VACCINES BEAT

FUTURE PROOFING HEALTH

VACCINES AGAINST CLIMATE THREATS, FOOD INSECURITY, AND ANTIMICROBIAL RESISTANCE

World Vaccine Congress, Washington, DC. March 31, 2026

April
2026

ISSN 2997-2833

AHF
Americas Health Foundation

"IMMUNIZATION IS A GLOBAL HEALTH AND DEVELOPMENT SUCCESS STORY SAVING MILLIONS OF LIVES EVERY YEAR"

WORLD HEALTH ORGANIZATION

VACCINES BEAT

Future-Proofing Health – Vaccines Against Climate Threats, Food Insecurity, and Antimicrobial Resistance

World Vaccine Congress, Washington, DC.
March 31, 2026

INDEX

LETTER FROM EDITOR

Welcome to Vaccines Beat 22nd issue!

In our *"Coffee with the Expert"* section, *Vaccines Beat*—as moderators of key discussions at the World Vaccine Congress 2026 (March 30–April 2, Washington, D.C.)—had the opportunity to engage leading experts ahead of the panel: **"Future-Proofing Health – Vaccines Against Climate Threats, Food Insecurity, and Antimicrobial Resistance."** The panel was chaired by our Chief Editor, Dr. Enrique Chacon-Cruz, and featured an outstanding multidisciplinary group: **Dr. Montserrat Arroyo Kuribreña**, Deputy Director General for International Standards and Implementation at World Organisation for Animal Health (WOAH), is a veterinarian with a Master's in Preventive Veterinary Medicine from University of California, Davis. Her career has focused on foreign animal disease prevention, trade, and zoonoses, with senior leadership roles in Mexican Veterinary Services and across WOAH. **Dr. Rino Rappuoli**, a global leader in vaccine R&D, has over four decades of contributions, including the development of CRM for conjugate vaccines and the pioneering of reverse vaccinology. He currently serves as Scientific Director of the Fondazione Biotecnopolo di Siena, Italy's national initiative for pandemic preparedness. **Dr. Clarisse Ingabire**, veterinarian and global livestock specialist at the World Bank, brings more than 15 years of experience advancing One Health, climate-smart livestock systems, and sustainable animal health across LMICs, driving policy, technical assistance, and investment. **Dr. Peter Hotez**, physician-scientist and global health leader at Baylor College of Medicine, is a recognized authority in vaccinology and neglected tropical diseases, and a leading advocate for vaccine equity and global health. This session highlighted a truly multidisciplinary perspective on the interconnected challenges facing our planet—and the critical role of vaccines as a unifying solution.

In our *"Editor's Corner"* section, we highlight the re-emergence of DNA vaccines as a fast, scalable, and increasingly precise platform. Advances in synthetic biology and delivery technologies have overcome past limitations, positioning DNA vaccines as a versatile tool for infectious diseases, cancer, and future pandemic preparedness.

In our *"Best Practice"* section, we highlight current strategies for pneumococcal vaccination in children, emphasizing the evolution toward higher-valency conjugate vaccines, WHO-recommended dosing schedules (2+1 or 3+0), and tailored approaches based on local epidemiology. High vaccine coverage, appropriate scheduling, and strategic catch-up programs remain essential to sustain reductions in invasive pneumococcal disease and optimize population-level protection.

Finally, in our *"Guest Contributor"* section, Dr. Mahmud Sheku, MPH, MS, PhD, together with Drs. Van Meter Connor, Robert A. Bednarczyk, PhD, Katherine Seib, MSPH, Emilia Grill, MPH, and Benjamin A. Lopman, PhD, from the Emory University Rollins School of Public Health, Atlanta, Georgia, USA, present a summary of a novel tool called "VaxImpact: An Interactive Web App Quantifying the Health and Economic Consequences of Declining Childhood Vaccination Across U.S. States."

As always, this issue features carefully curated and up-to-date information on the *"Latest Scientific Publication"* along with the most recent and important *"News and Alerts"*.

We hope you find this April issue both informative and engaging, and we look forward to continuing this shared commitment to advancing global health and building a healthier planet.

Enrique Chacon-Cruz, M.D., MSc
Chief Editor

Dr. Enrique Chacon-Cruz

Enrique Chacon-Cruz, M.D., MSc, Mexican-born medical doctor with a degree from Guadalajara, Mexico, and further specializations in Pediatrics and Infectious Diseases from institutions in Mexico City and the USA (Eastern Virginia Medical School). He also holds a Master's degree in Vaccinology and Drug Development from the University of Siena, Italy.

Currently, he is the CEO and Founder of "Think Vaccines" (Research, Education, and Consultancy for Vaccines and Vaccinology) based in Houston, Texas.

With over 140 research items published and/or presented at international meetings and more than 500 international lectures, all focused on vaccines, vaccination, clinical trials, and vaccine-preventable diseases. The latter conducted independently or in association with the Centers for Disease Control and Prevention (CDC), the University of California in San Diego, Eastern Virginia Medical School, and several other institutions.

Additionally, He is the President of the Immunization Committee of the Mexican Association of Pediatric Infectious Diseases, he is a member of the Mexican Committee for the Elimination of Measles, Rubella, and Congenital Rubella, member of the Immunization and of the Health Equity Committees of the European Society of Medicine and Overseas Fellow, Royal Society of Medicine, United Kingdom. He is also the former Director of the Mexican Active Surveillance Network for Bacterial Meningitis and the former Head of the Pediatric Infectious Diseases Department and the Research Department at the General Hospital of Tijuana, Baja-California, Mexico.

Coffee with the Expert

PANEL DISCUSSION: A ONE HEALTH PERSPECTIVE ON CLIMATE CHANGE, ANTIMICROBIAL RESISTANCE, FOOD AND ANIMAL HEALTH, AND THE EXPANDING ROLE OF VACCINES

World Vaccine Congress, Washington, DC. March 31, 2026.

Author:
Dr. Enrique Chacon-Cruz

Dr. Enrique Chacon-Cruz:

Welcome everybody, and happy to start with these globally crucial and relevant topics.

Climate change is reshaping disease ecology in livestock and agricultural systems, increasing zoonotic spillover risks, threatening food safety, and driving greater antimicrobial use in animal production. This accelerates antimicrobial resistance and raises risks for human health through foodborne pathogens, environmental transmission, and emerging infectious diseases. Today, four top scientists, Dr. Peter Hotez, Dr. Rino Rappuoli, Dr. Monserrat Arroyo, and Dr. Clarisse Ingabire and I will be hosting a conversation here.

How can international finance and global institutions strengthen vaccine R&D, and where are the greatest opportunities to improve equitable access across diverse policy and regulatory environments?

Dr. Clarisee Ingabire:

Thank you, Enrique, and thank you all for having us. It's a pleasure to be here this afternoon. My

name is Clarisse Ingabire, and I am a livestock specialist at the World Bank in Washington, D.C.

International financing institutions such as the World Bank and IFAD have an important role to play in vaccine R&D, even though we do not traditionally fund research directly. Our contribution is largely catalytic: we help de-risk investments through the financing we provide to governments—typically Ministries of Finance, Agriculture, and Livestock—to support priority areas such as environmental management, agricultural development, and livestock systems. Within these investments, there are always opportunities to influence and strengthen research and vaccine development.

We also have market-shaping power through our convening role. By bringing countries together around shared goals, we can help create predictable demand. For example, in the Sahel, our support to regional pest-eradication efforts enabled governments to pool financing and create a viable market for vaccines, allowing them to purchase directly from manufacturers.

In addition, we help strengthen the enabling environment. Although the funding is often modest, it acts as seed capital for reference laboratories, epidemiological surveillance, and intelligence systems. These investments generate the data needed for researchers and manufacturers to better understand diseases and produce effective vaccines that governments can subsequently procure.

Finally, we do not work alone. Because we sit at the table with governments, we can mobilize key partners—including WOAH, The Pan African Veterinary Vaccine Centre of the African Union (AU-PANVAC) Africa CDC, and others—to support regulatory harmonization, strengthen animal health systems, and build national capacity. This helps countries better articulate their needs and participate meaningfully in shaping vaccine research and procurement.

I'll pause here.

Dr. Enrique Chacon-Cruz:

Well, that's a great answer. Thank you, Dr. Ingabire. Now let me turn to Dr. Monserrat Arroyo..

The World Organization for Animal Health (WOAH) has identified priority diseases where improved vaccines could reduce antimicrobial use. How can these priorities guide investment and policy globally?

Dr. Montserrat Arroyo:

Thank you for that question and I'm really happy to be here today. I'm the World Organization for Animal Health Deputy Director General for International Standards and Implementation and since early in the year 2000, we have done a lot of work to bring recognition of the AMR impact. We need to nvest in the reduction of AMR and we have identifyomg the gaps, the different challenges and so that investments are targeted and efficient.

Last year, as we do every year during our General Assembly in may, we had a forum on Vaccines and vaccination, where we identified challenges throughout the implementation of vaccination for Animal Health, and through which challenges were identified as well as very pragmatic steps to address these challenges. So, what can we do to reduce the use of antimicrobials?Use vaccines? Where role do vaccines play in regards to AMR? We are at the right moment to act,we have a convergence of scientific, political and epidemiological factors that create this moment for action to reduce AMR. In 2024, member states through the United Nations Resolution made a commitment to invest for the reduction of antimicrobial resistance making specific commitments towards this reduction, being one of them the implementation of vaccination.

So how can we create the enabling environment so countries can actually implelement programs where vaccines can actually support the reduction of antimicrobial resistance? We all know that 70% of human diseases come from animals, so we need to focus on how we can avoid some of these spillovers. We need to make investment on animal health.

And in order to make investment for animal health, we need to be targeted and efficient because we all have competing priorities. So how can we prioritize? Well, WOAH decided, let's

make a list of diseases,prioritized by species that will effectively reduce antimicrobial use. And we have made these lists where priority diseases by species have been prioritized and which now allow us to produce target product profiles of vaccines where research and development can actually target vaccines for these diseases.

And we've targeted the three main species that actually have an extreme variation on antimicrobial use. Just by an example, there are countries that are using four milligrams per kilogram of antibiotics while others are using 300 milligrams per kilogram. This is a great area of opportunity to help countries reduce the use of antimicrobials, this is a big area where investments need to be made.

So the three main target species are pigs, chickens, and fish because if we invest in these species, for example, pigs, they are projected to account for 45% of global antimicrobial use. So if we can use vaccines for the main diseases that affect them, then these 45% of antimicrobial use can be efficiently reduced. In chickens, there have been advances in commercial systems that have reduced their AM use, but in low, middle, and income countries, small farmers lack affordable vaccines and therefore can be more prone to use antimicrobials

Because even if there are some vaccines, being able to make them accessible, usable, and affordable to low and middle income countries is still a long way ahead. And then finally, when we're talking about fish, aquaculture is considered to increase production in the next few years, by 17.4% by 2032. Therefore with this estimated increase in production, it's highly probable that And at the same time, when you have this increase, the disease pressure will increase too, and the need for effective response to disease increases too

so we need to reduce the need for antimicrobials infisheries. For example, Norway implemented a vaccine program which has allowed them to reduce 90% overall antimicrobial use in salmon So there are case studies that really show that by using vaccines, you can reduce antimicrobial use.

And by that, through that, you reduce antimicrobial resistance.

Dr. Enrique Chacon-Cruz:

Thank you. That's a great response, and I remember when Prof. Rino Rappuoli's lectured us about the salmon, because not only it decreased antimicrobial resistance to humans, but also increased production of salmon in that study.

It was good. It was cost effective intervention.

Okay, now the next question is for Dr. Peter Hotez.

What is the role of climate change in shaping vaccine policy, and how do we support the new vaccines required for the diseases that will surely emerge as a consequence of climate change? Yeah, well, thanks so much, and thanks for having me on the panel.

Dr. Peter Hotez:

It's great to see you, even though we both live in Houston. I had to come to Washington to see you.

I think when you think about vaccines for climate change, it's first imperative to talk about the diseases that are emerging because of climate change. Now, going on the cable news channels all the time in the last few years, it turns out one of the most common questions I'm asked is, hey, doc, what the heck is going on? That's actually the question. Hey, doc, what the heck is going on? You're like, okay, well, what do you really mean by that? What they're really getting at is why in the last couple of decades are we now seeing this kind of regular cadence, if you will, regular sequence of catastrophic pandemics? I'll benchmark it with severe deep respiratory syndrome.

The original SARS of COVID-19, of course, was caused by SARS-2, but SARS-1 emerged in 2002 out of southern China and infected Toronto, Canada. Then this regular onslaught came. You had Middle Eastern respiratory syndrome, another coronavirus in 2012.

You had H1N1 in 2009. Then you had Ebola in West Africa that came to Dallas, Texas in 2014. Then Ebola again in 2019.

Then we had Zika not only in Brazil and the Caribbean, but South Texas and South Florida. We've had the return of malaria transmission in South Texas, South Florida. You had, and then of course the biggest of them all, COVID-19.

Now we've got a problem with H5N1. Those are the better known ones. What's also happening that's kind of flying below the radar screen, unless you're living down in the Gulf Coast, is we've seen the return of dengue, chikungunya.

You're now seeing the expansion of yellow fever beyond the Amazon into more populated areas of southeastern Brazil that we hadn't seen before, and Colombia, which really concerns me because Brazil is the opposite of Las Vegas. What goes on in Las Vegas stays in Las Vegas. What goes on in Brazil never stays in Brazil.

It comes up to the Caribbean, Colombia, and eventually the Gulf Coast. What the heck is going on? I think climate change is clearly a factor, and that would help explain the mosquito-borne diseases. I take a walk in the morning in my neighborhood Houston, and mosquito season, I can assure you, has already started.

In fact, it started a few weeks ago, and now it's going to go to the end of December. Mosquitoes, like the warming temperatures, particularly in the 80s, chip died mosquito that we have on the Gulf Coast. Viruses are developing faster, and also the culex mosquitoes that transmit my style, and the same way as encephalitis, but the tick-borne diseases are not really accelerating in Texas like we've never seen before.

That one's a little more straightforward. You might say, well, what does that have to do? By the way, the same thing that's happening in the Gulf Coast and Texas, we're seeing a parallel phenomenon in Southern Europe. Just like we've seen the return of malaria to South Texas and South Florida, we've had to return malaria to Greece and Italy.

I don't want to ruin anyone's plans for summer travel to Southern Europe this summer, but that's going on as well in dengue in Paris. That one's a little more straightforward with climate. You might say, well, why would climate change affect something like a coronavirus, like SARS or COVID-19, or Ebola? The answer is most likely bats as a mammalian definitive host.

So, coronaviruses, filoviruses like Ebola are natural viruses of bats. Now, with the altered climate patterns, you see bats have new habitats, and they're coming closer to human populations, but that's not the only thing happening. So, climate change is clearly helping to drive these illnesses, but it's not just the bats coming closer to the people.

It's the people coming closer to the bats because we've seen this big expansion of urban populations. So now, for the first time, more people on our planet, this happened about 10 years ago, more people on our planet live in urban areas than rural areas, and the urban expansion is not symmetric. It's happening in these kind of ginormous clusters that we call megacities, and for someone I was a kid, three big megacities were always Tokyo, New York, and London.

Now, all the megacities are emerging in low- and middle-income countries. So, by one estimate, Lagos and Kinshasa in Nigeria and Congo, respectively, will have 40% of the world's people living in poverty by 2050. So, now the megacities are in places like Dar es Salaam and Kinshasa and Lagos, but also now in Bogota and Lima, Mexico City, Sao Paulo, and then also in the Middle East, and of course in Asia, particularly in India.

So, the kind of the apocalyptic version of the world is that you're seeing this whole new generation of hot and sweltering megacities, and that's where the next battle is, I believe. And so, when we think about vaccines, what vaccines are we going to need, think about those big hot and sweltering urban clusters, which are outstripping urban infrastructure for clean water, sanitation, for food security, for housing. So, you know, here in where I'm at, we are in Texas, which is kind of the tip of the sphere, the hot and sweltering megacities in Houston and Dallas, Fort Worth and San Antonio and Austin.

You go into the low-income neighborhoods, there's no window screens, lack of air conditioning, if you can believe it, but also there

are places of people are dumping their cars and truck tires in the low-income neighborhoods of the megacities of Texas. And, of course, those tires that are being dumped are this Ritz-Carlton Hotel for *Aedes aegypti mosquito.* So, this is why we're seeing this big round tonight.

And so, I think we're not ready. We're clearly not ready in the U.S. where we halted pandemic preparedness, but I think when you think about, okay, what are the vaccines that we're really going to need, clearly it's going to be for arbovirus infections, mosquito transmitted infections, tick-borne illnesses, but also anything that's coming from bats, like coronaviruses, like filoviruses. These are what we're going to need, and I don't think we've really put together a plan, certainly not in the United States, for how are we going to manage those and what are the vaccines we're going to have at hand.

And, in some cases, it may not even be new vaccines. I mean, for instance, in the U.S., we have no yellow fever vaccine stockpiled. So, when people ask me, hey, Doc, what scares you the most? People are often surprised when I say, actually, yellow fever, because historically, when yellow fever has struck the Gulf Coast cities and really going up the Mississippi, there's nothing that struck here like yellow fever and caused the abandonment of our towns and cities, and now that we're seeing the expansion of yellow fever, we're not ready.

So, these, and of course, if you think the anti-vaccine activists make up stories about COVID-19 vaccines, wait until you see what they're going to do with something like yellow fever vaccine, which actually has real side effects that are quite concerning, and that's going to block its uptake. So, we are in a very precarious position right now, and my view is the two big 21st century drivers on this are climate change together with the warming temperatures, ultra-rainfall patterns, but it's not climate change in isolation, it's climate change.

Dr. Enrique Chacon-Cruz:

So, just to finalize the question with you, do you think the anti-vaccine era is moving the world forwards or backwards in what is now the Anthropocene era?

Dr. Peter Hotez:

Well, I guess we first have to define what Anthropocene is, because it's not a household term, and it's somewhat controversial also.

I like it. I like it as a metaphor. Some people don't like it, and it kind of says, if you think of the big geological epic, you know, the Pilocene, the Pleistocene, and then the Holocene starting at the end of the Ice Age, there's some who would argue that humans have so profoundly altered our environment that we wound up buying ourselves our own geological epic, which is called the Anthropocene, and there are different people with different views on when the Anthropocene started.

Some would liken it to the start of the Industrial Revolution, and the chemical signature there was increased lead in the atmosphere, and then of course all the greenhouse gases. Others will benchmark it at the end of World War II, when for the first time we had radionuclides in the ground, and that was the chemical signature. But it goes hand in hand, that buying ourselves our own geological epic, those two big activities are going to be climate change and urbanization, and we have to really think about what are the vaccines for the Anthropocene network.

Dr. Enrique Chacon-Cruz.

Thank you, Dr. Hotez. Now, Dr. Rino Rappuoli, why new antibiotics alone are not sufficient to solve the problem of antimicrobial resistance?

Dr. Rino Rappuoli:

Well, thank you. It's a good question, a good follow-up, Peter, because I think for sure one thing that really marks the Anthropocene, if we use the term, is antimicrobial resistance.

That was a problem that we didn't have before the discovery of antibiotics. Obviously antibiotics are a fundamental tool of medicine, but the antibiotics solved one problem and created another one, which is probably as big as the problem we had before the discovery of antibiotics. So the problem with antibiotics is

that they are essential and we absoluley need them when people are sick, however since all the antibiotics that we've been using derive from natural products, during the evolution bacteria have been working for billions of years to find ways to survive in their presence.

So anytime you have a microorganism that produces an antibiotic, somewhere else there is another microorganism that knows how to neutralize that antibiotic, and becomes resistant. So the consequence of that is that as soon as the first antibiotic was developed and started to be used, immediately resistant bacteria were identified. Initially, this was not a real problem. If we could not use this antibiotic anymore, we had a new one, and if resistance occurred als to this,we could move to a new one, and so on. We did that over time, 1950s, 1960s, 1970s, 1980s, and then 1980s, that's when we got to the point where we had no new antibiotics, I mean, no new classes of antibiotics, and now we are in trouble because we don't have new antibiotics to solve the problem.

Fortunately, we have vaccines, and there is no resistance to most of the vaccines. Indeed with vaccines, we already erradicated smallpox, we conquered tetanus, diphtheria, measles, mumps, rubella, and we did not encounter resistance to those vaccines. There are some variants of viruses, and some non vaccine capsular types that can escape immunity, but the resistance, the way we have for antibiotics, doesn't exist in the case of vaccines.

When I look at the way we dealt with antimicrobial resistance, so far, from 1940s, when we started to use antibiotics to today, we had the assumption that antibiotics will solve everything. And that has been a very wrong assumption, because today we know that trying to solve the problem of antibiotics, only with antibiotics, is not going to work. We lost the battle, we lost the war.

In conclusion, if we really want to solve the problem of antimicrobial resistance, we need to use all the tools that we have, not just one product. So, we need to use vaccines, in humans, and I'm very glad to hear of the movement to use more and more vaccines in the animals. But maybe vaccines and antibiotics are not going to be enough.

We need other tools such as monoclonal antibodies, CRISPR-Cas solutions, pahges, good diagnosticsand any new technology that can be useful.

The problem of antimicrobial resistance is so important today, that we do need to use all the tools that we have and this that modern sciencecan provide. So, it's a long way to say that if we continue to believe that by using only antibiotics we will solve the problem, we'll make the problem bigger.

But my view is not pessimistic. I think we can address antimicrobial resistance, but we need to use all the most advanced science that we have today, to develop new tools, and to use the tools we already have. Vaccines, monoclonals, phages, whatever we can think of.

Dr. Peter Hotez:

Do you mind if I ask, you know, a question, a follow-on question?

Dr. Rino Rappuoli:

Sure.

Dr. Peter Hotez:

So, you know, as you know better than anyone, the 1920s and 1930s, the Russians were really pushing hard on bacteriophage, and I think they still have programs going, and at Baylor College of Medicine, in our microbiology department, we have an investigator named Anthony Maresso who's doing some exciting work. I'm curious your thoughts about therapeutic bacteriophages, as I guess you'd call them, halfway between an antibiotic and halfway between a vaccine.

Dr. Rino Rappuoli:

Good question, there's a lot of good history in the Eastern European countries and Russia. They had collections of hundreds of phages, and they were abloe to select the phages thatwould kill a given bacterium . There's never been a placebo-controlled trial, so it's impossible to say whether actually they really work, but I believe that they

worked, because they had the science and the tools to select the phages. Now, in the Western world, I've never been able, although many startups and biotechs have been trying, to do a real clinical trial to confirm whether they work .

Now, if you ask me personally what I think, I think they can work, and in cases where, there's no more alyternatives and you dealk with bactyreia that are resistant to everything, maybe it's a good thing to try therm. But I see them more as a last resource, if nothing else works. And the reason I say that is because, although I've not been working with phages now for 40 years, I started working with phages in microbiology, and anytime I made a plaque, in the center of the plaque I could always see some bacteria growing, and those were the bacteria resistant to the phage.

So, resistance to phage is very easy. So, I don't think you will solve the problems of the system. But the phages can be good to use once, especially in desperate cases, but I don't think they're widespread solutions, because they are also very immunogenic.

Dr. Enrique Chacon-Cruz:

Dr. Rappuoli, also, you know, your technology, reverse vaccinalology 2.0, you can actually treat diseases in patients infected with AMR bacteriae, which is a really novel concept. Okay, going with this same flow, I'm going to ask Dr. Clarisse Ingabire, is vaccination a solution to anti-microbial resistance, or just one piece of a much larger strategy? Or puzzle, let's say.

Dr. Clarisse Ingabire:

Thank you again for the excellent question. Vaccines are highly effective and widely used in the animal health sector, often through mass campaigns or targeted programs. However, structural challenges—such as limited access, cold chain constraints, and the difficulty of reaching remote smallholder farmers—mean that vaccination cannot be the only solution.

Because many smallholders lack information and accessible animal health services, they often rely heavily on antibiotics to manage illnesses such as mastitis, tick-borne diseases, fevers, and other morbidities. This reliance is compounded by the availability of substandard drugs. Strengthening vaccine R&D is therefore crucial, but so is improving farmers' understanding of diseases and appropriate treatments.

We also emphasize farm- and market-level biosecurity as essential preventive measures. Most of the diseases we deal with are of a transboundary nature, and animals frequently mix at grazing areas, water points, vaccination sites, and markets. In pastoral systems, constant animal movement further increases transmission risks. Changing on-farm practices and farmer behaviors is critical to reducing—or even breaking—these transmission cycles.

Surveillance is another key area. Given limited government financing and competing priorities such as education and health care, animal health surveillance must often focus on high-risk areas. Lessons from diseases like Highly Pathogenic Avian Influenza and foot-and-mouth disease, Rift Valley fever have taught us how pathogens and vectors move, how animals and people interact, and how to conduct better risk assessments. This allows us to identify hotspots where targeted vaccination or compartmentalization strategies are most effective.

Overall, vaccination must be part of a broader, integrated approach to disease prevention and preparedness—including biosecurity, surveillance, and farmer education. And once again, increased investment in the animal health sector is essential. Despite its significant contribution to national economies and GDPs, it continues to be underfunded.

Dr. Enrique Chacon-Cruz:

That's great. So, following your answer, I remember you gave us the example of Rift Valley Fever. How would you target that, using that example, to make it simpler to understand? Thank you.

Dr. Clarisse Ingabire:

Well, Rift Valley Fever is a prime example of a disease strongly influenced by climate change. Its occurrence is linked to rainfall anomalies,

vegetation patterns, and other environmental factors. Thanks to decades of research, scientists now monitor these indicators and issue early alert messages. These alerts help professionals—such as those in slaughterhouses—adjust their practices, use protective equipment, and reduce transmission from animals to humans.

Surveillance strategies also include monitoring unvaccinated "sentinel" herds in pastoral areas to detect outbreaks early. Vaccination is a critical tool, but it must be targeted and combined with risk assessment, alert systems, and strong government policies. Because these vaccines are not universally used by farmers, governments often subsidize vaccination in high-risk areas, ensuring the most vulnerable herds are protected.

Rift Valley Fever has become a priority in national zoonotic disease planning—alongside rabies, brucellosis, and tuberculosis. Through One Health collaboration, integrating human, animal, and environmental health sectors, countries can share information and make informed, coordinated decisions to prevent outbreaks and protect both animal and human populations.

Dr. Montserrat Arroyo:

Thank you. Clarisse made a very important point when she said, *"when we have the vaccines."* I want to emphasize this because vaccines are often seen as a simple or "magic" solution, when in reality, **their effective use depends on many enabling conditions**.

First and foremost, vaccination requires **investment in veterinary services**. Countries must have enough trained veterinarians and animal health professionals who can actually deliver vaccines in the field. For example, in Ghana, the number of veterinarians is about **ten times lower** than in many other countries, including some very lowincome countries. This means there is insufficient capacity to carry out not only vaccination, but the full range of essential veterinary activities.

This brings us to the broader question of **capacity**. Investing in capacity means having:

Surveillance systems that can identify priority diseases

Laboratory capacity to confirm diagnoses

Basic infrastructure to store, distribute, and administer vaccines safely

Only when these elements are in place can a country make informed decisions about vaccination.

Even then, additional questions arise. When a decision to vaccinate is taken, **does the vaccine exist in the country?** Is it **authorized by national regulatory frameworks**? If a vaccine exists, is it **effective against the specific strain circulating**? Is it **commercially available, affordable**, and supplied through a **reliable and sustainable production and distribution system**?

All of these factors must be carefully considered. Vaccination is not simply a policy decision; it is an operational reality that depends on strong systems and longterm investment.

Finally, when we speak about a **One Health approach**, this is where the challenge often lies. Too often, we remain reactive—responding once a crisis is already underway. To make One Health effective, we must become **proactive**, anticipating risks and addressing them early, instead of constantly running behind emerging problems.

Too often, our approach is reactive rather than preventive. We already apply forwardlooking thinking to issues such as climate change: we assess impacts, anticipate risks, and act in advance. The same logic should apply to animal and zoonotic diseases. We have early warnings, alerts, and scientific evidence that tell us which diseases are likely to emerge or spread. The question should be: which risks should we start preventing now, before they become crises?

Prevention can take many forms. Vaccination is a key tool, but it is not the only one—biosecurity, surveillance, and strong veterinary services are equally essential. However, prevention requires dialogue, political will, and sustained investment.

Crucially, this investment must be viewed beyond a narrow agricultural lens. Animal health is not "just agriculture"; it is fundamentally about food security, public health, and economic stability. Underinvestment in vaccines or

animal production systems directly affects the availability and affordability of food.

The impact is already visible. In 2021, widespread outbreaks of avian influenza severely reduced poultry production in many countries, leading to shortages of lowcost protein such as eggs and chicken. This contributed to a documented increase in global hunger—by around 5%—demonstrating how animal disease shocks can rapidly translate into food insecurity.

For this reason, investment in prevention must be multisectoral. It cannot rest solely with ministries of agriculture. Ministries of finance must recognize the broader economic implications, and the human health sector must also engage. Preventing spillover events, protecting food supplies, and reducing zoonotic risks all require strong and wellresourced veterinary services.

Antimicrobial resistance (AMR) provides another stark example. While 171 countries now have national AMR action plans, fewer than ten have allocated funding specifically for animal health activities. Economic analyses show the consequences of inaction are profound: if AMR in animals is not addressed, food security for up to two billion people could be compromised by 2050, due to reduced productivity and resilience in livestock systems.

These examples underline a central message: we cannot afford to wait and respond after crises occur. Shifting from reaction to prevention—through sustained, coordinated, and crosssectoral investment—is essential to protect animal health, human health, and global food security.

Dr. Peter Hotez:

Oh, so can I do a follow-on? Because I think you've made, you know, maybe one of the most important points of this afternoon, and that is our, you know, the phrase a little differently, our technical ability to make a vaccine is outpaced our political, social, financial instruments that we have to ensure it gets developed and used. I mean, we have now an N=2, in part because of people at this conference, right? We saw with human vaccines, with Ebola in 2019, you throw enough technology at it, you'll make a vaccine. In this case with Ebola, it was the vesicular stomatitis virus (VSV) and the adenovirus, multiple other technologies, and we wound up making a vaccine that stabilized the Democratic Republic of Congo in 2019. With COVID-19, we threw mRNA and DNA vaccines and particle technology and simple recombinant protein technology, and we wound up making a huge difference. And I like to believe that for most pathogens now, you know, if we take that approach, a parallel approach of using multiple technologies, we can make that vaccine.

But I think we're starting to realize that that's the easy part, because now, not even anti-vaccine activism aside, you know, countries still think this is something that we should do on the cheap, right? That there still is, even with COVID-19 and Ebola, there's not this understanding that the public health impact of an epidemic or a pandemic is just the tip of the iceberg. It's, you know, how damaging it is to the economy, how damaging it is to the security. And the G20 countries particularly have not positioned themselves to be willing to scale it up and pay for it.

You know, CEPI is a small start, but it's a very small start. We, you know, clearly, we have to recognize that these are security issues as important as, you know, invading a country militarily. And that's still not in the mindset yet.

Dr. Enrique Chacon-Cruz:

And there we have to really push harder on the policy in Africa's society. Maybe one thing that just adds to the problem, there is no predictability. In the case of animal health, we have a lot of companies that want to produce vaccines, but there is no predictability of the demand, because countries are not able to say, okay, you know, we're going to be vaccinating at this level, this amount.

So, it makes it very hard to actually be able to get certain vaccines to the correct market, because this predictability is not there.

Dr. Rino Rappuoli:

I would just like to make a comment on this, because the, as Peter said, toady we

could make most of the vaccines that we need . We have the technologies to do it.

It's just a question of investing and doing it. The problem is that, we all believe that the AMR is a very important problem that we need to tackle it. But none of the vaccines have AMR claims in their label. No label say that vaccines kill also bacteria resiatnt to anotbiotics.

Now, if it's not in the label, AMR it's not going to be the included in cost effectiveness calculations. So the today vaccines have no recognition for being able to address AMR. This is a problem we need to address.

We need to address many problems, starting from the regulatory pathway, because I feel that most of the vaccines for bacteria resistant to antibiotics are not developed, because there's no value for them. There's no market. And therefore while work on the technologies , but also we need to work on the policy to make sure that vaccines for AMR are developed. These are wonderful tools that can solve the problems, but we are not developing them because we have not been able to provide the value that they really have.

Dr. Peter Hotez:

oHotez:Just one other point. So there's a really interesting book written by someone who's been watching, interested in nuclear weapons, and it's called, the book is called The Gift of Time, and it's by Jonathan Schell. And he makes kind of a similar observation about nuclear weapons and technology.

It's not very hard to build a catastrophic hydrogen bomb, but the hardest part is the regulatory policy framework to keep it under wraps. And again, this concept of technology outpacing our political, social, and financial institutions. It's not only about vaccines, it's, it applies to other technologically, formerly technologically complicated innovation.

Dr. Enrique Chacon-Cruz:

This is flowing great, thank you. So this is a general question. How can we better communicate the animal-human environment link to climate and health policy makers? You notice that we can have livestock vaccines, but also human vaccines. And how can we identify the investments in the safety of climate mitigation? I'm trying to interconnect all of this.

Agricultural, you know, animal health, climate change, and human vaccines. So how can we better communicate this issue of animals, humans, in the climate-shared environment?

Dr. Montserrat Arroyo:

It is a difficult question, but one way forward is to anchor our messaging to commitments that already exist. For example, we can build on the UN resolution on antimicrobial resistance. The issue is no longer whether AMR is a problem—we already know that it is. We have strong scientific evidence and robust data demonstrating its scale and impact.

The real challenge is how we communicate this more effectively, particularly to decisionmakers outside the animal health community. Too often, we ask ministries of finance to engage with animal health arguments, rather than speaking in the economic terms that matter most to them. Instead, we need to clearly demonstrate the financial cost of AMR—how it contributes to GDP losses across countries—and this is already well documented.

We also have concrete examples that show the return on investment of prevention. In the United Kingdom, for instance, the introduction of *E. coli* vaccination in poultry led to an 80% reduction in antimicrobial use overall, not only for *E. coli* but for other diseases as well. This intervention achieved an estimated threetoone return on investment. These are the types of arguments that resonate across sectors.

This is where we need to "meet in the middle." While political will is often cited as the barrier, decisionmaking also takes place in a context of competing priorities. In a world of multiple crises, the question becomes: *what is the cost of inaction?* On AMR, we have clear evidence of widespread and longterm damage. It is a global problem that does not respect borders, and it is not confined to one sector—it affects human health, animal health, agriculture, the

environment, and economic development.

We are already seeing the consequences. AMR is contributing to increased complications and mortality in human health, including rising pediatric deaths. While low and middleincome countries are disproportionately affected, highincome countries are also experiencing growing impacts, supported by strong epidemiological data.

This underscores the need to communicate better and act more proactively, but also to ensure accountability. If countries commit to preventive measures such as vaccination, then vaccination coverage should be reflected as a concrete indicator within AMR national action plans. Financing also needs to be addressed more strategically. Currently, official development assistance and philanthropic funding often classify livestock vaccines narrowly as AMR prevention or food security interventions, rather than recognizing them as **longterm investments** in resilience.

Ultimately, we need a shift at all levels toward using economic evidence, addressing known system gaps, and strengthening both veterinary and human health services. Incentives must align with policy objectives, and persistent challenges—such as supply chains and coldchain capacity—must be resolved. Having a vaccine is not enough; without the systems to deliver and sustain it, the opportunity for prevention is lost.

Dr. Enrique Chacon-Cruz:

Thank you.

Dr. Rino Rappuoli:

Yeah, I think Dr. Montserrat has said a lot in this space. We have done a lot of progress in One Health, and we have made AMR as a common goal. Right now, most governments are aware that AMR is one of the big health issues or humans and for anomals

And now, many countries, have One Health Coordination Committee, and there is collaboration. They talk about broad collaboration, in some instances, it's still a concept, but it's something that we have already achieved, a first step, I would say. The issue comes again when it comes to funding, and prioritization.

Yesterday, in the AMR workshop, they said that when we communicate about the deaths coming from the AMR pandemic, policymakers might not necessarily be impressed, because people die every day, and there are so many other issues to deal with. Perhaps we need to communicate about the cost to the economy, about the economic cost and burden of doing nothing, and compare it to the benefits of investing. What is that right investment? And what is the return on that investment? We need to be able to convince the policymakers that are our interlocutors, to take action.

If I tell to invest on AMR using ethical issues, it doesn't really bring a benefit. If it's presented in a way that by investing you increase the efficiency at the production level and increases biosecurity, by reducing disease transmission by vaccination, then you may have a good argument.

Dr. Clarisse Ingabire:

Policymakers and regulation play a critical role because individual farmers may not change practices on their own. For example, if laws prohibit the use of certain antibiotics as growth promoters and are backed by effective inspection and surveillance, meaningful progress can be made. Similarly, national campaigns to raise awareness about biosecurity, disease prevention, and surveillance can help reduce antibiotic use at the farm level.

Collaboration with partners is also essential. By providing evidence, scientific insights, and data, we can help convince both policymakers and producers, creating the conditions to make real progress in addressing antimicrobial resistance (AMR).

Dr. Enrique Chacon-Cruz:

Thank you so much. Unfortunately, we're right on the time.

So, I think this was the hottest topic for today's congress, but if you can give us one minute, last words regarding these crucial

topics. This has been a great panel.

Dr. Peter Hotez:

Thank you. Thank you for organizing it. And thank you to my colleagues.

We have to remember in this century alone, in this new century, over the last 25 years, we've had six major, at least six major epidemics or pandemics because of zoonotic spillover, right? We've had three coronavirus pandemics, SARS-1, SARS-2, and MERS. We've had two Ebola, serious massive Ebola epidemics, 2014, 2019, and now H5N1 in the U.S., all from zoonotic spillover. And so, the point is Mother Nature is not being coy with us.

She's telling us exactly what she has in mind, right? She's going to be hurling more and more zoonotic spillover events in the coming years. This is just the beginning because they're accelerating because of climate change and urbanization, of course, is what I'm telling you. And yet, we still have the very sad fact that most Americans actually believe that COVID-19 occurred because of a lab leak or because of gain-of-function research.

Nobody in the United States, except the people up here and the people out there, know what zoonotic spillover is. And we have to flip that around. Yet, this is one of the greatest threats to humanity that we're not aware of, and it continues to accelerate extend.

Yet, this is one of the greatest threats to humanity that we're not aware of, and it continues to accelerate extend.

Dr. Enrique Chacon-Cruz:

Thanks, Peter.

Clarisse, short, but not subtle final words.

Dr. Clarisse Ingabire:

Collaboration and partnership are essential to translating scientific evidence into effective solutions. As emphasized today, getting the right information from academia and research is critical to developing the right vaccines and tools. At the same time, we cannot lose sight of equity and access. Many smallholder producers in the regions where we work lack funding and access to vaccines. We must explore innovative approaches that ensure these tools reach the people who need them most.

Climate change adds urgency. Its impacts are real and ongoing, and we must improve our ability to predict outbreaks, change behaviors, and intervene before a crisis occurs. This means strengthening pre-event surveillance to detect risks early and break transmission cycles before they escalate.

We now have unprecedented amounts of data and powerful tools, including AI, to analyze it and guide where attention and resources should be focused. To be effective, we must also engage policymakers—helping them understand the drivers of their decisions and empowering them to act decisively. By combining science, technology, equity, and strategic policy engagement, we can create a proactive, resilient approach to animal health and vaccine access.

Dr. Enrique Chacon-Cruz:

Great. Thank you, Clarisse. Monserrat, again, short but not subtle.

Dr. Montserrat Arroyo:

We need to go from reactive to preventive. And if we want to prevent, and we say that 70 percent of diseases come from animals, we do need to invest where the money will give better returns on investment. So we do need to invest in animal health.

Dr. Enrique Chacon-Cruz:

Thank you. Rino, please.

Dr. Rino Rappuoli:

Well, first of all, thank you for setting up this panel. I think, frankly, it's the first time in more than 40 years of my career doing vaccines that I'm sitting in the same panel as someone who is doing vaccines and talking about vaccines for animals. Now, what do we need? Well, I think we need two or three things which are essential.

One, we need to stop thinking that antibiotics alone will solve the problem. And a lot of the policies worldwide still believe that's the case. That's the first step.

The second thing, we need to have more of these meetings. We need to be open. We need to be... If people do vaccines for humans, they do vaccines for animals.

People do regulatory things. We need innovative financial mechanisms. The innovation should not be just scientific.

We need innovation in the financial mechanisms because we are facing a problem for which we don't have... I mean, the only solutions we may have are technical, but we don't have 100%. We don't have the policy solutions. We don't have the financial solutions.

We don't have the regulatory solutions. So I think we need to have more conversation on this side, and we need to convince that it's only by collaboration. We should acknowledge the different instruments and different things that we solve the problems that are facing.

Dr. Enrique Chacon-Cruz:

Thank you so much. I'm really honored for having you here, and I'm pretty sure we will have this discussion again. Thank you for attending this great, great panel.

News & Alerts

MOST RELEVANT MONTHLY NEWS ON VACCINATION AND EMERGING DISEASES WITH BIBLIOGRAPHIC ALERTS

A summary of the latest News & Alerts in the fields of vaccinology, vaccines, vaccination, and vaccine-preventable diseases. We curate the latest information on regulatory updates, emerging trends, breakthroughs in vaccine technology, vaccine safety and efficacy, global immunization developments and outbreak alerts, as a resource to keep our community informed.

EUROGIN: Merck's 9-valent HPV vaccine provides protection at least 14 years.
Among 2029 women in Scandinavian countries who were followed up for 14 years, vaccine effectiveness was 100%.
Published: March 19, 2026.
https://www.contemporaryobgyn.net/view/eurogin-merck-s-9-valent-hpv-vaccine-provides-protection-at-least-14-years

Yellow fever in the Americas: Nearly 3/4 of cases reported from Colombia.
From January 1 through February 21, 2026, 34 confirmed human cases of yellow fever were reported in four countries in the Americas Region, including 15 deaths. Leading in both cases and deaths is Colombia with 25 cases and 13 deaths, accounting for 73 percent and 87 percent of the total cases and deaths, respectively.
Published: March 18, 2026.
https://outbreaknewstoday.substack.com/p/yellow-fever-in-the-americas-nearly

Experimental hookworm vaccine shows promising protection in phase 2 human trial.
Researchers from the George Washington University School of Medicine and Health Sciences, in partnership with Baylor College of Medicine, announced on Mar. 18 that a candidate vaccine for hookworm infection showed encouraging results in a phase 2 clinical trial.
Published: March 18, 2026.
https://patientdaily.com/stories/680885243-experimental-hookworm-vaccine-shows-promising-protection-in-phase-2-human-trial

New vaccine to stop deadly meningitis epidemics confirmed to be safe.
Analysis of vaccination campaigns in Nigeria and Niger found very few serious adverse events among more than 4.8 million people immunized. In July 2023, the World Health Organization prequalified a new meningococcal conjugate vaccine, which protects against the five main causes of epidemic meningitis in sub-Saharan Africa. Although clinical trials had already shown the Men5CV vaccine to be safe and effective, WHO advised countries introducing it to closely monitor adverse events in these real-world conditions. A new study, published in Vaccine, provides the first large-scale real-world safety data for the vaccine following its use in outbreak response campaigns in Nigeria and Niger in 2024. It confirmed the vaccine's safety in real-world outbreak settings, with very low rates of serious adverse events and no new safety signals detected.
Published: March 18, 2026.
https://www.gavi.org/vaccineswork/new-vaccine-stop-deadly-meningitis-epidemics-confirmed-be-safe

Child mortality: millions of preventable deaths as aid cuts thwart progress, UN warns.
Millions of children around the world are still dying from preventable causes, and progress on tackling this is being harmed by global

aid cuts, United Nations (UN) leaders have warned. A major UN report, *Levels and Trends in Child Mortality*, estimated that 4.9 million children globally died before their 5th birthday in 2024, including 2.3 million newborns. Most of these deaths could have been prevented with proven, low-cost interventions and better access to healthcare, the report stated. Globally, deaths among children under 5 have fallen by more than half since 2000. The report noted, however, that the reduction in child mortality had slowed by more than 60% since 2015.
Published: March 19, 2026.
https://www.bmj.com/content/392/bmj.s540#:~:text=But%20we%20see%20worrying%20signs,of%20death%20among%20young%20children

Meningitis outbreak passes peak, says health agency (UK).
The peak of a fatal meningitis outbreak, thought to have originated in a Canterbury nightclub, has passed according to the UK Health Security Agency (UKHSA). A total of 29 confirmed or suspected cases of meningitis (*Neisseria meningitidids* serogroup B) have been linked to the Kent outbreak, which has killed two people.
Published: March 23, 2026.
https://www.bbc.com/news/articles/ckgwrxdldmzo

Chikungunya in Suriname: Significant increase in cases reported.
In a follow-up on the chikungunya outbreak that was declared in Suriname in January, the Ministry of Health has confirmed a significant increase in the cases of chikungunya virus. According to the Central Laboratory of the Bureau for Public Health (BOG) and the laboratory of the Academic Hospital Paramaribo, over 1,357 individuals have tested positive, confirming local transmission and one confirmed death and another being investigated.
Published: March 23, 2026.
https://outbreaknewstoday.substack.com/p/chikungunya-in-suriname-signicant

WHO: World Tuberculosis Day.
Each year we commemorate World TB Day to raise public awareness about the devastating health, social and economic consequences of tuberculosis (TB) and to step up efforts to end the global TB epidemic. The date marks the day in 1882 when Dr. Robert Koch announced that he had discovered the bacterium that causes TB, which opened the way towards diagnosing and curing this disease.
Published: March 24, 2026.
https://www.who.int/campaigns/world-tb-day

PAHO: Epidemiological Update Pertussis (Whooping Cough) in the Americas Region - 25 March 2026.
According to the latest data published by the World Health Organization (WHO), globally, 941,582 cases of pertussis were reported in 2024, representing a 5.8-fold increase compared to the number of cases reported in 2023 (n= 163,388 cases). The highest proportion of cases was recorded in the WHO regions of the Western Pacific (n= 593,659 cases) and Europe (n= 298,612 cases). In the Americas Region, there was a gradual decline in the number of cases reported annually between 2015 and 2019, and again in 2021–2022, when the number reached its lowest point at 3,284 cases. Subsequently, a significant increase in cases was recorded between 2023 (n= 11,202 cases) and 2024 (n= 66,184 cases), with a moderate decline during 2025 (n= 46,870 cases).
Published: March 25, 2026.
https://www.paho.org/en/documents/epidemiological-update-pertussis-whooping-cough-americas-region-25-march-2026

EMA: Vaccine Essentials: Supporting vaccine literacy.
The European Medicines Agency (EMA) is collaborating with healthcare professional organizations and learned societies to develop a communication tool on vaccines. 'Vaccine Essentials' is meant to help increase vaccine science literacy. It relies on vaccine science and regulation to address vaccine-related information gaps and concerns that healthcare professionals identify. The first Vaccine Essentials topic focuses on meningococcal B vaccines, also known MenB vaccines. These vaccines help prevent the invasive meningococcal disease (IMD) caused by Meningococci B bacteria. It is a serious bacterial infection that can have life-changing consequences for children and young adults.
Published: March 25, 2026.
https://www.ema.europa.eu/en/human-regulatory-overview/public-health-threats/vaccine-preventable-diseases-key-facts/vaccine-essentials-supporting-vaccine-literacy

New Covid strain that could evade protection from vaccine found in UK.
The Covid variant BA.3.2 has been detected in 23 countries including the UK. A new Covid variant spreading across the US has also been identified in the UK, health chiefs have warned. The strain, known as BA.3.2, has been detected in nasal swabs taken from four American travellers and clinical samples from five patients in four unidentified states.
Published: March 26, 2026.
https://www.independent.co.uk/news/health/new-covid-strain-uk-variant-vaccine-b2946014.html

ECDC: First human case of influenza A(H9N2) infection imported in the EU.
A human case of avian influenza A(H9N2) infection in a returning traveler from a non-European country where the virus has previously been identified in birds, has been reported in the Lombardy region of Italy. This is the first human case of avian influenza A(H9N2) reported in the EU/EEA.
Published: March 25, 2026.
https://www.ecdc.europa.eu/en/news-events/first-human-case-influenza-ah9n2-infection-imported-eu

MERS imported to France: a wake-up call to revamp preparedness, control, and research.
The reports of two imported cases of Middle East respiratory syndrome (MERS) in France in December 2025,1 along with the 14 cases reported in Saudi Arabia earlier in 2025, are reminders of the need to keep MERS under scrutiny. Although the pandemic potential of MERS-CoV is thought to be limited, the fluctuating pattern of cases and the simmering threat of the infection highlight why we should enhance research and control efforts.
Published: March 27, 2026.
BMJ 2026; 392 doi: https://doi.org/10.1136/bmj.s597

https://www.bmj.com/content/392/bmj.s597#:~:text=Opinion-,MERS%20imported%20to%20France%3A%20a%20wake%2Dup%20call%20to,revamp%20preparedness%2C%20control%2C%20and%20research&text=The%20reports%20of%20two%20imported,to%20keep%20MERS%20under%20scrutiny

Measles: 38 children dead in Bangladesh outbreak.
At least 38 children in Bangladesh have died from measles, leading health authorities to rollout a vaccination program for younger children in a bid to halt the outbreak. Official data show that in 2026 more than 2300 children have been admitted to hospital with suspected measles, of whom 684 have tested positive so far.
Published: April 2, 2026.
https://www.bmj.com/content/393/bmj.s654

A roadmap for Malaria-in-pregnancy vaccines: ADVANCE-VAC4PM Workshop findings now published.
Placental malaria (PM) is a severe disease that affects a particularly vulnerable demographic group, pregnant women. The burden of disease is high, threatening more than 100 million women every year, causing the death of an estimated 50,000 pregnant women and up to 200,000 infants. An effective vaccine would be an attractive tool to control PM on its own, or to complement the existing yet imperfect tools. The overall project objective is to advance the clinical development of two promising PM vaccine candidates, PRIMVAC and PAMVAC, identifying the best vaccination strategy to improve and broaden the vaccine-induced immune response for future phase 2/3 clinical trials.
Published: April 2026.
https://www.advance-vac4pm.eu/

Rodríguez-Morales AJ, Acevedo-Jimenez K, Guevara ME, Chang-Cojulun A, Brea-Del Castillo J, Palmieri M, Avila-Agüero ML, de Novales FJM, Torres-Martínez C, Olaya SX, Chacon-Cruz E, et al. Yellow Fever in Pregnancy: A Comprehensive Review of the Clinical Implications and Vaccination in the Context of the 2024–2026 Americas Outbreak. *Tropical Medicine and Infectious Disease*. **2026; 11(4):92.**
Editorial comment: Yellow fever remains a major threat in endemic regions, with pregnant women as a vulnerable but understudied group. Current evidence does not show increased disease severity in pregnancy, though adverse maternal–fetal outcomes can occur. Diagnosis and management are challenging in resource-limited settings. Available data support the safety and effectiveness of vaccination during pregnancy, with benefits outweighing risks in high-exposure

settings. A risk-based approach, integration into antenatal care, and improved surveillance and research are essential to reduce disease burden. https://doi.org/10.3390/tropicalmed11040092.

Liu R, Patterson L, Yeasmin M, Kim KH, Park BR, Bhatnagar N, Raha JR, Grovenstein P, Pal SS, Le CTT, Shin CH, Du L, Kumar M, Kang SM. Low-dose multivalent COVID-19 mRNA vaccines enhance broadly cross-reactive antibodies and protective immune responses of co-administered protein-based vaccines. *Virology.* **2026 Mar 21;619:110884.**
Editorial comment: Low-dose multivalent mRNA vaccines induce broader and stronger cross-reactive immunity than high-dose monovalent vaccines. Combining trivalent mRNA with variant spike proteins further enhances neutralizing responses, and coadministration with influenza vaccines improves immunogenicity against influenza. doi: 10.1016/j.virol.2026.110884

Ukraine warns of rabies, Lyme disease with the arrival of spring. With the arrival of spring, Ukranian hea
lth officials are warning of the increased rosk of two infectious diseases: rabies and Lyme disease.
Published: April 5, 2026.
https://outbreaknewstoday.substack.com/p/ukraine-warns-of-rabies-lyme-disease

Norovirus outbreak on Princess cruise ship sickens more than 150 passengers and crew.
A norovirus outbreak sickened more than 150 passengers and crew aboard a Princess cruise ship as it sailed through the Caribbean last week, the U.S. Centers for Disease Control and Prevention announced.
Published: March 15, 2026.
https://www.cbsnews.com/amp/news/norovirus-outbreak-on-princess-cruise-ship-sickens-more-than-150-passengers-and-crew/

WHO calls for action: "Together for health. Stand with science." to mark World Health Day.
The World Health Organization (WHO) today calls on people everywhere to renew their commitment to working together and supporting science as the twin engines driving better health, under the World Health Day 2026 theme: "Together for health. Stand with science." The campaign marks the anniversary of WHO's founding on 7 April 1948, launching a year-long public health campaign.
Published: April 6, 2026.
https://www.who.int/news/item/06-04-2026-who-calls-for-action---together-for-health.-stand-with-science.--to-mark-world-health-day

Next-Gen Yellow Fever Vaccine Hits the Mark in Mid-Stage Trial.
Yellow fever outbreaks in recent years and subsequent vaccine shortages have highlighted a need for updated shots that can be produced more rapidly. To help speed production, an investigational live-attenuated yellow fever vaccine is being developed that is produced in Vero cells instead of eggs. In this randomized phase II trial, the novel yellow fever vaccine proved noninferior to the FDA-approved shot for seroconversion at day 29.
Published: April 8, 2026.
https://www.medpagetoday.com/infectiousdisease/vaccines/120708

Watch out, hookworms: an effective vaccine might be on the horizon.
Promising results from an experimental hookworm vaccine trial offer hope for the more than 400 million who contract the parasitic infection every year. The phase 2 study, published last month in The Lancet Infectious Diseases, was a double-blind clinical trial. Participants who received the Na-GST 1/Al-CpG vaccine candidate had significantly milder infections than those in the placebo group, as well as volunteers who received one of two other vaccine candidates.
Published: April 8, 2026.
https://www.cidrap.umn.edu/misc-emerging-topics/watch-out-hookworms-effective-vaccine-might-be-horizon

Why mpox outbreaks can change course and what we can do about it.
A new model shows how the mpox virus can shift from transmission among adults to among children over the course of an outbreak. Our responses may need to adapt.
Published: April 9, 2026.
https://www.gavi.org/vaccineswork/why-mpox-outbreaks-can-change-course-and-what-we-can-do-about-it

Two new TB vaccine candidates show promise but fail to stop infection.

A large trial in India suggests the VPM1002 and Immuvac vaccine candidates are safe and may reduce the risk of active tuberculosis in adults and older children, but do not prevent infection or transmission.
Published: April 14, 2026.
https://www.gavi.org/vaccineswork/two-new-tb-vaccine-candidates-show-promise-fail-stop-infection

Forbes Africa: South Africa's first-in-human HIV vaccine trial signals a scientific power shift.
In February, the first trial participants received the BRILLIANT 011 experimental HIV vaccine – a first-in-human clinical trial by the BRILLIANT Consortium (BRinging Innovation to cLinical and Laboratory research to end HIV In Africa through New vaccine Technology) – led by the South African Medical Research Council (SAMRC).
Published: April 10, 2026.
https://www.eatg.org/hiv-news/forbes-africa-south-africas-first-in-human-hiv-vaccine-trial-signals-a-scientific-power-shift/

More Americans doubt vaccine safety than trust it, POLITICO Poll finds Health Secretary Robert F. Kennedy Jr.'s views are commonplace across the land.
Published: April 14, 2026.
https://www.politico.com/news/2026/04/14/poll-rfk-maha-vaccine-safety-americans-00869088?nid=0000018f-3124-de07-a98f-3be4d1400000&nname=politico-toplines&nrid=0000015a-ba47-d400-ad7e-be5750be0002

CEPI and PAHO expand partnership to strengthen regulatory systems and vaccine safety across the Americas.
The Coalition for Epidemic Preparedness Innovations (CEPI) and the Pan American Health Organization (PAHO) have expanded their collaboration through a series of new cooperation agreements to strengthen regulatory systems and pharmacovigilance programs across Latin America and the Caribbean, supporting faster, safer, and more equitable access to vaccines, with a focus on public health emergencies.
Published: April 14, 2026.
https://www.paho.org/en/news/14-4-2026-cepi-and-paho-expand-partnership-strengthen-regulatory-systems-and-vaccine-safety

Latest Relevant Publications

LATEST PUBLISHED PAPERS AND COMMENTARIES FROM THE CHIEF EDITOR

Latest impactful scientific publications that stand out for their potential bearing on healthcare. We introduce groundbreaking research findings, innovative treatment modalities, results from phase 1 to 3 vaccine clinical trials, or paradigm-shifting discoveries that redefine our understanding of infectious diseases and therapeutic approaches for all vaccine-preventable diseases.

01

Wise J. **Child mortality: millions of preventable deaths as aid cuts thwart progress, UN warns.** *BMJ*. 2026 Mar 19;392:s540.
doi: https://doi.org/10.1136/bmj.s540

Editorial comment: Millions of children around the world are still dying from preventable causes, and progress on tackling this is being harmed by global aid cuts, United Nations (UN) leaders have warned. A major UN report, *Levels and Trends in Child Mortality*, estimated that 4.9 million children globally died before their 5th birthday in 2024, including 2.3 million newborns. Most of these deaths could have been prevented with proven, low cost interventions and better access to healthcare, the report stated. Globally, deaths among children under 5 have fallen by more than half since 2000. The report noted, however, that the reduction in child mortality had slowed by more than 60% since 2015.

02

Levy C, Bizot E, Milcent K, Birgy A, Béchet S, Varon E, Cohen R. **Epidemiology and characteristics of bacterial meningitis of children with cerebrospinal fluid leakage or cochlear implant**. *J Pediatric Infect Dis Soc*. 2026 Mar 9:piag015.
doi: https://doi.org/10.1093/jpids/piag015

Editorial comment: Among children older than 3 months with bacterial meningitis in France, the authors specifically analyzed cases associated with known cerebrospinal fluid (CSF) leakage—defined as meningeal breach and/or cochlear implant–related meningitis—within a nationwide prospective cohort conducted in France between 2001 and 2024, encompassing 227 pediatric wards and 168 microbiology laboratories. Of 5,879 cases of bacterial meningitis, 251 (4.3%) were associated with documented CSF leakage. In this subgroup, ***Streptococcus pneumoniae*** was the predominant pathogen (78.9%), followed by ***Haemophilus influenzae*** (10%), predominantly non-typeable strains. Only two cases of ***Neisseria meningitidis*** were identified, both occurring in children with cochlear implants.

03

Song Y, Li R, Guo H. **Senescent Cancer cell-derived vaccines: Current Progress, immunological challenges, and translational perspectives.** *Vaccine*. 2026 Mar 7;79:128430.
doi: https://doi.org/10.1016/j.vaccine.2026.128430

Editorial comment: To review advances in therapeutic cancer vaccines focusing on senescent cancer cells (SCCs) as a novel whole-cell vaccine platform with potential for personalized therapy and population health impact. Narrative review of English-language studies (PubMed, Web of Science, Scopus; through January 2026) on cancer vaccines, cellular senescence, and SCC immunology, emphasizing translational and public health relevance. SCCs demonstrate enhanced immunogenicity, including sustained antigen presentation, activation of innate immune pathways, and SASP-mediated modulation of the tumor microenvironment. Preclinical data show induction of antigen-specific T-cell responses and potential to overcome immune evasion. Evidence remains largely preclinical or early phase. SCC-based vaccines are a promising but still experimental strategy in cancer immunotherapy.

04

Katumba H, Migisha R, Komakech A, Wenani D, Kobusingye JO, Mfitundinda E, Zalwango JF, Kaliisa R, Park I, Atim D, Muruta AN, Kwesiga B, Bulage L, Lukabwe I, Ario AR. **Delayed patient isolation and associated factors during the mpox outbreak in Uganda, July-December 2024.** *Int J Infect Dis.* 2026 Mar;164:108346.
doi: https://doi.org/10.1016/j.ijid.2025.108346

Editorial comment: Among 832 mpox patients, 91% had delayed time to isolation (TTI); 57% were male, 86% were ≥18 years, 83% had not sought care prior to isolation, and 89% reported self-medication. Delayed TTI was independently associated with age ≥18 years (aOR 2.6, 95% CI 1.6–4.2) and self-medication (aOR 5.4, 95% CI 1.7–17.1). Qualitative interviews (n=9) linked delays to limited diagnostic capacity and economic barriers, whereas shorter TTIs (n=6) were attributed to prior awareness from social media and response teams. Delayed TTI was common and driven by adult age, self-medication, diagnostic gaps, and economic constraints, as well a no access to vaccination.

05

Troccoli CS, Nascimento PS, Villar LM, Miguel JC, Hofer CB, Potsch DV. **Long-term persistence of Seroprotection following a modified hepatitis B vaccine schedule in people living with HIV.** *Vaccine.* 2026 Mar 18;79:128483.
doi: https://doi.org/10.1016/j.vaccine.2026.128483

Editorial comment: In this interventional study, people living with HIV (PLHIV) who previously received a modified HBV vaccination schedule (four 40-µg doses) were reassessed after a median of 14.5 years. Anti-HBs titers were measured pre- and 1–6 months post–40 µg booster. Among 75 participants, 81.3% maintained seroprotective anti-HBs levels, including 59% strong responders (≥100 mIU/mL). Despite waning titers, 96% achieved seroprotection after boosting, indicating robust immunological memory. Higher initial anti-HBs levels independently predicted long-term protection and booster response. The modified schedule provides durable seroprotection and sustained immune memory in PLHIV more than a decade after vaccination.

06

Nguyen BL, Isoda N, Hew YL, Huynh LT, Le KT, Shimazu Y, Kobayashi D, Nguyen DH, Nguyen TD, Chu D-H, et al. **Efficacy and Limitations of an Improved Vaccine Derived from an Updated Vaccine Strain Against H5 HighPathogenicity Avian Influenza.** *Vaccines.* 2026; 14(4):291.
doi: https://doi.org/10.3390/vaccines14040291

Editorial comment: A candidate H5N1 avian influenza vaccine (rgPR8/VN23) was developed from a Vietnam strain and evaluated in poultry. Vaccination induced strong immunity, providing early and near-complete protection in juvenile chickens, with reduced viral shedding. In laying hens, protection was incomplete with a single dose but improved with higher dosing.The vaccine is highly effective in young chickens, though optimized strategies are needed for laying hens.

07

Sinha D, Coquant G, Yuan X, Paul S, Longet S. **Postpandemic adjuvants to tailor vaccine-induced immunity.** *Trends Immunol.* 2026 Mar 19:S1471-4906(26)00001-3.
doi: https://doi.org/10.1016/j.it.2026.01.001

Editorial comment: Adjuvants are essential for enhancing the magnitude, breadth, functionality, and durability of vaccine-induced immunity. However, achieving long-term protection, variant cross-reactivity, and robust mucosal responses remains challenging. This review examines emerging adjuvants that target specific immune pathways, highlighting preclinical and clinical evidence supporting improved humoral, cellular, and mucosal immunity. It also discusses age-tailored strategies for children and older adults. Overall, the authors emphasize next-generation adjuvants with the potential to address key unmet public health needs in the post-pandemic era.

08

Abdel-Qadir H, Bhatt HA, Swayze S, Paterson M, Ko DT, Juurlink DN, Kwong JC. **Association between COVID-19 vaccination and sudden death in apparently healthy younger individuals: A population-based case-control study.** *PLoS Med.* 2026 Mar 19;23(3):e1004924.
doi: https://doi.org/10.1371/journal.pmed.1004924

Editorial comment: This population-based case-control study used linked administrative data from Ontario, Canada (April 1, 2021), excluding individuals >50 years or with major comorbidities. Recent COVID-19 vaccination (within 6 weeks) was associated with a lower risk of death (aOR 0.63; 95% CI 0.55–0.72), consistent across sensitivity analyses, including individuals <40 years, in-hospital deaths, and after excluding opioid-related deaths. Self-controlled case series analyses showed no increased risk of sudden death following first, second, or third vaccine doses. These findings do not support an increased risk of sudden cardiac death after COVID-19 vaccination in young, healthy adults.

09

Thuluva S, Matur RV, Gunneri S, Ningaiah S, Yerroju V, Mogulla RR, Dhar C, Thammireddy K, Paliwal P, Kawade A, Nanjappa P, Pramod J, Narang M, Chakravarthy BS, Virupakashappa PM. **Immunogenicity and safety of biological E's 14-valent pneumococcal conjugate vaccine (PNEUBEVAX 14®) administered in a 2p + 1 schedule to healthy infants: a multicenter, randomized, active controlled, single-blind, phase III trial.** *Lancet Reg Health Southeast Asia.* 2026 Mar 3;46:100746.
doi: https://doi.org/10.1016/j.lansea.2026.100746

Editorial comment: Among 380 (95%) completers, both vaccines achieved high sero-response rates across shared serotypes, with comparable post-primary and post-booster responses. BE-PCV14 additionally elicited strong responses to serotypes 22F and 33F, as well as cross-protective 6A. Safety profiles were similar between groups, with mostly mild to moderate adverse events and no vaccine-related serious adverse events.BE-PCV14 was highly immunogenic, well tolerated, and comparable to PCV13, while expanding serotype coverage, supporting its use in routine infant immunization programs.

10

Cortes-Azuero O, O'Driscoll M, Ribeiro Dos Santos G, de Jesus R, de Lima STS, Scarponi D, Mukandavire C, Deol A, Kraemer MUG, de Souza WM, Salje H. **The epidemiology of chikungunya virus in Brazil and the potential impact of vaccines: a mathematical modelling study.** *Lancet Infect Dis.* 2025 Nov 27:S1473-3099(25)00605-X. doi: 10.1016/S1473-3099(25)00605-X. Erratum in: Lancet Infect Dis. 2026 Feb 13:S1473-3099(26)00083-6.
doi: https://doi.org/10.1016/S1473-3099(26)00083-6 PMID: 41319657.

Editorial comment: This study estimated the burden of chikungunya (CHIKV) in Brazil (2014–2024) using a Bayesian model integrating serological data and reported cases and deaths. An estimated 18.3% of the population had been infected, with highest risk in the northeast and southeast, while only 1.13% of infections were detected by surveillance. Symptomatic disease increased with age and was more frequent in females. Modeling suggests that vaccinating 40% of individuals ≥12 years (≈73 million doses) could prevent up to 1.6 million cases and 198 deaths over five years.

11

GBD 2023 Lower Respiratory Infections and Antimicrobial Resistance Collaborators. **Global burden of lower respiratory infections and aetiologies, 1990-2023: a systematic analysis for the Global Burden of Disease Study 2023.** *Lancet Infect Dis.* 2025 Dec 15:S1473-3099(25)00689-9.
doi: https://doi.org/10.1016/S1473-3099(25)00689-9

Erratum. Correction to Lancet Infect Dis 2026; 26: 343–61. April 1, 2026

Editorial comment: In 2023, lower respiratory infections (LRIs) caused 2.5 million deaths and 98.7 million DALYs globally, with the greatest burden in children <5 years and adults ≥70 years. While under-5 mortality declined by 33% since 2010, progress in older adults has been minimal. Sub-Saharan Africa remains furthest from global mortality targets. ***Streptococcus pneumoniae*** remained the leading cause of LRI deaths (25%), followed by ***Staphylococcus aureus*** and ***Klebsiella pneumoniae***. Newly modeled pathogens, including non-tuberculous mycobacteria and ***Aspergillus*** spp., contributed substantially, together accounting for ~22% of LRI mortality.

12

McLachlan I, Robertson C, Morrison K, et al. **Effectiveness of the maternal RSVpreF vaccine against severe disease in infants in Scotland, UK: a national, population-based case-control study and cohort analysis.** *Lancet Infect Dis.* 2025;26:362–373.
doi: https://doi.org/10.1016/S1473-3099(25)00624-3

Editorial comment: Among 27,565 live births, 50.2% of pregnant women received RSVpreF vaccination, with most vaccinated >14 days before delivery. A total of 354 infants ≤90 days were hospitalized with RSV-related LRTI. Vaccination was less common among cases (12.1%) than controls (43.2%). Maternal vaccination reduced RSV-related LRTI hospitalizations by 82.2% (95% CI 75.1–87.3), preventing an estimated 219 admissions. Effectiveness remained high in both preterm (89.9%) and term infants (81.5%) and was consistent in sensitivity analyses.

13

Buerger V, Pfeiffer A, Schoengrundner P et al. **Safety and immunogenicity of a live-attenuated chikungunya virus vaccine in adolescents: final results from a 12-month, double-blind, randomised, placebo-controlled, phase 3 trial in endemic areas of Brazil.** *Lancet Infect Dis.* 2025; 26, 417-428.
doi: https://doi.org/10.1016/S1473-3099(25)00631-0

Editorial comment: In this trial (2022–2024), 754 adolescents were randomized to VLA1553 or placebo. In seronegative participants, VLA1553 induced seroprotective antibody responses in 98.8% at 28 days and 98.3% at 12 months.

The vaccine was generally well tolerated, with mostly mild-to-moderate adverse events (e.g., headache, injection-site pain, myalgia, fever). Serious adverse events were rare and limited.VLA1553 demonstrated strong, durable immunogenicity and a favorable safety profile, supporting its use for chikungunya prevention in adolescents, particularly in endemic settings.

14

Carboni F, Bechi N, Proietti D, Balocchi C, Casini D, Brogioni B, Luzzi E, Tontini M, Cartocci E, Brunelli B, Reyter S, Margarit I, Romano MR, Adamo R. **Immune responses to glycoconjugate vaccines rely on a balance between polysaccharide length and glycosylation density.** *Carbohydrate Polymers.* 2026:125250.
doi: https://doi.org/10.1016/j.carbpol.2026.125250

Editorial comment: Glycoconjugate vaccine immunogenicity depends on glycan density and conjugation strategy. The authors evaluated whether polysaccharide length can compensate for low glycan density in site-selective conjugates using meningococcal (A, C) and pneumococcal (8, 14) polysaccharides with fHbp as carrier. Oligosaccharides >15–20 repeating units induced strong anti-glycan responses—even with single-site conjugation—except for meningococcal A, which required longer chains. Increasing glycan density via random conjugation did not improve polysaccharide immunogenicity and reduced protein responses. These findings highlight the need to balance glycan length and density in glycoconjugate vaccine design.

15

De Bock M, Marbaix S, Goovaerts H, Debiève F, Proesmans M, Raes M. **Health and Economic Impact of Seasonal Maternal Vaccination With Bivalent Respiratory Syncytial Virus Prefusion F Vaccine in Belgium.** *Pediatr Infect Dis J.* 2026 Apr 7.
doi: https://doi.org/10.1097/INF.0000000000005226

Editorial comment: RSV is a leading cause of severe lower respiratory infections in infants, placing a major burden on hospitals; maternal vaccination may mitigate this impact. A static cost-effectiveness model (public payer perspective) evaluated maternal RSVpreF vaccination versus no immunization in newborns, using Belgian real-world and clinical data. Maternal vaccination is cost-saving and dominant—preventing 1 death and 2,242 hospitalizations in 46,542 infants, saving €8.57M, with net savings and +80 QALYs. Maternal RSVpreF vaccination is a cost-saving, high-impact strategy for reducing RSV burden in infants.

16

Hernán MA, Álvaro-Meca A, Calvo-Alcántara MJ, Navarro Gómez ML, Ramos JT, Estévez JC, Basanta M, Ruiz S, Matáix ÁL, Cosano L, Silva AP, Salas P, Arribas JR, Molero JM, Berenguer J. **Effectiveness and Safety of COVID-19 mRNA Vaccines in Children 6-17 Years Old: A Population-based Study in Madrid.** *Pediatr Infect Dis J.* 2026 Apr 1;45(4):e121-e124.
doi: https://doi.org/10.1097/INF.0000000000005109

Editorial comment: The benefit–risk of COVID-19 mRNA vaccination in children remains uncertain. Population-based matched study (Madrid) comparing vaccinated vs. unvaccinated children (6–17 years), assessing 240-day risks.

Minimal impact—no significant reduction in hospitalization or MIS-C; no myocarditis cases. Moderate reduction in hospitalization (~45% effectiveness); small, non-significant MIS-C reduction. Myocarditis/pericarditis**:** No increased risk detected. Overall benefits and risks were small, with modest benefit mainly in adolescents.

17

Põder A, Ong-Lim A, Rivera Medina D et al. **Efficacy, immunogenicity, and safety of a cell culture-derived quadrivalent influenza vaccine compared with a non-influenza vaccine in infants and children across five influenza seasons: a phase 3, multinational, observer-blind, randomised controlled trial.** *The Lancet Child & Adolescent Health.* 2026 May; 10: 352-363.
doi: 10.1016/S2352-4642(26)00009-X

Editorial comment: This was a phase 3 randomized, observer-blind trial in 75 sites across 15 countries, comparing cell-based quadrivalent influenza vaccine (QIVc) vs MenC in children aged 6–47 months, with ~180-day follow-up. Among 5723 participants, QIVc reduced RT-PCR–confirmed influenza (3.6% vs 6.1%; efficacy 41.3%) and culture-confirmed influenza (1.5% vs 2.9%; efficacy 46.9%). No vaccine-related serious adverse events were identified; most reactions were mild. QIVc demonstrated moderate efficacy and a favorable safety profile, supporting its use in young children.

18

van Riet E, Corleis B, Giersing BK, Hatherill M, Burhan E, Jassat W, White RG, Lewinsohn D, Cobelens F. **Accelerating research and development of new vaccines against tuberculosis: 5-year progress on the global roadmap.** *Lancet Infect Dis.* 2026 Mar 18:S1473-3099(26)00019-8.
doi: https://doi.org/10.1016/S1473-3099(26)00019-8

Editorial comment: In 2021, a global roadmap outlined key actions to accelerate tuberculosis vaccine development. Since then, the pipeline has diversified, with several candidates in phase 3 trials and increased regulatory preparedness in LMICs. However, the number of candidates remains limited, development challenges persist, and investment is still risky due to uncertain demand and weak procurement commitments. Greater funding diversification, stakeholder coordination, and planning for cost-effective implementation—while addressing hesitancy and stigma—are essential to ensure successful uptake of future TB vaccines.

19

Kitano T, Yoshida S. **Nine-Valent Human Papillomavirus Vaccination and Related Cancers in Males.** *JAMA Oncol.* 2026 Apr 9:e260496.
doi: https://doi.org/10.1001/jamaoncol.2026.0496

Editorial comment: This large multicenter retrospective cohort study (2016–2024) evaluated HPV-related cancer incidence in males aged 9–26 years receiving the 9-valent HPV vaccine versus unvaccinated controls. After propensity score matching (510,260 per group), vaccination was associated with a significantly lower risk of HPV-related cancers (HR 0.54; 95% CI 0.37–0.81), consistent across age groups. These findings support the effectiveness of the 9-valent HPV vaccine in reducing HPV-related cancers and reinforce the value of sex-neutral vaccination strategies.

20

Vaughan AM, Park C, Ngo VP, Contreras ZA, Lee JJ, Danza P, Haddix M, Moir O, Green N, Brown M, Burleson T, Marutani A, Nicholas A, Hallum T, Vetrone S, Ortiz L, Fernandez G, El-Tobgy E, Escobar J, Gandela TN, Mondy C, King J, Dean B, Rubin E, Valadez P, Fogleman S, Terashita D, Balter S, Halai UA. **Investigation of and Response to Autochthonous Dengue, Los Angeles County, California, USA, August-November 2024.** *Emerg Infect Dis.* 2026 Apr 6;32(5).
doi: https://doi.org/10.3201/eid3205.251812

Editorial comment: Between August–November 2024, 14 locally acquired dengue cases were identified in Los Angeles County, indicating short transmission chains after traveler importations, with one cluster lasting up to 7 weeks. Patients had a median age of 54 years, and 43% required hospitalization. Delays in care and diagnosis were common. These findings highlight the growing risk of dengue transmission in nonendemic areas and the need for rapid public health and vector control responses.

21

Lesenfants M, Suffredini E, Mancini P et al. **Public health responses following identification of poliovirus in wastewater.** *Lancet Public Health.* 2026; April 10
doi: https://doi.org/10.1016/S2468-2667(26)00051-4

Editorial comment: Poliovirus remains a global threat, with both wild and vaccine-derived strains detected—even in polio-free countries. A review of 26 events across 21 countries shows that wastewater detection consistently triggered public health responses—often before paralytic cases—including enhanced surveillance and targeted vaccination. These findings reinforce environmental surveillance as a critical early warning tool for polio and beyond.

22

Crotty S. **Immunological memory to vaccines.** *Immunity.* 2026; 59: 813-832.
doi: https://doi.org/10.1016/j.immuni.2026.02.019

Editorial comment: Vaccines save lives through immune memory. This review highlights the integrated roles of B cells, CD4+ and CD8+ T cells, and antibodies—across circulating, tissue-resident, and hybrid immunity—drawing on human data. Understanding the function and durability of these layers, while addressing key misconceptions, is essential to guide next-generation vaccines and immune-based interventions. A video lecture accompanies this review (https://youtu.be/8DeZJ6V7nuI).

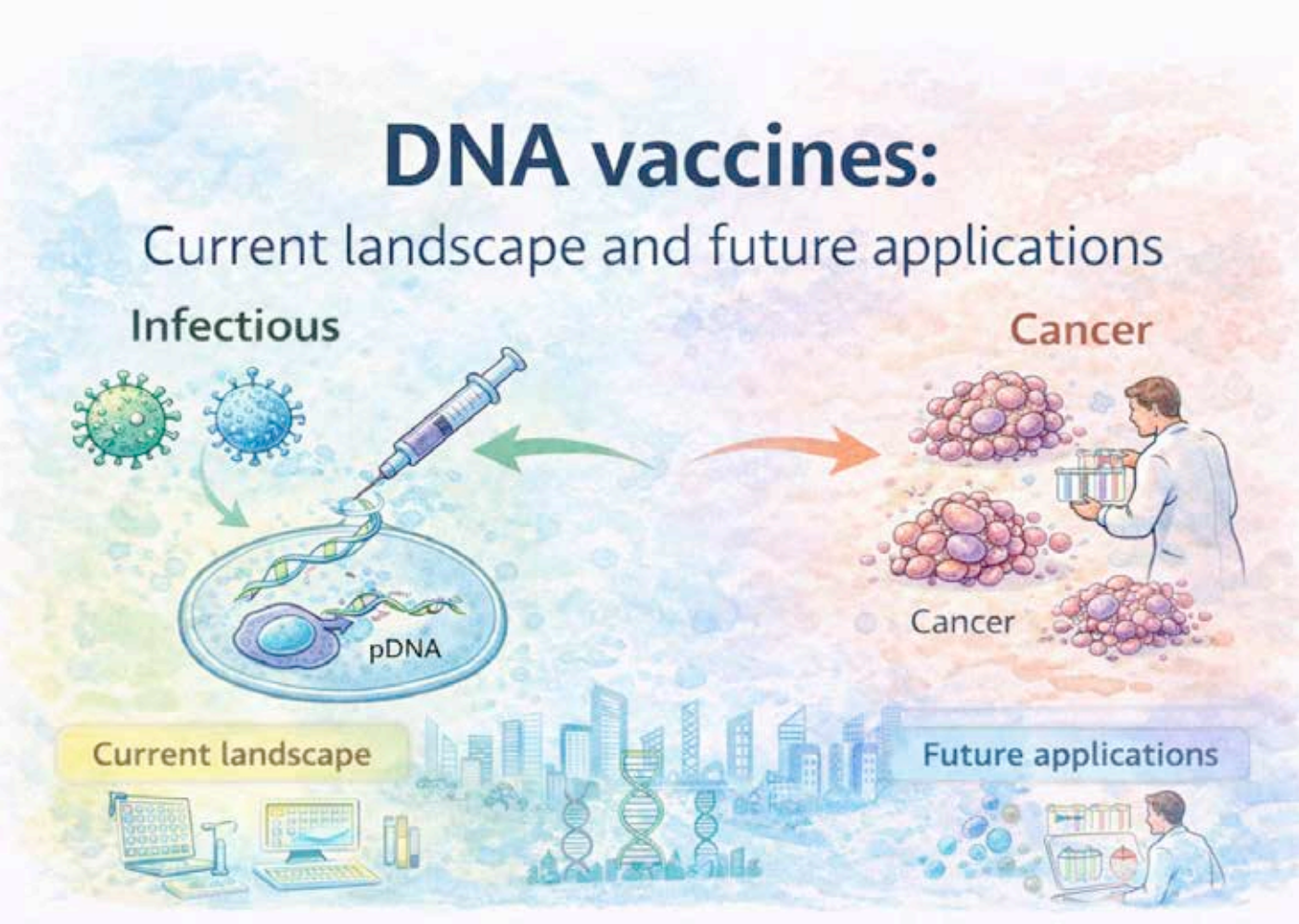
23

Esteban I, Patino CM, Ferreira JC. **Utilizing surrogate endpoints in clinical research: a strategic approach to overcome practical challenges.** *J Bras Pneumol.* 2026 Mar 20;51(6):e20250476.
doi: https://doi.org/10.36416/1806-3756/e20250476

Editorial comment: A fine review of the need for correlates and surrogates of protection in vaccine clinical trials.

Editor's Corner

DNA VACCINES: CURRENT LANDSCAPE AND FUTURE APPLICATIONS



Introduction

Nucleic acid vaccines have recently gained considerable attention due to their promising results in clinical trials for the prevention and treatment of various diseases, including cancers and viral infections such as SARS-CoV-2. Compared with traditional protein- or virus-based vaccines, nucleic acid vaccines offer several advantages that make them one of the most promising platforms for disease prevention and therapeutic applications [3]. Unlike conventional vaccines, which often require lengthy production processes involving embryonated chicken eggs or cultured cells, nucleic acid vaccines can be designed and manufactured rapidly, allowing faster development and scalable production—an especially critical advantage in responding to emerging pandemics.

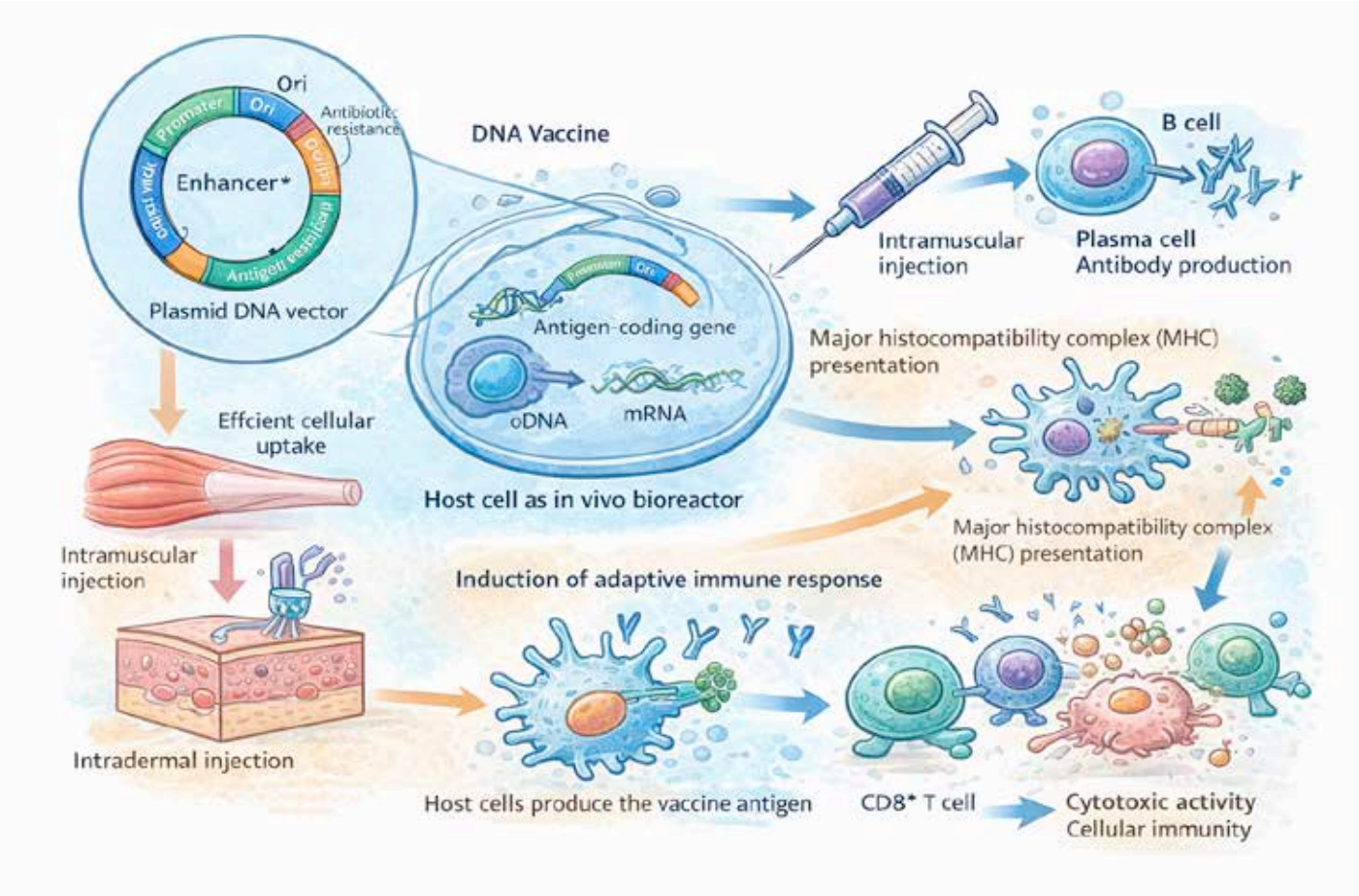
Deoxyribonucleic acid (DNA) vaccines have re-emerged as a versatile and scalable platform, driven by advances in synthetic biology and delivery technologies, positioning them as powerful tools in the post-mRNA vaccine era. Historically regarded as less potent than viral- or mRNA-based platforms, recent breakthroughs have substantially enhanced their immunogenicity, safety, and precision. These advances include the development of synthetic gene circuits, self-amplifying DNA (saDNA), and DNA-encoded monoclonal antibodies (DMAbs), enabling programmable antigen expression and more robust immune activation. Clinically, DNA vaccines are now expanding into a broad range of applications, from prevention of infectious diseases to therapeutic cancer immunotherapy and the treatment of immune-mediated disorders.

DNA vaccines: Structural conformations and implications for immunogenicity

A DNA vaccine is typically generated by cloning a gene segment encoding a target antigen into a circular DNA vector—most commonly plasmid DNA or minicircle DNA constructs—which are designed for efficient expression in mammalian cells. Once engineered, the DNA construct is administered to the host through delivery routes such as intramuscular or intradermal injection, often combined with technologies that enhance cellular uptake, including electroporation or nanoparticle-based delivery systems.

Following administration, host cells—such as myocytes in intramuscular delivery or dermal antigen-presenting cells in intradermal administration—internalize the DNA and

Figure 1. Schematic representation of a DNA vaccine and its mechanism of action in host cells.



utilize their transcriptional and translational machinery to express the encoded antigen. In this process, host cells effectively function as **in vivo bioreactors**, producing the vaccine antigen directly within the body. The synthesized antigen is subsequently processed and presented through major histocompatibility complex (MHC) pathways, leading to activation of both humoral and cellular immune responses. This endogenous antigen production closely mimics natural infection, enabling DNA vaccines to stimulate robust $CD4^+$ and $CD8^+$ T-cell responses as well as antigen-specific antibody production (see Figure-1).

Current developments of DNA vaccines:

1. Improved delivery technologies

One of the historical limitations of DNA vaccines has been efficient delivery into host cells. Recent developments have significantly improved this through:

- Electroporation, which enhances cellular uptake of plasmid DNA and increases antigen expression.
- Needle-free jet injection systems and microneedle arrays.
- Nanoparticle and polymer-based delivery platforms that improve stability and targeting.

These technologies have markedly increased the immunogenicity of DNA vaccines in humans.

2. Synthetic biology and optimized plasmid design

Modern DNA vaccine platforms now incorporate several molecular innovations, including:

Differences Between DNA and mRNA Vaccines:

Feature	DNA Vaccines	mRNA Vaccines
Genetic material	Circular DNA plasmid encoding the antigen	Messenger RNA (mRNA) encoding the antigen
Cellular location of action	Must enter the cell nucleus for transcription into mRNA	Functions directly in the cytoplasm
Expression pathway	DNA → mRNA (in nucleus) → antigen (in cytoplasm)	mRNA → antigen (direct translation in cytoplasm)
Delivery methods	Often intramuscular/intradermal, sometimes enhanced by electroporation	Usually lipid nanoparticles (LNPs) delivered intramuscularly
Speed of antigen expression	Slightly slower, requires transcription step	Rapid, translation begins immediately
Stability	More stable; DNA tolerates higher temperatures	Less stable; requires cold-chain storage
Manufacturing	Relatively simple and scalable plasmid production	Also scalable but involves RNA synthesis and LNP formulation
Risk of genomic integration	Theoretical but extremely low	None, does not enter nucleus
Immune response	Strong cellular immunity (T cells) and antibody responses	Strong humoral and cellular responses
Clinical maturity	Several veterinary vaccines; emerging human applications	Widely validated in humans (e.g., COVID-19 vaccines)

- Codon optimization to improve antigen expression.
- Synthetic promoters and regulatory elements to enhance transcription.
- Minicircle DNA vectors, which remove bacterial backbone sequences to improve safety and expression efficiency.
- Self-amplifying DNA (saDNA) constructs that increase antigen production.

These approaches make DNA vaccines more potent and precise.

3. DNA-encoded therapeutics

A major emerging field is the use of DNA to encode therapeutic proteins, including:

- DNA-encoded monoclonal antibodies (DMAbs)
- DNA-encoded cytokines and immunomodulators.

Current Landscape of DNA Vaccines in Infectious Diseases:

1. Licensed or Authorized DNA Vaccines:

Although most DNA vaccines remain investigational, a few important milestones demonstrate the platform's clinical viability.

SARS-CoV-2:

- ZyCoV-D (India) – the first human DNA vaccine authorized for use (2021).
- Uses a plasmid DNA platform delivered intradermally with a needle-free injector.
- Demonstrated the feasibility of DNA vaccines for large-scale pandemic response.

This authorization marked a major milestone in nucleic-acid vaccinology and highlighted the speed and scalability of DNA vaccine manufacturing.

2. Major Viral Targets in Clinical Development

HIV

HIV has historically been one of the first targets for DNA vaccine technology, with early clinical trials beginning in the late 1990s. These trials established proof of concept for safety and immunogenicity, although achieving strong protective efficacy remains challenging.

Current research focuses on:

- Prime-boost regimens (DNA prime + viral vector boost)
- Mosaic antigen constructs to address viral diversity.

Influenza

DNA vaccines targeting influenza hemagglutinin or conserved viral proteins are under evaluation. These candidates aim to:

- Enable rapid pandemic vaccine production
- Potentially support development of universal influenza vaccines.

Zika Virus

Following the 2015–2016 outbreak, DNA vaccines rapidly entered clinical testing.

- Early candidates such as GLS-5700 (Inovio) progressed to human trials and demonstrated safety and immunogenicity.

Zika vaccine development became a model for rapid nucleic-acid vaccine design after genome sequencing of emerging pathogens.

SARS-CoV-2

Beyond ZyCoV-D, multiple DNA vaccine candidates were developed globally:

Examples:

- INO-4800 (Inovio)
- INO-4802, a pan-variant COVID-19 DNA vaccine candidate designed to target multiple variants simultaneously.

These efforts illustrated how DNA vaccines can be rapidly adapted during emerging pandemics.

Major Cancer Targets in DNA Vaccine Development:

In general, these are the key advantages of DNA Cancer Vaccines:

- Induction of strong $CD8^+$ T-cell responses
- Ability to encode multiple tumor antigens
- Rapid and scalable manufacturing
- Good safety-profile in clinical trials.

HPV-related cancers:

The most advanced DNA cancer vaccines target cancers caused by human papillomavirus (HPV).

Example: VGX-3100

- DNA vaccine encoding HPV16 and HPV18 E6/E7 oncogenic proteins
- Targets cervical intraepithelial neoplasia (precancerous lesions)
- Evaluated in Phase III clinical trials and shown to induce regression of HPV-related lesions.

This program represents one of the most clinically advanced DNA vaccine approaches in oncology.

Melanoma:

Several DNA vaccines target melanoma antigens.

Example: SCIB1

- Plasmid DNA vaccine encoding melanoma antigens TRP-2 and gp100
- Designed to induce strong cytotoxic T-cell responses
- Evaluated in Phase I/II clinical trials.

These vaccines aim to stimulate immune recognition of melanoma cells expressing these antigens.

Breast cancer:

DNA vaccines targeting breast cancer antigens and neoantigens are under early clinical investigation.

Example:

- Poly-epitope DNA vaccines targeting tumor antigens in triple-negative breast cancer
- Early trials demonstrated strong immune responses and encouraging survival outcomes.

Lung cancer:

Some DNA vaccines encode multiple tumor antigens for non-small cell lung cancer (NSCLC).

Example:

- STEMVAC, a multi-antigen DNA vaccine targeting proteins involved in cancer stem cells and tumor progression.

Categories of DNA Cancer Vaccines:

1. Tumor-associated antigen vaccines

These vaccines encode shared cancer antigens found in many patients.

Common targets include:

- HER2/neu
- PSA (prostate-specific antigen)
- MUC1
- WT1
- HPV E6/E7

Advantages:

- Easier manufacturing
- Applicable to larger patient populations.

2. Neoantigen DNA vaccines

A newer approach involves personalized cancer vaccines.

These vaccines encode tumor-specific mutations unique to each patient, identified by tumor genome sequencing.

Advantages:

- Highly specific
- Reduced risk of targeting normal tissues.

This strategy is becoming central in precision oncology.

3. DNA-encoded immunotherapies

Another emerging strategy is DNA-encoded monoclonal antibodies or cytokines.

Examples:

- DNA-encoded checkpoint inhibitors
- DNA-encoded cytokines (IL-12)

This approach allows host cells to function as in vivo bioreactors producing therapeutic proteins.

4. Combination Strategies

Most cancer DNA vaccines are now being tested in combination therapies, such as:

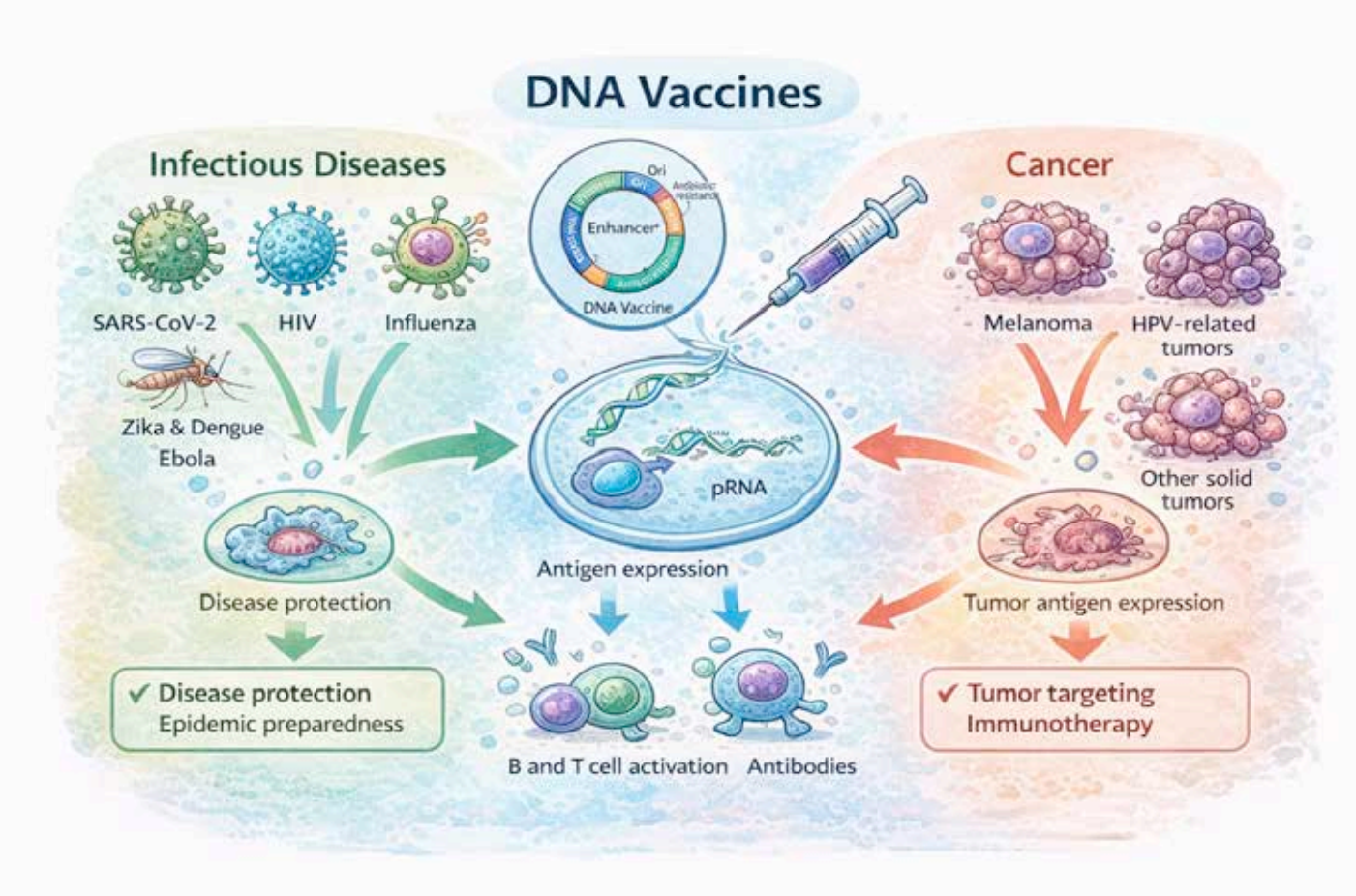
- Checkpoint inhibitors (anti-PD-1, anti-CTLA-4)
- Radiotherapy
- Chemotherapy
- Oncolytic viruses

These combinations aim to overcome tumor immune evasion.

Conclusions:

DNA vaccines are emerging as a versatile platform with the potential to reshape modern immunotherapy and vaccinology. Their genetic flexibility allows rapid adaptation to newly emerging pathogens while also enabling the design of therapeutic strategies for complex diseases. Moving forward, progress will depend on integrating advances in systems biology, precision

Figure 2. Schematic overview of DNA vaccines for infectious diseases and cancer:



immunology, and translational research to refine antigen selection, improve delivery technologies, and better characterize immune responses.

The use of high-throughput genomic and immunological tools will facilitate the rational development of vaccines tailored to specific diseases and population needs. At the same time, precision immunology may support more individualized vaccination strategies by aligning vaccine constructs with the immune profile of each patient.

Equally important will be translating technological innovation into clinically feasible solutions. Scalable manufacturing processes, more efficient delivery systems, and reliable biomarkers of immune protection will be critical to advancing DNA vaccines from experimental platforms to widely applicable medical tools. With continued progress in these areas, DNA vaccines could become a powerful and adaptable approach for both preventive and therapeutic interventions across infectious diseases, cancer, and immune-mediated conditions.

ibliography:

1. Neeli P, Chai D, Roy D, Prajapati S, Bonam SR. **DNA Vaccines in the Post-mRNA Era: Engineering, Applications, and Emerging Innovations.** *Int J Mol Sci.* 2025 Sep 7;26(17):8716. doi: 10.3390/ijms26178716.
2. Wang C, Yuan F. **A comprehensive comparison of DNA and RNA vaccines.** *Adv Drug Deliv Rev.* 2024 Jul;210:115340. doi: 10.1016/j.addr.2024.115340.
3. Amanpour S. **The Rapid Development and Early Success of Covid 19 Vaccines Have Raised Hopes for Accelerating the Cancer Treatment Mechanism.** *Arch Razi Inst.* 2021 Mar;76(1):1-6. doi: 10.22092/ari.2021.353761.1612.
4. Bhojnagarwala PS, Jose J, Zhao S, Weiner DB. **DNA-based immunotherapy for cancer: In vivo approaches for recalcitrant targets**. *Mol Ther.* 2025 Jun 4;33(6):2719-2739. doi: 10.1016/j.ymthe.2025.04.008.
5. Tiptiri-Kourpeti A, Spyridopoulou K, Pappa A, Chlichlia K. **DNA vaccines to attack cancer: Strategies for improving immunogenicity and efficacy.** *Pharmacol Ther.* 2016 Sep;165:32-49. doi: 10.1016/j.pharmthera.2016.05.004.
6. Kaushik M, Madeswaraguptha P, Vanangamudi M, Surendran V, Ashique S, Islam A, Mojgani N, Hussain A. **Recent progress, challenges (stability and in vivo distribution), and opportunities of DNA & mRNA vaccine in cancer immunotherapy.** *Adv Immunol.* 2025;166:211-258. doi: 10.1016/bs.ai.2024.10.008.
7. Sen A, Singh V, Ashique S, Jagriti, Biswas S, Islam A, Ehsan I, Mojgani N. **DNA and mRNA vaccines: Significant therapeutic approach against cancer management.** *Adv Immunol.* 2025;165:1-36. doi: 10.1016/bs.ai.2024.10.007.
8. Pagliari S, Dema B, Sanchez-Martinez A, Montalvo Zurbia-Flores G, Rollier CS. **DNA Vaccines: History, Molecular Mechanisms and Future Perspectives.** *J Mol Biol.* 2023 Dec 1;435(23):168297. doi: 10.1016/j.jmb.2023.168297.
9. Manickan E, Karem KL, Rouse BT. **DNA Vaccines - A Modern Gimmick or a Boon to Vaccinology?** *Crit Rev Immunol.* 2017;37(2-6):483-498. doi: 10.1615/CritRevImmunol.v37.i2-6.140.
10. Silveira MM, Moreira GMSG, Mendonça M. **DNA vaccines against COVID-19: Perspectives and challenges.** *Life Sci.* 2021 Feb 15;267:118919. doi: 10.1016/j.lfs.2020.118919.
11. Lopes A, Vandermeulen G, Préat V. **Cancer DNA vaccines: current preclinical and clinical developments and future perspectives**. *J Exp Clin Cancer Res.* 2019 Apr 5;38(1):146. doi: 10.1186/s13046-019-1154-7.
12. Sheridan C. **First COVID-19 DNA vaccine approved, others in hot pursuit**. *Nat Biotechnol.* 2021 Dec;39(12):1479-1482. doi: 10.1038/d41587-021-00023-5.

Best Practice

CURRENT INDICATIONS AND STRATEGIES FOR PNEUMOCOCCAL VACCINATION IN CHILDREN

Introduction

Streptococcus pneumoniae remains one of the most important causes of preventable illness and death worldwide, particularly among children under five years of age. The burden is disproportionately concentrated in low- and middle-income countries, where access to timely diagnosis, treatment, and vaccination may be limited. Pneumococcal disease encompasses a wide clinical spectrum, ranging from common infections such as acute otitis media and sinusitis to severe invasive conditions including pneumonia, bacteremia, and meningitis.

Before the widespread introduction of pneumococcal conjugate vaccines (PCVs), pneumococcal disease caused an estimated 14.5 million cases and approximately 735,000 deaths annually among HIV-uninfected children under five years of age. Over the past two decades, the integration of PCVs into national immunization programs has dramatically altered this landscape. Modeling studies suggest that by 2015, global pneumococcal cases in this age group had declined to about 3.7 million, with deaths reduced to approximately 294,000.

The global expansion of PCV programs represents one of the major successes of modern vaccination strategies. Between 2000 and 2015, pneumococcal mortality in children under five declined by roughly 51%, largely attributable to vaccine introduction and increasing coverage. Continued scale-up of pneumococcal vaccination is expected to have an even greater impact, with projections indicating that PCVs could

prevent nearly two million additional deaths among young children between 2021 and 2030.

By 2024, pneumococcal conjugate vaccines had been incorporated into the routine immunization schedules of 162 of the 194 WHO Member States. Global coverage with the final PCV dose reached approximately 67%. Among the 157 countries reporting national data after introducing PCV, median coverage was substantially higher, at 89%, although wide variation persists across settings. In Gavi-eligible countries, where pneumococcal disease burden remains highest, 50 of 57 countries had introduced PCV by 2024, with last-dose coverage averaging around 75%.

Pneumococcal protein-polysaccharide conjugate vaccines:

The first PCVC to be widely implemented in infant immunization programs was the 7-valent PCV (PCV7), introduced in 2000. Its success in reducing invasive pneumococcal disease rapidly led to the development of higher-valency vaccines designed to broaden serotype coverage. Countries that initially adopted PCV7 later transitioned to expanded formulations, most commonly the 13-valent vaccine (PCV13-Pfizer), while others introduced alternative products such as the 10-valent vaccine (PCV10-GSK).

Over time, the pneumococcal vaccine landscape has continued to evolve. In 2019, a new 10-valent vaccine developed by the Serum Institute of India (PCV10-SII, Pneumosil®) received WHO prequalification, providing an additional option particularly relevant for low- and middle-income countries. Beyond these widely used formulations, several other conjugate vaccines containing between 7 and 20 serotypes have received regulatory authorization, including three products with expanded coverage beyond 13 serotypes.

The next generation of pneumococcal vaccines is already advancing through late-stage clinical development. Some candidates aim to include more than 20 serotypes, while others explore innovative strategies such as alternative conjugation technologies or the use of pneumococcal proteins as carrier antigens, with the goal of improving immunogenicity and broadening protection against pneumococcal disease.

Serological endpoints for assessing immunogenicity and non-inferiority of pneumococcal conjugate vaccines (PCVs):

To facilitate the evaluation of new PCVs, the World Health Organization (WHO) has established immunological criteria designed to demonstrate non-inferiority compared with licensed reference vaccines. These criteria allow new formulations—including higher-valency vaccines—to be assessed without the need for large efficacy trials. The evaluation focuses primarily on two immunogenicity endpoints measured approximately four weeks after completion of the primary infant series.

The first endpoint is the proportion of vaccine recipients achieving serotype-specific immunoglobulin G (IgG) concentrations at or above 0.35 µg/mL, determined using the standardized WHO reference ELISA or an appropriately validated alternative assay. This threshold is widely considered a correlate of protection against vaccine-type invasive pneumococcal disease and is commonly referred to as the proportion of "Sero responders."

The second endpoint is the geometric mean concentration (GMC) of serotype-specific IgG antibodies, which provides an overall measure of the magnitude of the immune response.

In comparative studies, non-inferiority is typically demonstrated when the candidate vaccine meets predefined statistical margins for both endpoints relative to the comparator vaccine. However, regulatory guidance recognizes that strict equivalence across all serotypes may not always be achievable. Consequently, if one or more serotypes fail to meet both criteria, satisfying at least one of the immunogenicity endpoints may still be considered acceptable for licensure, provided the overall immune profile remains comparable to that of the reference vaccine.

The 0.35 µg/mL threshold is based on pooled efficacy data from earlier trials of PCV7 and experimental higher-valency formulations, which demonstrated strong protection against vaccine-type invasive pneumococcal disease, corresponding to functional opsonophagocytic antibody titers (OPA) >1:8. Nevertheless, the relationship between lower serotype-specific GMCs and clinical protection remains incompletely understood. Importantly, these immunological benchmarks are intended to

support aggregate assessments of non-inferiority across serotypes rather than to define absolute protection for each individual serotype. For this reason, trials must prespecify appropriate non-inferiority margins and implement statistical approaches that account for multiple serotype-specific comparisons (see Figures 1 and 2).

WHO recommendations for pneumococcal conjugate vaccines (PCVs) in children:

- At least three doses of a PCV are recommended in infancy to ensure adequate protection against pneumococcal disease.
- Vaccination schedules may follow either a 3+0 or a 2+1 regimen, depending on local or national epidemiology, programmatic considerations, and health system capacity.
- First dose: PCV should be administered starting at ≥6 weeks of age, typically aligned with routine infant immunization schedules.
- For the 2+1 schedule:
  - The primary series consists of two doses, given at intervals of at least 8 weeks.
  - A booster dose is recommended between 9 and 18 months of age to enhance and prolong immune protection.
- The 3+0 schedule consists of three primary doses in early infancy without a booster and may be preferred in settings where early protection against invasive pneumococcal disease is a priority.
- National immunization programs should select the schedule that best addresses local pneumococcal disease burden, transmission dynamics, and vaccine coverage patterns.

Catch-up pneumococcal vaccination in children

- In previously unvaccinated children aged 1 to 5 years, catch-up pneumococcal vaccination is recommended to provide protection against invasive pneumococcal disease.
- In children aged ≥24 months, a single dose of PCV can be administered as part of the catch-up strategy.
- In children aged 12–23 months, current

Figure 1. Comparison of seroconversion proportions according to non-inferiority criteria:

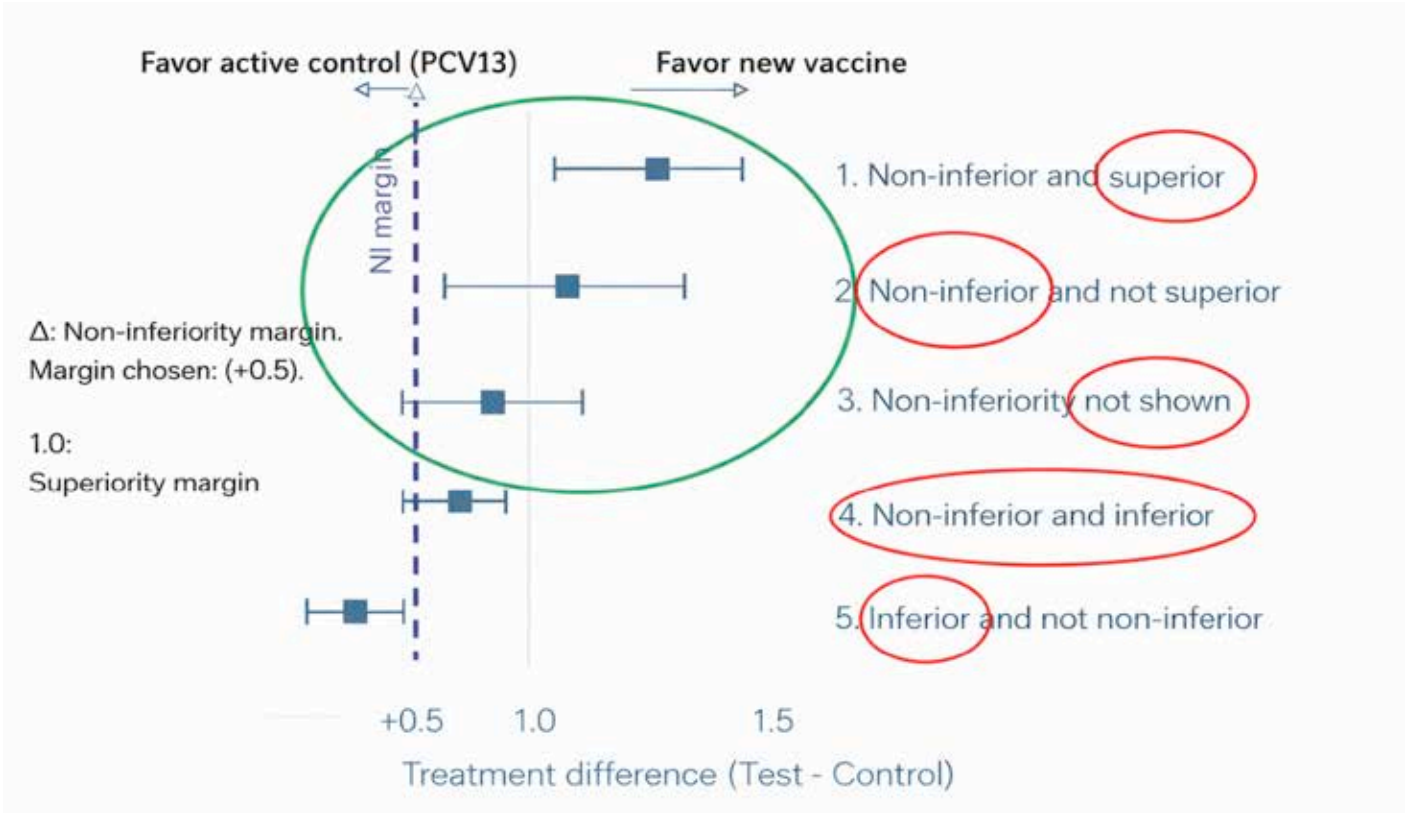
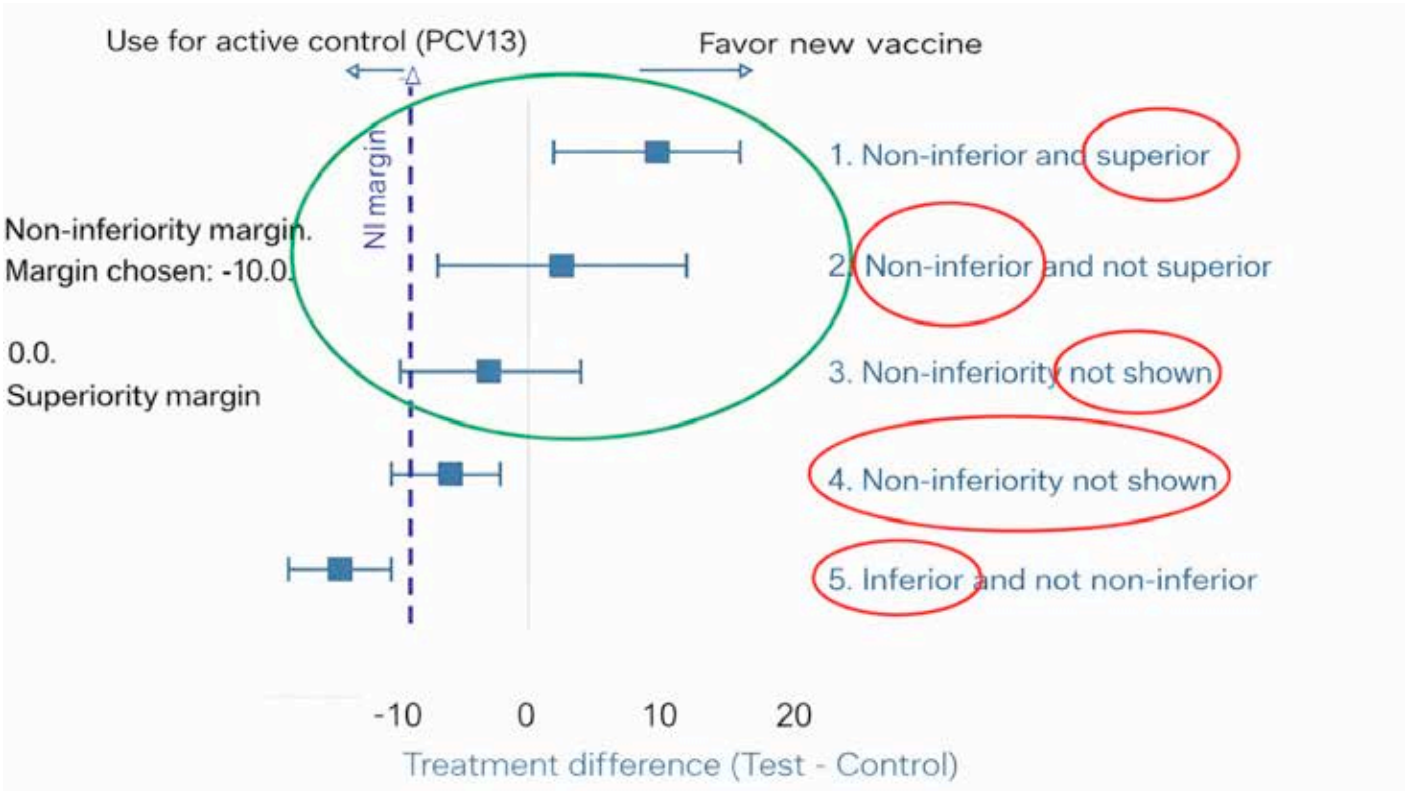


Figure 2. Comparison of geometric mean antibody concentrations according to non-inferiority criteria:



evidence is insufficient to definitively determine whether one or two doses are required for optimal protection.
- Therefore, countries that adopt a single-dose catch-up strategy in this age group should carefully monitor vaccine impact and potential vaccine failures through surveillance systems.
- National immunization programs should consider local epidemiology, pneumococcal disease burden, and vaccine coverage levels when implementing catch-up vaccination strategies.

interchangeability of pneumococcal conjugate vaccines (PCVs)

- Currently, evidence on the interchangeability among all available PCVs remains limited.
- Once a PCV product has been introduced into a vaccination program, switching to another product is generally not recommended, unless there are substantial epidemiological, programmatic, or financial considerations.
- If the vaccination series cannot be completed with the same PCV product, the available PCV may be used to complete the schedule.
- Restarting a vaccination series with a different PCV is not recommended, including during the primary infant series.
- When a change in product is necessary, the replacement vaccine should be another who-prequalified PCV that has demonstrated adequate immunogenicity based on non-inferiority criteria.

Reduced-dose PCV schedules (1+1):

Countries seeking to reduce program costs or the number of injections in the infant immunization schedule may consider a 1 primary dose plus 1 booster (1p+1) PCV schedule as an off-label alternative to the standard 3-dose schedule, provided certain conditions are met. The best example currently is the United Kingdom.

Key requirements include:

- Strong population immunity in children under 5 years, demonstrated by:
  - A well-established vaccination program

with ≥80% coverage of the third dose during the previous 5 years,
  - A recent multi-age vaccination campaign achieving ≥80% coverage in children under 5 years, or
  - Low levels of vaccine-type pneumococcal carriage or disease, confirmed through reliable surveillance data.
- The capacity to deliver a booster dose between 9 and 18 months of age, with sustained vaccination coverage of ≥80% over the previous 5 years.

Before implementing a 1p+1 schedule, countries should also:

- Carefully evaluate the balance between potential cost savings and possible reductions in protection, and
- Ensure robust surveillance systems are in place to monitor invasive pneumococcal disease or pneumococcal carriage and detect any changes in vaccine-type disease.

Currently WHO-prequalified pneumococcal conjugate vaccines (PCVs):
Accumulating epidemiological evidence demonstrates that national PCV programs can substantially reduce vaccine-type invasive pneumococcal disease (IPD) and childhood pneumococcal pneumonia when implemented with high coverage. Historically, these public health gains have been achieved with WHO-prequalified vaccines such as PCV13 (Pfizer), PCV10 (GlaxoSmithKline), and PCV10 (Serum Institute of India), delivered through either a 3p+0 or a 2p+1 infant immunization schedule. More recently, the vaccine landscape has expanded with the introduction of additional higher-valency products, including the 14-valent pneumococcal conjugate vaccine (PCV14, Pneubevax®; Biological E.), which aims to broaden serotype coverage while maintaining strong immunogenicity. As newer PCVs become available, maintaining high vaccination coverage and appropriate scheduling remains critical to sustaining reductions in vaccine-type IPD, decreasing pneumococcal pneumonia in children, and strengthening population-level protection through herd effects.

Bibliography:

1. WHO position paper: Pneumococcal conjugate vaccines in infants and children aged <5 years – September 2025. https://www.who.int/publications/i/item/who-wer10039-411-437.
2. WHO: Pneumococcal Disease. https://www.who.int/teams/health-product-policy-and-standards/standards-and-specifications/norms-and-standards/vaccine-standardization/pneumococcal-disease.
3. WHO Prequalification of Medical Products: Pneubevax 14®. https://extranet.who.int/prequal/vaccines/p/pneubevax-14r.
4. von Gottberg A et al. Effects of vaccination on invasive pneumococcal disease in South Africa. N Engl J Med. 2014;371(20):1889–99.
5. Malley R. Antibody and cell-mediated immunity to Streptococcus pneumoniae: implicationsfor vaccine development. J Mol Med (Berl). 2010;88:135–42. doi: 10.1007/s00109-009-0579-4.
6. Francis JP et al. A longitudinal study of natural antibody development to pneumococcal surface protein A families 1 and 2 in Papua New Guinean Highland children: a cohort study. Pneumonia (Nathan). 2016;8:12. doi: 10.1186/s41479-016-0014-x.
7. Feemster K et al. Implications of cross-reactivity and cross-protection for pneumococcal vaccine development. Vaccines (Basel). 2024;12(9):974. doi: 10.3390/vaccines12090974.
8. Recommendations to assure the quality, safety and efficacy of pneumococcal conjugate vaccines. In: WHO Expert Committee on Biological Standardization, sixtieth report. Geneva: World Health Organization; 2013. Annex 3 (WHO Technical Report Series, No. 977; https://www.who.int/publications/m/item/pneumococcal-conjugate-vaccines-annex3-trs-977.
9. Ngocho JS et al. Effectiveness of pneumococcal conjugate vaccines against invasive pneumococcal disease among children under five years of age in Africa: a systematic review. PLoS One. 2019;14:e0212295. doi: 10.1371/journal.pone.0212295.
10. de Oliveira LH et al. Declines in pneumonia mortality following the introduction of pneumococcal conjugate vaccines in Latin American and Caribbean countries. Clin Infect Dis. 2020. doi: 10.1093/cid/ciaa614.
11. Clarke E et al. Immunogenicity and safety of a novel ten-valent pneumococcal conjugate vaccine in healthy infants in the Gambia: a phase 3, randomised, double-blind, non-inferiority trial. Lancet Infect Dis. 2021;21:834-46. doi: 10.1016/S1473-3099(20)30735-0.
12. Deloria Knoll M et al. Systematic review of the effect of pneumococcal conjugate vaccine dosing schedules on immunogenicity. Pediatr Infect Dis J. 2014;33 Suppl 2:S119–29. doi: 10.1097/INF.0000000000000079.
13. Cohen O et al. Pneumococcal conjugate vaccine (PCV) review of impact evidence (PRIME). Geneva: World Health Organization; 2017. https://terrance.who.int/mediacentre/data/sage/SAGE_Docs_Ppt_Oct2017/9_session_PCV/Oct2019_session9_PCV_PRIMEsummary.pdf.
14. Bertran M et al. Invasive pneumococcal disease 3 years after introduction of a reduced 1 + 1 infant 13-valent pneumococcal conjugate vaccine immunization schedule in England: a prospective national observational surveillance study. Lancet Infect Dis. 2024;24:546–56. doi: 10.1016/S1473-3099(23)00706-5.

Guest Contributors

VAXIMPACT: AN INTERACTIVE WEB APP QUANTIFYING THE HEALTH AND ECONOMIC CONSEQUENCES OF DECLINING CHILDHOOD VACCINATION ACROSS U.S. STATES

Mahmud Sheku, MPH, MS, PhD Student. Emory University Rollins School of Public Health, Atlanta, Geogia, USA. Contributions: Connor Van Meter, MSPH; Robert A. Bednarczyk, PhD; Kathrine Seib, MSPH; Emilia Grill, MPH; and Benjamin A. Lopman, PhD.

Recent declines in childhood vaccination coverage in the United States have raised concern among vaccine scientists. Kindergarten vaccination rates have decreased across multiple states[1] (CDC 2023), and exemption rates for one or more childhood vaccines increased from 3.3% to 3.6% across 40 states[2]. At the same time, measles cases in 2024-2025 have surged, reaching over 2,000 reported cases nationally[3], the highest number recorded in the U.S. since 1991. Reported pertussis cases have also increased substantially compared to prior years[4].

These trends highlight how quickly vaccine preventable diseases can re-emerge when population immunity declines. While measles has drawn public attention, declines in coverage may also affect other vaccine-preventable diseases, including rotavirus, pertussis, and invasive pneumococcal disease (IPD), that receive comparatively less sustained media focus despite imposing a substantial health and economic burden. Because disease transmission is nonlinear, even modest sustained reductions in coverage can allow susceptible individuals to accumulate across birth cohorts, increasing outbreak risk and amplifying downstream population-level health and economic consequences.

At the same time, childhood immunization policy in the U.S. is in flux. In early 2026, following a presidential memorandum directing a review of the U.S. vaccine practices relative to peer nations, the Department of Health and Human Services and the Centers for Disease Control and Prevention (CDC) updated the childhood immunization schedule5. Under this revised framework, the rotavirus vaccine and five other vaccines that were previously recommended universally for all children are now only recommended for high-risk groups or through shared clinical decision-making. These changes represent a departure from the traditional Advisory Committee on Immunization Practices (ACIP) consensus process. As a result, differences have emerged between federal recommendations and immunization schedules maintained by professional organizations such as the American Academy of Pediatrics, potentially adding complexity to clinical decision-making. Public health experts have noted the on potential impact of such changes on vaccine uptake, confidence, and disease outcomes.

In this evolving immunization landscape shaped by vaccine hesitancy, misinformation, and ongoing policy discussions, policymakers and public health leaders need tools that translate changes in vaccine coverage into projected health and economic consequences. To address this need, our team at Emory University's Rollins School of Public

Health developed VaxImpact6, a publicly available, interactive, state-specific decision-support platform that projects the additional burden associated with declining infant vaccination.

What is VaxImpact?

VaxImpact is a decision-support tool that uses calibrated, state-level equilibrium transmission models to estimate how reductions in infant vaccination coverage could affect disease burden across U.S. states. It provides state-level projections, accounting for differences in baseline state-level vaccination coverage, state-specific population size, birth cohort structure, and transmission dynamics.

This initial release modeled three routine childhood vaccine preventable diseases, including rotavirus (diarrheal disease), pertussis (whooping cough), and invasive pneumococcal disease (IPD). These diseases have predictable relationship between vaccination coverage and their corresponding disease burden.

Rotavirus was modeled using a Susceptible-Infection-Recovered (SIR) framework. Pertussis and IPD are modeled using a Susceptible-Infection-Recovered-Susceptible (SIRS) framework with waning immunity. Models incorporated state-specific population size, birth rates and vaccination coverage. Coverage declines of 0-20 percentage points were applied to infant cohorts and translated into effective age-band coverage. We compared a one-year shock scenario with a five-year sustained decline scenario in which reduced coverage accumulates across successive birth cohorts. Models were calibrated to reproduce national surveillance-based disease burden and vaccination impact patterns. Outcomes include additional annual cases, hospitalizations, deaths, missed workdays, and total economic costs (direct medical costs and productivity losses).

How does the tool work?

VaxImpact allows users to simulate vaccine coverage declines and explore projected impact in real time. Users can select one of the three modeled diseases, specify a coverage decline (0-20 percentage points), choose between a one-year shock or a sustained five-year decline scenario, and toggle between total burden and additional burden to see the impact attributable to declining coverage in each state. For each state, the platform dynamically updates projections of additional annual cases, hospitalizations, deaths, lost workdays, and total costs. Users can hover over individual states to view state-specific characteristics and projected outcomes.

What do we project?

One-year 0-20% decline

Nationally, a one-year 20% decline in infant vaccination coverage is projected to result in 230,358 additional rotavirus cases (3,294 hospitalizations; 2 deaths), 13,559 additional pertussis cases (644 hospitalizations; 6 deaths), and 1,426 additional IPD cases (1,183 hospitalizations; 44 deaths), with associated annual total costs of $259 million, $44 million, and $25 million, respectively.

Five-year 0-20% decline

Following a five-year decline of 20%, impacts increase substantially due to the accumulation of susceptible children, resulting in 809,819 additional rotavirus cases (11,580 hospitalizations; 6 deaths), 56,502 additional pertussis cases (2,768 hospitalizations; 27 deaths), and 4,631 additional IPD cases (3,844 hospitalizations; 142 deaths), with projected annual disease-specific total costs exceeding $911 million, $183 million, and $81 million, respectively.

State-level variation

Projected impacts vary substantially across states. This variation reflects differences in baseline vaccination coverage, population size, birth cohort structure, and state-specific transmission dynamics.

For instance, under a sustained five-year 20% decline in vaccine coverage for each of the modeled disease:

Rotavirus: National rotavirus burden in under five children is projected to increase by 154% by 2031. In states with higher population and low to moderate baseline coverage, like Texas, the scenario could result in 6,542 additional cases per 100,000 children (a 354%

increase in disease burden) compared to 3,671 additional cases per 100,000 children (a 97% increase) in Georgia by 2031.

Pertussis: National pertussis burden in children under 14 years is projected to increase by 65% by 2031. In Texas, the scenario could result in 108 additional cases per 100,000 children (a 54-fold increase) compared to 71 additional cases per 100,000 children (a 72% increase) in Florida by 2031.

Invasive Pneumococcal Disease: National IPD burden in under five children is projected to increase by 98% by 2031. In California, the scenario could result in 19 additional cases per 100,000 children (a 112% increase in disease burden) compared to 16 additional cases per 100,000 children (a 76% increase) in Florida by 2031.

These findings demonstrate how sustained reductions in coverage can lead to disproportionate increases in disease burden and economic losses borne by families, healthcare systems, insurers, employers, and state and federal public health programs.

Why does this matter now?

The resurgence of measles and the increase in pertussis cases have demonstrated how quickly vaccine-preventable diseases can return when population immunity declines. While measles often serves as the visible signal of coverage erosion, other diseases may increase more quietly but still pose substantial burden with real consequences for individuals, children, families, public health, and the U.S. health care system.

As vaccination policy discussions intensify at both federal and state levels, stakeholders require evidence-based projections to inform immunization program planning, legislative discussions, public communication strategies, and resource allocation. By translating changes in vaccine uptake into projected additional cases, hospitalizations, deaths, and economic costs, the VaxImpact helps quantify the potential consequences of declining coverage to inform ongoing immunization policy debates and outbreak prevention efforts.

Looking ahead

Routine childhood immunization programs have dramatically reduced morbidity and mortality from vaccine-preventable diseases in the United States over the past six decades. These gains were achieved through sustained high vaccination coverage, strong public health infrastructure, and consistent immunization policy. However, this progress can erode quickly if coverage declines. Rebuilding population immunity after sustained reductions may take years, particularly as susceptible individuals accumulate across birth cohorts. Maintaining these gains, therefore, requires science-driven immunization policies aimed at sustaining higher coverage levels. In an evolving immunization landscape, a publicly available scenario-based tool like VaxImpact can support proactive planning and evidence-based policymaking.

We invite vaccine researchers, immunization program leaders, and policymakers to explore the platform and consider how state-specific projections can inform local decision-making.

Future development of VaxImpact will expand to additional vaccine-preventable diseases, age groups, and other granularity, further enhancing the tool's utility for immunization program planning and policy evaluation.

Reference
1. CDC. Vaccination Coverage and Exemptions among Kindergartners. SchoolVaxView. July 31, 2025. Accessed March 1, 2026. https://www.cdc.gov/schoolvaxview/data/index.html
2. Seither, R. Coverage with Selected Vaccines and Exemption from School Vaccine Requirements Among Children in Kindergarten — United States, 2022–23 School Year.
3. CDC. Measles Cases and Outbreaks. Measles (Rubeola). February 27, 2026. Accessed March 1, 2026. https://www.cdc.gov/measles/data-research/index.html
4. CDC. Pertussis Surveillance and Trends. Whooping Cough (Pertussis). January 5, 2026. Accessed March 1, 2026. https://www.cdc.gov/pertussis/php/surveillance/index.html
5. Affairs (ASPA) AS for P. [node.field_full_title]. January 5, 2026. Accessed March 1, 2026. https://www.hhs.gov/press-room/cdc-acts-presidential-memorandum-update-childhood-immunization-schedule.html
6. VaxImpactMap: Costs of Declining Childhood Vaccination. VaxImpactMap. Accessed March 1, 2026. https://vaximpactmap.org/

VACCINES BEAT

Who we are

At Vaccines Beat, we understand that vaccines and immunization have become a crucial topic of discussion at the center of any public health analysis. Therefore, timely, relevant, accessible, and well-curated information for all vaccine preventable diseases is key to advancing better health policies.

For this reason, a team of passionate vaccine professionals has created Vaccines Beat and each month diligently works to share with the healthcare ecosystem information, knowledge, and insights to improve global health.

Vision

Vaccines Beat aims to become the beacon of insight in the public health ecosystem through its distinctive monthly newsletter. With an in-depth 360 perspective, carefully curated information and expert analysis, this novel platform fosters collaboration among a diverse global network of stakeholders.

Mission

Vaccines Beat's main task is to inform through the review of the most recent developments in vaccines, immunization, and vaccine preventable diseases. Our mission extends to sharing best practices from successful initiatives worldwide while building bridges through editorial collaboration with regional and international stakeholders.

Vaccines Beat highlights the importance of information sharing & collaborative efforts within the public health community to boost vaccination campaigns, R&D, public policy, access, awareness, and equity.

Vaccines Beat encourages stakeholders to take action and promote sustainable commitment with continued support through multi-stakeholder synergies.

ISSN: 2997-2833

For any information required, please write to:
info@vaccinesbeat.org

Visit: https://vaccinesbeat.org

SPONSORS

PARTNERS