EUROPEAN COMMISSION
EUROPEAN HEALTH EMERGENCY PREPAREDNESS AND RESPONSE AUTHORITY

Workshop on next generation vaccines

9 December 2022

Outcomes document

Background

The success and rapid development of COVID-19 vaccines has shown the enormous potential of next-generation vaccine platforms. The use and expansion of these novel platforms may also decrease the response time when new viruses emerge in the future. There is a need to increase research and development efforts targeting pathogens with pandemic potential, shorten the time from research to market authorization and antivirals and allocate funding into both. The further improvement and development of vaccines, such as broad-spectrum vaccines that can induce a global, serotype-independent protection, will better prepare us in the event of a new outbreak. The Health Emergency Preparedness and Response Authority (HERA) mission is to prevent, detect, and rapidly respond to health emergencies. The workshop on next-generation vaccines was an opportunity for HERA to identify the challenges and opportunities that lie ahead.

Scope of the workshop on next generation vaccines

HERA's workshop on next generation vaccines took place virtually on 9 December 2022. The workshop was attended by 141 participants, including industry representatives, national authorities, and presenting scientists and companies. The workshop was an opportunity to discuss and showcase current advances towards the development of innovative vaccines, including a new generation of COVID-19 vaccines that are more broadly protective and provide longer lasting immunity, use innovative modes of administration and delivery systems, and could potentially ensure vaccine equity worldwide.

The workshop was organised in three sessions:

- Session 1: New science and technologies for vaccines
- Session 2: Presentations by vaccine developers
- Session 3: General discussion

Session 1: New science and technologies for vaccines

In the first session, four scientists were invited to present their views on the current developmental landscape and associated challenges in the field of vaccinology.

The session's first speaker was **Hanna Nohynek,** Chief Physician, Deputy Head, Unit Infectious Diseases Control and Vaccines, Department Health Security, Finnish Institute for Health and Welfare. Dr Nohynek discussed the vaccine development landscape from a European perspective, including lessons learnt during the COVID-19 pandemic and how to decrease vaccine hesitancy.

The second speaker was **In-Kyu Yoon,** Director & Global Head of Programmes and Innovative Technology at the Coalition for Epidemic Preparedness Innovations (CEPI). Dr Yoon presented CEPI's experience in engaging and prioritising innovation for speeding up the development of new vaccines, such as CEPI's 100 days mission to develop a safe and effective vaccine, and the creation of viral libraries. He also discussed future needs regarding COVID-19 and other respiratory diseases.

The third speaker was **Robin Shattock, Head** of Mucosal Infection and Immunity within the Department of Medicine at Imperial College London. Prof Shattock discussed the different approaches for vaccine development, such as genetic material, antigens, and the use of whole viruses. He discussed applications and challenges of multivalent recombinant vaccines as well and highlighted the need to develop COVID-19 mucosal vaccines that could prevent transmission.

The first session was closed by the talk of **Ana Maria Henao Restrepoa,** Head of the World Health Organization's (WHO) Research & Development Blueprint. Dr Restrepoa discussed how scientific strategies from recent outbreaks could help us prepare for current outbreaks and future Pathogen X (a hypothetical, unknown pathogen that could cause a future pandemic). She presented how WHO drives and incorporates innovation into response to public health threats and their experience in coordinating global research.

In general, the speakers highlighted the success of the development of COVID-19 vaccines. Other key takeaways included the need for increased collaboration and trust, broad-spectrum vaccines, and innovations for speeding up the development of new vaccines that will contribute to vaccine equity.

Session 2: Presentations by vaccine developers

For the second session, HERA launched a call for expression of interest[1] to showcase current work towards the development of innovative vaccines, including a new generation of COVID-19 vaccines. Ten companies were selected to present their work to develop novel vaccines with advantages, including, longer duration of protection; broader

[1] Call for expression of interest to present products or innovations under development at a next generation vaccines workshop on 9 December 2022 (europa.eu)

spectrums of protection against variants; efficacy against transmission; innovative administration methods and better storage and handling conditions which will contribute to vaccine equity. **Annex** contains abstracts from presenters and applicants to the call.

The session included the following vaccine developers:

Sebastien Henry, Executive Vice President Technical Operations at Micron, presented the dissolving microneedle patch technology for the administration of vaccines. The patch technology distinguishes itself by the ease of application, high acceptability assessed in infants and young children, and customisability of the delivered formulations, all while eliciting strong immune response in the conducted trials.

David Hoey, Chief Executive Officer at Vaxxas, followed with the presentation of a high-density microarray patch for the application of vaccines to the skin. The combination of vaccine formulation and high-density micro-projections triggers release of pathogen-associated and damage-associated molecular patterns promoting a robust immune response.

In addition, the small size, sharps-free waste and thermostability of the patch technologies can simplify vaccine logistics and avoid the need of cold chain, contributing to vaccine equity,

Andrew Kilianski, Senior Director for Emerging Infectious Diseases at IAVI, presented a vesicular stomatitis virus vector SARS-CoV-2 intranasal vaccine candidate. The mucosal immunisation route leads to establishment of both systemic and mucosal immunity, thus offering potential benefits over conventional parenteral immunisation. As mucosal route remains the main viral entry points, the vaccine could potentially protect from pathogen invasion at mucosal surfaces and therefore prevent transmission of the virus.

Özlem Tureci, Chief Marketing Officer at BioNTech, outlined BioNTech's broad toolkit of mRNAs vaccines. Notably, in 2022, BioNTech initiated trails with herpes zoster vaccine candidates. Further trials with herpes simplex virus type 2, malaria and tuberculosis are to follow.

Mike McGinnis, Chief Business Officer and **Joan Fusco**, Chief Development Officer at Public Health Vaccines, presented three recombinant VSV (rVSV) vaccines against Marburg disease, Nipha virus, and Sudan virus. While all three diseases are prone to outbreaks with a particularly high case fatality rates, currently no approved vaccines exist. The rVSV vaccine vector platform affords a proven blueprint for product development with streamlined processes for candidate clonal selection, manufacturing unit operations, analytical control strategies, and adaptable nonclinical and clinical approaches.

Hanne Callewaert, Chief Executive Officer, co-founder, and **Kai Dallmeier,** research associate professor at AstriVax-KU Leuven, depicted the Plug & Play Plasmid-Launched Live-Attenuated virus vaccine platform technology. This self-amplifying vaccine system will potentially allow for reduced dose schedule, improved thermostability, and simple

production and supply, all while eliciting a vigorous polyfunctional immune response. Proof of principle data obtained for yellow fever, rabies, and hepatitis B further highlight the advantages of this vaccine platform technology.

Emanuele Ciglia, Senior Medical Manager at CSL Seqirus, followed with the presentation of CSL Seqirus' novel influenza vaccine. The vaccine is produced in cell cultures and formulated with higher doses of antigens and addition of adjuvants allowing for a highly effective end-product with a better antigenic match with the circulating flu viruses and enhanced responses in elderly.

Venigalla B. Rao, Professor at Catholic University of America, presented the non-infectious, bacteriophage T4-based, multicomponent, needle and adjuvant-free, mucosal COVID vaccine. In the conducted preclinical animal studies, the vaccine was proven to elicit a robust humoral, cellular, and mucosal immune response with a production of broadly neutralizing antibodies. The phage construction can be easily adapted to display multiple COVID-19 variant trimers, as well as foreign antigens from other viruses.

Bruno Santos, Chief Executive Officer, and Pedro Madureira1, Chief Scientific Officer at immunethep, followed with the presentation of a peptide-conjugated vaccine (Paragon Novel Vaccine) which blocks bacterial glyceraldehyde 3-phosphate dehydrogenase (GAPDH) - an enzyme involved in the inhibition of host immune response. This vaccine could prevent the infection caused by five different bacteria: *Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Streptococcus pneumoniae* and Group B *Streptococcus.* Immunethep also presented an inhaled COVID-19 vaccine (SILBA) that protects from infection caused by different variants of SARS-CoV-2 and prevents transmission. This adjuvated vaccine composed of whole inactivated viruses and administered via the mucosal route can potentially elicit robust systemic and mucosal immunity.

Mathieu Epardaud, Research fellow, BioMAP&LovalTech, presented a nasal vaccine against COVID-19 composed of fusion proteins (spike proteins and nucleoproteins) and mucoadhesive nanocarriers. The resulting product maintains efficacy against all variant, does not require any adjuvant and, similarly to other presented mucosal vaccines, could have the capacity to prevent contagiousness providing an early and local control of infection. Additionally, its thermostability and easy administration allow to simplify logistics of vaccine distribution.

Session 3: General discussion

The session started with a presentation of HERA's mechanisms to encourage and fund vaccine development in the European Union, such as Horizon Europe and EU4Health. During 2023 and beyond, HERA will continue to ensure the further development of medical countermeasures for epidemic and pandemic preparedness. This work will comprise, among others, development of innovative vaccines, therapeutics and diagnostics, including for COVID-19 aiming for investments worth at least EUR 80 million, and access to innovative medical countermeasures (MCMs) against antimicrobial

resistance. In addition, HERA develops a financing mechanism referred to as the “HERA INVEST”, which will effectively top up the InvestEU guarantee through a blending operation to leverage high-risk private investment in the development and production of MCMs[2].

The session continued with a discussion among vaccine developers in which they expressed the need for clearly defined research priorities for innovative technologies and suggested the formation of a strategic forum to match ideas with concrete needs. Companies noted a wish for broader funding approaches for companies of all sizes and at all stages of vaccine development. Participants showed interested towards future workshops on more targeted themes, such as mucosal vaccines.

Conclusions

The workshop highlighted the need for broad-spectrum vaccines, innovations to speed up vaccine development, and increased collaboration between academia, industry and governmental authorities. It was stressed that next generation vaccines should not be restricted to mRNA vaccines. Other platforms, should benefit from the same increase in speed of discovery, development, and manufacturing. Novel vaccines should also be more accessible, affordable, easy to store, transport, and administer. Multivalent and combination approaches should be prioritised to stimulate both mucosal and systemic immunity.

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[2] hera_2003_wp_en.pdf (europa.eu)

Annex

Abstracts provided by the applicants to the call for expression of interest to present products or innovations under development at the Next generation vaccines workshop.

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AC Immune

Advantages of next generation SupraAntigen® platform liposomal vaccines to immunize against pathological targets of Alzheimer's disease. E. Fiorini1, M. Vukicevic1, R. Carpintero1, M. Rincon1, P. Lopez-Deber1, M. Ayer1, I. Rentero1, S. Siegert1, C. Babolin1, E. Gollwitzer1, V. Giriens1, C. Morici1, M. Beuzelin1, A. Gesbert1, S. Rivot1, N. Chuard1, S. Delpretti1, P. Donati1, J. Streffer1,2, A. Pfeifer1 and M. Kosco-Vilbois1

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Background: Alzheimer's disease (AD) is a silent pandemic that is expanding with the ageing of the global population. Amyloid plaques, composed of misfolded Abeta species such as neurotoxic pyroglutamate (pyroGlu)-Abeta and oligomeric Abeta are one of the early hallmarks of AD. We have compared our liposome-based SupraAntigen® vaccine platform to commonly used approaches, such as protein-conjugate-based vaccines.

Methods: Mice and Non-Human Primates (NHPs) were vaccinated with different anti-Abeta vaccine formulations: a liposome-based SupraAntigen® vaccine (i.e., optimized ACI-24) containing the antigenic peptide Abeta 1-15, an adjuvant and a universal T-helper cell peptide; and CRM-conjugated vaccines containing various antigenic Abeta peptides (e.g., ACC-001) or full-length Abeta (i.e., AN1792) mixed with adjuvant.

Results: When immunizing mice and NHPs with vaccines containing the various Abeta peptides, all animals developed anti-Abeta 1-42 titers. However, only the liposomal-based optimized ACI-24 induced a homogenous and robust response to the Abeta-toxic species, pyroGlu-Abeta. Furthermore, this protective IgG response was maintained over time and could be consistently boosted.

Conclusions: For vaccines targeting Abeta, the liposome-based SupraAntigen® vaccine demonstrated a superior quality of the IgG repertoire generated post-immunization. The responses in NHPs were well tolerated, homogenous, robust and boostable over time, while broadly engaging key pathological species like pyroGlu-Abeta and oligomeric Abeta.

AstriVax – KU Leuven

We are a private – public partnership with the joint ambition to address real-world challenges in vaccinology. AstriVax is a biotech company, based on mature KU Leuven technology, led by a seasoned leadership team with over 50 years of cumulative industry vaccine development expertise. The Rega Institute (KU Leuven) has a strong track record in translational virology, as exemplified by multiple successful alliances with pharmaceutical companies.

Our collaboration leverages complementary discovery and development expertise. The Plug&Play Plasmid-Launched Live-Attenuated virus (PLLAV) vaccine platform technology we offer has a unique mechanism of action. PLLAV holds the potential to address key challenges in vaccinology such as the need for long-term effectiveness, increased thermostability, better compliance and scalable manufacturing.

AstriVax' ambition in the coming years is (i) to bring the first thermostable yellow fever vaccine into a first-in-human Phase 1 trial, (ii) to further advance two pipeline vaccine candidates towards clinical trials (e.g., rabies and treatment of chronic hepatitis B) and (iii) to fuel the preclinical pipeline with several prophylactic and therapeutic leads. The latter is in collaboration with the KU Leuven, focusing on the development of vaccines that can serve as 'prototypes' for emerging pathogens with pandemic potential, including a second-generation variant-proof Corona vaccine.

Bavarian Nordic

The SARS-CoV-2 vaccine candidate ABNCoV2. Bavarian Nordic´s ABNCoV2 is being developed as a “universal” next-generation booster vaccine to elicit a broad immune response, to provide protection against emerging variants of concern (VOCs), and to yield a long-lasting immune response. ABNCoV2 is a non-adjuvanted capsid virus-like particle displaying the receptor binding domain of the spike protein of the SARS CoV-2 virus. The advantages of this vaccine platform include its potential to induce rapid and durable immune protection and its capacity for high-yield manufacturing. Furthermore, the ABNCoV2 vaccine platform is also adaptable, providing flexibility to rapidly accommodate any emerging SARS-CoV-2 mutations that may warrant antigen modification. ABNCoV2 has shown to be highly immunogenic in relevant preclinical models, inducing a durable and highly protective response from a SARS-CoV-2 challenge. Results from a Phase 2 trial has confirmed the ability of ABNCoV2 to significantly boost long-lasting antibody titers against various VOCs, including Omicron. Cellular immunity data observed in all VOCs, show a predominance of IFN-γ-secreting cells over IL-4-secreting cells, suggesting a balance in favour of a stronger Th1 response over a Th2 response. ABNCoV2’s safety profile is consistent with other authorized injectable vaccines. ABNCoV2 is currently evaluated in a phase 3 trial (NCT05329220).

BioMAP&LovalTech

LoValTech develops a nasal vaccine against COVID-19, composed of a unique multivalent fusion protein combined with biocompatible mucosal nanocarriers. It has demonstrated in relevant pre-clinical models its ability against available variants to (1) protect from symptomatic forms of the disease, (2) induce systemic and mucosal immunity, particularly in the respiratory tract: route of viral entry and (3) block contagiousness, reducing viral circulation and the emergence of new variants. Its thermostability is convenient for logistic in developing countries where the vaccination coverage rate is still very low.

LoValTech takes advantage of the ongoing Regulatory Toxicity and Immunogenicity studies to test and validate two innovative medical devices to target the nasal mucosa inductive sites developed in collaboration with the companies Medspray and Aptar Pharma.

Phase I/II clinical trials are scheduled with the CHRU of Tours and the CIC of the AP-HP of the Cochin hospital in September 2023.

LoValTech has opened up new possibilities for the design of innovative new vaccines combined with previously inaccessible nasal delivery technology and will design, based on its human health technology platform, a portfolio of next-generation vaccines specifically tailored against priority infectious agent to trigger tailored protective immune responses.

BioNTech

BioNTech is an immunotherapy powerhouse aspiring to translate science into survival. Building upon our COVID-19 vaccine leadership, to deliver breakthroughs against infectious diseases with high-unmet need, we are advancing a broad toolkit of mRNA vaccines, ribologicals and ribolysins. Following more than a decade of mRNA research, our toolkit of multiple mRNA formats and varying delivery applications allow flexible delivery routes to precisely address diverse and difficult-to-target pathogens. About 20% of deaths worldwide are caused by infectious diseases. In response to over >600,000 undiscovered viruses thought to be transmissible from mammal/avian hosts to humans. We are using our platforms to tackle the biggest global killers, high burden infectious diseases and be prepared for emerging and new threats.

In 2022, we initiated first-in-human trials with herpes zoster vaccine candidates, and aim to start trials with HSV-2, malaria and tuberculosis vaccine candidates shortly. These programs build on our validated platform of nucleoside-modified mRNA-LNPs with an optimized backbone design.

Our goal is to enable end-to-end manufacturing and delivery of our vaccines globally. For the next five years, BioNTech have a reserve and maintain manufacturing capabilities to produce at least 80 million mRNA-based vaccine doses per year.

Catholic University of America

A Bacteriophage-based, Highly Efficacious, Needle- and Adjuvant-Free, Mucosal COVID-19 Vaccine. The Food and Drug Administration authorized mRNA- and adenovirus-based SARS-CoV-2 vaccines are intramuscularly injected in two doses and effective in preventing COVID-19, but they do not induce efficient mucosal immunity, or prevent viral transmission.

We have designed a non-infectious, bacteriophage T4-based, multicomponent, needle and adjuvant-free, mucosal COVID vaccine that is decorated with spike trimers on the capsid exterior and packaged with nucleocapsid protein molecules in the interior. Intranasal administration of two doses of this T4 SARS-CoV-2 vaccine 21-days apart induced robust mucosal immunity, in addition to strong systemic humoral and cellular immune responses. The intranasal vaccine induced broad virus neutralization antibody titers against multiple variants, Th1-biased cytokine responses, strong CD4+ and CD8+ T cell immunity, and high secretory IgA titers in sera and bronchoalveolar lavage of vaccinated mice. All these responses were much stronger in intranasal vaccinated mice than that induced by the injected vaccine. Furthermore, the nasal vaccine provided complete protection and sterilizing immunity against the mouse-adapted SARS-CoV-2 MA10 strain, the ancestral WA-1/2020 strain, and the most lethal Delta variant, in both BALB/c and human angiotensin converting enzyme (hACE2) knock-in transgenic mouse models. Additionally, the vaccine elicited virus-neutralizing antibodies against SARS-CoV-2 variants in bronchoalveolar lavage, did not affect the gut microbiota, exhibited minimal lung lesions in vaccinated and challenged mice, and is stable for at least ten weeks at ambient temperature.

This modular, needle-free, phage T4 mucosal vaccine delivery platform, therefore, is an excellent candidate to design efficacious mucosal vaccines against other respiratory infections and for emergency preparedness against emerging epidemic and pandemic pathogens.

CSL Seqirus

CSL Seqirus Effectiveness of influenza vaccines varies from season to season, and conventional influenza vaccines typically offer inconsistent protection against infection. As second largest manufacturer of influenza vaccines worldwide, CSL Seqirus is committed to developing new technologies for improving both pandemic and seasonal influenza vaccines. Two factors that may have a negative impact on effectiveness of influenza vaccines are: Antigenic mismatch between circulating influenza viruses and viruses used for producing vaccines due to egg-adaptation, as well as reduced ability of the immune system to provide effective response upon vaccination in older adults (immunosenescence). Newer technologies aim to overcome these problems. Producing influenza vaccines in cell cultures instead of chicken eggs may provide a better antigenic match to circulating influenza viruses. Additionally, use of an adjuvant as well as of higher antigen dose increases immune response in older adults. Both approaches are designed to provide better effectiveness of resulting influenza vaccines. CSL Seqirus manufactures cell-based and adjuvanted influenza vaccines and aims at combining these two proven technologies together in one vaccine. Furthermore, CSL Seqirus is investigating next generation mRNA influenza vaccines, which offer potential advantages over conventional mRNA vaccines. Finally, a collaboration with Arcturus Therapeutics opens to broadening CSL Seqirus' vaccine program to other pathogens beyond influenza.

IAVI

IAVI is an international non-for-profit organization that envisions a world, where all people have equitable access to innovative vaccines and therapeutics. The preclinical data generated to date with our vesicular stomatitis virus vector (VSV) SARS-CoV-2 intranasal (IN) vaccine candidate (called V590), are promising and support moving forward with the mucosal vaccination approach. V590 has demonstrated safety and the ability to prevent disease and potentially block infection in hamsters. The Phase 1 vaccine material has been manufactured, and we are in the process of conducting additional IND-enabling studies including biodistribution and immunogenicity studies that will start soon. Our phase 1 clinical trial as the goal of eliciting more durable systemic immunity and establishing immunity resident in the mucosal tissues. We believe to have developed a flexible vaccine platform that allows the development of other IN VSV vaccines in the future, including for new emerging coronaviruses as well as other pathogens. Accordingly, we have also generated VSV constructs representing many of variants of concern if needed for future vaccine development. In addition to our CoV-2 vaccine we plan on moving forward in clinical development with our VSV-Marburg virus, VSV-Sudan virus and VSV-Lassa fever virus vaccine candidates.

Idevax

Vaccines have been shown to save lives. We are living in challenging times where infectious diseases, like the Covid-19 pandemic and the current mpox emerging health emergency, thrive and create serious global health concerns. Although vaccines are most often administered intramuscularly, intradermal injection can offer a solution due to its dose-sparing potential. Studies using Influenza, Polio, Rabies, Hepatitis B and more recently SARS-Cov and mpox vaccines have shown that only one fifth of the dose is needed to achieve a non-inferior immune response compared to the full dose administered intramuscularly or subcutaneously due to the rich immune properties of the skin. Our own data using a HepB vaccine confirm these findings.

Interesting, the Covid pandemic has accelerated the widespread use of mRNA vaccine technology in not only infectious diseases but also for cancer vaccines that are quite often administered intradermally.

To overcome the challenges of intradermal injection using the Mantoux technique that uses a regular needle and syringe, requires a lot of training, and is perceived as very painful by the vaccines, VAX-ID® (Idevax BV) has been developed. It is an award-winning patented drug delivery device that allows for accurate, standardized, and reliable intradermal injections with high ease of use.

Immunethep

The major goal at Immunethep is to develop immunomodulatory therapies that restore the ability of our immune system to control infections caused by multi-resistant bacteria. The development of these immunotherapies was possible due to the discovery of a conserved mechanism responsible for inhibiting the immune system. This mechanism consists in excreting a highly immunosuppressive protein – GAPDH. Based on this discovery, Immunethep developed two different products that target excreted bacterial GAPDH:

i) Paragon Novel Vaccine (PNV) – First vaccine that prevents infections caused by 5 different bacteria. These bacteria are considered major threats for public health: Staphylococcus aureus, Escherichia coli, Klebsiella pneumoniae, Streptococcus pneumoniae and Group B Streptococcus; ii) UnimAb – Fully humanized antibodies that can be used in acute settings to treat bacterial infections. These antibodies address the same bacteria, and the goal is to use it as an alternative to antibiotics, having the great advantage of not causing the emergence of resistant strains.

With the start of COVID-19, Immunethep considered that it should use their knowledge to contribute to the fighting against this pandemic. Immunethep developed an inhaled COVID-19 vaccine (SILBA) that protects from infection caused by different variants of SARS-CoV-2 and prevents transmission.

Micron Biomedical

Micron Biomedical, Inc. (Micron) is a clinical stage life sciences company advancing its microneedle patch technology for self-administration and simple, less-skilled caregiver administration of drugs and vaccines without needles.

Micron's technology is designed to deliver a wide range of compounds including nucleic acids, peptides, proteins, and viruses (inactivated and live-attenuated), as well as small-molecule drugs. The benefits of the technology include the potential to enhance the efficacy of drugs and vaccines, ease-of-use enabling self-administration and administration by less skilled caregivers, sharps-free waste, thermal stability and small size. As a result, Micron's technology simplifies storage and distribution with the potential to have products mailed to people's homes or available to pick up at the pharmacy without needing a professional to administer. This makes Micron's technology very well suited to respond to pandemics.

Micron's technology has been studied extensively with a wide range of vaccines preclinically. The technology has also been successfully investigated in the US in a Phase 1 clinical trial for seasonal influenza vaccination and recently completed a Phase 1/2 clinical trial for measles-rubella vaccination in adults, toddlers and infants in The Gambia (results pending). Other clinical trials are scheduled to take place in 2023 and beyond.

Osivax

Osivax is a late-clinical stage franco-belgian biotech company pioneering a novel class of universal vaccines to prevent current and emerging infectious diseases, especially rapidly mutating respiratory viruses that cause pandemics such as influenza or coronavirus. Osivax uses its disruptive patented Virus-like-Particle (VLP) technology platform oligoDOM® to design first-in-class vaccines that induce superior T-cell responses in addition to strong and sustained B-cell responses against conserved internal proteins of rapidly mutating viruses. Osivax's lead vaccine, OVX836 universal influenza A vaccine uses a disruptive approach targeting an internal highly conserved antigen to provide broad-spectrum efficacy. Four human clinical trials with 850+ subjects demonstrated an excellent safety profile, powerful T-cell responses, and protective efficacy of 75-80% against symptomatic influenza caused by several strains (H1N1 and H3N2), when the average effectiveness of conventional seasonal flu vaccines is about 40%. Osivax is using the OligoDOM® platform to develop other vaccine candidates, such as OVX033, a first in-class vaccine targeting an internal highly conserved antigen to prevent existing and emerging strains of coronavirus (including Covid-19) with demonstrated proof of efficacy in animal models. Based on the versatility of its oligoDOM® technology platform, Osivax intends to expand into other infectious disease indications through combinations and collaborations worldwide.

Pfizer – BioNTech

Pfizer-BioNTech COVID-19 and Flu Development Program. In addition to vaccine development programs the companies are pursuing separately, Pfizer and BioNTech are jointly investigating and identifying novel approaches for optimal protection against COVID-19 as SARS-CoV-2 continues to evolve. As part of our long-term scientific COVID-19 vaccine strategy, we have an ongoing program examining multiple paths to potentially generate a vaccine that would provide more robust, longer-lasting, and broader immune responses against SARS-CoV-2 infections and severe COVID-19 (subject to clinical trial success and regulatory approval). Two vaccine candidates currently in development are 1) modified RNA that encodes for an enhanced spike for improved prefusion stability and exposure of more neutralization-sensitive epitopes, and 2) modified RNA that encodes for non-spike T cell antigens for generating broader T cell-mediated response against SARS-CoV-2. Further, Pfizer and BioNTech are developing a modified RNA vaccine that aims to help prevent the impact of influenza and COVID-19 and simplify immunization practices for health care providers and individuals (subject to clinical trial success and regulatory approval).

Public Health Vaccines

Public Health Vaccines (PHV) is a privately held biotechnology company developing vaccines for the prevention and control of global emerging infectious diseases; including two rVSV-based clinical-stage vaccine assets against Marburg virus (developed in collaboration with BARDA) and Nipah virus (developed in collaboration with CEPI). The company is also developing an rVSV-SUDV vaccine against Sudan ebolavirus. The rVSV platform technology is supported by the experience and expertise of the PHV team that developed the now licensed rVSV-EBOV vaccine and have previously supported the development and licensure of more than 10 products. The rVSV vaccine vector platform affords a proven blueprint for product development with streamlined processes for candidate clonal selection, manufacturing unit operations, analytical control strategies, and adaptable nonclinical and clinical approaches. These vaccines address TPP and use requirements for emerging and pandemic threats by ease of tech transfer (in-country), single dose immunization regimen, early onset of protection (7d), durability of protection, potential for dose-sparing (live viruses) and safety. PHV is leveraging its design, development and execution experience to address unmet needs for pandemic and emerging infectious disease preparedness. PHV welcomes partnerships and collaborations to deliver innovative products to areas and populations most in need at the frontline of disease threats.

Takeda

Two-Years of Immunogenicity and Safety of a Purified Inactivated Zika Vaccine Candidate. Sustained low levels of Zika virus (ZIKV) in Southeast Asia and Latin America underscore its significance as a public health threat for populations living in endemic countries and travelers. Therefore, there remains an unmet medical need globally for safe and effective vaccines against ZIKV.

In a recent publication[1], we reported results from a phase 1 trial showing 2-year persistence of immune response to Takeda's prophylactic purified formalin-inactivated whole Zika virus vaccine candidate (PIZV) compared with that observed after natural infection. The primary objectives were safety, tolerability, and the immunogenicity of three dose strengths (2µg, 5µg, and 10µg) of PIZV administered each as two doses 28 days apart to 18- to 49-year-old adults. A clear dose-response trend was observed in all PIZV groups, and the highest dose was selected for further clinical development. Participants who received 10µg PIZV were followed over 2 years, and neutralizing antibody responses were compared with individuals with confirmed ZIKV infection. Through 2 years post-vaccination, persistent immune responses with high geometric mean titers were observed in both flavivirus-naïve and flavivirus-primed participants. Furthermore, 10µg PIZV-induced neutralizing antibodies responses comparable to individuals who underwent a natural ZIKV infection. No safety concerns have been identified for PIZV. These results support the further clinical development of PIZV.

[1] Acosta CJ et al. Persistence of Immunogenicity of a Purified Inactivated Zika Virus Vaccine Candidate in Healthy Adults: 2 Years of Follow-Up Compared With Natural Infection. J Infect Dis. 2022 Dec 9:jiac482. doi: 10.1093/infdis/jiac482. Epub ahead of print. PMID: 36484441.

Univercells

Univercells is a Belgian life-sciences company with a mission to make biologics available to all. Innovation in biomanufacturing technologies is the only means to ensure sustainable reductions in the production cost of vaccines while ensuring flexibility, rapid scalability and quality. Founded in 2013, Univercells focuses on radical technology innovation (including DNA/mRNA-based), their industrialization and dissemination to support global health initiatives and pandemic readiness. Our mRNA manufacturing system is developed in response to observed limitations in mRNA manufacturing during COVID-19. We leveraged our proven approach and success developing best-in-class manufacturing equipment for viral vaccines. Our mRNA technology lowers barriers to drug development and production globally and enable self-sufficient production of mRNA vaccines up to commercial scale in small footprint facility. We design for access and autonomy. In June 2022, Univercells was selected by the WHO as technology provider to Afrigen Biologics (South-Africa) who hosts the WHO mRNA Hub. Our mRNA system will support the development and scaling up of Africa's first-ever COVID-19 vaccine. This mRNA vaccine platform will underpin the development of a portfolio of mRNA vaccine candidates to address unmet global health needs. While the world prepares for the next pandemics, Europe can still lead by example building future-proof infrastructures leveraging European innovations.

Vaxxas

Vaxxas is developing an advanced technology platform that enables vaccines to be applied to the skin using a high-density microarray patch (HD-MAP). This combination product improves thermostability, extending the reach of vaccines, simplifying logistics, and eliminating problems of cold chain distribution seen during the Covid-19 pandemic. Vaxxas' HD-MAP is designed for low skilled administration, with the potential for self-administration. In this scenario, the vaccine could be shipped directly to people's home avoiding the need to congregate at a vaccine clinic or pharmacy. Findings in Avalere Health's latest report suggest the impact MAPs could have in playing a key role in future pandemic response. Based on U.S. modelling use of MAPs could mean 35% fewer cases, 30% fewer deaths, and reduce pandemic duration by up to 150 days.The HD-MAP is a completely distinct and differentiated vaccine delivery technology: the high-density of micro projections activates Damage Associated Molecular Patterns (DAMPs) and colocalizes the vaccine with immune cells in the skin. In clinical studies, this technology has shown a stronger, faster immune response compared to needle and syringe. The Vaxxas HD-MAP vaccination platform has the potential to fundamentally improve pandemic vaccination through production efficiencies, breadth and speed of access, and population coverage.