SMALLPOX AND VACCINATION

WHITE

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Smallpox and Vaccination

BY

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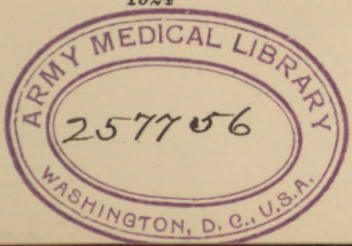

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HARVARD HEALTH TALKS

PRESENTING the substance of some of the public lectures delivered at the Medical School of Harvard University, this series aims to provide in easily accessible form modern and authoritative information on medical subjects of general importance. The following committee, composed of members of the Faculty of Medicine, has editorial supervision of the volumes published:

SMALLPOX AND VACCINATION

SMALLPOX AND VACCINATION

I. Smallpox

SMALLPOX, once the scourge of our forefathers, has become such a rare disease in Massachusetts that we have become unmindful of its pestilential power. We are no longer familiar with its terrors, and seldom do we see the unsightly mark of its touch on those about us. In this part of the country, if we think of it at all, we hazily include it with other old-time diseases which for one reason or another have disappeared as civilization has advanced. We hear much nowadays about the conquest of this or that disease, and we are inclined to believe that improved sanitation, better living conditions, and higher

standards of personal hygiene are responsible for the disappearance of smallpox. Unless our interests embrace the problems of preventive medicine, we have little conception of what a loathsome and dangerous disease smallpox really is; we do not realize that it still exists with all its horrible features, and that, instead of being conquered, it is at best only held at bay by the continued practice of vaccination.

Because of the prevailing ignorance of the menace of smallpox, and because of the lack of appreciation of the great protection afforded by vaccination, it seems desirable to present in this lecture a description of the disease and its ravages, its present prevalence and its threatened dangers; to discuss the practice of vaccination; and, finally, to show that compulsory vaccination, intelligently conceived and rigorously enforced, is the one certain means of safeguarding ourselves against this noisome pestilence.

SMALLPOX AND VACCINATION

The Disease. Smallpox, or *variola*, is one of the most highly communicable diseases of man. A single and short exposure is sufficient to cause infection. The disease may be transmitted by direct contact of the sick with the well, or in a variety of other ways. Any object, utensil, or material that has come in contact with a smallpox patient may carry the virus and spread the disease, and it is also possible that the infection is airborne. Inasmuch as the disease is contagious before the eruption appears, and therefore, before it is usually diagnosed, it may spread before its presence is known. After an incubation period varying from five and a half to sixteen days, but ordinarily from ten to twelve days, there is usually a sudden onset of subjective symptoms, such as a chill and *malaise*, then a feverish period of a few days' duration in which the patient generally complains of dizziness, headache, backache, general body pains, nausea,

gastric distress, and vomiting. Sometimes even delirium and convulsions occur. On the third day of the disease a general minute skin eruption appears, which in the succeeding eight days passes through the stages of papule, vesicle, pustule, and crust.

There are three types of smallpox, namely: true smallpox, or *variola vera*, either mild or severe, in either the discrete or confluent form; the so-called "black" smallpox, or *variola hemorrhagica*, appearing as the hemorrhagic and the purpuric types, both of which represent the most malignant manifestations of the disease; and a mild and benign affection called varioloid, which may occur in vaccinated persons. Alastrim, kaffirpox, and amaas, although aberrant forms of the disease, should for public health purposes be considered as true smallpox. Ordinarily smallpox attacks a person only once in a lifetime, but two and even three attacks have been known.

There is, unfortunately, no specific treatment for the disease.

Among the more common complications of smallpox, inflammations of the throat, lungs, kidneys, and joints are encountered. Deafness, blindness, and, more rarely, insanity may follow an attack of the disease. It is the skin eruption which is responsible for the scars with which the disease brands those of its victims who resist its full fury.

Before the days of vaccination the disease was considered one particularly contagious for children. Just as measles, scarlet fever, and diphtheria have always been essentially childhood diseases, so smallpox reaped its greatest harvest among those of tender years. Vaccination has changed the age period at which the incidence of the disease is greatest. Wherever child vaccination has been practised the disease has shifted its attack either to those adults who have never been vaccinated or to those

whose immunity has lapsed with the passing of time.

Smallpox is no respecter of persons, save the vaccinated. It attacks the young and the old of every condition, of all races in all countries, in all climates, and at all seasons of the year. At times it masquerades in a benign form, and then without warning it may reveal its true malignant character. It seems to appear in waves or cycles, sometimes with a definite periodicity which enables us to anticipate its coming. In Japan, for example, about every eight or ten years there have been true epidemics. On the other hand, it frequently persists as an endemic disease, sometimes severe, more often mild in character, but always with a well-known tendency to increase in virulence. Even although for a considerable period of time it may be of no more immediate moment or have more serious consequences than its familiar relative, chicken pox, yet it

must always be regarded as a pestilential disease of the first magnitude.

The Smallpox Problem. The smallpox problem is a comparatively simple one. It can be resolved into two main phases, namely, the transportation of the contagion from an infected to a healthy community, and the degree of susceptibility of the population to which the disease is carried. The disease can be carried through the agency of infected materials or persons, and their transportation or migration can be more or less restricted. Absolute control, however, is impossible, and we have had abundant opportunity to learn that medical inspection, fumigation, and quarantine are at best only sanitary filters through which undetected contagion may and sometimes does pass. We must grant, therefore, that, no matter how perfect our quarantine laws may be and no matter how conscientiously they are enforced, smallpox may gain

entrance through our ports or across our borders. But — and herein lies the solution of the whole problem — smallpox could not exist, let alone spread, if it were not for the presence of susceptible individuals in every community. A thoroughly vaccinated community cannot be invaded by smallpox, and smallpox can be banished and forever shut out by the practice of communal vaccination. If universal vaccination were possible, the disease would cease to be.

History of the Disease. Smallpox is an ancient disease with a lurid history. Owing to a lack of reliable records, it is impossible to locate its origin, to trace all the lines of its spread, or to know the full extent of its ravages in early times. The disease certainly existed in the Orient, particularly in China, before the beginning of the Christian era. From the East it was carried to Europe as early as the sixth century, if not before. There it

continued, and its prevalence greatly increased during the seventeenth century, reaching its greatest height during the following one hundred years.

From the official data kept in England during that period we can glean some idea of the importance and destructiveness of smallpox. Lord Macaulay, in his *History of England*, writing of the time of William and Mary said: "That disease, over which science has since achieved a succession of glorious and beneficent victories, was then the most terrible of all the ministers of death. The havoc of the plague had been far more rapid: but the plague had visited our shores only once or twice within living memory; and the smallpox was always present, filling the churchyards with corpses, tormenting with constant fears all whom it had not yet stricken, leaving on those whose lives it spared the hideous traces of its power, turning the babe into a changeling at which the mother shuddered, and mak-

ing the eyes and cheeks of the betrothed maiden objects of horror to the lover." Other writers state that at the end of certain epidemics eighty to ninety per cent of the population represented survivors from attacks of smallpox. From time to time it ravaged the towns of England, usually appearing in a virulent form and leaving in its train deafness, blindness, mutilation, and disfigurement. In 1802 Admiral Berkeley, in a speech before the House of Commons, said: "It is proved that in this United Kingdom alone, 45,000 persons die annually of the smallpox: but throughout the world what is it? Not a second is struck by the hand of Time but a victim is sacrificed upon the altar of that most horrible of all disorders, the smallpox."

France and Germany were equal sufferers with England. In France (1754) "every tenth death was due to smallpox, and one-fourth of mankind was either killed by it or crippled or disfigured for

life." In the German-speaking countries over 65,000 persons died of smallpox in 1796, and in Prussia (1803) 40,000 people succumbed annually to this scourge. These records should suffice to show the destructive power of smallpox when unrestrained by vaccination.

Like all other diseases, smallpox has ever followed the march of emigration. In the sixth century the Crusaders spread it, on their travels; in the eighth the Saracens brought it to Spain, and the Spaniards took it to Mexico in 1520. Since that time the American continent has never been rid of its presence.

The smallpox that America knew in Colonial days was smallpox at its worst. It came in cycles, spreading from one part of the country to another, and leaving devastation in its track. It destroyed the most susceptible but conferred upon those surviving an attack a life-long protection against further attacks. It receded and was absent until a new and

unprotected population grew up, then, after a lapse of years, it came again to plague the colonists. Attacking as it did a people without any vaccinal protection, it claimed as its victims the majority of the population and it smote these victims with its full power. Some idea of its violence may be gained from the records of that time. Those of Boston are illustrative and reliable. Smallpox prevailed there as an epidemic in 1649, 1666, 1678, 1690, 1702, 1721, 1730, 1752, 1764, 1776, 1778, and 1792. Cotton Mather said in 1698: "The smallpox has four times been a great plague upon us. . . . Often had one hundred bills desiring prayers for the sick been read in one day, in one of our assemblies. In one twelvemonth, about one thousand of our neighbors have been carried to their long home." In 1752, the disease was exceptionally severe. The town then contained 15,684 inhabitants; of these 5,998 were supposed to have had the disease.

One thousand eight hundred and forty-three removed out of town. All the remainder, except 174, had the disease by inoculation, or in the natural way. In the twenty days beginning May 19 there were 220 deaths, averaging 11 per day. In the 1792 epidemic, the town contained about 18,000 inhabitants, of whom 10,665 were supposed to have had the disease previously. The rest had it. A person who had not had the disease was a rarity, and its brand was visible on the faces of practically all adults.

Such is a part of the grim record of the disease in the days before the discovery of vaccination, and although as a result of Jenner's beneficent discovery, we in this part of the United States are no longer so afflicted, it must be remembered that its terrible history is still being repeated to-day in other parts of the world, and that smallpox is still the same dangerous and hideous disease, with all its inherent power for destruction.

India is one of the greatest present sufferers from this scourge. In the years 1918 to 1922 nearly 650,000 deaths from smallpox were reported. China pays a huge annual toll in sickness, damaged bodies and lives to this account. Scotland, Germany, France, Spain, Australia, Burmah, Mexico, Brazil, Argentine, Chile, Costa Rica, Santo Domingo, and Canada have all had epidemic visitations within the past five years. Once more the disease has assumed epidemic proportions in England, and there the people are returning to the vaccinal protection that had been allowed to lapse as a result of the efforts of anti-vaccinationists. There these false prophets still preach their dangerous doctrines that smallpox has become a trivial disease, that it can be controlled by sanitary measures alone, and that vaccination is impotent to protect against infection. The smallpox situation to-day refutes their every claim.

Let us take the facts as they stand. The disease prevails in epidemic proportions in Canada, Mexico, and England. The journey from these countries to the United States varies from a few days to a week. The incubation period of smallpox is never less than five days and usually is ten or twelve days. There is, therefore, no way to prevent the entrance of the infection through our ports. Quite aside from the possible entry of any fresh infection from abroad, the present conditions in this country should be sufficient to convince us that we can no longer maintain our complacency. The disease is here; endemic in some states, epidemic in others. Although it is mostly of the mild type, yet it has lost none of its killing power, and there is scant solace or security in the fact that the virulent form is limited to a few outbreaks. It seems an anachronism, if not an arraignment of our civilization, that a disease against which we possess a sure

weapon should, in enlightened communities, not only prevail but continue to spread and to kill. In semi-civilized lands, where popular health education and administration have scarcely begun, but where the people know the terrors of smallpox, vaccination is eagerly sought by those who see the protection it gives; but here we have for a long time been shielded from the full effect of its ravages, and we are apt to neglect what we feel is a bothersome practice against a supposedly imaginary menace. It is a discouraging fact — a fact repeated over and over again — that communities, even whole states, come to realize the seriousness of smallpox and to be made aware of the value of vaccination only after having experienced the disease in epidemic form. It is always a bitter and costly experience, and now with smallpox present and spreading, health officials and educators are putting added energy in their efforts to bring the public to a

realization of the true situation. After all, the presence of a controllable disease in any community depends upon the will of its people.

II. Measures for the Control of Smallpox

Inoculation. Before the days of Jennerian vaccination man made every effort possible within his limited knowledge to protect himself and his against this pestilence. Smallpox spelled death to him. All his superstitious rites and all his simple medicines failed to save him. He readily grasped the fact that those who were so fortunate as to recover from an attack of smallpox were doubly fortunate in that they were nearly always spared from having the disease a second time. He looked upon smallpox as inevitable, and reasoned that so long as one must have the disease, it was better to have it in full health at a

propitious time than to await its natural coming. He accordingly practised inoculation, a form of what we now know as active immunization; and even though it was a hazardous procedure and frequently killed those whom it was intended to protect, yet it was widely employed in eastern countries. From India it was introduced into England about 1721 and popularized by Lady Mary Montagu, and at about the same time it was introduced into this country by Dr. Zabdiel Boylston of Boston.

Inoculation, or variolation, consisted in transferring matter from a true smallpox pustule to the abraded skin of the person to be protected. This procedure usually produced a mild form of the disease, which, anticipated and controlled, was preferable to a fortuitous and virulent attack, but it had serious disadvantages. Infections other than smallpox were transmitted along with the variolous matter. Further, the in-

duced disease was true smallpox, and, therefore, inoculated persons frequently served to spread the disease to others. Then, too, the infection sometimes ran a typical and fatal course. Unsatisfactory and dangerous as it was, it offered immunity at a comparatively small risk. Since the introduction of vaccination, however, the practice of inoculation has been abandoned.

Isolation. The next step in the struggle to control the disease was the isolation of the patient. The contagiousness of smallpox was early recognized, and it was reasoned that by removing a case from contact with others, a source of infection was stopped. So it is, but it must be remembered that the disease is communicable and requires isolation before it is apparent that it is smallpox. Furthermore, where the disease is mild, little or no notice is taken of it until the infected one has had opportunity to in-

fect others, and a similar condition arises when the disease on account of its mildness is mistaken, as it frequently is, for chicken pox. The first point is well illustrated by the experience of Minnesota and Massachusetts in 1917. Four immigrants from the ship, *Kristianiafjord*, who had been exposed to smallpox on the sea journey, but who were apparently well on arrival, were responsible for two outbreaks of a particularly severe form of the disease — in Eveleth, Minnesota, and in Worcester, Massachusetts. In the former town 92 cases and 17 deaths, and in Worcester 48 cases with 10 deaths resulted from the visit of these immigrants, who had shown no signs of the disease at the time of admission into the country.

The benign, the unrecognized, and the concealed cases have limited and always will limit the value of isolation and quarantine as anything more than desirable adjuncts in controlling the spread of

smallpox. The record of admissions, listed according to the day of the disease upon which patients entered the isolation hospital at Glasgow during the epidemic of 1920, shows that a considerable proportion of the patients had more or less abundant opportunity for passing on their disease to others before they were segregated. This record is so typical of other hospital experiences that it is inserted here.

NUMBER OF DAYS ELAPSING BETWEEN ONSET OF THE DISEASE AND ADMISSION TO HOSPITAL

Days	Cases	Days	Cases	Days	Cases
1	12	9	2	22	2
2	66	10	1	24	2
3	136	11	2	25	1
4	126	14	1	26	1
5	73	16	1	29	1
6	49	17	1	32	1
7	27	20	2	40	1
8	7	21	2	41	1

ADMISSIONS TO HOSPITAL SUMMARIZED IN WEEKS

Week of illness	Cases
First week	489
Second week	13
Third week	6
Fourth week	6
Fifth week	2
Sixth week	2
Total	518

Numerous epidemics have originated from mild cases which have been diagnosed as chicken pox, and which therefore have been allowed far more freedom than would be accorded a smallpox patient. Health officers have come to look with suspicion upon any cases of alleged chicken pox in adults.

The reluctance to call a physician, or the fear of the isolation hospital or the pest-house, not uncommon in some of our foreign-born, lead to the concealment of their smallpox sick. Such an instance was in part responsible for an epidemic of serious proportions which originated

in Holyoke, Massachusetts, in 1872, and spread to many other parts of the state.

Sanitation. Hospitalization, isolation, and quarantine have their places in limiting the spread of smallpox, but they are at most auxiliaries. The application of the principles of modern sanitary science to our water and food-supplies, to our surroundings and to our homes, has brought cholera, typhoid fever, yellow fever, and the malarias well under control; but smallpox presents features which are not amenable to such methods of sanitary practice. Contrary to popular belief, smallpox does not originate or propagate in filth; it does not necessarily choose dirty avenues for its spread, nor does it single out the unclean for its victims. Being an insidious disease with a high transmissibility, possibly air-borne and surely and swiftly passed on by direct contact, it is obvious that its way cannot be blocked by the methods which

are so successful in destroying or staying the dissemination of such diseases as typhoid fever and cholera. Because smallpox thrived in the days before sanitation, and because it still thrives in countries where the practice of individual and collective hygiene is primitive, it does not necessarily follow that it flourishes because of the absence of modern sanitary measures, or that perfect sanitation will control it.

To illustrate this point, it is quite likely that such progressive and well administered cities as Kansas City, Denver, Los Angeles, and Detroit would with reason hotly resent any claim that the smallpox epidemics from which they have recently suffered were due either to any fault or lack of municipal sanitation or to a low standard of personal cleanliness among their inhabitants. Their experience, on the one hand, comprising cases in wholesome surroundings and among the higher social groups, with, on

the other hand, the success of vaccination as a preventive measure wherever practised, as in the squalid sections of India, only goes to prove that, great as are the general benefits accruing from pure-water supplies, proper ventilation, clean surroundings, and strict personal hygiene, these benefits, although raising the physical wellbeing of man, do not suffice for the prevention or suppression of smallpox.

From over a century's experience in controlling smallpox, sanitarians have learned the futility of depending upon notification, isolation, quarantine, surveillance of contacts, disinfection, fumigation, and other similar measures, either alone or together, to check or stamp out the disease. They have learned to utilize them as aids, but above all else they must, can and do place their reliance upon vaccination as a simple and sure means of protection against this scourge.

III. Vaccination

History. The gift of the practice of vaccination came in 1798 from the English physician, Edward Jenner. When an apprentice to a surgeon some thirty years earlier, he became interested in the popular local belief that any person who had had cowpox could not take smallpox. He learned that milkers frequently had pustular eruptions on their hands, contracted from cows having similar eruptions on the udder, and he found further that such individuals had been known to escape smallpox even when directly exposed to it. He conceived the idea that it might be possible, by artificially transferring the infection from kine to man, to establish the same protection which seemed to follow the accidental infection. He put this notion to experimental test, and in 1798 published his results in his now famous "Inquiry into the Causes and Effects of the Variolae

Vaccinae." There he reported his observations on the apparent immunity against smallpox possessed by persons who had suffered accidental infections with cowpox, and described his classic experiment of 1796, in which he vaccinated an eight-year-old boy with material taken from a pustule on the hand of Sarah Nelmes, a dairymaid, who had received a cowpox infection from her master's cows. The boy developed what is now known as a typical "take," and later, when Jenner inoculated him with true variolous matter taken directly from a smallpox pustule, no disease followed, and, after a second similar attempt, Jenner remarks, "no sensible effect was produced on the constitution." He demonstrated, therefore, that cowpox naturally or artificially transmitted to man is in itself harmless and affords protection against smallpox.

There is evidence that Jenner was not the first one to try cowpox vaccination.

In the graveyard of the ancient Dorset Church of Worth Matravers, in England, there is a tombstone with the inscription: "Sacred to the memory of Benjm. Jetsy (of Downshay), who departed this life April 16th, 1816, aged 79 years. He was born at Yetminster in this country, & was an upright & honest man; particularly noted for having been the first person (known) that introduced the Cow Pox by inoculation, & who from his great strength of mind made the experiment from the cow to his wife and two sons in the year 1774." Even if the fact recorded in this epitaph is true, the credit for the discovery of vaccination must remain with Jenner, because it was he who made his discovery known, and who by his enthusiasm and persistence established the practice of vaccination.

Jenner's method continued in use for a half century or more, when it was found that, instead of using vaccine directly from the original cowpox pustle

of the cow, or indirectly by transferring such matter from arm to arm, it was possible to vaccinate calves with the purified virus of cowpox, and from this source to obtain an abundance of potent vaccine. This method eliminated many of the dangers of vaccination, such as the possible transference of secondary infections from a diseased donor to a healthy recipient, and led the way to a uniform and controlled procedure for producing vaccine virus.

Because of the prevalence and dread of smallpox, vaccination was eagerly accepted both in England and in this country, and from the first years of the nineteenth century its adoption became widespread. While Jenner and his followers subsequently modified their claims as to the nature of cowpox and the duration of the immunity produced by vaccination, the great basic fact of his discovery remained unchanged, and accumulating experiences showed that here

at last was a simple means for abating or mitigating this old-time evil.

It cannot be denied that the Jennerian method, or the early use of animal vaccine, was not without its faults. The source and quality of the vaccine were often far from satisfactory, and the operation itself frequently was crudely performed. The unfortunate consequences following vaccination, repeatedly quoted by anti-vaccinationists, date back in the main to the days before the development of our present methods of preparing vaccine virus and of performing vaccinations.

What is vaccination? Vaccination is the introduction into the skin of the harmless virus of cowpox, or *vaccinia*, which confers upon the individual protection against smallpox, or *variola*. The method, in its essentials, duplicates nature's own way of bringing about immunity. The unknown virus of cowpox causes the human body to manufacture

substances antagonistic to itself and also to the virus of smallpox. The practice comprises three factors: the vaccine virus itself, the operation of vaccination, and the care of the vaccinated area. The preparation of vaccine virus may be briefly described as follows: the seed vaccine containing the virus of *vaccinia*, or cowpox, obtained originally from a case of cowpox and cultivated by repeated transfers in a long series of healthy calves, is inoculated into superficial scratches on the shaven and cleansed skin of normal calves. After a period of five or six days, during which time the animal is kept under the best possible sanitary conditions, this vaccinated area is thoroughly cleansed, and the contents of the developed vesicles are collected and ground with diluted pure glycerine containing a small amount of carbolic acid. This "crude" vaccine is then stored for a month or more at a freezing temperature. The glycerine

destroys the majority of the bacteria inevitably present in the crude material; and on further exposure to cold, the glycerine and carbolic acid reduce the bacteria to a negligible number. The vaccine at this stage is then subjected to exacting tests, which would reveal any harmful organisms if present. When the product has passed satisfactorily all bacteriologic and biologic examinations, it is put into sterile tubes and again stored in the cold until required for use.

The whole process is, of course, carried out under the most rigid aseptic precautions. Since 1902 practically all the vaccine virus produced in this country has been prepared under Federal supervision. The establishments manufacturing vaccine virus are regularly inspected by officials of the United States Public Health Service, and all steps in the preparation of the vaccine must be performed strictly according to Federal regulations. Only those laboratories which

comply with every feature of the regulations are licensed and permitted to distribute this product. The vaccine employed to-day is a highly refined and harmless biologic agent, and is a far different product from that supplied before the time when the Federal government assumed supervisory control of its manufacture.

Just as the method of preparing vaccine virus has been perfected and standardized, so too the technic of vaccinating has been improved by the application of the principles of modern asepsis and the substitution of a slight superficial lineal scratch for the former cross-hatching, cutting and scraping of the skin. A modern vaccination properly performed leaves a scar so slight that it cannot be considered a blemish, and the possibility of accidental infection is reduced to a minimum.

The after care of the vaccination site must always rest largely with the patient

or the family, but the exercise of ordinary cleanliness is all that is required to prevent any troublesome developments.

In the last twenty years we have come a long way from crude vaccine and clumsy or careless vaccination, so that the danger of vaccination as performed to-day is negligible in comparison to the danger it averts.

Vaccination should be performed on the upper arm. The ideal method consists in scrupulously cleansing the skin, and then rubbing the vaccine virus into two superficial scratches on the skin, each about three quarters of an inch long and an inch apart. The tiny scratches soon heal, and after three or four days, if the vaccination runs a true course, a small papule may appear at the place where the vaccine was applied. A day or two later this papule develops into a vesicle, which becomes surrounded by a red and swollen area. About the eighth day the vesicle turns yellowish

and the area of redness about it may widen; but about the tenth day the process begins to subside, leaving a crust which, when it drops off about the twentieth day, leaves behind it the typical scar. The scar is evidence of the success of the vaccination.

Vaccination should be done preferably in the second six months of life, again in early school days, and whenever smallpox appears in the community. As a rule one successful vaccination protects for a period of from five to seven years, and two vaccinations are usually sufficient to protect for life. In the infrequent instances where a vaccinated person contracts smallpox, the disease runs a mild course. A word of caution about the acceptance of a widespread belief may be said here. Failure on the part of a person to develop a "take" does not necessarily indicate immunity. Either the vaccine virus was inert, the operation of vaccination was improperly per-

formed, or else a modified or immune reaction resulted but passed by unnoticed. Vaccination, to accomplish its aim, should be repeated until the usual "take" develops or until an accelerated or vaccinoid reaction is obtained.

Efficacy of Vaccination. If after a century's history any further evidence were necessary of the value of vaccination as a protection against smallpox, every fresh outbreak piles up additional proof of the far more favorable experience of the vaccinated as compared to the unvaccinated. The analyses of the records of all recent epidemics bear out the statement made above, that smallpox rarely attacks and still more rarely kills those vaccinated within seven years, and that two vaccinations are usually sufficient to protect for life. Of the many such records, three trustworthy reports may be taken as showing the comparative fates of the vaccinated and the unvac-

RECORDS OF 185 CONSECUTIVE CASES OF SMALLPOX OCCURRING IN MASSACHUSETTS IN 1894 (THE TOTAL INCIDENCE OF THAT YEAR)

Ages	Vaccinated			Unvaccinated			Of unknown or doubtful history			Total		
	Cases	Deaths	Fatality rates	Cases	Deaths	Fatality rates	Cases	Deaths	Fatality rates	Cases	Deaths	Fatality rates
			%			%			%			%
Under 1	0	0	..	7	5	71.0	0	0	..	7	5	71.4
1–4.....	1	0	0	20	3	15.0	0	0	..	21	3	14.2
5–9.....	2	0	0	14	0	0	0	0	..	16	0	0
10–14.....	3	0	0	3	0	0	0	0	..	6	0	0
15–19.....	7	1*	14.3	6	1	16.7	1	0	..	14	2	14.2
20–29.....	33	2†	6.0	23	7	30.4	7	2	28.5	63	11	17.4
30–39.....	16	2*	12.5	10	5	50.0	1	0	..	27	7	26.0
40–49.....	13	1*	7.7	2	1	50.0	4	1	25.0	19	3	15.8
50.....	8	0	0	0	0	0	2	1	50.0	10	1	10.0
Unknown ...	2	0	0	0	0	0	0	0	0	2	0	0
Total.....	85	6	7.1	85	22	25.9	15	4	26.7	185	32	17.3

* Vaccinated in infancy.

† One vaccinated in infancy; the other presented doubtful scar, but previous vaccination was claimed.

cinated. First there is the smallpox record of Massachusetts of 1894, when the disease appeared in a moderately severe form, and when the history of every reported case was studied.

The figures for the more severe Glasgow outbreak of 1920–21 are:

Age group	Vaccinated	Died	Fatality per cent	Unvaccinated	Died	Fatality per cent
0–1.....	0	0	0	16	11	68.7
1–5.....	1	0	0	32	11	34.3
5–10....	8	0	0	41	10	24.3
10–15....	21	0	0	23	6	26.0
Total..	30	0	0	112	38	33.9

Then, more recently the New York State statistics for 1923 show the following:[1]

No. new cases	No. vaccinated during 7 years preceding	No. last vaccinated more than 7 years previous	No. never successfully vaccinated	No. history not obtained or uncertain
375	2	11	362	0

[1] Since this lecture was written an outbreak of malignant smallpox in Minnesota brings new evidence of the protection given by vaccination. The reported cases

Communal Vaccination. It has become a general public-health axiom that where there is the largest proportion of vaccinated persons, there is the smallest number of smallpox cases. Smallpox cannot spread in well-vaccinated communities, irrespective of the hygienic habits of the people or the unsanitary conditions of their surroundings. In addition to the experiences of Denver, Detroit, and other American cities already quoted, one other example may be

are arranged according to their vaccination histories in this table:

January 1, 1924, *to August* 6, 1924

	Cases	Deaths
Never successfully vaccinated	151	36
Vaccinated over 7 years ago	40	6
Vaccinated less than 7 years ago	2	0
Had smallpox in childhood	2	0
Total	195	42

The Minnesota State Board of Health remarks: "Thousands have been vaccinated in the localities already invaded by malignant smallpox and for this reason the number of cases and deaths, though needlessly large, is relatively small."

cited. In the Toronto epidemic of 1919–20 the vast majority of cases occurred in unvaccinated individuals. Among the 40,000 Jews living there under very poor sanitary conditions, but who are practically one hundred per cent vaccinated, there was only one case of smallpox.

Those countries and states which have practised general vaccination hold it as one of the greatest benefits that can come to their people. Such is the case of the Philippines. There the American authorities have demonstrated in an unanswerable way that vaccination systematically performed can transform a previously highly susceptible population into an immune population. The Filipinos, representing every grade of civilization from the savage to the cultivated, have always been particularly vulnerable to the attack of smallpox. Previous to American occupation smallpox was rife in these islands and it was virulent smallpox. To-day, on the basis of population,

there is less smallpox in the Philippine Islands than there is in the United States. The story of how such a change has been brought about comprises every feature of the relation between vaccination and smallpox, and no similar story has been so frequently quoted — and misquoted — as that of the Philippines. Because of the confused opinions which exist concerning the efficacy of vaccination in the Philippines, and because of its importance in the present discussion, the main features of the story may be briefly considered.

Prior to, and in the first few years of, American occupation the yearly deaths from smallpox were counted in the tens of thousands. The American authorities then began a campaign of compulsory vaccination and the disease disappeared in the wake of the vaccinators. The annual deaths in the islands fell to a few hundreds, and these occurred mostly in remote provinces to which potent vac-

cine could not be supplied because of unfavorable climatic conditions — vaccine virus being extremely sensitive to heat. For seven years prior to 1914 there was not a death from smallpox in the city of Manila. Systematic vaccination had rid the city of the plague, and had driven it into the more inaccessible provinces of the islands. Then, in 1914, with the withdrawal of American authority, the administrative conduct of vaccination broke down. The circumstances are thus described by Heiser, who was Consultant in Health to the Governor-General:

"After 1914, general vaccination of new-born children and other unprotected persons was not effectively carried out. It is true that the records show that sufficient quantities of vaccine were made and sent out, but it is likewise true that the results of careful investigations instituted recently show that much of the vaccine was never applied, or not

used until it had deteriorated. Minor health officials and vaccinators found it much easier simply to report vaccinations than actually to carry out the procedure. Quantities of vaccine virus were actually discovered in waste-paper baskets. In some instances many more vaccinations were reported than would have been possible with the quantity of vaccine sent to the vaccinators. In another instance the total vaccinations reported in Pangasinan exceeded the population by 50,000. Thus, a huge unvaccinated population came into being, and it was only necessary for the ever-present spark to fall among them to start the conflagration. The spark fell, and in consequence more than 50,000 unfortunate victims have lost their lives."

The outbreak of 1918, instead of demonstrating the failure of vaccination, actually brought new evidence of its great value. Of the thousands of deaths, 93 per cent occurred in persons who had

not been vaccinated; and — what is still more striking — nearly 90 per cent of the cases were among unvaccinated children, the majority of whom were born after 1913. When the situation was finally revealed, active, systematic vaccination was resumed and the islands are again almost free from smallpox. As an illustration of the power of vaccination to abate the scourge, the Philippine story is singularly complete: first, a population plagued with the disease; its rapid disappearance in unsanitary as well as in sanitary districts following vaccination; its recurrence with its heavy toll among the unvaccinated when vaccination is neglected; and finally, again, its control by renewed and general vaccination.

Japan has been, since time immemorial, a great sufferer from smallpox. Exposed to especially virulent contagion from Manchuria, this country has been repeatedly invaded by the malignant disease and has felt its true destructive

power. Kitasato has stated that from the year 123 B. C. to the restoration of the Meiji Era (1875), about fifty epidemics have occurred, each one of which extended over a number of years, sweeping all through the country and diminishing the population considerably. The Japanese first sought what protection quarantine might afford, but still the disease came in. In 1849 they tried voluntary vaccination; but although it slowed the annual attack, it gave only partial relief because it was not adopted throughout the Empire. In 1874 laws compelling vaccination were enacted, but they were not sufficiently enforced. This step had its effect in reducing the number of cases and deaths and it even mitigated to an appreciable extent the cyclic epidemics. In 1909 a more rigid compulsory law was placed on the statute books, which provides that every Japanese baby shall be vaccinated within 90 days after birth, and every child shall be revaccinated

during the tenth year. Even with this law in operation Japan is not yet a thoroughly vaccinated country, because vaccination is neglected in many rural parts of the Empire. The results of its last and continuing effort are, however, plainly evident in its smallpox record for the past decade. During no similar period in their history have the Japanese people suffered so little from this pestilence. There the officials hold fast to their hard won advantage over their old foe. They place their reliance upon compulsory vaccination, and each year, as a result of its continued enforcement, the percentage of the unvaccinated dwindles. As an example of the sentiment of the people, there is a small fishing town on the west coast, until recently isolated and formerly ravaged by smallpox, where there stands a monument to Edward Jenner, erected by a grateful people.

India is becoming increasingly appreciative of the benefits bestowed by vac-

cination. India has been always plagued with smallpox. Pringle wrote: "If cholera carries off hundreds every year, if the victims of famine were to be counted by thousands, these are but infinitesimal quantities beside the frightful devastation caused in India by smallpox." The disease has raged epidemically with a cycle of about seven years. During these epidemic periods the disease was of the most malignant confluent kind, from which few of either natives or Europeans escaped, many of them dying on the first, second, or third day of the eruption. It struck the lowest and highest born in the land, claiming in one ruling family between the fifteenth and eighteenth centuries five out of the sixteen Maharajahs.

It is not to be wondered at that smallpox became so firmly established in India. The great mass of the population lives in villages which are collections of small attached tenements separated by narrow streets or lanes. The tenement

is mainly of the one-room variety, in which the whole family lives, eats, and sleeps. There is no possibility of isolating infected persons. Add to this the fact that the great majority of the population are poor, ignorant, and highly fatalistic, and you have ideal conditions for the continued propagation of smallpox.

Previous to the discovery of vaccination the Indians for centuries had practised inoculation in seeking relief from the scourge. Cowpox vaccine was introduced into Bombay in 1802, and arm-to-arm vaccination extended to other provinces and continued in all parts of India except the larger cities until the beginning of the present century. Now calf-vaccine virus has entirely superseded the older method, but with the exception of a small part of British India, vaccination remains on a voluntary basis. An amended compulsory vaccination act of 1909 applies only to an area with a

population of less than sixteen millions, or less than seven per cent of the total population of the Empire. The official record of smallpox deaths for the various provinces is given on the next page.

The death-toll from smallpox in India is appalling, yet there has been a marked fall in the death-rate. Jelalm Shah of the Governmental Health Commission of India states that this decrease is due entirely to vaccination, and he points to the Madras figures, which show that smallpox is still ready to assume epidemic proportions when vaccination is neglected or inefficiently performed. In that Presidency an unsatisfactory vaccine virus, prepared with lanoline instead of glycerine, was exclusively used, and the percentage of successful primary vaccinations fell as low as seventy.

The people of India know the terrors of the disease and the value of vaccination, and "in spite of their poverty, ignorance and fatalistic attitude have

Area	Period	Total smallpox deaths	Average annual mortality per million of population
British	1868–1877	1,436,009	1032.3
India	1878–1887	1,460,890	771.9
	1888–1897	961,424	466.0
	1898–1907	832,165	373.9
	1908–1917	851,799	348.0
	1918–1922	411,764	329.4
Bombay	1868–1887	168,910	537.2
Presidency	1888–1907	88,245	240.5
	1908–1917	44,850	230.0
	1918–1922	22,772	239.0
United	1868–1877	500,194	1587.9
Provinces	1878–1887	670,951	1535.6
of Agra	1888–1897	305,002	662.1
and Oudh	1898–1907	79,950	168.5
	1908–1917	103,396	219.9
	1918–1922	21,836	97.0
Central	1868–1887	153,764	1020.1
Provinces	1888–1907	93,576	502.7
	1908–1917	27,953	254.1
	1918–1922	10,452	190.0
Punjab	1868–1887	354,440	1099.3
	1888–1907	195,304	520.7
	1908–1917	117,960	589.5
	1918–1922	33,899	328.7
Madras	1868–1887	656,336	1163.9
	1888–1907	450,945	673.0
	1908–1917	223,765	540.4
	1918–1922	146,774	716.0

voluntarily adopted vaccination as the only sure protection from the appalling consequences of smallpox." [1]

There is no need to recite the smallpox histories of European countries, because they are fully presented in many available publications. They all yield convincing proof that, in those countries in which compulsory vaccination has obtained, smallpox has been brought to heel.

There is one history, however, which, because of events of the past two years, is pertinent to the present discussion, and that is the history of England. England, before the days of vaccination, had been stricken time and again with smallpox, and so constantly was it prevalent in the seventeenth and eighteenth centuries that few Englishmen showed faces free from pock marks. The English acclaimed Jenner's discovery and made the practice of vaccination their own. Prior

[1] Jelalm Shah.

to 1871 they placed their reliance upon voluntary vaccination, and then put into effect a rigorous law which required vaccination of infants. Although this statute contained no provision for revaccination in childhood, its effect on the death-rate is strikingly apparent in the records of deaths from smallpox in England and Wales from 1867 to 1923 inclusive.

Years	Deaths
1867–1876	58,218
1877–1886	18,026
1887–1896	5,092
1897–1906	4,761
1907–1916	139
1917–1923	102 [1]

[1] 7 years only (1923 provisional).

The very efficacy of vaccination militated against its strict continuance. Through its agency smallpox was brought under control, and the rarity and mildness of the disease caused the English to forget its terrors. They were swayed by the preaching of fanatical or selfish agitators, and at the anti-vaccination-

ists' behest, in 1898 they relaxed their governmental control of vaccination. They inserted into their compulsory law a "conscience clause," which exempted from vaccination those who should claim conscientious scruples against the practice. For a time smallpox remained quiescent; but as more and more exemptions were claimed, and an unvaccinated child population progressively accumulated, it became evident to health officials that it was only a question of time when smallpox would return and claim the misguided victims of their false prophets. Now in England, smallpox is once more coming into its own.

SMALLPOX CASES NOTIFIED IN ENGLAND AND WALES

Year	1912	1913	1914	1915	1916	1917
Cases	121	113	65	93	159	7
Year	1918	1919	1920	1921	1922	1923
Cases	63	311	280	336	973	2,504

These figures are all the more telling when it is remembered that there has

been at the same time a remarkable decline in other notifiable infectious diseases. While the disease, to be sure, is mostly of the mild type, it is, however, true smallpox; and unless it develops an unusual trend or unless drastic measures are taken to halt its spread, there is the grave likelihood that it will increase in virulence.

That the increase in smallpox is not due to any freakish dispensation of Providence but is the result of the neglect of vaccination — a neglect directly brought about by the activities of anti-vaccinationists — is clearly and convincingly brought home by the facts. There is an increase in the number and proportion of the unvaccinated. Whereas in the eighteen-seventies the number of vaccinations represented at least 85 per cent of the births, the proportion has now fallen, according to the last available figures (1921), to less than 40 per cent.

Considerably less than half the children in England and Wales, therefore, are now vaccinated. The dangers of this condition have been foretold. Thanks to the presence of a large number of vaccinated persons and to the aid of other methods of prevention, such as prompt isolation and the vaccination of contacts, the English have so far escaped a great epidemic. Minor outbreaks are now of constant occurrence. The average number of new cases each week has risen from nineteen in 1922 to forty-six in the present year. Smallpox is now virtually endemic in some areas of the North and the Midlands.

It only remains to be added that it is the vaccinated who are escaping the contagion, and furthermore, there is the expected but none the less distressing corollary that it is the children who constitute an increasing proportion of the unvaccinated, and therefore of the victims.

The whole smallpox story has therefore been written by England. In several respects it is like the experience in the Philippines. First, centuries of pestilence; then the partial success of inoculation in abating the pestilence; next, the discovery of vaccination and its brilliant record in controlling smallpox during the nineteenth century — a victory so complete as to delude the English into thinking that the disease was conquered; then the rise of the anti-vaccinationists, their successful efforts in breaking down the barriers that had so long and so effectually stayed the invasion; and, finally, the alarming return and spread of the disease among the unprotected. The story is profoundly impressive. It stands as a forceful demonstration of the value of vaccination; it blazons a warning against false prophets. It should serve as a lesson to all. The facts are known and appreciated by sanitarians, but the public is not especially interested, nor is

it receptive of the repeated admonitions of its health officers. There is not yet enough smallpox to frighten the people, and there is enough mischievous propaganda to make them believe that there is no danger from smallpox and that there is danger from vaccination.

Smallpox in the United States. The United States to-day, in one part or another, furnishes examples of every phase of England's smallpox history. Following the introduction of vaccination into this country in 1801 by Dr. Benjamin Waterhouse of Cambridge, Massachusetts, the smallpox situation underwent a remarkable change. The epidemics lessened in frequency and severity and never since that time has the country been so scourged as formerly. Those states that have practised vaccination persistently have fared the best so far as smallpox is concerned, and their fortunes vary according to the thoroughness with

which the practice is employed. Leake and Force of the United States Public Health Service, in a critical study of the smallpox records of twenty states, with a comparison of the existence and enforcement of state vaccination laws, and the attitude of the public toward these laws, have proved beyond peradventure that the people of any community or state can determine just what their smallpox fate shall be.

In the light of our present knowledge, and with the means at our disposal for its complete suppression, it amazes one to reflect that not only have some states continued to tolerate this evil, but other states have abandoned their former safeguard and have literally invited the return and spread of smallpox.

Some of us are ignorant of the real nature of the disease, and are unaware of the destruction and sorrow it caused our forebears. It no longer torments us as it did them. Then, too, some of us are

heedless of a known danger until we are threatened with its immediate presence, and others of us require a tragedy to open our eyes to impending peril. There is, furthermore, a growing reaction to mandatory regulation of our conduct, and there is always the inclination among some of us to lend a sympathetic ear to the last and loudest exhorter, no matter how unsound the doctrine preached.

Some states have already passed through the fire, and their unhappy experience has taught them to dread the flame and to safeguard themselves against any subsequent burning. Others are now caught in the conflagration and are seeking the protection afforded by vaccination. Still others, vain in their radicalism, spurn any official advice, and apparently can be stirred only by a similar catastrophe. The time has come when we can no longer regard smallpox as a trivial disease; and if we are not to repeat England's experience, we

must take the lesson to heart and raise our defences before the plague returns to us.

Lest it be charged that the menace is imaginary, that the situation holds nothing in it to cause us alarm, or that vaccination is not the great boon that it is claimed to be, let us consider the record of three states. Massachusetts may be taken as an example of a state which, having suffered the heaviest blows from smallpox, early inaugurated and has clung to compulsory vaccination. California may be chosen as a state in which the lesson learned was forgotten; where the priests of Baal prevailed, but where now the old lesson is once more being driven home with convincing force. Minnesota affords an example of a state where the people hold personal liberty higher than the common good, and choose to suffer from smallpox rather than submit to compulsory vaccination.

SMALLPOX AND VACCINATION

Massachusetts in the seventeenth and eighteenth centuries had been a heavy sufferer from smallpox, and the people, after seeking the partial and somewhat hazardous protection afforded by inoculation, eagerly adopted Jennerian vaccination. At the same time they enacted laws providing for the proper isolation and care of smallpox cases. For some time vaccination was purely voluntary; but when its value became more and more apparent, a compulsory vaccination law was passed, in 1855. With some modifications, this law still stands, and in this state every child, unless exempted by a physician, must be vaccinated as a requisite for public-school attendance. Until 1872 the law was not strictly enforced; and when the world-wide epidemic reached Massachusetts, this fact became apparent. In that year and the one following it there were approximately 1600 smallpox deaths and the official state records show that the

great majority of these cases and deaths occurred in adults who either had not been vaccinated since childhood or who had never been vaccinated at all. Renewed efforts were made by the officials of the newly created State Board of Health to enforce the law and to extend the practice of vaccination. The success of their efforts is reflected in the striking decrease in the disease which ensued. Since 1873, with a population increasing from 1,600,000 to approximately 4,000,000, the total number of deaths for the entire state for any one year has never reached 50, with the exception of the years 1901 and 1902. In those years an outbreak occurred, largely confined to the city of Boston, and the total deaths in the two years numbered 387. Once more it was found that there had accumulated a considerable proportion of unvaccinated persons, but the wholesale vaccination of the people of Boston brought the epidemic to an abrupt end.

Here is a state of four million people, with seaports open to every land, exposed to the introduction of the disease from all parts of the country, but a state with free vaccine virus and a compulsory vaccination law well, if not completely, obeyed. Massachusetts is by no means invulnerable, because the vaccinal protection of its adult population has largely lapsed with the course of time; yet it is unlikely that smallpox will ever again secure a foothold within its borders. The danger of vaccinal neglect and the worth of vaccination were so convincingly demonstrated, especially by the last epidemic of 1902, that the state in 1904 began the manufacture and free distribution of vaccine virus. Since that time, this Commonwealth has been free from smallpox to such an extent as never before. With its smallpox cases nearly always under the one-hundred mark since 1902, and with a maximum of 40 yearly cases and a total of one death

since 1917, the record of Massachusetts stands as a conspicuous example of the efficacy of vaccination in preventing smallpox, and as an unanswerable challenge to those who doubt its value.

California also affords a striking illustration, but in a very different way. Prior to 1911 vaccination was mandatory, and smallpox never reached epidemic proportions. The disease was so well under control that the people lost sight of its possibilities and were influenced by the active campaign waged by the organized opponents of vaccination. The health officials tired of attempting to enforce a law which had become unpopular; so the law was repealed, and since 1911 California has relied upon quarantine, notification, isolation, and voluntary vaccination for protection. These measures, as usual, have proved to be inadequate, and what was prophesied has happened. The cases, held in the hundreds in the years of com-

pulsory vaccination, have mounted into the thousands for each of the past six years, and apparently the peak of the infection has not yet been reached. As might be expected, as a result of the abandonment of the requirement of vaccination as a condition to school attendance, the number of children attacked by the disease is steadily increasing.

Minnesota's experience represents the price paid for the neglect of vaccination. There the anti-vaccinationists prevail, and with the people their word bears greater weight than that of the health officials. In 1903 compulsory vaccination was abandoned. There is now no law requiring children to be vaccinated before entering school, and health officers are powerless to enforce vaccination, even in the face of exposure or at the time of an epidemic. All that they can do is to require notification and isolation or quarantine of cases, and place in quarantine those who have been in con-

tact with smallpox and who refuse to be vaccinated. There the anti-vaccinationists are vociferous in their protests, and go to great pains to persuade the people to resist and refuse vaccination. In consequence, the only protected inhabitants of the state are the small minority who appreciate the value of vaccination and have sought its protection of their own free will, or who have been vaccinated in states where compulsory vaccination is enforced.

What then is the result of such wholesale neglect of vaccination? It is precisely what one might expect. Minnesota is a heavy sufferer from smallpox, not only in epidemic years, but every year. Since 1900 there have never been less than a thousand reported cases, and the figures mounted to over six thousand in 1920, to over nine thousand in 1921, approximately twenty-two hundred in 1922, and nineteen hundred in 1923. These figures, when compared to those

of the larger, but vaccinated, population of Massachusetts (29, 37, 2, and 6 cases in the same years), are momentous. Moreover, the state health officials of Minnesota say that a great many cases are unreported, and that whenever an investigation is made by the state inspectors it is found that the unreported cases are several times more numerous than the reported.

The record of smallpox and vaccination in Minnesota from 1913 to 1923 inclusive can be condensed into a brief table:

	Cases	Deaths
Never vaccinated	33,108	107
Vaccinated over 7 years ago	1,458	1
Vaccinated less than 7 years ago	586	0
Total	35,152	108

The one vaccinated person who died was a man, 47 years old, who had been vaccinated in childhood.

Although, as a rule, the disease is of the mild type, yet outbreaks of virulent smallpox have occurred, especially that

of 1917. In Minnesota, therefore, the people choose to have smallpox and for their choice they pay a heavy price in sickness, suffering, and lost time, and in the expenditure of private and state funds.

Glancing back over the records of these three states, we find Massachusetts well vaccinated and with smallpox a rare disease; California with decreasing vaccination and increasing smallpox; and Minnesota with little vaccination and with the most smallpox.[1]

Once more the point may be stressed that the absence or prevalence of smallpox is dependent upon the people's word.

[1] Minnesota's unfortunate smallpox experience still continues. Between January 1, 1924, and August 1, 1924, there have been 1613 reported cases with 51 deaths. Malignant smallpox was introduced into Duluth in January by an itinerant laborer from Canada. From this case hemorrhagic smallpox spread to eight counties and crossed the border into Wisconsin. Altogether 195 cases of this virulent form of the disease have been reported, of which 42 were fatal. The vaccination histories of these cases are given on page 49.

Compulsory Vaccination. In the early days of vaccination, when smallpox still raged, people needed no urging to be vaccinated. They knew only too well the nature of the danger that threatened them; a danger ever present, and one against which, until Jenner's discovery, they had found no means of protection. Vaccination then was not only voluntary, it was eagerly sought. Through this general but individual desire for escape from the plague there gradually arose group immunity, and eventually state-wide or country-wide immunity. As the communal immunity increased, smallpox decreased. Epidemic outbreaks diminished in severity and extent, and the disease became limited to the unvaccinated, and in its milder form to some of those who had outgrown their previous immunity. As a demonstration of the efficacy of vaccination, wherever generally practised, the proof was complete and convincing.

But, as smallpox receded and succeeding generations came along with no first-hand knowledge of its terrors, the necessity for vaccination became less apparent to the masses, and protective vaccination was less commonly sought. Children were allowed to grow up without being vaccinated, and revaccinations in adult life were largely neglected, except by those who knew the ways of the disease. With the gradual falling off of vaccinations there accumulated a larger and larger proportion of susceptibles. The situation was quite different from that prevailing when the practice of voluntary vaccination was at its height. Smallpox was unexpected, and early cases were missed and passed on the infection to the unprotected. The menace was unappreciated or belittled. When the outbreaks grew to epidemic size, the danger became real and stirred a popular desire for vaccination. Then, with the disease again under control,

public interest waned and the cycle began all over again. It takes years for the cycle to run its course, and before its course is ended a new and uninformed population has arisen. The lesson must each time be learned afresh.

Such has been the history of voluntary vaccination. Wherever it has been depended upon to protect a people against smallpox, it has failed of any enduring success.

Physicians, sanitarians, public-health and social workers are familiar with the story. They know the disease and they know its power for harm. They know the value of vaccination, they practise it upon themselves and escape infection, even though they visit and nurse smallpox patients. They urge its universal adoption, but the average layman is indifferent to their advice.

The shortcomings of sanitary measures, the inadequacy of voluntary vaccination, and, on the other hand, the

signal success of compulsory vaccination, all prove the soundness of the conclusion that smallpox can be banished and conquered only by universal vaccination, and that universal vaccination can be brought about only by law. The justification for compulsory vaccination lies in the principle of the greatest good to the greatest number — individual preference must yield to the common welfare. The same principle underlies the laws requiring the isolation and quarantine of persons suffering from communicable diseases, with this difference — the unvaccinated person is a potential source of infection, while the smallpox patient is an immediate source.

What, then, are the reasons why compulsory vaccination is not everywhere in force? The reasons are several. In some states which have had no recent visitation from smallpox, and especially in those where the population density is low, there has been no popular demand

for general protection against a distant danger. In such states health officers usually hold authority to vaccinate all persons who have been exposed to infection.

In a few states health officials, finding the task of enforcing vaccination laws too onerous, have either failed to favor any extension of such legal control or have offered little or no resistance to the partial or complete repeal of existing laws. In only a small number of states is vaccination demanded as a requisite for school attendance, while in others such a statute applies only to cities of the first and second class or operates as a local option. In Minnesota, no one can be compelled to submit to vaccination, even at the time of an epidemic, though the person has been directly exposed to infection.

Such a situation naturally fosters the continuance of smallpox, and the absence, weakness, or repeal of compulsory

vaccination laws is due either to the apathy or indifference of the public, to the difficulty and expense of enforcement, or to the activities of individuals and organizations opposed to vaccination itself or to its compulsion by law. The nature of this opposition will bear a brief consideration.

Individual opposition comes from persons of various types. There are some who have been prejudiced by stories of the dangers and accidents associated with vaccination — stories originating largely from unfortunate occurrences in the days of inoculation and of crude vaccine. Such stories, with a wealth of horrid detail, are generously supplied either by rabid individuals with more zeal than critical judgment, or in a more subtle and plausible form by propagandist societies.

There are others whose bias has come from a first-hand, second-hand, or even less immediate acquaintance with un-

pleasant or distressing physical disturbances following vaccination, and usually wrongly ascribed to the practice. The various modern philosophical and religious sects which deny either the existence of physical disease or its parasitic origin, contribute a large share of conscientious if not militant objectors.

One of the most frequent remarks of such objectors is to the effect that, while vaccination may be all very well for those who desire it, yet anyone not desiring it should not be obliged to be vaccinated. They argue that in remaining unvaccinated they incur no risk to anyone but themselves. Such a standpoint is essentially selfish and shows a lamentable ignorance of the ways of smallpox. Quite aside from the personal danger to the unvaccinated individual, each such susceptible person means one more vantage-ground for the continuance and spread of the contagion. By contracting the disease, he may serve as a source

from which it may be passed to other persons of the same class, and to still others who have never learned the value of vaccination, and who, therefore, have not sought its protection. Since it is obviously an impossible task to reach every inhabitant of a state with the knowledge that vaccination is necessary and desirable, it follows that, if sole reliance were to be placed on voluntary vaccination, there would necessarily remain no small part of the population, apart from conscientious objectors, which would be susceptible to infection from those self-willed sources. Each vaccinated person, on the contrary, blocks the spread of smallpox to his associates and neighbors. If individuals chose to take their chances of contracting the disease, they would undoubtedly be acting within their rights, were it not for the fact that by so doing they become possible agents in the transmission of smallpox. It is not unreasonable to demand that they

sacrifice such a privilege to the rights of others.

These objections constitute the main arguments of the organized anti-vaccinationists, who seek to discourage individual vaccination, and at the same time to encourage individual and concerted opposition to statutory insistence on general vaccination.

Their main contentions have already been answered: smallpox is a definite pathological entity; it is transmissible and highly so; it exists in all countries; it is increasing; the danger of vaccination is negligible; vaccination is efficacious for preventing individual and communal infection.

Does then a law compelling persons to be vaccinated against their will, in order that they cease to be potential sources of disease to their fellow men, infringe any constitutional right of the individual?

To argue that personal liberty is violated is to confess a narrow and selfish

conception of our cherished rights. That a state or local health board or school board may demand that we be vaccinated either during an epidemic, as a requirement for school attendance, or at other times for the protection of all, and in so doing deprives us of none of the rights guaranteed to us by the Federal Constitution is the practically unanimous decision of all the higher courts, including the Supreme Court of this country.

Conclusion. With all the foregoing facts in mind, we may summarize the claims for vaccination as follows:

Duly and efficiently performed, it will protect the constitution from subsequent attacks of smallpox as much as that disease itself will.

It protects the individual against smallpox for a period which has not been determined mathematically for the individual, but which averages about seven years.

The protection may be renewed by a second vaccination.

The beneficial effects of vaccination are most pronounced in those in whom the vaccine affection has run its most typical and perfect course.

Persons successfully vaccinated on two occasions are usually immune against smallpox for life.

A person vaccinated once, and at a later time contracting smallpox, as a rule has the disease in a less serious form than unvaccinated persons (varioloid). The degree of favorable modification of smallpox is in inverse proportion to the period of time elapsing between the vaccination and the attack of smallpox.

Vaccination and revaccination, systematically and generally carried out, confer complete protection to a community or a nation. In other words, while the individual protection is not always lasting, the communal protection is absolute.

Vaccination, then, becomes a personal gift and a public duty. To be vaccinated is to receive individual protection and to shield others against an unnecessary and loathsome disease. To advocate and support compulsory vaccination is a national obligation which falls upon all of us. By so doing we can rid our country of one more cause of suffering and death.