Want to develop vaccines in Africa? Then invest in expertise and infrastructure

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Aerial view of the UK's national synchrotron, Diamond Light Source Ltd (Diamond) on the Harwell Science and Innovation Campus in Oxfordshire. Credit: Diamond Light Source

In little more than a year from the onset of COVID-19, scientists successfully developed vaccines against the SARS-CoV-2 virus for world-wide use.

Three main factors contributed to this extraordinary feat.

One, unprecedented collaboration between international scientists. Two, scientists were able to obtain exquisitely detailed images of the virus proteins and the human proteins that they interact with—right down to the positions of the atoms.

Three, expertise and infrastructure, developed over many years, involving tens of thousands of scientists supported by national governments and substantial private investment. Developing this skilled workforce was only possible because societies agreed to sponsor their best researchers to solve acute problems by providing appropriate tools and resources.

The African contribution to this massive achievement proved quite small. African researchers remain challenged by the lack of sustainable and accessible funding, infrastructure and expertise.

In late May President Cyril Ramaphosa announced that South Africa was "developing a local vaccine manufacturing plan to produce vaccines locally through strategic partnerships and technology transfer." The goal, he said, was to cover the entire vaccine production value chain. He said Africa wants to do things for itself and that "we must also look at how vaccine manufacturing capacity developed during COVID-19 can be repurposed for the future production of other vaccines and related technologies."

In this article we unpack how the three-year START program (Synchrotron Techniques for African Research and Technology)—funded with a grant from the UK Research and Innovations' Science and Technology Facilities Council—substantially prepared South Africa's capacity to do this type of work. It trained students and postdoctoral research assistants at eight South African universities and

the country's National Institute for Communicable Disease (NICD). It also allowed access to the UK's national synchrotron, Diamond Light Source. Funded through a £3.7 million (about US$5million) Global Challenges Research Fund grant, the initiative provided an exceptional combination of expertise and experimental resources.

Innovative technologies

Understanding biological systems is critical to the prosperity, and possibly, survival of the human race. Without it, we are threatened by disease, energy and food insecurity, pollution and climate change. Studying biological macromolecules—such as proteins at atomic resolution—empowers us to develop drugs, vaccines, herbicides and pesticides. And it helps us design non-polluting industrial processes to create the chemicals that we need.

The branch of science that deals with this is called Structural Biology.

Structural biologists unravel the intricacies of protein structures using highly brilliant synchrotron radiation in a technique called X-ray crystallography or by cryo-electron microscopy (cryo-EM). These structures form the basis for developing new drugs or vaccines to stop diseases. In particular, the recently developed, Nobel prize-winning, technique of cryo-EM was essential for the development of the COVID-19 vaccines.

However, Africa largely remains a spectator in the race to build these innovative technologies despite START showing how it could be done. The program has yielded extraordinary impact with relatively modest investment over a short space of time. It has triggered a step change in structural biology research in Africa, demonstrating what is needed and that it works. Existing research hubs and networks were strengthened, and new ones developed. Young career scientists grew in confidence and

skills through international collaborations, mentoring, writing proposals and crunching data.

The South African groups regularly collected data at synchrotrons and electron microscopes to augment our understanding of potential treatments. These have included SARS-CoV-2 (COVID-19), snakebite venom, HIV, tuberculosis, malaria, human papilloma virus, cardiovascular disease, as well as equine diseases. Work has also been done to create industrial enzymes for the manufacture of medicines and commodity chemicals.

The structural biology laboratory at the NICD, for example, focused on understanding the antibody response to communicable diseases such as HIV and COVID-19 to guide the search for effective vaccines. In addition, the NICD has developed structural biology projects to understand how antibodies recognize and stop SARS-CoV-2 variants of concern.

The START grant has contributed to:

- research papers in leading international journals,
- the development of a small but growing network of suitably equipped labs across South Africa,
- vibrant international collaborations, and
- numerous early career scientists trained in world class Structural Biology, including synchrotron and cryo-EM techniques.

Unfortunately, the funding for START has ended.

Now what?

National government must build on the foundations of the START program. Only a sustained national policy will ensure that structural

biology can achieve world-class science and grow relevant research across Africa.

Structural biology remains a niche science on the continent, largely ignored by the infrastructure roadmaps. Ramaphosa's vision of African vaccines needs to be supported by a national strategy for structural biology. The aim would be to grow the community of scientists. This, in turn, would massively impact vaccine and drug development as well as other regional challenges.

Teaching, training and infrastructure in protein crystallography and cryo-EM need to expand dramatically from a tiny base.

The structural biology community requires a modern cryo-EM center in South Africa. This would require substantial investment beyond the means of critically stressed tertiary education institutions.

The support of the international community is crucial.

The COVID-19 pandemic has shown how important it is to have both national and international approaches to research and development with access to the right type of world class equipment, training and expertise.

Vaccines need to be developed in Africa against diseases arising in Africa. This makes financial sense and places emphasis on Africa solving Africa's problems. The World Bank has estimated that the slow rollout of COVID-19 vaccines could cost the continent $14 billion a month. Even this pales in comparison to the long-term cost of malaria, tuberculosis, HIV, and other poverty-related diseases.

Required steps involve:

Local infrastructure and capacity. The infrastructure put in place by the

START program needs to be expanded to national reference laboratories, sustainably funded, well-equipped and staffed by experts.

Capacity retention. Early career researchers trained in South Africa need to be retained to prevent loss of knowledge and expertise. The need to provide all young researchers opportunities to further develop their careers is obvious. But this cannot be done without growth. It is therefore urgent to implement policies that stimulate the structural biology research environment and create new posts. This is key to ensuring that diversity, fresh ideas and novel approaches relevant to Africa are brought into the local and international scientific community.

Access to international infrastructure. Synchrotrons, neutron sources and cryo-EM facilities around the world are open to African researchers. The challenge is to produce world-class research and competitive proposals to gain access. Funding for this must come from the South African Treasury. This should be enhanced by membership of international organizations.

START has boosted the skills and enthusiasm of South African bioscientists. They have seen the benefit of a structural approach in designing medicines for African diseases. The program has opened doors to international co-operation and technology that Africa can't afford. Young researchers have committed to careers in structural biology, hoping to practice their skills locally. Local research into both vaccines and medicines has started.

Ramaphosa's desire to develop vaccines in South Africa could be realized by building on the foundation that has been laid. But only if there's substantial and sustained investment in both human resources and infrastructure.

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