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VACCINATION (from Lat. vacca, a cow), the name given in France to the Jennerian practice of cowpoxing, shortly after the practice began in England (1799). To replace smallpox inoculation by cowpox inoculation under certain specific circumstances was Jenner's tentative project. The history of the introduction of cowpoxing, given in the article JENNER, is here supplemented from the point of view of historical criticism.

Jenner's originality in starting vaccination in practice is for the most part misunderstood. When he published his *Inquiry* in June 1798, he had twice succeeded in raising vaccine vesicles by experiment. A third experiment, in the summer of 1798, failed from the outset; and his fourth and last experiment, in November-December, 1798, led to nothing but extensive phagedenic ulceration in two cases out of six vaccinated.

In this posture of affairs Woodville of the inoculation hospital, London, succeeded in January 1799, in starting a succession of arm-to-arm vaccinations from a London cow, which were exceptionally free from the ulcerative termination. From that source Jenner himself was supplied with lymph in February, while more than two hundred practitioners both at home and abroad were supplied some three weeks later.

The so-called lymph is as remote from the cow as ordinary humanized lymph; it differs from the latter merely in the circumstance that the calf (on its shaven belly) becomes the vaccinifer, instead of the child, and that the cycle of the disease is very much abbreviated or contracted in the calf: the vesicles are distended with lymph about the fourth or fifth day, instead of the seventh or eighth, and are almost unattended by areolar redness and constitutional disturbances, the animal being able to support fifty to a hundred or more vesicles without the smallest inconvenience. On the child's arm the vesicles after calf-lymph are slower in development than in the calf, and are attended by areola, etc.

The other anomalous source of "vaccine" is human smallpox. Jenner having succeeded in passing off his doctrine that cowpox is smallpox of the cow, it occurred to some persons about forty years after to prove the doctrine by experiment, the proof being to variolate the cow on the udder. This was accomplished in 1838, after much trouble, by Theile in Kazan (Russia), who inoculated several thousands of persons with variolous matter "passed through the system of the cow." Within a few months of that experiment, the same thing was attempted by Ceely of Aylesbury, who succeeded, after many failures, in raising a large variolous pock, not on the udder of the cow, but on the mucous membrane of the vulva. But the real practical application of this idea was reserved for Badcock, a dispensing chemist at Brighton.

At Boston, the same kind of lymph was raised and put in use in 1852. But at Attleborough, Mass., the same experiment had in 1836 led to disaster. Smallpox was inoculated on a cow's udder, and the product used to vaccinate about fifty persons. The result was an epidemic of smallpox a panic, and the suspension of business.

The risks of vaccination may be divided into the risks inherent in the cowpox infection and the risks contingent to the puncture of the skin. Of the latter nothing special requires to be said; the former will be discussed under the five heads of (1) erysipelas, (2) jaundice, (3) skin eruptions, (4) vaccinal ulcers, and (5) so-called vaccinal syphilis.

(1) A Slight degree of erysipelas was recognized by Jenner himself, and even postulated by him, as part of the natural history of cowpox in man; and it is so recognized by the more unbiased writers of recent date. The usual time for it corresponds to the appearance of the areola (eighth or ninth day), that efflorescence round the pock being normally a slight erysipelas. It may start, however, from the puncture or scratch in the skin, after a day or two's interval; but that form of it (the "early erysipelas" of German writers) is much rarer than the erysipelas of the areola, or "late erysipelas."

(2) It is only within the last few years that jaundice has been recognized as a post-vaccinal effect; and at present there is only one accepted instance of it on the large scale. This was the epidemic among re-vaccinated

adults in a large shipyard at Bremen from October 1883 to April 1884. Circumstantial evidence (agreement and difference) clearly traced the epidemic to the vaccination.

(3) The eruptions that follow vaccination are proper to cowpox infection. The eruption is a kind of exanthema, or “secondary” of the local infection, and does not ordinarily appear before the second week. One of its commonest forms is a patchy rose-rash, or macular roseola, not easily distinguishable from the macular roseola of syphilis. Another form is lichen or dry papules, apt to scale; it may also occur as a vesicular eruption, and in the form of pemphigoid bullæ or blebs.

(4) Ulceration of the vaccine vesicle, or of the site of it, is one of the commoner forms of “bad arm.” It is a return to the native or untamed characters of cowpox on the cow’s teats, or on the milker’s hands or face, or in the child’s arm after experimental inoculation with primary lymph. It crops out not unfrequently in everyday practice, and is probably dependent for the most part on the lateness at which the lymph was taken for vaccination, or on retardation of the process in the vaccinifer, or on emptying the latter’s vesicles too much; however, it may result from picking the scab or otherwise dislodging it. Healing is frequently an affair of weeks, and may be aided by mercurial treatment.

(5) It has been proved by many experiments, undersigned or otherwise, in Paris (1831 and 1839), Vienna (1854), and elsewhere, that an infant with congenital syphilis develops correct vaccinal vesicles, provided its skin be clear of eruption and the lymph have been take at the usual time; also that the lymph taken from the correct vesicles of the syphilitic child produces correct vesicles in its turn, but does not produce syphilis in the vaccinated child. The congenital taint is, in fact, irrelevant to the course of cowpox infection. So far as experiment and casual experience can prove anything, that has been proved.

In the polemical writings of anti-vaccinists, such diseases as scrofula, tubercle, hooping-cough, diarrhea, and other common causes of infantine mortality are alleged to have increased owing to vaccination. There is little to no reason, in theory or experience, to suspect that tuberculous or scrofulous infection is ever communicated by vaccine lymph.

The value of cowpox as a protection against smallpox may now be judged of apart from the fanciful doctrine of variole vaccine by which it was originally recommended. It has been put to a test extending over eighty years; and in some circumstances it has been possible to apply the logical methods of agreement and difference with a good deal of cogency. The upsetting fallacy of all vaccination logic is that of *post hoc ergo propter hoc*; and the only way to escape it is to hold intelligent views of history, the natural history, and the epidemiology of smallpox. The epidemic of 1871-72 was one of the worst in the whole history of European smallpox; and it may be that it was one of the last flickers of a slowly expiring flame. The universal practice of cowpoxing, however, is based upon the assumption that this contagious skin disease imported from the tropics is a thing that Europe must reckon with for an indefinite time. On the other hand, the teaching of epidemiology is that a foreign pestilence never stays unless it finds quarters suited to its existence, and that it may even take its departure capriciously, as in the case of the plague, after it has had a certain career, or on being displaced by some congener such as typhus. Vaccination is considered to have turned smallpox in great part aside from the early years of life and thrown it more than ever upon the later ages, while measles and other maladies proper to childhood have at the same time increased.

Thus far as regards the utility of vaccination to the state; we have now to consider its utility to the individual. Do the vaccinated escape in an epidemic? or, if they do not escape an attack of smallpox, do they escape death from it? In answer to the first question, apart from the familiar negative experience of everyone, we have the statistics of smallpox hospitals, which relate to the poorer class and probably do full justice to the fact of non-vaccination, inasmuch as the unvaccinated residue is mostly to be found in those slums and tenements of the poor where smallpox (now as always) is apt to linger. At the Eastern Metropolitan Hospital (Homerton) from its opening early in 1871 to the end of 1878 there were 6,533 admissions for smallpox, of which 4,283 had vaccination marks, 793 had no marks although vaccinated, and 1,477 were unvaccinated, giving a proportion of 0.29 unvaccinated. In the epidemic hospitals of Liverpool, Glasgow, and Dublin the proportion was 0.25 during the same period. In the army and navy, where vaccination and re-vaccination are absolutely without exception, the proportion is accordingly

0. It would thus appear that the rather excessive proportion of cases among the small residue of unvaccinated in the civil population must have other associated circumstances besides non-vaccination; and these are not far to seek.

The next question is the death-rate among the vaccinated and unvaccinated respectively. The total death-rate from smallpox in modern times is almost the same as it was in the 18th century; large aggregates collected by Jurin and others in pre-vaccination times show a mortality of 18.8 per cent., and corresponding aggregates in English and American hospitals, mostly since 1870, show a mortality of 18.5 per cent.

The returns from special smallpox hospitals make out a very small death-rate (6 per cent.) among the vaccinated and a very large death-rate (40 to 60 per cent.) among the unvaccinated. The result is doubtful qua vaccination, for the reason that in pre-vaccination times the death-rate (18.8 per cent.) was almost the same as it is now in the vaccinated and unvaccinated together (18.5).

The practice of re-vaccination was first recommended in England by G. Gregory, and in Germany for the army by Heim (1829). It has been more or less the law in Prussia since 1835; "re-vaccination of school pupils at the age of twelve is an integral part of the vaccination law." Notwithstanding the fact that Prussia was the best revaccinated country in Europe, its mortality from smallpox in the epidemic of 1871 was higher (59,839) than in any other northern state. The efficacy of re-vaccination is sometimes sought to be proved by the immunity of nurses in smallpox hospitals. The experiment of not re-vaccinating the nurses was tried at the small-pox hospital of the South Dublin Union in 1871-72; twenty-nine out of the thirty-six attendants had not been re-vaccinated, and these all escaped smallpox as well as the other seven. But nurses are not rarely chosen from among those who have had smallpox, and cases of smallpox in re-vaccinated nurses are not unknown. The evidence as to re-vaccination on a large scale comes from the army. According to a competent statistician (A. Vogt), the death-rate from smallpox in the German army, in which all recruits are re-vaccinated, was 60 per cent, more than among the civil population of the same age; it was ten times greater among the infantry than among the cavalry, and sixty times more among the Hessians than among the Wurtembergers. The Bavarian contingent, which was revaccinated without exception, had five times the death rate from smallpox in the epidemic of 1870-71 than the Bavarian civil population of the same ages had, although revaccination is not obligatory among the latter.

The susceptibility to cowpox infection diminishes with age; among the pupils of twelve years in Prussian schools it fails in about one-fourth of the attempts, and at later periods of life the proportion of failures is still greater.

It is often alleged that the unvaccinated are so much inflammable material in the midst of the community, and that smallpox begins among them and gathers force so that it sweeps even the vaccinated before it. Inquiry into the facts has shown that at Cologne in 1870 the first unvaccinated person attacked by smallpox was the 174th in order of time, at Bonn the same, year the 42nd, and at Liegnitz in 1871 the 225th.

Vaccination was made compulsory in Bavaria in 1807, and subsequently in the following countries :— Denmark (1810), Sweden (1814), Wurtemberg, Hesse, and other German states (1818), Prussia (1835), Roumania (1874), Hungary (1876), and Servia (1881). It is compulsory by cantonal law in ten out of the twenty-two Swiss cantons; an attempt to pass a federal compulsory law was defeated by a plebiscite in 1881.

In only a few States or cities of the American Union there is a vaccination statute; in Lower Canada there is no compulsion. Vaccination was compulsory in Great Britain in 1853, and has been compulsory in South Australia since 1872, in Victoria since 1874, and in Western Australia since 1878. In Tasmania a compulsory Act was passed in 1882. In New South Wales there is no compulsion, but free facilities for vaccination. Compulsion was adopted at Calcutta in 1880 and since then at eighty other towns of Bengal, at Madras in 1884, and at Bombay and elsewhere in the presidency a few years earlier.

In the following countries there is no compulsory law, but governmental facilities and compulsion on various classes more or less directly under Governmental control, such as soldiers, state employes, apprentices, school pupils, etc.: - France, Italy, Spain, Portugal, Belgium, Norway, Austria, Turkey. Re-vaccination was made compulsory in Denmark in 1871 and in Roumania in 1874; in Holland it was enacted for all school pupils in 1872.

The various laws and administrative orders which had been for many years in force as to vaccination and revaccination in the several German states were consolidated in an imperial statute of 1874.