply of fresh lymph from it.

According to my experience, then, and reverting to the results shown by table A, the value of vaccine lymph preserved in this way may be expressed by saying, that if kept for one or two years, or for any shorter period, the chance of success in vaccinating with it—that is, with any single tube—is as nine to one. It would be interesting to know whether different modes of operating would be attended with different degrees of success—whether scratches, or punctures, or incisions, would be the most effectual. I am inclined to think that none of these methods has much, if any, advantage over the others as respects efficiency; and that this ratio of 9 to 1 approaches very nearly to the result which would be attained in whatever way the operation might be performed. On looking back, however, I consider it probable that, with greater care in the selection of the lymph at first, and by taking it oftener at the expiration of the sixth day than of the seventh, my success would have been greater. Few of my Medical friends who use the method, own to failing so often as once in ten vaccinations. But probably if they kept an accurate record of their cases, it might turn out that they fail oftener than they suppose. I doubt whether any one will be disposed to object, that to succeed nine times for once that I fail with lymph a year old, is no great amount of success after all. But supposing such an objection made, I may answer it by the question—If your success is greater, how does it happen that you cannot, without a great effort, or rather by any effort, keep up a supply

of lymph in your own hands, while I, on the contrary, failing once in ten times, have found it not only possible, but easy—

First, To be self-dependent for lymph for twelve years;

Secondly, To answer without delay during that period all demands made upon me from all quarters for remittances (and they have been numerous and incessant); and,

Thirdly, To accumulate, or rather suffer to accumulate, without an effort, a capital stock, so to speak, of this substance, on which I could draw to any amount at a moment's notice?

About four years ago, I had between 200 and 300 charged tubes, which had accumulated on my hands in this way out of my ordinary practice, apart altogether from the practice of the Dispensary. I still possess a large stock, to which continual additions are being made, and which I value very highly, because I know with absolute certainty that at least 90 per cent of the whole number contain reliable lymph.

It has been said by a high authority on the subject of vaccination (Mr Marson), that "with good lymph, and the observance of all proper precautions, an expert vaccinator should not fail above once in 150 times." I suppose he means with fresh lymph transferred from arm to arm. In point of fact, however, few or none attain to this amount of success, or anything approaching to it, for the obvious reason that we cannot always command "good" lymph in the sense in which Mr Marson uses the words, and we cannot always be sure that it is active, however unexceptionable it appears. I think it probable that lymph from different sources has different degress of activity from the first, even when the vesicles from which it is taken appear in all respects alike, and also that different infants are in different degrees sus-

ceptible of vaccinia; so that lymph which will succeed with one, may not succeed with another.

But independently of these considerations, we are often in practice compelled to use lymph of which we are somewhat doubtful. Thus on one of our vaccination days I sometimes find that of perhaps 15 infants vaccinated the week before, only 3 are brought back for inspection; and of these one yields no lymph at all, the second presents two clusters of vesicles which have already by accident been broken, and have discharged more or less, while the vesicles of the third yield a copious supply, but the inflammation and induration round them are very considerable. I have therefore to vaccinate the 15 or 20 new patients who have presented themselves with lymph which is not so good—that is, not quite so sure to succeed—as I could wish. But I have no alternative.* Its being likely to fail in one or more of the 15 or 20 new cases, is no sufficient reason for not using it.

I admit that it is proper to aim at a high standard of success, and also that it is *possible* to succeed so well as not to fail more than once in the 150 times; but when I state my own experience to have been, that I fail once in ten times, I speak of actual facts, not of actual possibilities, and can guarantee that amount of success as the very lowest, not as the highest attainable under the use of this method.

For if any one wishes to have fewer failures, he has only to vaccinate with two tubes instead of one—two tubes, I mean, containing lymph taken from different infants. The result will be, that he will be about as sure of success as if he vac-

* This is, of course, an *argumentum ad hominem*; for, in point of fact, I have the tubes to fall back upon, and in such cases especially, their peculiar value is manifest.

cinated from one tube to-day, and having failed, vaccinated from another this day week. The chance of failing twice in succession in attempting to vaccinate the same infant, is obviously much less than of failing once. Now, if to-day I vaccinate a child from two tubes containing lymph from two different sources, making four scratches instead of two, I bring two successive vaccinations to coincide, as it were, and am evidently much less likely to fail than if I used only one tube. How much less likely, can be ascertained by actual experiment. But were there no other causes of failure than such as are resident in the lymph itself, it admits of demonstration *a priori*, it is mathematically true, that you would exactly square your chance of success, if you vaccinated with two tubes charged with lymph from two different sources.

But as there are other causes of failure which do not depend on the quality of the lymph, but on some error, for instance, in the operation, or some insusceptibility on the part of the infant, the calculated result of 9 times 9 successful cases to 1 failure will not, of course, be attained in practice.

The following table is extracted from a register of 140 successive vaccinations performed by me exactly in the same manner as the 341 formerly enumerated, except that in each I used two tubes, applying the contents of the one tube to the one scratch, and of the other to the other.

TABLE B.

Number of Cases.	Date.	Age of Lymph applied		Number of Clusters formed		Total.	Successful Cases.	Failures.	Total Cases.
		To 1st Scratch.	To 2d Scratch.	At 1st Scratch	At 2d Scratch				
*	*	*	*	*	*	*	*	*	
*	*	*	*	*	*	*	*	*	
90	May 14	Not marked.	Not marked.	1	1	2	1		
91	June 10	2 years.	Not marked.	1	1	2	1		
92	July 4	10 months.	9 days.	1	0	1	1		
93	July 4	14 months.	9 days.	1	1	2	1		
94	July 5	14 months.	10 days.	1	0	1	1		
95	July 5	1 year.	11 months.	1	1	2	1		
96	July 6	1 year.	11 days.	1	1	2	1		
97	July 6	1 year.	11 months.	1	1	2	1		
98	July 11	14 months.	11 months.	1	1	2	1		
99	July 26	14 months.	1 year.	1	1	2	1		
100	July 27	14 months.	1 year.	1	1	2	1		
101	July 27	14 months.	1 year.	1	1	2	1		
102	July 28	1 year.	2 weeks.	1	1	2	1		
103	Aug. 22	15 months.	1 year.	1	1	2	1		
104	Aug. 28	15 months.	1 year.	1	1	2	1		
105	Aug. 29	15 months.	1 year.	1	1	2	1		
106	Aug. 29	27 months.	1 year.	1	1	2	1		
107	Aug. 29	15 months,	1 year.	1	1	2	1		
108	Aug. 29	15 months.	1 year.	1	1	2	1		
109	Sept. 5	15 months.	13 months.	1	1	2	1		
110	Sept. 11	15 months.	1 year.	1	1	2	1		
111	Sept. 21	13 months.	Not marked.	1	1	2	1		
&c.	&c.	&c.	&c.	&c.	&c.	&c.	&c.	&c.	
140							133	7	140

Here, in 22 successive vaccinations there were no failures. 44 tubes were employed, most of them containing lymph above a year old, and only two of the 44 failed to produce either a vesicle or a cluster of vesicles. These two, it may be noticed, contained the same lymph, and had only been sealed up for nine days. The result of the whole was that of the 140 cases, 133 succeeded and 7 failed—that is, the successful cases were to the failures as 19 to 1. I had, therefore, more then doubled my success by employing, in each case, lymph from two different sources, and that too, although, instead of making four scratches, I limited myself to two.

And had I used three tubes, I would have more than trebled it. Nor is it always of trivial importance to be able thus to multiply at will one's chance of success.

I find, for example, an unvaccinated infant exposed to the contagion of small-pox. His life depends upon his being vaccinated on the instant. If I fail, he probably takes small-pox and dies. Can I hesitate—possessing, as I do, much more lymph than I can use—to give him a double or a threefold chance of escape?

I said that there did not appear to be any tendency at all in the lymph to deteriorate. I should have said, to lose its activity. For neither I, nor any one else here, has met with a shadow of evidence leading to the suspicion that it deteriorates or degenerates in any proper sense of the word.

When M. Bousquet states as the result of many years extensive trial of the fusiform tube method in France—"que le vaccin se détériore assez rapidement dans les tubes"—he merely means to say that it quickly becomes inert, or, as he expresses it, "que la conservation du vaccin dans les tubes n'est pas de longue durée." He does not hint at its ever having occurred to him as an objection to either the fusiform or the bulbed tubes—the only tubes with which he was acquainted—that, their contents becoming decomposed, it might be dangerous to make use of them. I mention this total absence of suspicion of the existence of any such danger on the part of this eminent vaccinator and author, as good evidence that no such danger exists. I may add, that neither would any doubt as to the safety of our tube method ever have occurred to us in Edinburgh, where many thousands of infants have been vaccinated from tubes within the last ten years, had we not read the following passage in

one of the papers presented to parliament in 1857, relative to the history and practice of vaccination. "Lymph," says Mr Marson, in a paper otherwise of great practical value, "ought not to be kept in a stoppered bottle above 24 hours in warm weather, or 48 in cold. Like all other animal substances, it soon begins to undergo chemical changes which render it unfit for use. When it has become putrid, or even putrescent, it will produce the fatal results which are well known to follow inoculation with decaying animal matter. Much the same remarks apply, *mutatis mutandis*, to the lymph preserved in capillary tubes, as to that preserved in bottles."

Now I might ask here—Will you give me a security that if I keep a charged ivory point for a certain time, the dried lymph will not begin to decay?

Doubtless it would not be easy to ascertain this by the unaided sense of smell. The quantity is too minute for that; and so also the quantity of lymph which one of the tubes contains, although amply sufficient to vaccinate one patient, is so small that you may ascertain its putrescency by chemical tests perhaps, or by the microscope, but not otherwise. Others may investigate this subject. I have been in no haste to do so; and yet I am perhaps justified in saying, that our collective experience in this city has long since disposed of the question, regarding the probable putrescency of the lymph in the tubes, as one of no practical consequence whatever. I do not mean to say, that once sealed up it undergoes no change. I know not what changes may take place in it; but I do assert, after a very ample experience of the working of the method for twelve years, that *the properties of the lymph remain entirely unaltered in so far as they*

can be judged of by the effects produced when we vaccinate with it. I never saw any consequences follow from the use of old lymph, which I have not equally seen follow from vaccination with fresh matter. However long it is kept, it produces the genuine vaccinia, and nothing else. The only fear that any one need entertain in vaccinating with it is, that it may fail; and if it have been active at the time it was sealed up, and contain no admixture of pus or blood, I believe that he may be almost as confident of success as if he vaccinated from arm to arm. Possibly, though I speak here with hesitation, the more recent lymph is more likely to produce large confluent clusters, with active inflammation round them; while the older—that which is years old—is more apt to yield clusters of two or three *discrete* vesicles, or even a single vesicle, instead of a cluster. But the production of even one vesicle is of course decisive of the lymph having retained its virtue.* It may have undergone a *diminution* of activity, or what is just as probable, it may have been deficient in energy from the first. But one thing is certain, that a single vesicle, small, retarded perhaps, and which an unpractised eye might suppose had not vigour enough to struggle onwards to maturity, is nevertheless as

* In such cases—and they happen occasionally, whether you vaccinate with fresh lymph or from tubes—Bryce's test may be applied about the fourth day, not as a test, but in order to obtain additional vesicles, and secure to the patient the additional protection which some believe to be afforded by a plurality of vesicles. For my own part, I am unwilling to believe that one vesicle is not as effectual a protection to the system as five or ten; but Mr Marson's observations seem to prove the contrary. See his paper on this subject in Vol. XXXVI. of the *Transactions of the Royal Medical and Chirurgical Society of London*, and reprinted among the papers on vaccination presented to Parliament in 1857.

perfectly normal a specimen of the disease, as two large clusters would have been. And for the proof of this—take of the contents of that imperfect-looking vesicle, and vaccinate with them, and you will reproduce vaccinia in its utmost apparent vigour.

Such is the evidence upon which I rest the conclusion that vaccine lymph, the vehicle of the greatest gift which, through the instrumentality of medicine, divine Providence has bestowed upon mankind, instead of being as perishable as it is precious, is, on the contrary, under certain easily attained conditions, highly indestructible.

Preserved in the manner I have described, it resembles more than anything else the seed of a plant, which you may store up for years, in perfect confidence that the principle of life in it will survive, and that when committed to a congenial soil, it will one day germinate.

Now, what I undertook to prove at the outset was, that the universal adoption by the Medical profession of our tube method, would be an effectual remedy for the present continual scarcity of lymph, to which, undeniably, very much of the mortality from small-pox is due in this and other countries; and I have endeavoured to prove this by showing—

I. First, That the method is in the highest degree simple and manageable; and,

II. Secondly, That lymph preserved in this way retains its virtue unimpaired for years.

It is the combination of these two advantages which constitutes the peculiar value of the method, and which renders it not only possible but easy for any practitioner, however seldom he may vaccinate, to be self-dependent for lymph.

The following is a tabular view of two series of vaccinations, each consisting of six successful cases and one failure, which I have extracted from my register, not as giving a favourable view of the working of the method, but merely as showing how the lymph accumulates on one's hands, after making all allowance for omissions, and accidents, and disappointments. Let it be recollected that by a charge I mean enough to vaccinate one patient.

FIRST SERIES.

Number of Cases	Successful	Failed	Charges taken	Charges accumulated
1	1	..	9	
2	1	..	0	
3	0	1	0	
4	1	..	8	
5	1	..	0	
6	1	..	12	
7	1	..	3	
			32	
Deduct the 6 tubes used			6	26

SECOND SERIES.

Number of Cases	Successful	Failed	Charges taken	Charges accumulated
1	1	..	9	
2	1	..	5	
3	1	..	2	
4	0	1	0	
5	1	..	3	
6	1	..	1	
7	1	..	0	
			20	
Deduct the 6 tubes used			6	14

Here I had accumulated without an effort, after seven vaccinations, in the one instance 26, and in the other 14, charges of reliable lymph; and the result would have been

precisely the same, whether I had vaccinated at intervals of two days, or of several months. And any medical man, although he had but six infants to vaccinate in the course of a year, may, in the same way, have a capital of 14 or 26 charged tubes with which to commence the operations of the year following. The accumulation evidently goes on *ad infinitum*, and instead of scarcity there is superabundance.

The practitioner is thus at all times in circumstances to vaccinate at a moment's notice, as occasion or necessity may require. He can consult his own convenience, and that of his patients: he can choose his own time for vaccinating, and avail himself of opportunities for so doing wherever he may happen to be. When he gets a supply of fresh lymph, he need be in no haste to use it, for it will be as fresh in his hands twelve months hence as it is to-day. If an epidemic of small-pox break out, he is prepared for the emergency. He saves the lives of the unvaccinated whom he finds exposed to the contagion, by the instant application of the antidote. He can offer the protection of revaccination to the vaccinated, and follow up his offer by the immediate performance of the operation. I would have every one who vaccinates to conduct vaccination in this way—the only way, as it seems to me, by which the benefits of JENNER'S great discovery can be applied so as to ensure the effectual suppression of small-pox. And at the present time, when new legislative measures are being proposed on the subject of vaccination, it is highly desirable that we should be able universally to vaccinate in the efficient manner which I have just described. Nothing would tend more to facilitate legislation, and to simplify the arrangements necessary for carrying out the provisions of Vaccination Acts

Much has been said of the neglect of vaccination* on the part of the people; but there is good reason to believe that they are often unjustly blamed. I was glad to find Mr Griffin of Weymouth saying a word in their defence in his letter to the most Honourable the Privy Council a few months ago; and I willingly add my testimony, that even among the most abject of the Scotch and Irish population in Edinburgh, there is no repugnance to the practice of vaccination. I have met with a few instances of opposition, but I cannot recollect above one or two at most in the course of ten years which did not give way before a single word of explanatory expostulation. That there are prejudices existing in regard to vaccination is not to be denied; but they are generally given expression to vaguely and uncertainly, and in a manner which indicates a desire to be better informed. The offer to vaccinate on the instant is the best argument wherewith to combat them. According to my experience, it is irresistible. One of the few prejudices to be met with is often put in the form of a question, "Is it not a dangerous thing for the cow-pox and small-pox to meet?" The proper answer is, "Certainly not. If you wish to save your infant's life, now that the small pox is next door to you, it must be vaccinated immediately." But if I were not at all times prepared with the

* At the Royal Dispensary, the number of vaccinations have gradually risen, with fluctuations, depending upon the amount of small-pox prevalent at different times, from 237 in the year 1848 to upwards of 850 in 1859. This satisfactory increase, indicating that the people are becoming more and more disposed to avail themselves of the benefits of the Institution, is clearly traceable to the introduction of the tube method, and the facilities it affords to the vaccinator for the regular and efficient discharge of his duties.

means of vaccinating, I would not be prepared with this answer, and would be constrained to leave the people in possession of their prejudice. No doubt the lower orders are everywhere more or less apathetic and dilatory; but it is to be recollected that vaccination is not brought to them as it is to the middle and upper classes. They must go and seek it, at stated seasons only, often at great inconvenience to themselves, and not always with the certainty of getting it. In many places, however intelligent they may be on this subject, it is well known that there is much to discourage them in the frequent delays and disappointments, and even repulses, which they meet with in consequence of the scarcity of lymph, and which often require more importunity and perseverance than can reasonably be expected of them.

But if, by the general adoption of a method which converts a state of almost perpetual scarcity into one of perpetual plenty, every Medical practitioner, in his own sphere, were at all times able to vaccinate, as it were, on demand, we should soon hear less said about prejudices obstructing the progress of vaccination; and instead of having vainly to deplore the loss of nine thousand lives annually from small-pox in the United Kingdom, we should every year be vaccinating to better purpose, and advancing towards a result which JENNER all along contemplated as destined ultimately to be realised, and which certainly ought never to be lost sight of by us as one to which an indefinitely near approach may be made—
THE TOTAL EXTINCTION OF SMALL-POX.

APPENDIX A.

I mentioned that, in conducting the first series of observations recorded in the foregoing pages, I exposed the greater part of the lymph, during several hours daily, for months together, to a temperature of between 80° and 90° of Fahrenheit; and therefore the conclusions arrived at may airly be regarded as holding true of climates considerably warmer than that of Edinburgh, or of any part of Great Britain. It remains to be proved, whether the employment of these tubes in climates differing much in temperature from ours would be followed by the same success. This can only be determined satisfactorily by observations similar to those recorded above. But it is now, I believe, well ascertained, that when lymph is sent in the tubes to hot climates, it retains its virtue in the great majority of instances, notwithstanding the high temperature to which it is exposed on its passage. We are in the habit of sending remittances of it from Edinburgh, sealed up in this way, to all parts of the world, and, so far as our information goes, with almost uniform success. There is a want of full information on the subject, owing to the circumstance that we do not receive reports from our correspondents, except occasionally. But we rarely or never hear of failures; and there is a large and growing demand for tubes, on the part of

practitioners resident in India, and in tropical countries generally.

The instances of success which have come to our knowledge are now so numerous, as to warrant us in affirming that the difficulty so long and so painfully felt, of transmitting lymph in an active state to warm climates, no longer exists. A few examples may be mentioned.

Professor Christison informs me that his son, Dr Alexander Christison, Superintendent of Vaccinations at Simla, in the north of India, finds the charged tubes sent out to him from Edinburgh, from time to time, to be "most useful, and the result excellent."

Professor Simpson and others have repeatedly sent tubes to a correspondent at Penang, on the Malacca coast, in north latitude 5°, and in every instance the lymph was found to be active.

Dr Andrew Balfour of Portobello, when resident at Hong Kong a few years ago, received from Edinburgh three several remittances of charged tubes. The first was sent round the Cape, and the other two overland. In all three instances the lymph had retained its virtue. Dr Balfour had never succeeded with lymph sent out in the dry state.

Dr William Robertson of Edinburgh, who was Inspecting Physician to the Civil Hospital at Renkioi, during the late Russian war, took out with him to Turkey, in the spring of 1855, a considerable number of charged tubes, and performed numerous successful vaccinations with them among the Greek population there, in the summer of that year, and also in July 1856. Some of the lymph which proved successful had been sealed up for a year, and had been ex-

posed to a temperature which, in the shade, sometimes rose to 97° of Fahrenheit.

Several years ago an eminent missionary, the Rev. H. M. Waddell, carried some tubes, with which I furnished him, to Old Calabar, on the west coast of Africa, and introduced vaccination there for the first time, after numerous ineffectual attempts had been made to introduce it by means of dry lymph. This fact is interesting, from the circumstance that Calabar is situated in north latitude 5°—that is, eleven degrees nearer the equator than St Louis on the Sénégal, of which the French author formerly quoted says, "Rien de plus difficile que de conserver le vaccin aux antilles et au Sénégal. Il est rare que celui qui vient d'Europe y réussisse;" and eight degrees farther south than Bathurst on the Gambia, where, for years after the establishment of the colony, repeated attempts were made without success, to introduce vaccination by lymph sent out from England.

The Report of the National Vaccine Establishment for 1852 refers to the constant disappointments which had occurred in transmitting lymph to the various British stations on the African coast; and after mentioning that the plan usually adopted by the Vaccine Board was to send it out in tubes [with terminal bulbs] hermetically sealed, attributes the failures to "the varying circumstances of temperature, and other unknown atmospheric conditions, in consequence of which the fluid lymph may be disposed to undergo decomposition." It is difficult to see, however, what other atmospheric influences, known or unknown, except that of temperature, can possibly affect lymph enclosed in hermetically sealed tubes. There are doubtless conditions of the atmosphere in Africa, as well as elsewhere (in the upper

provinces of India, for example), which render vaccination next to impossible at certain seasons of the year; and probably failures, which are due to this cause, have sometimes been ascribed to the inertness of the lymph employed. But at all events, if this substance, hermetically sealed up in cylindrical capillary tubes without bulbs, resists the supposed injurious effect of exposure to high temperatures on its passage round the Cape, or overland to India and China, it can scarcely be doubted that it will equally resist such exposure, whatever be its destination; and that it will be quite as certain to retain its virtue when collected and preserved in a tropical climate, as when sent thither from a temperate one.

APPENDIX B.

It should be explained that these 341 vaccinations were all performed in one way—viz. with Dr Weir's vaccinator.

This instrument is very generally used in Edinburgh, and consists of four needle points set into one end of an ivory handle, of which the opposite extremity is armed with a lancet, originally intended to serve the double purpose—1*st*, Of opening the vesicles and taking charges of lymph from them; and, 2*dly*, Of scraping the dry lymph from the squares of glass, preparatory to vaccinating with it.

Since the tubes came into use, however, the lancet at one end, which used to be of steel, may be made of ivory or silver, and a common lancet kept for the purpose of opening vesicles.

The operation is performed in the following manner:—The instrument (Fig. 5) with a charge of fluid lymph on it at *a*, which may have either been taken directly from a vesicle or blown out of a tube, is held at right angles to the surface of the infant's arm, and two scratches are made about an inch apart, by drawing the needles rapidly and lightly once or twice across the skin, which must be held somewhat tight. After the lapse of a few seconds a slight oozing of blood becomes perceptible, just sufficient for the most part to tinge the lymph while it is being gently rubbed on. The result is the production of two clusters of confluent or coherent vesicles. The common

lancet, not quite so sharp as is necessary for venesection, is also used in Edinburgh, but never, as in England, to make punctures. It is either held transversely, so as to make two clusters of scratches; or, which is preferable, two clusters of superficial scratch-like incisions are made with it. I find it still quite sharp after a thousand vaccinations.

With a little practice, the operation may be performed almost as rapidly with the lancet as with the vaccinator; but with either instrument our method seems to have the advantage of that by puncture in two respects.

1*st*. It gives no pain at all.

2*dly*. It saves time.

Dr Gregory advises to make six or eight punctures, and to keep an ivory point in each wound for half a minute. The operation, therefore, according to this plan, occupies three or four minutes; while with the vaccinator, or even the lancet used as above described, it does not occupy at most more than ten or fifteen seconds—a material difference, especially when several vaccinations have to be performed at the same time. The number of vesicles in each cluster varies considerably. Examined on the fourth or fifth day, I find very generally ten in each, which, by the eighth day, have become confluent. A cluster of ten vesicles is not so large as might be supposed. It covers on the eighth day an area which, if circular, would have a diameter of about two-fifths of an inch. The crowding may be avoided, by having only three, or even two, needle points, or, if the lancet be used, by not crowding the incisions together.

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