Vaccines and pandemic: what have we learned?

Vacunas y pandemia, ¿qué aprendimos?

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For centuries, humans have searched for ways to protect ourselves against deadly diseases. From experiments and opportunities to the global launch of vaccines in the middle of a pandemic, immunization has a long history. Vaccines have become the best "lifesavers" for mankind compared to any other invention in medicine in the history of human beings [(1)].

Historically, since the 15th century, people have attempted to prevent various contagious diseases: for example, when smallpox was intentionally exposed to healthy people, a practice known as variolation. Some historical sources suggest these practices were taking place as early as 200 BCE in China. In 1796, English Physician Edward Jenner inoculated 8-year-old James Phipps with matter collected from a cowpox sore. Although suffering a local reaction and feeling unwell for several days, the boy made a full recovery [(1,2)].

Two months later, Jenner repeated the inoculation on the same child but with matter from a human smallpox sore. The child remained in good health and became the first human to be vaccinated against smallpox. This was a historic milestone in the face of the constant smallpox epidemics and pandemics that plagued the world at that time [(1,2)].

On January 30, 2020, the WHO director general declared the outbreak of the novel coronavirus to be a Public Health Emergency of International Concern, and on March 11, the WHO confirmed that COVID-19 was upgraded to pandemic status.

COVID-19 vaccines were developed, produced and distributed with unprecedented speed, many using new mRNA technology. In December 2020, the first doses were successfully administered.

Throughout 2021 and 2022, the COVID-19 vaccine rollout continued with increased speed and the vaccine was delivered across continents. A relevant aspect considered as a threat were the inequities in vaccination coverage during a pandemic; an example is that, as of July 2021, almost 85 % of vaccines were administered in high- and middle-income countries [(3)].

For over two centuries, people have been vaccinated against deadly diseases, ever since the world's first vaccine against smallpox was researched. History has taught us that a comprehensive and effective response to vaccine-preventable diseases takes time, financial support and collaboration, as well as active and continuous surveillance.

Vaccination is part of a multifaceted public health response to the future emergence of other pandemics, in addition to other response and control measures such as surveillance, quarantine and drug therapy. However, not all disease threats have a corresponding vaccine, and for those that do, there are significant challenges to their successful use in a pandemic [(4)].

Pandemics have swept through human populations for centuries, causing millions of deaths. It is estimated that bubonic plague killed between 25 and 75 million people in Europe in the 14th century; recurring waves of this disease swept through Europe until its last major appearance in England in 1660. It was declared eradicated in 1980.

The 1918-1919 great "Spanish" influenza pandemic killed between 40 and 70 million people worldwide. Other less severe pandemic influenzas emerged in 1957–1958, 1968 and 2009. Avian influenza, H5N1, which mainly infects wild birds and poultry, began infecting humans in 2003 and has a high case fatality rate, but the virus has not yet adapted to spread between people [(5)].

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Other diseases of current concern that could threaten the world population include severe acute respiratory syndrome (SARS), caused by a coronavirus that emerged in the early 2000s and spread rapidly from its source (Asia, 2002–2003) to Europe and the Americas before the outbreak was contained. It resulted in 8,098 reported cases and 774 deaths. Since the SARS threat faded in 2004, no new cases have been reported. Several SARS vaccines are being tested in animals and are in early human research in the event that SARS reemerges [6].

A challenge in responding to pandemic diseases is that their corresponding vaccines may not exist or, especially in the case of influenza viruses, existing vaccines may not be effective. Although the production methods and infrastructure for influenza vaccines are well established, each new strain requires a new vaccine. Therefore, any new pandemic influenza vaccine will take four to six months to be produced in large quantities. For other emerging threats without licensed vaccines, such as SARS, Marburg virus, Nipah virus and the like, the time required to develop and produce a safe and effective vaccine is unknown and will depend on the nature of the threat and the current state of research. In almost all cases, several months would be needed to respond with the first doses of vaccines. Until a safe and effective vaccine was ready, other medical and public health measures, such as social distancing, quarantine and the use of antiviral drugs, would need to be employed to try to limit the spread of the disease [7,8].

In all pandemic situations where a vaccine is available or potentially available, a large and rapid supply of vaccine would be necessary. While we can attribute many achievements in public health to vaccination, the future presents continuing challenges. There remain infectious diseases for which effective vaccines have not yet been found (e.g., HIV/AIDS, malaria and leishmaniasis) or which occur in areas of the world where vaccination infrastructures are poor or non-existent. In other respects, the cost of vaccines is too high for poorer countries to afford [9].

From innovative practices in the 1500s to new technologies used in the production and design of COVID-19 vaccines, a long road has been traveled. Vaccines help protect against more than 20 diseases: from pneumonia to cervical cancer and Ebola disease. In the past 30 years, child mortality rates have dropped by more than 50% thanks in large part to vaccines. But much remains to be done [10].

In the coming decades, vaccine research will need international cooperation, funding and commitment. It will also require a vision to ensure that no child or adult suffers or dies from a vaccine-preventable disease [10].

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