The Most Influential Scientists in the Development of Public Health: Edward Jenner (1749-1823)

Muharem Zildzic[1,2], Lejla Zunic[1]

[1]University of Zenica, Zenica, Bosnia and Herezgovina

[2]Academy of Medical Sciences of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina

Corresponding author: Academician Professor Muharem Zildzic, MD, PhD. Academy of Medical Sciences of Bosnia and Herzegovina, Sarajevo, Bosnia and Herzegovina E-mail: zildzic@yahoo.com. ORCID ID: http// www.orcid.org/0000-0001- 5418-2274.

Review, Received: Dec 16, 2022, Accepted: Jan 29, 2023. doi: 10.5455/ijbh.2023.11.58-61, Int J Biomed Healthc. 2023; 11(1): 58-61

Edward Jenner (1749 - 1823) is one of most influential scientists - an English doctor, the pioneer and discoverer of smallpox vaccine and the father of immunology. He was born on May 17, 1749 in Berkeley, Gloucestershire, England and died on January 26, 1823, also in Berkeley (1). Edward Jenner, at the age of 14, was apprenticed to a local surgeon and then trained in London. In 1772, he returned to Berkeley and spent most the rest of his career as a doctor in his native town (1-3). Edward Jenner was born at a time when the patterns of British medical practice and education were undergoing gradual change. Slowly the division between the Oxford- or Cambridge-trained physicians and the apothecaries or surgeons, who were much less educated and who acquired their medical knowledge through apprenticeship rather than through academic work (1).

In the first edition of the Encyclopædia Britannica, which was published in 1768, is described how in 17th-century English physician Thomas Sydenham included procedures such as bloodletting, induction of vomiting, and administration of enemas in order to "keep the inflammation of the blood within due bounds". It is because smallpox outbreaks brought on desperate pleas by believers for divine assistance in lifting the scourge, almost all parts of the world (2). Over thousands of years, smallpox killed hundreds of millions of people. It began as early as 1350 BCE, with cases being found in the study of Egyptian mummies (2). The rich, the poor, the young, the old. It was a disease that didn't discriminate, killing at least 1 in 3 people infected, often more in the most severe forms of disease (1). The ancient practice of variolation (named for smallpox, also known as variola or 'la variole') was widely used in Asia and some parts of Africa. This consisted of transferring to healthy people small amounts of material from smallpox sores, resulting in milder forms of illness and much lower mortality than natural infection. Some sources suggest practices of variolation were taking place as early as 200 BCE. Written accounts from the mid-1500s describe a form of variolation used in China known as insufflation, where smallpox scabs were dried, ground and blown into the nostril using a pipe (1). In India, similar practices were

carried out through inoculation, using a lancet or needle to transfer material from smallpox pustules to the skin of healthy children. Accounts from the 18th century suggest this technique dates back hundreds of years. Variolation (in the form of inoculation) was introduced in Europe by Lady Mary Wortley Montagu 300 years ago in 1721, after she had observed the practice in the Ottoman Empire, where her husband was stationed as ambassador to Turkey. Around the same time, it came to public attention in the American colonies. Enslaved West Africans had long practised the technique, and after his slave Onesimus told him about how it worked in 1716, Cotton Mather publicized it and argued for its use in response to a 1721 outbreak of smallpox in Massachusetts (2).

Because Edward was only five when his father died, he was brought up by an older brother, who was a clergyman (1). He attended grammar school and at the age of 13 was apprenticed to a nearby surgeon. In the following eight years Jenner acquired a sound knowledge of medical and surgical practice. On completing his apprenticeship at the age of 21, he went to London and be-

came the house pupil of John Hunter, who was on the staff of St. George's Hospital and was one of the most prominent surgeons in London (1). Even more important, however, he was an anatomist, biologist, and experimentalist and he also concerned himself with problems of physiology and function. Friendship between the two men lasted until Hunter's death in 1793 because no one else could Jenner gave the stimuli that so confirmed his natural bent - a great interest in biological phenomena, disciplined powers of observation, sharpening of critical faculties, and a reliance on experimental investigation. From Hunter, Jenner received the characteristic advice, "Why think [i.e., speculate] - why not try the experiment?" (2). In addition to his training and experience in biology, Jenner made progress in clinical surgery. After studying in London from 1770 to 1773, he returned practice in Berkeley and enjoyed substantial success were he became skillful, and popular. He joined two medical groups for the promotion of medical knowledge and wrote occasional medical papers. He played the violin in a musical club, wrote light verse, and, as a naturalist, made many observations, particularly on the nesting habits of the cuckoo and on bird migration (1).

He observed that dairymaids who had cowpox did not get small pox. In May 1796 Jenner found a young dairymaid, Sarah Nelmes, who had fresh cowpox lesions on her hand. On May 14, using matter from Sarah's lesions, he inoculated an eight-year-old boy, James Phipps, who had never had smallpox (2). Phipps became slightly ill over the course of the next 9 days but was well on the 10th. On July 1 Jenner inoculated the boy again, this time with smallpox matter. No disease developed; protection was complete. Jenner inserted pus taken from a cowpox pustule and inserted it into an incision on the boy's arm. He was testing his theory, drawn from the folklore of the countryside, that milkmaids who suffered the mild disease of cowpox never contracted smallpox, one of the greatest killers of the period, particularly among children. Jenner subsequently proved that having been inoculated with cowpox Phipps was immune to smallpox. He submitted a paper to the Royal Society in 1797 describing his experiment, but was told that his ideas were too revolutionary and that he needed more proof. Undaunted, Jenner experimented on several other children, including his own 11-month-old son. In 1798 Jenner, having added further cases, published privately a slender book entitled "An Inquiry into the Causes and Effects of the Variolae Vaccinae" (1, 3). The reaction to the publication was not immediately favourable. Jenner went to London seeking volunteers for vaccination but, in a stay of three months, was not successful. In London vaccination became popularized through the activities of others, particularly the surgeon Henry Cline, to whom Jenner had given some of the inoculant, and the doctors George Pearson and William Woodville. Difficulties arose, some of them quite unpleasant; Pearson tried to take credit away from Jenner, and Woodville, a physician in a smallpox hospital, contaminated the cowpox matter with smallpox virus. Vaccination rapidly proved its value, however, and Jenner became intensely active promoting it. The procedure spread rapidly to America and the rest of Europe and soon was carried around the world (2). In 1798, the results were finally published and Jenner coined the word vaccine from the Latin 'vacca' for cow. Jenner was widely ridiculed. Critics, especially the clergy, claimed it was repulsive and ungodly to inoculate someone with material from a diseased animal (2). Advantages of vaccination and the protection it provided won out, and vaccination soon became widespread.

Edward Jenner carried out research in a number of other areas of medicine and was also keen on fossil collecting and horticulture.. One of the deadliest diseases known to humans, smallpox remains the only human disease to have been eradicated. Many believe this achievement to be the most significant milestone in global public health. It wasn't until May 1796 that the world's first vaccine was demonstrated, using the same principle as variolation but with a less dangerous viral source, cowpox. Having heard of local beliefs and practices in rural communities that cowpox protected against smallpox,

Jenner received worldwide recognition and many honours, but he made no attempt to enrich himself through his discovery and actually devoted so much time to the cause of vaccination that his private practice and personal affairs suffered severely. Parliament voted him a sum of £10,000 in 1802 and a further sum of £20,000 in 1806.

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Smallpox was widespread in the 18th century, and occasional outbreaks of special intensity resulted in a very high death rate. The disease, a leading cause of death at the time, respected no social class, and disfigurement was not uncommon in patients who recovered (2). The only means of combating smallpox was a primitive form of vaccination called variolation - intentionally infecting a healthy person with the "matter" taken from a patient sick with a mild attack of the disease (2).

Key components of the worldwide smallpox eradication effort included universal childhood immunization programmes in some countries, mass vaccination in others, and targeted surveillance-containment strat-

egies during the end-game. Important person who survived smalpox are Mozart was infected, as was Phipps remained in perfect health, the first person to be vaccinated against smallpox. Abraham Lincoln. Lady Mary Wortley Montagu with her son. Ancient Japanese illustration of smallpox. Smallpox was highly infectious, with no known cure.

The practice, which originated in China and India, was based on two distinct concepts: first, that one attack of smallpox effectively protected against any subsequent attack and, second, that a person deliberately infected with a mild case of the disease would safely acquire such protection. It was, in present-day terminology, an "elective" infection - i.e., one given to a person in good health (1). The inoculated person could disseminate the disease to others and thus act as a focus of infection (2).

During the 19th century, vaccination programs, many of them compulsory, were instituted in many countries. At first vaccine was obtained directly from vaccinated persons, but soon it was being commercially harvested from pustules grown on the skin of inoculated calves. Later in the century it became apparent that the cowpox virus had been supplanted in vaccines by a different strain. Vaccines are responsible for many global public health successes, such as the eradication of smallpox and significant reductions in other serious infections like polio and measles.

Even so, vaccinations have also long been the subject of various ethical controversies. The key ethical debates related to vaccine regulation, development, and use generally revolve around (1) mandates (2), research and testing (3), informed consent, and (4) access disparities. In the United States, state policies mandate certain immunizations, including school entry requirements, which cover significant numbers of children (4). The first school vaccination requirements were enacted in the 1850s to prevent smallpox (5). The vaccine was soon in use on other continents, where vaccine continued to be inoculated from arm to arm until vaccination programmes were established. Mandatory smallpox vaccination came into effect in Britain and parts of the United States of America in the 1840s and 1850s, as well as in other parts of the world, leading to the establishment of the smallpox vaccination certificates required for travel (6).

By the beginning of the 20th century, smallpox was no longer endemic in several countries of continental Europe. Endemic smallpox was eradicated from the United Kingdom in 1934, the U.S.S.R. in 1936, Canada in 1946, the United States in 1949, Japan in 1951, and China in 1961. Still, in an age of global travel only an international effort could completely eradicate the disease (2). In 1967 WHO began to vaccinate entire populations around every reported outbreak of smallpox. The disease was no longer endemic in India by 1975 and in Ethiopia by 1976. The last endemic case of smallpox (actually an infection of variola minor) was recorded in Somalia in 1977. No cases were reported from 1977 to 1980, with the exception of two cases in England in 1978 whose source was in a laboratory, and in 1980 the disease was declared exterminated. In former Yugoslavia in 1972 was registered 32 cases. In 1967 the World Health Organization (WHO) began a global vaccination program against smallpox, and in 1980 the disease was officially declared eradicated (2).

Complications were many. Vaccination seemed simple, but the vast number of persons who practiced it did not necessarily follow the procedure that Jenner had recommended, and deliberate or unconscious innovations often impaired the effectiveness. Pure cowpox vaccine was not always easy to obtain, nor was it easy to preserve or transmit. Furthermore, the biological factors that produce immunity were not yet understood; much information had to be gathered and a great many mistakes made before a fully effective procedure could be developed, even on an empirical basis (2).

While some European regions eliminated the disease by 1900, smallpox was still ravaging continents and areas under colonial rule, with over 2 million people dying every year. It took another 50 years to achieve global solidarity in the fight against the disease (1).

Vaccine research and studies in vaccine delivery were carried out around the world in the search for more resilient and effective vaccines. By the 1950s, advances in production techniques meant that heat-stable, freeze-dried smallpox vaccines could be stored without refrigeration. Vaccination led to smallpox elimination in western Europe, North America and Japan. In the absence of a large-scale coordinated international programme, the disease persisted in other areas (2).

In 1958, the World Health Assembly called for the global eradication of smallpox – the permanent reduction to zero cases – without risk of reintroduction. As the World Health Organization launched the Smallpox Eradication Programme in 1959, WHO Member States enhanced their support and cooperation. Good progress was made in many countries with the support of technical assistance and vaccine provision coordinated by WHO. Efforts were redoubled with the launch of the Intensified Smallpox Eradication Programme in 1967 (3). The Soviet Union provided freeze-dried vaccine, which became the basis for elimination of smallpox from eastern Europe, China and India. With renewed political commitment and the contributions of hundreds of thousands of local surveillance officers and health workers, even regions with nascent health systems and tremendous logistical challenges made remarkable progress.

Throughout this period WHO played a critical role, with international workers supporting legions of national personnel. With this strategy they were able to eliminate highly contagious smallpox from the district within weeks. In higher-risk countries, laboratories began to produce higher-quality freeze-dried vaccines, and mass production of the innovative and easy-to-use bifurcated needle to administer doses contributed to vaccination efforts. Thanks to the combined efforts of national health agencies, WHO and scientists around the

world, smallpox was eliminated from South America in 1971, Asia in 1975 and Africa in 1977 (2).

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A cure was never found for smallpox before eradication, with those infected being treated only by cleaning wounds and lessening pain. Instead, following the discovery of Dr Jenner's vaccine, eradication was achieved through prevention, as he himself predicted. Bolstered by efforts united around the world, Jenner's concept survived to defeat a historic scourge. After 3000 years of suffering and death from the disease, there hasn't been a recorded case of smallpox in almost half a century (1, 3).

Esward Jenner, physician and scientists, not only received honours as discoverer and pioneer of immunology, but also aroused opposition and found himself subjected to attacks and calumnies, despite which he continued his activities on behalf of vaccination.

Edward Jenner's wife (he maried her in 1788), was ill with tuberculosis, and died in 1815, and Jenner retired from public life. He passed away in the city were he was born - Berkeley, Gloucestershire, England, on January 26, 1823, exactly 200 years ago. No more smallpox, but there is COVID-19. Who will be new "Jenner"?

- **.Author's contribution***: Author's were involved in all steps of preparation this article. Final proofreading was made by the first author.*
- **Conflict of interest***: None declared.*
- **Financial support and sponsorship***: Nil.*

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