ISSN: 2639-4391

MEDDOCS Open Access Publisher

Annals of Epidemiology and Public Health

Open Access | Mini Review

Covid-19 Vaccines and Public Health Efforts: A Brief Summary

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Received: Jul 21, 2023
Accepted: Aug 09, 2023
Published Online: Aug 16, 2023
Journal: Annals of Epidemiology and Public Health
Publisher: MedDocs Publishers LLC
Online edition: http://meddocsonline.org/

Mini-Review

The road to Covid-19 vaccines has been a real challenge. The genetic sequence of SARS-CoV-2 was obtained in January, 2020: Earlier vaccinal studies began on Spring 2020 and in less than 12 months (December, 2020) the European Medicines Agency (EMA) could recommend the first conditional authorisation for a Covid-19 vaccine [1]. Immediately after (6th January, 2021) a second recommendation was given, for another Covid-19 vaccine [2].

Such a development in less than 1 year from the identification of the virus is unprecedented in the history of vaccinology [3]. Shortly after the descovery of that novel and extremely pathogenic Coronavirus (SARS-CoV-2), much effort was put into developing a vaccine. More than 150 companies and academic institutions started working on COVID-19 vaccines [4], using DNA-based and RNA-based vaccines, Non-Replicating Viral Vectors (NRVV), Replicating Viral Vectors (RVV), Inactivated Vaccines (IAcV), Live-Attenuated Vaccines (LAVs) and protein subunits, among other strategies [1]. Other than the development strategy for the seasonal influenza flu vaccine, typical vaccine development for a novel pathogen was expected to take several years of research to fully understand the viral structure-function relationship and the critical protective host immunity pathways [2]. However, COVID-19 pandemic diffusion and the subsequent worldwide increase in mortality and severe pneumonia incidence rendered the development of an effective vaccine urgently relevant. A need was widely recognized to develop a safe vaccine that would save lives, time, and money [5]: Government cohoperation was globally developed, in order to give people a concrete option to receive the vaccine just when necessary [6]. Moreover, a tight collaboration between governments and pharmaceutical companies while adhering to regulations to create safe and effective vaccines played a crucial role in that way to develop an effective vaccine [7].

When analyzing vaccine development, it can be recognized that any step was completed successfully, by mixing effective main factors as [8]: Previous research about mRNA technology; human Coronavirus studies, especially those about SARS (Severe Acute Respiratory Syndrome) and MERS (Middle East Respiratory Syndrome); huge economic resources and scientific and technological efforts as well; vaccine production starting in parallel with the completion of the authorization process; results evaluation by national/international regulatory agencies by the way that those results were obtained (rolling review process).

Usually, the typical time needed to develop a vaccine using conventional methods was 15 years [9]. That type of conventional process could start with exploratory work on design and evaluation in animal models, followed by a phase involving more extensive pre-clinical experiments: After those steps, vaccine production process could be designed, towards clinical trials construction [7]. Such a typical process could end by submitting a license application to appropriate regulatory agencies, after obtaining final results applied to the appropriate endpoints; one or two more years could be needed for licensing [10,11].

The scale of population impact of the Covid-19 pandemic has driven a completely new strategy design, with the use of next-generation vaccine technology platforms through novel paradigms just to accelerate an effective and rapid vaccine development [8]. Both standardized and innovative methods were integrated in such a novel strategy, in order to successfully obtain a vaccine in a short time, with a lot of effort and money [3].

One thing that was learned from Covid-19 pandemic first phase was that previous pharmaceutical market's financial and regulatory mechanisms did not give enough incentive to support vaccine development before that catastrophic outbreak occurred [5]. To compensate, academic institutions and enterprises all around the world started early to create an enormous number of vaccine candidates [12], by using some different methods: mRNA or DNA technology, or identification of specific immunogenic epitopes and proteins [13]. Even more and more research appeared to be needed, in order to find the most effective vaccine candidate that could start reducing the rising number of Covid-19 cases [14].

Novel vaccine development paradigms were applied, involving parallel and adaptive development phases, innovative regulatory processes and scaling manufacturing capacity [15]. Besides, a strong international coordination and cooperation between public health bodies and governments, regulators and vaccine developers soon appeared as one of the key factors for a successful end with several promising late-stage vaccine candidates [2].

The vaccine was recognized as a powerful tool to tackle the pandemic: However, concern about the extraordinary low timeline of its development was one of the main causes of people hesitancy in accepting those new vaccines [3]. It must be recognized that the real starting point of the timeline for SARS-CoV-2 vaccine development and discovery was not January 2020, date for the publication of virus genetic sequence but almost more than two decades earlier, with early studies about mRNA technology [8].

Another relevant contribution came from the pandemic trend, which involved some unusual circumstances, as compared to other public health crises in the past [16]. It can be recognized that SARS-CoV-2 genome was sequenced, assembled and released very early in the course of the pandemic. That genomic information drove biomedical response studies against this novel pathogen in several different ways [17]. In September 2020 over 180 vaccine candidates were in development, many of which employed traditional vaccine technologies [9], whereas public attention globally focused on vaccine development platforms that used new technologies (mRNA vaccines). Since then, the utilization of highly adaptable vaccine platforms (RNA) in combination with the adaptation of structural biology tools to design agents (immunogens) that could powerfully stimulate the immune system [18] lead to a rapid success.

Despite these important efforts, more than three years since the outbreak of Covid-19 it is well known that the causative SARS-CoV-2 has been continuously evolving and generating variants [19]. In some circumstances, existing vaccine-induced antibodies could not fully neutralize the variants, especially the newly isolated variants [20]. It can be highlighted that mutated strains have brought new challenges to Covid-19 preventing and controlling strategies [8], so that a request for vaccines that could provide more effective and broad-spectrum protection has appeared [7,21]. In the last more than three years, efforts involving countries from all around the world, regardless of geographical characteristics and/or political orientation, have contributed to a useful joined involvement [22] and collaboration to obtain speedy and viable Covid-19 vaccines, whose research and development has not ended yet.

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