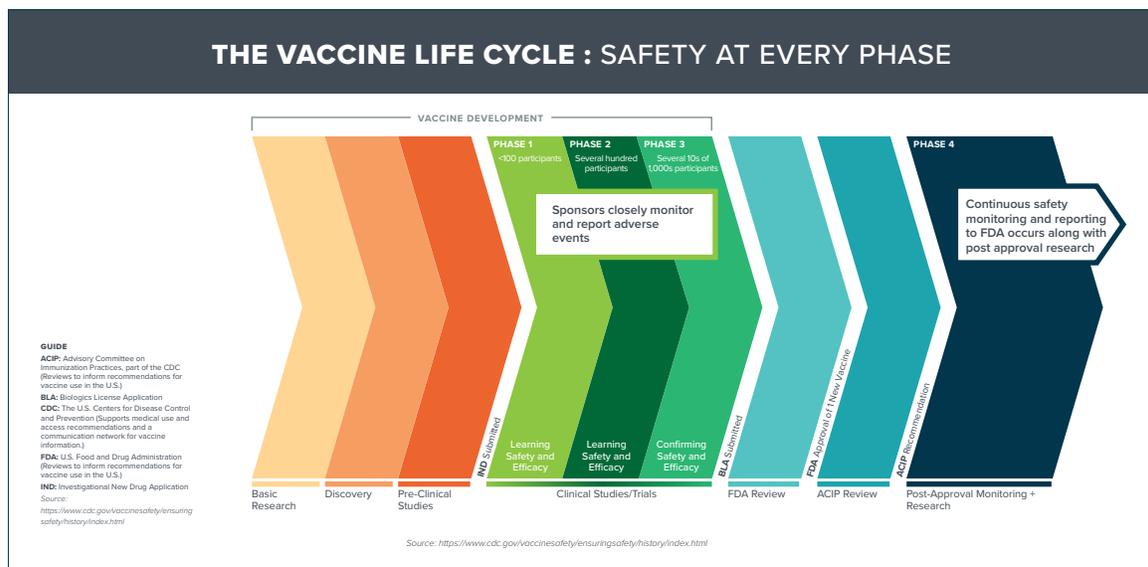


COVID-19 VACCINE RESEARCH AND DEVELOPMENT

As the COVID-19 pandemic continues to impact patients worldwide, America's biopharmaceutical research companies are working around the clock with stakeholders across the research and development (R&D) ecosystem to advance vaccine candidates that will help prevent infection and stop the spread of the virus. In a matter of months, incredible progress has been made. The private sector has moved more than two dozen unique vaccines from initial R&D into preclinical testing and clinical trials.

Across the board, COVID-19 vaccines will further undergo extensive testing for safety and effectiveness prior to any regulatory approval. Once a vaccine is licensed, regulatory authorities and the vaccine sponsor routinely monitor its use and investigate any potential safety concerns. Post approval research will further continue after vaccines are licensed.



A STEP-BY-STEP GUIDE TO COVID-19 VACCINE DEVELOPMENT

Scientists have been using the following steps to guide COVID-19 vaccine development:

- 1 Identify and sequence the virus.** This occurred just a few weeks after the first case was discovered. The day after the genetic sequence of the virus was released, researchers around the world started work on vaccine candidates. The decades-long investments biopharmaceutical companies have made in new technologies, research and previous vaccines have prepared the biopharmaceutical industry to act swiftly, without cutting corners.
- 2 Determine the target and create vaccine candidates.** Vaccines work by imitating an infection to teach the immune system how to recognize, remember and target microbial invaders without actually causing an infection. A wide range of approaches are being tested across the globe to greatly improve the chances of success. Multiple vaccine candidates will be created with the most promising being advanced.
- 3 Conduct preclinical trials.** Once researchers identify a candidate vaccine and vaccine delivery mechanism, researchers examine whether vaccine candidates produce the outcome they expect and look for any signs of negative reactions in animal and human cells or tissue systems.

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Conduct clinical trials. If a potential vaccine is successful in preclinical studies, scientists begin studying it in humans. Initial trials involve just a few dozen participants to assess safety and optimize dosing. Additional trials involve hundreds to even a few thousand people to better understand how the immune system responds to a vaccine, whether it is effective and durable at producing immunity, and to further understand the vaccine's safety profile. From there, thousands or even tens of thousands of participants may be involved in trials to further increase understanding of the vaccine's safety and efficacy profile.

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Regulatory review and approval. When a vaccine successfully makes it through clinical trials, researchers can apply for licensure from the U.S. Food and Drug Administration (FDA). Applications must meet FDA's robust standards for safety, efficacy, purity and potency to obtain approval, and include data generated in pre-clinical and clinical trials as well as significant information on manufacturing processes.

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Manufacture and distribute. The transition from laboratory to manufacturing facility to global distribution is generally a complex, multi-year undertaking. However, to meet the current public health crisis, companies are initiating manufacturing scale-up in advance of FDA review so that a potential vaccine is ready to be distributed as soon as it obtains regulatory approval or emergency use authorization. Companies are also working closely with local governments and NGO partners to lay the groundwork for distribution on a global scale when a vaccine is ready.

INNOVATIVE CLINICAL TRIAL APPROACHES

Clinical trials have long been a time-consuming part of the biomedical R&D process, due to the increasing complexity of clinical procedures and protocol designs as well as the high standards required to demonstrate the safety and efficacy of a potential treatment. Traditionally, participants in clinical trials are managed on-site at hospitals or clinics, which can create challenges to recruitment due to the need to travel to attend trial site visits for medical procedures and other activities related to their trial participation.

But with COVID-19 prompting further utilization of and innovations in telehealth, some sponsors have adopted digital technologies to facilitate decentralized clinical trials, meaning patients are able to volunteer to participate remotely and are monitored using technology such as computers and cell phones. These tools can remove some of the practical barriers that can slow down recruitment and allow trials to recruit more rapidly. Clinical investigators are also able to use these digital tools to help reach a more diverse group of patients, helping clinical trials to be more reflective of the population that will eventually take their medicine if the trials are successful.

ENSURING VACCINE SAFETY

Complementary to the robust R&D process, government regulators have constant access to the largest, most robust and sophisticated electronic safety monitoring system for vaccines and take the following critical steps to ensure ongoing vaccine safety and efficacy:

- Prior to granting approval and licensure, the FDA closely reviews data captured during each step of the development process, as well as information on how the vaccine is manufactured, to evaluate the safety profile and help ensure consistent purity and potency.
- The Centers for Disease Control and Prevention's (CDC) long-standing vaccine safety program closely monitors the safety of distributed vaccines. Data show that the U.S. vaccine supply is the safest in history, due in part to this program. One important element of the program, the Immunization Safety Office (ISO), monitors possible vaccine side effects and works with public health stakeholder to assess possible connects to vaccines.

- In the United States, national-level safety reporting and data gathering systems for vaccines provide sponsors and regulators to closely monitor and assess possible safety signals for vaccines. This robust network of systems has been established and expanded over the past several decades and stakeholders across the health care system rely on them. This includes The Vaccine Adverse Event Reporting System (VAERS) (Managed by FDA and CDC) and MedWatch (FDA's system for voluntary adverse event reporting by health care professionals, patients, and other (non-manufacturers) for vaccines which get directed to the VAERS). CDC ISO maintains the Vaccine Safety Datalink (VSD) in partnership with national health care organizations to monitor for safety signals, conduct follow up investigations and disseminate information about vaccines.

The biopharmaceutical industry is committed to ensuring the highest of standards of research, clinical testing and manufacturing are upheld throughout the vaccine research and development process and post-approval. Industry sponsors will be confident in the safety and efficacy of any new vaccine based on data from rigorous, large clinical trials including the expectation that diverse populations are included, before submitting the data FDA and other national regulatory agencies around the globe for review. The industry believes in a transparent review process of vaccine candidates by the FDA, including by the Agency's Advisory Committees.

POST-APPROVAL RESEARCH

Research is a critical part of the development of new vaccines, but it doesn't stop once a vaccine is approved by the FDA. Post-approval research often utilizes data gathered from the "real-world" practice of medicine, referred to as real-world data (RWD). These data can lead to more efficient vaccine development programs and provide more robust information about the benefits and risks of vaccines. RWD can come from a variety of sources, including electronic health records, payer administrative claims and patient registries. When RWD is analyzed, evidence about the usage and potential benefits of a vaccine is generated; this is known as real-world evidence (RWE). When appropriately generated, RWE represents a valuable source of information about the real-world benefits and risks of a vaccine in a broader, more diverse population than studied in a clinical trial. RWE is used by physicians, patients, payers, health authorities and biopharmaceutical companies to better understand the safety and efficacy profile of the vaccine in real-world use.

LEADING IN RESEARCH & DEVELOPMENT

The biopharmaceutical industry's unique role in the research ecosystem is to utilize its scientific and industrial expertise to take the necessary risks to build upon and further advance basic science research into safe and effective treatments that can be made available to patients. The federal government cannot research, develop and manufacture vaccines and other new treatments without the resources, scientific expertise, R&D, manufacturing and technological platforms from private sector biopharmaceutical companies.

"We always need a pharmaceutical partner...I can't think of a vaccine, even one in which we've put substantial intellectual and resource input, that was brought to the goal line without a partnership with industry."

— Dr. Anthony Fauci of National Institute of Allergy and Infectious Diseases