Australian Embassy
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Australia-Germany Research Network

Embassy
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Canberra

Australian
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Science

Under the Microscope

Expert Webinar on COVID-19 Vaccine Research in Australia & Germany

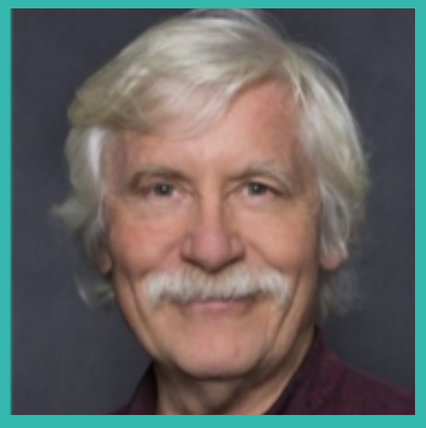
Official Transcript

On 30 June 2020, the Australian Embassy Berlin hosted an expert webinar to discuss the race for a COVID-19 vaccine. The event was was supported by the German Embassy Canberra, the Australian Academy of Science, and the Australia-Germany Research Network (AGRN).

Ambassador H.E.
Lynette Wood

Laureate Professor
Peter Doherty

Professor Doctor
Marylyn Addo



Emeritus Professor
Hans Bachor

Paul Richards

This live webinar took place on 30 June 2020, when the world had just crossed over 10 million infections and 500,000 deaths due to COVID-19. The date was on the eve of the six month mark since WHO received the first reports of a cluster of cases of pneumonia of unknown cause in China.

Due to technical issues with the recording, we are not able to provide a high-quality audio or video recording of the webinar. Instead, we provide below a transcript of the webinar. We hope you find it useful and informative.

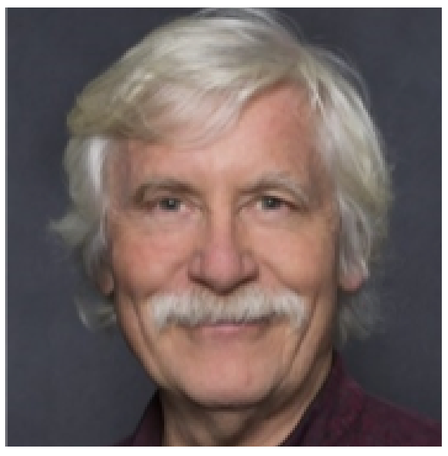
Panellists

Laureate Professor Peter Doherty is one of Australia's leading immunologists. Professor Doherty is the patron of the eponymous Doherty Institute, which has been at the forefront of Australia's response to the COVID-19 pandemic. The Institute is currently investigating two protein-based and two viral vector vaccines. Professor Doherty and Swiss researcher Rolf Zinkernagel were awarded the Nobel Prize in Physiology or Medicine in 1996 for their discoveries of how the immune system recognises virus-infected cells, a discovery which has had practical implications for cancer treatments. Professor Doherty was Australian of the Year in 1997.

Professor Doctor Marylyn Addo is one of Germany's pre-eminent infectious diseases specialists. She is head of infectious disease at the University Medical Center Hamburg-Eppendorf, Germany, a member institute of the German Center for Infection Research (DZIF). Her research group works on clinical management, epidemiology and the immunology of newly emerging infections. Professor Addo has developed and tested vaccines for Ebola and MERS, and is currently developing a viral vector-based COVID-19 vaccine

Moderator: **Paul Richards,** Director of Communications and Outreach at the Australian Academy of Science. Paul is an esteemed science communicator who has played a critical role in the success of the Academy's communications initiatives, growing the online audience from 9000 Facebook followers to over 2.3 million. Prior to joining the Academy, Paul worked in journalism for 17 years, including 10 years as a producer on one of Australia's largest news programs.

Welcome remarks provided by **H.E. Lynette Wood**, Australian Ambassador to Germany, and **Emeritus Professor Hans Bachor**, Secretary for Education and Public Awareness at the Australian Academy of Science.



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Australian Academy of Science

Origins of the Virus

I want to begin our session today talking about the origins of the virus. SARS-CoV-2, the virus that causes COVID-19, is thought to have emerged in bats. Millions of people around the world come into close contact with bats. Why haven't we seen a coronavirus pandemic of this scale before?

We have already had two near events. In 2002, the original SARS virus which came out of bats and infected people. This was not nearly as infectious as this one [SARS-CoV-2] but it killed about 10% of the people it infected, much higher than the current death rates.

Then of course we had the MERS virus which came along, probably out of the Middle East and again probably out of bats, or maybe via camels. That was a bit more infectious and of course is still going, killing about 30% of people so a much more dangerous virus.

Suddenly we get this new pandemic virus. I've been thinking about this and I think this is the only truly novel respiratory virus pandemic in modern history. We've seen influenza viruses before and even though they may be novel in some senses, we do have cross-reactivities with immunity with other influenza viruses. This is quite a benchmark and I think we should be very much warned that these things are around and out there and there are a lot more of them.

COVID-19 is another coronavirus like the common cold, why is this new virus so contagious and deadly?

We have been living with coronaviruses. In Germany there are four strains circulating which, as you mentioned, cause the common cold and usually mild infections, but as Peter has mentioned, this [SARS-CoV-2] is the third big coronavirus with pandemic potential we've faced in a span of less than 20 years.

First we had SARS with 10% mortality and then MERS with 30% or up to 40% mortality. We don't know why SARS came and went, it just disappeared, so that was also why we couldn't make a lot of headway there in terms of vaccine development. With MERS it was a similar story - very few people globally have been infected. It emerged from Saudi Arabia, the big concern at the time was, with having Mecca and the Hajj there, respiratory viruses could spread around the world, but it actually wasn't as contagious. Coronaviruses with high mortality aren't as easily transmissible.

What makes SARS-CoV-2 so deadly in a sense is not its mortality rate. We're working out the numbers still, but the mortality rate is probably around 1%. SARS-CoV-2 is rather so deadly because it's so contagious and spreads quickly across the world, and because we have asymptomatic carriers who can transmit the virus. Having a new respiratory virus in an immune naive community is a challenge we hadn't foreseen.

Developing a Vaccine

Historically it hasn’t been possible to create safe and effective vaccines for human coronaviruses. Due to it being a new virus there’s also limited data on SARS-CoV-2. How likely is it we’ll be able to develop a vaccine?

I think it’s pretty likely. I think Marylyn is probably more authoritative on this than I am. Really the reason we haven’t developed vaccines against the common cold coronaviruses – there are four of them – is we haven’t really tried. People did try with SARS, the original virus, but when it died out the funding was dropped immediately. It’s a pity we didn’t go further but that was the reality. It’s also a pity we didn’t go a lot further with antiviral drugs to treat the original SARS.

How likely do you think it is that we’ll be able to develop a vaccine?

There are no guarantees. Nobody can say we will definitely have a vaccine, and there are many open questions. However, there is an unprecedented amount of vaccine research going on, and many consortia are on the way. Over 200 vaccine constructs are in different stages of development. We already have vaccines in clinical trials. We know some of these vaccine trial candidates are safe and immunogenic, so they do make T-cells and antibodies.

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The big question is going to be, are those immune responses now protective against disease. Our track record with respiratory viruses is not stellar. A vaccine that has already saved many lives is the influenza vaccine but compared to other vaccines that we know, it's not the best we have.

I am, however, optimistic. People ask why it takes so long to develop a vaccine. If you consider, the new virus was discovered in January. It was only three months between the discovery of a new pathogen and the start of the first vaccine clinical trial – that is, the first vaccine going into a person's arm. This is absolutely record-breaking, we've never had something like that. That's also without compromising safety of the vaccine or participants in the trial. These early vaccines will give us data throughout the summer, and hopefully by the second half of the year, some signals about immune protection.

In terms of the efforts currently underway, are there any more likely to succeed than others?

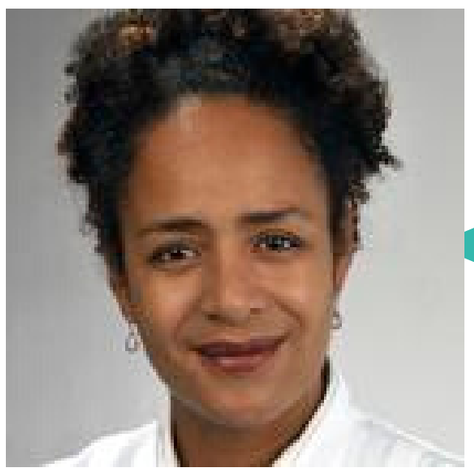
That's a difficult question. I share Marylyn's opinion – it's highly likely we'll get a very good vaccine, and maybe one better than a flu vaccine, but we'll see.

There are loads of vaccines in development. The ChAdOx1 vaccine from Oxford is already well into phase II trials. My sense is that the Brits for instance have made a lot of that gena vaccine even before the final testing is done. They've taken a punt on it, but when you consider the expense of this pandemic, blowing a few million on developing a vaccine is not that expensive. They could be ready to go later this year or early next year.

The best estimates with the Australian primary candidate vaccine – which is the protein vaccine out of the University of Queensland and Paul Young's group – is that it could be ready mid-2021, and could be made in Australia which is good, because we don't have that much manufacturing capacity; Germany is in much better shape than we are in that respect. I'm optimistic. I'm bullish about the vaccines but anyone in science knows we can be horribly wrong.

Speed of Vaccine Development

Can you give us some insight into efforts to speed up what is still a long process?



One time point that made a head start into where we are now is the Ebola pandemic in 2014. At that point, the world realised that, even for a not as contagious virus as Ebola virus, we were not well prepared. We had no medication, no therapy and no vaccine. In the aftermath of that, the WHO convened an expert panel and that panel was asked, "So tell us what are the ten pathogens that we think could cause pandemics in the coming years?" SARS and coronaviruses and MERS were on the list. The list is updated every year, and includes a 'Disease X'. COVID is Disease X but thankfully comes under the family of viruses we already know.

Usually we are playing catch up trying to develop vaccines and therapeutics. We decided at that point though that we needed to get ahead of the game and try to develop vaccines and therapeutics ahead of time. That's also how CEPI [the Coalition for Epidemic Preparedness Innovations] started. Their mission is to develop vaccines before epidemics hit. A lot of the consortia who are now in the race for a COVID vaccine were already in a race for other vaccines such as MERS. We were financed by CEPI to develop a MERS vaccine. It's always about team work, with different partners able to provide different scope.

It's the same with Oxford, who were also involved in MERS vaccine development. They've taken the approach that they could use the same platform and instead of having a MERS antigen in there they could adapt it to a SARS-CoV-2 antigen. Now they're up and running. This process has sped up vaccine development quite dramatically.

We also have new tools. Firstly, as I said, it was only a matter of weeks from the first pneumonia to discovery of the pathogen. The sequence was made available very promptly, so essentially in January people could start constructing their vaccines. We have technologies that enable this, that are very quick to develop. A lot of the frontrunner vaccines, for example RNA or DNA vaccines, can be generated synthetically, so they go through development and into production rapidly. I think there are several components that add to the speed of vaccine discovery.

This is really record-breaking times to human trials. See how long it has taken to bring vaccines from development into clinical trials. COVID-19 has been a tiny amount. People say it's taking too long but in fact we've never been so fast.

There are 15 vaccines in clinical development that are on their way. The top four are viral vector vaccines, including the one that Peter mentioned being developed at Oxford, then there are RNA and DNA vaccines – some of those trials are actually taking place in Germany – and inactivated vaccines.

Protection is the hard part. Obviously in Australia and Germany infection rates are going down, so it will be more difficult in those countries to prove the vaccine is effective and protects against disease.

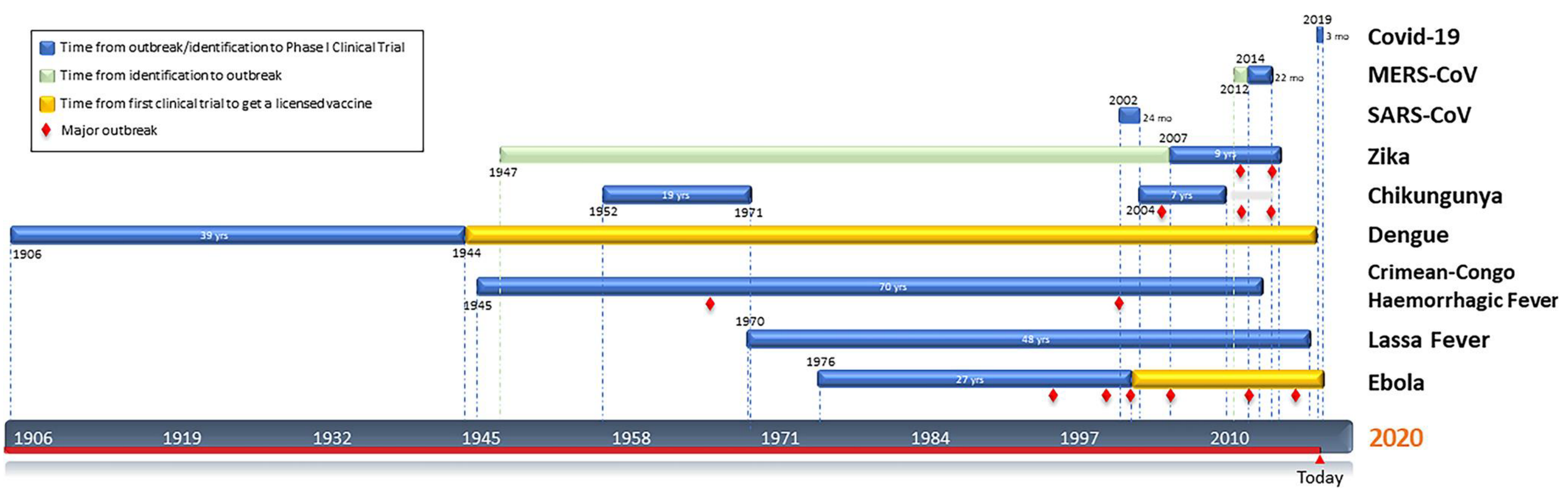


Fig. 1: New emerging diseases vaccine timeline. COVID-19 vaccines: breaking record times to first-in-human trials
Young Chan Kim, npj Vaccines, Published: 30 April 2020

Several Approaches to a Vaccine

Peter, the Doherty Institute is investigating two protein based and two viral vector vaccines. How are those approaches different and where are they up to?

I couldn’t really give you the particular details on that. I know they’re all very much in the early pre-clinical testing stage. We’re only now establishing capacity to do a lot of virus challenge. Our big CSIRO lab that has been testing some of the vaccines including the Oxford vaccine is using ferrets. They’re pretty much overloaded and we’ve been having to expand capacity. The Australian vaccines are all at a very early stage, except for the University of Queensland one, which I believe is in pre-clinical testing in ferrets and hamsters in the Netherlands and is expected to go into phase I human trial in July some time. Some of the Australian vaccines looked as though they were giving extremely good antibody responses in the initial vaccination dive experiments in normal mice, but they’re way behind in global terms.

Marylyn, in terms of the work you and your colleagues have been doing on a vaccine, how is that going? You spoke to the fact a lot of the work done prior to COVID-19 has set up the platform for your work now, so how are things progressing?

We use a viral vector platform called Modified Vaccinia Virus Ankara (MVA). This viral vector in its form without genetic modification is actually a licensed vaccine in Germany for smallpox. This vector can be used to vaccinate, and it has a lot of safety data already. We may actually need different vaccines for different groups. This platform is already used for immunocompromised people, children and pregnant women, so it has a good safety profile.

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We have an emerging infections unit at the German Center for Infection Research (DZIF), with a team of researchers in Munich, Marburg and Hamburg. I think of vaccine development as a relay. The vaccine was constructed by Professor Sutter in Munich who has tested the vector in small animal models, and it's now being produced for GMP [Good Manufacturing Practices] production. This is often a bottleneck as it's expensive and production capacities are limited in our countries. The company we're working with is currently producing a MERS vaccine for another trial so they had to shift slots to accommodate the SARS-CoV-2 vaccine.

At the same time that the other groups are doing the animal work and the company is doing the production, we are doing the big regulatory piece and preparing for clinical trial. We are scheduled to start in September with a phase I trial for COVID. We have just published our MERS data back-to-back with the Oxford group, so we can compare it side by side to see how these two coronavirus vaccines will fair and maybe we can draw some interesting conclusions from that.

Potential risks associated with vaccine development for COVID-19

Antibodies that bind virus without neutralizing infectivity can cause disease through increased viral replication or formation of immune complexes that deposit in tissue and activate complement pathways associated with inflammation. T helper 2 cell (T_H2)–biased responses have also been associated with ineffective vaccines that lead to enhanced disease after subsequent infection. Antibody-dependent enhancement (ADE) of viral replication has occurred in viruses with innate macrophage tropism. Virus-antibody immune complexes and T_H2-biased responses can both occur in vaccine-associated enhanced respiratory disease (VAERD).

	Antibody-mediated		T cell–mediated
	ADE	VAERD	VAERD
Mechanism	Fc-mediated increase in viral entry	Immune complex formation and complement deposition	T_H2-biased immune response
Effectors	Macrophage activation and inflammatory cytokines	Complement activation and inflammatory cytokines	Allergic inflammation and T_H2 cytokines
Mitigation	Conformationally correct antigens and high-quality neutralizing antibody		T_H1-biasing immunization and $CD8^+$ T cells

https://science.sciencemag.org/content/368/6494/945.full
Rapid COVID-19 vaccine development. Barney S. Graham. Vol. 368, Issue 6494, pp. . 368 945-946.
DOI: 10.1126/science.abb8923

Delivering a Vaccine

If a vaccine is successfully and safely developed, how difficult will it be to deliver? We struggle to deliver standard childhood vaccines across the planet in an effective manner. How can we ensure we get as close to universal vaccination as possible?

This is clearly an enormous challenge. 12 of these vaccines are being developed under the auspices of CEPI. That includes the University of Queensland vaccine. Now all those vaccines are developed, they're not patented, and the understanding is that these will be made globally available at the cheapest possible cost. I understand that most of the vaccine companies have signed on to the idea that they will provide vaccines at cost.

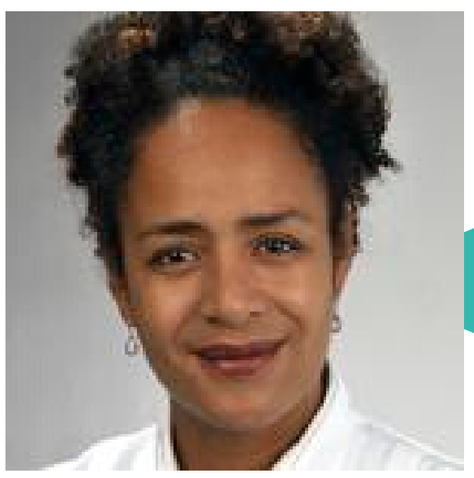
But manufacturing of course is a tremendous issue and some vaccines will be much harder to make than others in very large quantities. As Marylyn mentioned, some of the nucleic acid vaccines, the synthetic ones, they're really rather new, they could be made in very large quantities pretty fast. We hope they work. I'm not sure about MVA. That's a very familiar vaccine platform, as are the adenovirus ones. Fortunately for the protein one that's being made by the University of Queensland, we have in the CSL company a very large production facility at Broadmeadows where we could actually make 100 million doses of this vaccine a year.

It's not just the vaccine itself and getting it out there, but you also have to think, if you're going to vaccinate the whole population of the world, you would need 8 billion syringes and 8 billion vials unless you give it some other way – like puff it up the nose or give it in a patch. If you needed two shots, you'd double those numbers. The actual logistics of providing a vaccine, like any of the vaccines globally, would be massive.

But there is an enormous commitment to doing this globally and there's a lot of action. India, for example, has traditionally since HIV made generic drugs and vaccines and there have been agreements with the various companies that these would be made at low cost for use in the poorer countries in the world. For instance, the drug Remdesivir made by Gilead is being provided and manufactured in India by a company on that basis.

In general, the world is working together very well on this. There is a commitment to global control, because I think there is also a great consciousness that this is a global problem. If we are to return the world to normal economic activity, we have to solve this problem globally. It can't just be solved locally. I think we're doing extremely well in that respect, except possibly for some of the United States leadership, but globally the WHO has been doing a great job, and generally everyone has been coming to that party pretty well.

How has global collaboration assisted with the search for a global vaccine and any other reflections?



These situations can bring out the best in international collaboration. We've just had another fundraising event, artists came together for a concert on the weekend and a really significant amount of money was raised for the cause. No vaccine is even showing that it's working yet, yet we've raised so much money to ensure access is there and that we can enhance production capacity. A lot of risk has been taken to buy contingencies of production capacity. It's really amazing.

I think the world has understood, with different stakeholders working toward the fact that we have to ensure equal access to this vaccine across the world. If we don't solve this problem as a global problem then we will not succeed. We have seen how connected we are in this pandemic, so much so that in a matter of weeks or months this virus has spread across the world. A unilateral or national approach like closing borders will not tackle this.

What if we want to go back to normal? We have to talk about the fact there might be a new normal; it's not a given that we'll go back to exactly where we were. Oftentimes it's said that when we have a vaccine, everything will go back to normal. We have to be cautious about that and go stepwise, but I'm extremely enthusiastic about the amount of international collaboration we've seen. There is a lot of exchange, there could always be more exchange and synergy, but organisations, especially like CEPI, are trying to share the expertise so not any one consortia has to start from scratch – so there are common standards and standardised immune monitoring. This is also important so the results we see are somewhat comparable. If one consortium does A and another does B, we have to also be able to compare what these studies will show us.

I think international collaboration is essential, and I really also applaud the WHO for their leadership in this and CEPI as well. Gavi too, which talks to the policy makers. Scientists are trying their best but this time I also sense that policy makers are already very early on in the game making big headway to ensure that we reach the common goal that we've set out to reach.

Pre-Vaccine: Living a 'new normal'

Let’s talk briefly about that new normal we’re living through, at least pre-vaccine. What if a vaccine can’t be developed or it takes some time? Could Australia for instance eliminate COVID-19 without a vaccine? How viable is this approach for other countries?

A couple of weeks ago we looked to be pretty close to eliminating it but now of course we have a flare up of cases in Victoria due to some breakdown with respect to security guards in quarantine hotels.

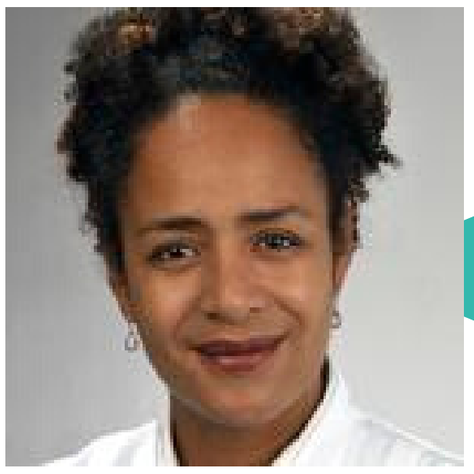
Eliminating it was never a strategy, it’s possible but difficult and not a possibility for most of the world. Australia and New Zealand, both of which have done rather well on this, both have the advantage of being island nations and they also had the great advantage that we had very little community transmission before we woke up to it and started to prevent ingress. Whereas in Europe and the United States, clearly the virus was in the community for quite a long time before it was actually detected in any serious way.

One way out of this is a vaccine. The other ways out of it are treating COVID much better. If we could ensure that people didn’t die, or that most people didn’t die, and we could make it the case that we could treat it and not nearly so many people got sick, then we could stop treating it like something super special, if we had drugs to do that for instance. The development of antiviral drugs is extremely important.

The other way of handling this, it’s a very expensive way but it reflects the AIDS model. If a vaccine didn’t work, and it’s very unlikely we’ll get a vaccine for AIDS, then you handle it with antiviral drugs. That’s the way people live with HIV. They take a cocktail of drugs each day. There’s also another strategy – HIV prep. What happens here is that people who put themselves at risk of catching HIV take a pill beforehand and that protects them. We could envisage that if we didn’t get a SARS-CoV-2 vaccine or if the vaccine did not work well in a key target group like the elderly – that has been the experience with influenza virus of course – then they could take another pill. I mean most of them are taking so many pills that if you shook them they’d rattle anyway. That’s a first world strategy at least initially.

Other possibilities are long-acting monoclonal antibodies, which are passive immunisation, that could be used as a protective, but if the vaccine isn’t protecting I’d wonder whether these would protect. These are the types of roads we could go down.

Treatments are starting to emerge as options in the short time while a search for a vaccine continues. What therapeutic options are the most promising?



I think at the moment there are two candidates that emerge, but actually we have a treatment working group and a list of over 200 substances that are in clinical development or considered for the treatment of COVID-19. Most of them at this point are repurposed drugs.

The frontrunner at this point, as Peter mentioned, Remdesivir, is actually a drug that was developed for the treatment of Ebola. A couple of years back there was a trial where three monoclonal antibodies and Remdesivir were tested, and the monoclonal arms did so much better than Remdesivir, so its trial was stopped. Now this drug, which is a broad-spectrum antiviral, has the advantage of having a lot of clinical data from these Ebola trials, meaning it's already ready for human use. And now we have a drug which has already been put through a placebo controlled study, and demonstrated that there is moderate immune activity. This is not going to be our saving drug that ends the search for further treatments, but I think it's very important first step to show antivirals can make an impact.

Part of the pathology in COVID-19 is also inflammation. We've seen this second disease wave where people get really sick. There is data out there that Dexamethasone may have mortality reduction benefits in certain groups, so I'm looking forward to seeing primary data on that. Six months into a pandemic, this is some significant progress.

Now specific drugs are being developed and I think while we're talking about the vaccine, it's critical that we also continue the development of therapeutics because it's going to be a while until we have developed and delivered a safe and effective vaccine to the world. We'll probably still have infections, like we do with influenza, and we'll need multiple tools to treat those individuals.

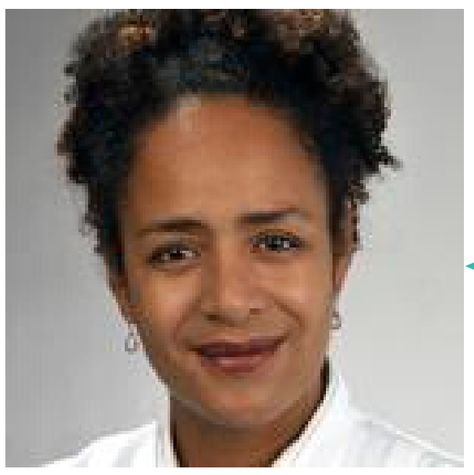
Peter mentioned monoclonal antibodies as prevention, but I see potential there also as therapeutics; those clinical trials will probably start in the second half of the year. There are plasma therapies on the way, the studies are not yet conclusive, but also in the case of Ebola recombinant plasma wasn't a successful treatment, with antibody monoclonals now actually the treatments of choice. I do have some hope that we'll have another tool in our arsenal against the disease with monoclonals as well.

Webinar Q&A

We'll now have some questions from the audience.

The first question is: Past attempts at developing vaccines to prevent SARS were troubled by some adverse inflammatory events following virus challenge. Do we understand the basis of this as a rare but serious potential safety concern?

We always think the worst-case scenario would be if a vaccine didn't work, but in fact the worst case would actually be if a vaccine made the disease worse. We have seen that with some vaccines. An HIV vaccine trial had to be stopped because the people who were vaccinated had more infections than the control group. This is of course a concern and we have to make sure we address this.



For coronavirus vaccines, two potential challenges have been raised in Barney Graham's article [see slide 2 above] – antibody-dependent enhancement (ADE) and vaccine-associated enhanced respiratory disease (VAERD). These have been seen with other coronaviruses and other respiratory viruses. All vaccine programs take this into account and try to address it in their animal models. CEPI actually has a working group on this issue too.

The risk for COVID-19 vaccine development is considered low, but all consortia clinical trials will address this and have specific measures to look for any signals it could go in this direction. It's critical we make sure this isn't happening, and there is indeed a very active discussion going on in the scientific community to address this.

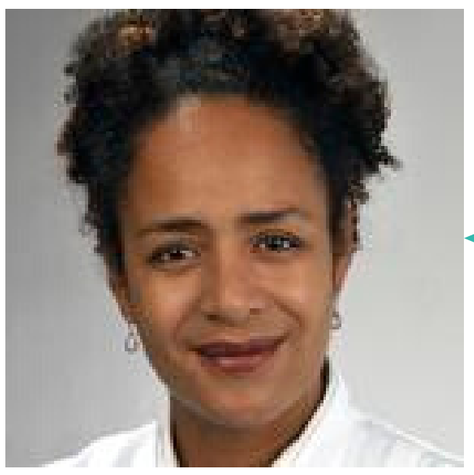
A range of factors such as genes and blood type seem to be linked to the severity of infection. Could we need personalised vaccines?

I don’t think so. I think personalised medicines are kind of a thing we talk about for the future. It could be the case that one of the reasons that, for example flu vaccines, don’t work well in particularly some elderly people could have a genetic basis but I don’t know any details.

I think what Marylyn was saying that with these coronavirus vaccines, there was an indication about the potential need for personalised vaccines that came through from earlier attempts, particularly with the SARS vaccine. But as I understand it, everyone who studied SARS is now studying these new viruses and vaccines and fortunately hasn’t seen anything like that.

But it is the reason we have to go so carefully with rolling out the vaccine. As with Ebola, the only way you can really test the vaccine at this stage, after you’ve gone through animal testing and you’ve tested it for safety, is to vaccinate substantial numbers of people and put them out there in a situation where they can be infected with the virus. We would tend to do that with younger people. As younger people generally don’t have such severe disease, we can’t do anything that would put them at additional risk. It’s one reason why we have to go very carefully with these vaccines.

How do vaccine approval processes work? Does each country have to conduct its own testing and grant its own approvals?



This is the first time I've seen this work very nicely in terms of not taking any shortcuts; safety is of the utmost importance in this scenario.

Oftentimes in regulatory processes, the whole approval processes are consecutive. You have to gather some data, build a dossier, bring it to the regulators and then only after that could you submit the next step. Now we have rolling applications, so you can roll in your safety and stability data as it comes off the press.

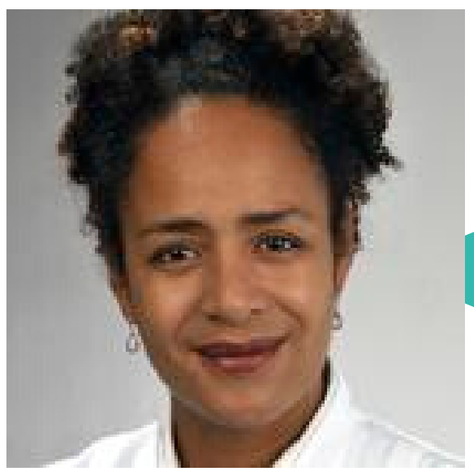
There's also international collaboration. Our competent authority in Germany, the Paul Ehrlich Institute, speaks to the European authority and to the FDA in a very animated exchange. Obviously the regulators have different national laws and sometimes they're not compatible but we've seen how quickly international efforts are working.

What do we know about the variety of immune responses in people who've tested positive for COVID-19, and does the severity of symptoms have any impact?

That's being worked through right now by a number of labs who are looking in very great detail at the T-cell and antibody responses. My understanding is there has been a paper saying antibody responses can fall off very quickly, but we're still waiting to see a lot of results. We are hearing from a few labs there can be some problems with T-cell responses but it's still early days.

What is clear is the majority of younger people who are either asymptomatic or not severely affected are probably immune to reinfection. There's some debate about that but my personal sense is, most of the situations where people thought they were discovering reinfection were actually persistence of viral genome and they were picking it up with the very sensitive PCR [Polymerase Chain Reaction] test. Marylyn has had a lot more experience than we've had in Australia – we really haven't had that many cases.

I'd like to ask you the same question, Professor Addo, and also whether there are greater clinical risks or side effects associated with faster vaccine development?



On natural immunity, as Peter said, we have had a lot of cases in Germany. I think the research and the data on T-cell and antibody responses is emerging. There was talk about an immunity passport in Germany, but the data and evidence is not quite ready for that yet.

The vast majority of young, immunocompetent individuals will raise antibodies within 2-3 weeks. There are different classes of antibodies – IgA, IgG, IgM – and depending on that, the serum conversion can occur earlier or later. Some of the antibodies show cross-reactivity. As we mentioned at the very beginning, there are coronaviruses that have been circulating even before COVID, and there is a risk of cross-reactivity. So there are many things we need to work out in our understanding of immune responses and reinfections.

As a matter of fact, there are studies emerging showing 1) that antibodies wane quite quickly, and 2) asymptomatic infection, as already shown in MERS, where if you have a mild infection you may not be exposed to as much antigen. There is a pre-peer review study from Germany that shows that there are asymptomatic individuals who don't raise antibody responses at all. We're not ready for prime time though – we have yet to understand this.

To the second part of your question about speed and safety, on the one hand we think it's taking too long to develop a vaccine, but then on the other hand there are safety concerns. We're giving these vaccines to healthy individuals so there are no short cuts taken that would put the safety of individuals at risk. We want to do something good with these interventions and not do harm, that's why we proceed carefully, and that's why the perceived speed is slow. We have to make sure safety is ensured. Data on the first candidate vaccine is reassuring, with no severe adverse effects.

Viruses are going to continue to evolve. What's the case for prioritising vaccination in research over treatments to reduce the severity of the virus? Could there be a point where we reach a shift, or do you think we're way off that and need to pour as much into vaccine research as possible?

Basically I think we need to pour as much effort as we can into every possible avenue, and that's in effect what I think is happening. As we've discussed, there are a large number of vaccines being developed, but there are also other people in different specialties, say structural biologists who are making designer drugs – like the approach with HIV and anti-influenza anti-virals – so they're pushing ahead as fast as possible. Other groups with that particular expertise have been pushing fast with the monoclonal antibodies. With a real emergency like this which is causing such social and economic damage, we just progress everything as fast as we can possibly go.

I think the one thing that we didn't do which we could have done ahead of time is keep up with developing antiviral drugs against the other coronaviruses. Antiviral drugs will work across a class of viruses, that's true for the influenza virus antivirals, and it's a pity we didn't really push ahead with the COVID ones. As it happens we have Remdesivir, but that was developed for Ebola, and there are a number of other candidates under development now for COVID.

CEPI has done the best you could do with vaccine development pre-knowing what the pathogen is. They were funding platform technologies where you could slot in some new genetic viral material and develop it. You will always have a lag phase with a vaccine because you're doing something quite new, if it's a new pandemic study. With a drug, you can potentially develop a drug that will work across a whole spectrum. I think this is one of the things we should focus on for the future.

Of course, one of the reasons we don't worry so much about bacterial diseases when it comes to pandemics, except maybe with multi-drug resistant organisms like some of the tuberculosis strains, is because we have broad spectrum antibiotics. If we could have something somewhat similar at least across a particular type of virus, I think we'd be in much better shape. I think we should be making them against any virus type that looks like a potential threat and could come out of, say, bat populations, which seem to be particularly threatening.

Final thoughts then. What worries you about the next phase of COVID-19 and what gives you hope?

I think we've been busy trying to deal with the scientific and medical questions in the first six months of the disease. We're just now starting to appreciate the collateral damage – economic and other – so I think that we'll probably see what effects that has.

On the other hand, while Australia and Germany have curbed the first wave, I think we are very well prepared for a second one. We're seeing small little outbreaks but I think we will be able to handle them and not reach capacity in our health systems, and I'm pretty confident about that. However, seeing COVID-19 affecting Africa and India and other disadvantaged countries worries me. While the virus infects everybody, it affects different populations differently. Australia and Germany are in fortunate positions with democracies and stable healthcare systems and vibrant economies – we've taken a hit but we will emerge – but it will affect other populations disproportionately.

What gives me hope, and this has given me hope in the past, is how the world can come together to face these really threatening situations together – scientifically, and as a community. I can think of small instances of neighbourhood help in Germany, but also examples on the political scale. That gives me hope, and that also makes me certain we can tackle this problem together and hopefully in a couple of years' time we will look back to this webinar and say, see we had a nice vaccine and now we're onto our next virus. I'm sure there are going to be other situations like this, and we have to prepare for that as well.

There's still a lot we don't understand about COVID-19 and we're realising that there are some very severe consequences, especially for people who've been on ventilation that may be long term. That's not uncommon with these severe virus infections especially in elderly people.

My sense of this is, when we talk about 10 million cases worldwide, it has to be much, much higher than that. Many countries don't have the capacity to do a lot of testing for background and asymptomatic testing. Whether it's two-fold or ten-fold too low we really don't know, quite frankly. A lot of the rapid-screening antibody tests are still pretty suspect, so we don't really know background infection rates.

I think if we look at COVID-19 in retrospect, we'll say this was terrible but it wasn't the most terrible thing that could have happened. What really concerns me is there are much more terrible viruses out there and there's no particular reason why we couldn't get a virus that's as infectious as this and does kill very large numbers of people. It's not nearly as lethal as the 1918-19 influenza virus for instance. I think this has been a kind of trial run for humanity because as long as we keep flying around the place in very large numbers, we're going to have these pandemics.