How were COVID vaccines developed so quickly?

The answer lies in the implicit underlying global *COVID Vaccine Innovation Ecosystem* that effectively brought together the five steps that were needed to make the innovation of the vaccines happen.

Introduction

At the beginning of 2020 the emergence of the novel and highly contagious COVID virus shook the entire world to its core. On November 9, 2020 Pfizer and BioNTech announced the first viable vaccination for COVID-19, with a more than 90 percent effectiveness.

How did this happen so quickly?

The answer lies in the efficiency of an implicit global *COVID Vaccine Innovation Ecosystem* that made superfast innovation happen. This ecosystem facilitated the 5 steps that together delivered a crucial part of the solution to the COVID Crisis – effective vaccines.

The working of the global implicit *COVID Vaccine Innovation Ecosystem*

Five steps were needed to make the successful innovation of a COVID vaccine happen.

STEP 1: Identifying the COVID Challenge.

The COVID Challenge in the vaccine space was immediately obvious: to prevent or limit the spread of the COVID-19 virus through the innovation of an effective vaccination. But this raised the question of how to go about making an innovative vaccine solution to the virus happen?

STEP 2: Creating a variety of competing value-adding conjectures (VACs) about how to solve the Challenge.

The global implicit *COVID Vaccine Innovation Ecosystem* went about dealing with this question by generating a variety of competing value-adding conjectures (VACs) about the mechanisms that would produce a sufficiently strong and long-lasting immune response in the targeted vaccinated population. Very different mechanisms were selected by the various players who conjectured that their approach would yield effective results.

The conjecture creators were helped enormously by the strength of the scientific knowledge on which they were able to draw. This knowledge resulted from research over many years done by many different kinds of organisations, including for-profit companies, universities, and government research institutes. Government funding of this scientific base played a crucial role. The knowledge enabled the VAC creators to come up with conjectures regarding how to create and strengthen immune responses in inoculated people.

Significantly, there was little international coordination over who the VAC proposers should be and how they should come up with their intended solutions. The implicit global door was open to anyone. The VAC proposers that spontaneously emerged included big pharma companies such as Pfizer, AstraZeneca, Sanofi, etc; smaller biotech specialists; universities and government research institutes; and even the Chinese and Russian armies. They were free to follow the methodology and conjectures of their own choosing.

Very important in explaining the rapidity of the innovation process was the intense degree of competition that motivated the VAC proposers. Perhaps most important was the potential financial reward that was promised to the winners. Governments of the richest and largest countries immediately took out conditional contracts with proposers, guaranteeing the purchase of tens of millions of vaccines contingent on successful completion of Stage Three clinical trials.

But non-financial incentives were also important. The most significant of these was the promise of huge reputational benefits that would accrue to the winners. In addition, governments were highly motivated by their desire to start protecting their local populations as soon as possible.

It is significant to add that not only was there competition between the players creating vaccinations. There was also competition between the competing mechanisms, technologies and processes they used. The intensity of these two forms of incentivised competition contributed to the speed of development of the vaccines.

Both informal discussion and the publication of the results of clinical trials provided feedback regarding which methods were likely to be most promising. In turn this prompted new search paths and the pivoting of VACs.

In this way the beginnings of a Darwinian process of evolution emerged with the generation of a variety of solutions. But what about the next step in the evolutionary process, selection?

STEP 3: Selecting the best of these VACs.

Selection processes – i.e. deciding which vaccines produced by which players should be chosen - were globally decentralised. Each country's regulatory institutions, operating according to somewhat different selection criteria, provided one selection mechanism. Direct government intervention offered another. For instance, both the Chinese and Russian governments started vaccinating soldiers before what in advanced Western countries would have been the completion of Stage Three clinical trials.

Different selection processes imply the possibility not only of different players being chosen but also different mechanisms, processes and technologies. Over time this increases variety in the ecosystem as a whole, contributing to further evolution.

STEP 4: Implementing the selected VACs.

The effective dissemination of selected vaccines focuses attention not only on the vaccine itself but also on a host of practical questions regarding complementary requirements such as

manufacturing scale-up, logistical distribution and storage prerequisites, the skill requirements of those who are to administer the vaccinations, etc.

The diffusion of vaccines also raises complex questions about the morality and ethics of early distribution. Should the first recipients of the chosen vaccine be those with the ability to pay? Or should priority be given to those systemically important for the health of nations and the global system such as front-line medical workers? What about older people who are most at risk of serious effects? How are these questions to be answered and - a quite different point – how should they be dealt with?

The answers to question such as these also have implications for the selection process and its evolutionary effects.

STEP 5: Evaluating the strengths and weaknesses of the *COVID Vaccine Innovation Ecosystem*.

The time has not yet come for a comprehensive evaluation – or, more likely, evaluations - of the strengths and weaknesses of the *COVID Vaccine Innovation Ecosystem*. But before this can happen it is necessary to conceptualise the existence of such a system. The fact, as made clear here, that this system is invisible and tacit is a potential complication. It is necessary, therefore, that the reality of this de facto system be recognised.

Conclusion

In this brief account it is suggested that the remarkable success of the search for an effective COVID vaccination is due to the existence of an implicit *COVID Vaccine Innovation Ecosystem* that underlies the efforts that have been made. If further progress is to be made in evaluating the strengths and weaknesses of this ecosystem, and therefore perhaps improving its performance, it is first necessary to acknowledge the reality of this invisible system. It is hoped that the present article will make some contribution in so doing.