YOUR GUIDE TO COVID-19 VACCINES

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Introduction

December marks a sombre anniversary for the world. It has been one year since the COVID-19 pandemic became a part of the lives of people across the globe. It has changed the way many systems functioned and how people went about their daily lives. It has seen over 75 million individuals across the world become infected and over 1.6 million deaths.

It has become a part of everyday life as masks and sanitizers have become essential when going out and interacting in public. The elderly and individuals with comorbidities have spent a large part of this year living in isolation to ensure that there is no accidental exposure to the virus.

Schools have largely moved to an online platform and an office for work has become obsolete. This has all happened as a result of a pandemic that has held the world to ransom for the last year. Scientists have worked around the clock to provide a solution to the pandemic.

This pandemic has seen several scientists and medical organizations from across the world have worked tirelessly to provide a possible solution. The solution has come in the form of a vaccine as a cure would be nearly impossible to achieve.

Since December 2019, large strides have been made in finding a vaccine. The clinical trial process has been expedited significantly for this to be achieved and trials have occurred across the world to provide the necessary context for vaccines to be fully validated and tested. As a result of these efforts, a number of different trials have reached completion and are ready to be rolled out on a public scale in several different countries.

This article will seek to provide a comprehensive breakdown of the vaccination field. It will provide a detailed definition of what a vaccine trial is and then explain the different phases that make up a normal vaccine trial. It will also explore the different types of vaccines that are available and examples of successful vaccines such as influenza and Ebola vaccine.

It will also provide a brief discussion of the criteria for vaccine storage and the vaccines that are currently in the final phases of approval or that have already been approved. Lastly, it will look at critical problems around vaccine administration such as vaccine hesitancy and the hopes of herd immunity.

Explaining vaccine trials

A vaccine trial is a clinical trial that is used to test the efficacy of a vaccine or medical technology before it is licensed and allowed to be distributed to the public (Halloran, Longini & Struchiner, 2020). This is done to ensure that any side effects to a particular pharmaceutical product or technology have been adequately accounted for and resolved before allowing for the product to be rolled out to the public.

In order to ensure that there is a standard of good clinical practice, a standardized set of rules and regulations have been put in place to ensure all vaccine trials adhere to the same safety protocols. The most basic rule of any clinical guideline is for the benefits being presented by a particular clinical trial (Offit, 2018).

The stages of human testing are usually preceded by animal testing which works to ensure that all significant adverse side effects have been determined and the product has been readjusted accordingly for administration in humans (Offit, 2018).

Stages of a clinical trial

A clinical trial usually consists of five stages, each of which serves a particular purpose in the vaccine trial.

Preclinical trial

The preclinical trial is the initial phase of a vaccine trial that is used to determine an antigen or foreign substance that will elicit a similar response within the body as the virus that the vaccine is being developed for (Weatherspoon, 2018).

This process can take several years and it is the vaccine that elicits the most protective response from the body's immune system that is selected for the proceeding phases of a vaccine trial (Weatherspoon, 2018).

Phase I

Phase I occurs after several versions of a vaccine has been selected based on the response the body's immune system has had to the antigen present in the vaccine solution. These versions of the vaccine are tested to determine the version of the vaccine which provides the most effective response from the body's immune system and is also the safest in terms of possible side effects (Weijer, 2020).

This version of the clinical trial looks at also beginning to compile a safety profile for the vaccine that is being tested. These versions of a vaccine are usually tested amongst a small group of adults. Participants in this phase are closely monitored to determine the possible side effects that could occur from administering the vaccine (Weijer, 2020).

These adverse events are usually anticipated based on preclinical trial data and are monitored closely to ensure that minimal harm occurs to participants. Serious side effects that severely impact the wellbeing of the individual bring a clinical trial to a halt and are usually discontinued (Weatherspoon, 2019).

Phase II

This phase is used to test the vaccine amongst individuals who are currently living with the condition or virus that the vaccine is meant to treat (Weatherspoon, 2019). This is tested on a noticeably larger group of individuals to further expand on the safety profile of the vaccine that is being tested.

The same dose that was administered in phase I is used as this dosage was determined to elicit very little or no side effects within the individuals (Weijer, 2020). The period that participants are monitored for is longer than in phase I. This is to ensure that there are no possible long term side effects of having the vaccine administered to an individual.

The information collected during this phase of the study contributes to the overall efficacy of a vaccine trial in two ways. The first is that it expands on the safety profile of the vaccine and finalises the version of the vaccine that is used amongst a larger population in phase III. The information collected also informs the strategy of administration for phase III of the vaccine trial (Weijer, 2020).

Phase III

In this trial, the sample size of the participants being used is significantly larger than other trials and can consist of several thousand participants. This phase is used as a form of comparison as it compares the effects elicited by the vaccine to other similar products on the market (Weijer, 2020). This comparison consists of proving that the treatment can demonstrate a safety profile and efficacy rate that is similar to other drugs on the market.

This process can involve the use of randomization which involves administering the vaccine being tested to some participants and pre-existing products available to other participants. Neither the participant nor researcher is aware of how the products have been administered amongst the sample population. This eliminates the possibility of bias and skewing of results in determining the efficacy of the vaccine (Weatherspoon, 2019). For the vaccine to receive Phase IV approval, the governing ethical body is required to approve the drug for use.

Phase IV

This is the final phase of the vaccine trial process as the vaccine and all supporting data are submitted for the approval of the ethical committee for that country. The vaccine is required to demonstrate consistency in the induced reaction amongst the participants who have received it and consistency in the dosages being manufactured (Weijer, 2020).

This phase of a trial can also be used to further determine the safety profile and efficacy of the drug. Other potential uses of the drug are also examined which in turn opens the possibility to another clinical trial using components of the vaccine (Weatherspoon, 2019).

Different types of vaccines

In order to understand the efficacy of a vaccine, the type of vaccine must first be understood. Different types of vaccines exist to determine the efficacy of the dosage and method being used to deliver the dosage. A successful vaccine type would be that which elicits the desired immune response to counteract the effects of the vaccine.

Live attenuated vaccines

This type of vaccine uses a weakened form of the virus that is being studied. The similarity in the reactions caused by the germ in the vaccine causes the body to create a strong immune response to the vaccine material (Zoppi, 2020). The right dosage of the vaccine often ensures a life-long immune response to the virus that the individual was vaccinated against.

This vaccine does have its limitation however as it is not recommendable for individuals with weakened immune systems and other associated disorders. This is because the immune response of these individuals will be overpowered by the weakened form of the virus and as such makes the individual sick with the virus rather than vaccinating them against it.

Lastly, the vaccine itself needs to be stored at cooler temperatures in specific conditions for it to remain in working order. These conditions have often proven to be difficult to meet especially in more developing countries that are unable to provide the necessary storage facilities (Zoppi, 2020).

Inactivated vaccines

Inactive vaccines use a destroyed version of the virus-cell to provide immunity against a virus. These cells are usually destroyed or killed using chemical solutions and controlled amounts of heat therapy. This form of vaccine was one of the first used. It does not, however, provide lifelong

immunity against the virus that it was created for, and often multiple vaccination dosages are required over a single lifetime to provide the necessary immunity against the virus (Zoppi, 2020).

Subunit, Recombinant, Conjugate, and Polysaccharide Vaccines

This group of vaccines uses specific genetic parts of the virus instead of the whole virus cell. The parts of the virus that are used in the vaccine is still able to elicit a strong response from the body in terms of an immune response (Zoppi, 2020).

Unlike inactivated vaccines and live attenuated vaccines, these are safe to use in individuals with compromised immunity systems. It also elicits a strong response which does not need to be consistently maintained as frequently as inactivated vaccines (Zoppi, 2020).

Toxoid Vaccines

This form of vaccine uses the by-product of the virus, mainly the toxins that are created as a result of the virus's interactions within the body. This creates immunity to the specific parts of the virus-cell that are responsible for causing a viral reaction in the body. This then focuses on the body's immune response to a specific toxin within the body and this vaccine also needs to be used more than once in a single lifetime (Zoppi, 2020).

DNA and Viral Vector Vaccines

This is a recently developed type that has been used most frequently in the COVID-19 vaccine development process (Zoppi, 2020). DNA vaccines create specific antigens of a virus; antigens are the material of a virus that leads to the creation of antibodies.

Once it has been injected into the body, the DNA material associated with a virus cell is produced and the body recognizes it as the virus-cell itself and formulates an immune response to ensure that the virus does not cause the body to fall ill (Zoppi, 2020). This type of vaccine also provides lifelong protection due to the strength of the body's immune response to the vaccine.

Viral vector vaccines enter the body disguised as natural infection. It assists the immune system by identifying viral cells and creating an immune response against them. These types of vaccines function by creating extra antigen components from the virus-cell so the body can create an immune response (Zoppi, 2020).

Repurposed vaccines

These are vaccines that have been created to fight other illnesses and have yielded successful results that are now being used as a possible solution to another virus as it has been found to yield similar results of success in combating another type of virus all together (Corum, Wee & Zimmer, 2020).

<u>Examples of successful vaccines</u>

Influenza vaccine

The influenza virus, or better known as "the flu", is a range of viral cells that cause several different symptoms of illness within an individual. These often range from more common symptoms such as a stuffed nose and sore throat to more severe symptoms such as dehydration and a fever (Longo, 2012).

The virus itself has a wide range of different variations that cause a variety of clustered illnesses. Thus, the vaccine has had to take a similar approach. The first influenza vaccine was created for the

common strain of the virus that lead to symptoms of illness such as a stuffed nose, sore throat, fever, and so on. It was initially conceptualized in the 1930s and used an inactivated vaccine approach (Barberis, Myles, Ault, Bragazzi & Martini, 2016).

The roll-out of the vaccine had two objectives, achieve high rates of vaccination to protect individuals who did not receive the vaccine and to protect the population against the disease. Safety and efficacy were closely monitored to ensure that there were no possible adverse events that could occur from administration (Barberis et al, 2016).

At present live attenuated vaccines are looked at as being used more than the original inactive component vaccine that has been the staple when attempting to prevent the flu. These innovations look at reducing the risk of an adverse event occurring and also look at prolonging the period that an individual can go without requiring another vaccine shot (Barberis, 2016).

Measles vaccine

The first version of the measles vaccine became available to the public in the 1960s. Before the availability of the vaccine, the death rate and rate of infection were at an all-time high in both adults and children (Najera, 2019).

This vaccine also saw resistance initially as there were still large outbreaks of cluster infections that occurred, especially in individuals who had not yet been vaccinated against the virus. This vaccine used a live attenuated approach and would ensure lifelong prevention against the virus (Najera, 2019).

Due to an unfounded paper published by a medical doctor in the 1990s, the vaccine is treated with suspicion by parents as the paper published linked the vaccine to autism in children. This paper, however, had no scientific validation and the principal author had all qualifications stripped as a result (Najera, 2019).

Despite this, a large number of children still go without being vaccinated as a result and are at risk for contracting measles throughout the world. For the individuals who have taken the vaccine, it has provided lifelong protection against the virus (Najera, 2019).

<u>The vaccines that are becoming available</u>

Pfizer-BioNTech vaccine

This vaccine has begun use in the United Kingdom as the governing and ethical authorities have approved the vaccine for emergency use (Lawton, 2020). The vaccine itself began in March when the collaboration between Pfizer and BioNTech took place.

The vaccine uses a genetic approach as it uses the messenger RNA of the coronavirus cell. This mRNA is the component that is responsible for the delivery of instructions to creating the spike protein cells within the virus. This component has been synthesized and utilized in the vaccine (Lawton, 2020).

The mRNA that was synthesized is placed in a nanoparticle that is injected into the arm of an individual. Here it converts the specialized immune cells that have reacted to the presence of the vaccine component within the body (Lawton, 2020). The mRNA acts the way it would in a normal virus-cell by delivering the instructions thereby converting them into spike protein cells (Lawton, 2020).

These cells are then identified as an antigen by the body's immune system and an immune response is utilized by the body in response. This then allows for cell memory to ensure that an immune response is available should the body become infected by coronavirus cells (Lawton, 2020).

Currently, the period for which the protection offered by these vaccines is unclear as the expedited process of the vaccine trial was to determine the efficacy and safety profile of the vaccine. At present, the Pfizer BioNTech vaccine has been found to have a 95% efficacy rate (Corum et al, 2020). The vaccine is administered over two weeks several weeks apart and immunity begins to build up after four weeks of the first dose of the vaccine (Lawton, 2020).

Moderna Vaccine

The vaccine created by the biotechnology company Moderna has yielded impressive results. The outcome of the vaccine has seen a 100% efficacy rate amongst participants. This means that no participant contracted COVID-19 in phase III of the clinical trial process (Cohen, 2020).

Like the vaccine developed by Pfizer and BioNTech, this vaccine also utilizes an mRNA approach for the delivery of the vaccine component and also needs to be administered over two dosages (Cohen, 2020). The vaccine has also shown to be effective as far as three months as far as researchers know and are also being rolled out on an emergency basis as it has been approved by the FDA in the United States of America (Johnson, 2020).

Research has also shown that the Moderna vaccine could also work against asymptomatic infection as well as symptomatic infections. Side effects associated with the Moderna vaccine include headaches, pain, and swelling at the site of vaccine administration (Johnson, 2020).

Johnson & Johnson

Johnson & Johnson have also made significant strides in the area of vaccine research and have also seen high efficacy levels with the vaccine that they have been testing to combat the COVID-19 pandemic. This vaccine uses a viral vector approach and has used the genetic material of the coronavirus and implanted it into a modified version of the adenovirus (Corum & Zimmer, 2020).

The adenovirus causes mild flu-like symptoms and the modified version of the virus can enter cells but is unable to replicate itself or induce illness. By doing this, the vaccine allows the body to create a rapid immune response and results in minimal harm to the participant in doing so (Corum & Zimmer, 2020).

Unlike the vaccines developed by Pfizer and Moderna, it can be administered over a single dosage and is just as effective. The conditions for storage of this vaccine is also easier as it can be stored for up to three months before being administered and the tougher outer core of the adenovirus shell means it can handle harsher conditions and does not require the same complex criteria for storage (Corum & Zimmer, 2020).

The vaccine trial process has also been stalled somewhat as a serious medical event halted the vaccine trial process momentarily as all the necessary guidelines and protocols had to be re-evaluated before resuming (Corum & Zimmer, 2020). It is currently in its' second phase III of the clinical trial process as researchers continue to evaluate and critically analyse the safety profile of the vaccine.

Oxford-Astrozenenca vaccine

The Oxford-Astrozeneca vaccine also uses a genetic vaccine model, however, unlike the Pfizer and Moderna vaccines, it uses double-stranded DNA to implant the genetic material of the coronavirus (Knoll & Wonodi, 2020). Here a modified version of a chimpanzee adenovirus was used to hold the coronavirus genetic sample and like the adenovirus used by Johnson & Johnson, it can enter cells but cannot replicate once it is inside them (Knoll & Wonodi, 2020).

After it is injected into the body, it works similarly to that of an mRNA vaccine in that a specialized immunity cell is latched onto, and the spike protein associated with the coronavirus is replicated within the cell, these proteins act like coronavirus cells in terms of their genetic material and as such elicits an immune response from the body (Knoll & Wonodi, 2020).

The vaccine is currently in phase III and is expected to be released in 2021 with some countries such as the United Kingdom and Canada have already pre-ordered their dosages.

Vaccine Administration Issues

One of the most significant issues that have arisen from the discussions around a COVID-19 vaccine has been vaccine hesitancy. Vaccine hesitancy is defined as the refusal or delay in accepting the vaccine services that are available due to pre-existing misassumptions (Macdonald, 2020).

Studies have found that vaccine hesitancy has increased globally, with Africa seeing a significant increase this year, particularly around taking the COVID-19 vaccine. This is due to several misconceptions that could exist as a result of misinformation or a lack of adequate knowledge (Macdonald, 2020).

Stigma also exists around a lack of understanding of the safety and benefits that vaccines provide in terms of counteracting the virus. Fear of the possible side-effects and paranoia of the actual vaccine contents has also arisen (Macdonald, 2020). This general mistrust is also directed at governments and the intentions in the administration of the vaccine (Macdonald, 2020).

Counteractive methods should focus on education. Educating the general public on the benefits these vaccines pose is crucial in realigning the public a need for acceptance of a vaccine. For the COVID-19 pandemic to eventually be eradicated, every individual who can be vaccinated should be. If the disease is going to be entirely removed from society and normal life is going to resume, the vaccines that have become available need to be administered and accepted willingly by the public.

Conclusion

South Africa finds itself in a second wave with a stronger, more mutated version of the original SARS.COV.2 strain. Now more than ever, it is imperative for its citizens to adhere to protocols and guidelines in keeping each other safe. Collaborations with the likes of COVAX, GAVI, and other organizations means that the virus will eventually reach South African shores and make the pandemic something of the past.

Until then, adherence to social distancing, wearing a mask, and sanitizing is essential. In doing so, it ensures the optimum numbers of lives are saved during this period and when the vaccine becomes available, the need for these measures will be a relic of the past.

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