Strategic Priority 7: Regional engagement strategy to identify IA2030 global priority endemic pathogens

World Health Organization

Immunization, Vaccines and Biologicals

Vaccine Prioritization & Platforms Team

PDVAC, 12 December 2023

Goals and Outline

Goal: To present the global list of priority endemic pathogens for vaccine R&D

1. Rationale and anticipated change
2. Process and methodology
3. Results: What do stakeholders value?
4. Results: Global pathogen priorities
5. Support in developing regional R&D agendas
6. Monitoring
7. From analyses to actions

What is our goal?

As a global health community, we must focus our efforts on developing vaccines for the pathogens that most impact communities across the world.

What?

- **Identify R&D priorities:** list of global endemic pathogen targets for new vaccines

Why?

- Because we want to develop vaccines that respond to regional and global needs
- Because we want to accelerate vaccine development by aligning immunization stakeholders
- Because we want to track progress in vaccine and immunization R&D under IA2030

How?

- **According to IA2030 Core Principles**
  - *People centered*: vaccines are developed to meet people's needs
  - *Data driven*: systematic and evidence-based approach to identify priorities
  - *Partnership based*: in partnership with regions and immunization stakeholders;
  - *Country owned*: countries and regions can translate vaccine priorities into local R&D strategies
- **With support from SP7 WG, PDVAC, and SAGE**
- Complementarity to other projects (Vaccines and AMR, R&D Blueprint)

How will the Global priority list be used?

Priorities will **inform** stakeholder strategies
Priorities should be **considered** in the context of existing global, regional and country R&D strategies

Regional stakeholders

- **Industry**: inform vaccine R&D investments
- **Funders**: inform capacity building for vaccine R&D
- **Researchers**: inform evidence generation activities
- **Policy makers**: build awareness of R&D pipelines

Global stakeholders

- **WHO:** inform activities to accelerate evidence generation, R&D, and policy making to serve low-resource settings
- **Gavi**: inform Vaccine Investment Strategy (VIS)
- **IA2030:** to monitor progress in global R&D for new vaccines

Process to identify endemic pathogens for new vaccine R&D

We used robust research process with regions to create the Global pathogen priority list.

Mid 2022
1. Review the landscape

Nov 2022– May 2023
2. Synthesize Data

Nov 2022– May 2023
3. Conduct survey

May 2023 - December 2023
4. Identify pathogen priorities

July 2023 onwards
4a. Support regional R&D agendas

2024 onwards
5. Monitor and update

Process to identify regional and global priorities

Step 1: Review the landscape

Mid 2022

1. Review the landscape

- Understand existing priorities
- Learn from previous prioritization exercises
- Define criteria for prioritization
- **Define pathogens in scope**

- Initial scope set by identifying pathogens through landscape review and applying screening questions

Screening questions	Rationale
Not emerging infectious diseases	WHO R&D Blueprint is identifying priorities
Human pathogens	Focus on human health
Without licensed vaccines, or where existing vaccines do not meet the needs of certain populations	Focus on the most acute needs
Have candidates in clinical development	Focus on targets with higher probability of success
Prioritized by existing roadmaps, TPPs, or VVPs, or recommended by regional advisors	Focus on pathogens of broad interest

- Scope has been updated based on regional advice, pipeline review, and new product licensures

MCDA: Multi-criteria decision analysis, PDVAC: Product Development for Vaccines Advisory Committee, IVB: WHO Headquarters Immunization, Vaccines, and Biologicals

Process to identify regional and global priorities

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Define pathogens in scope

PDVAC Actively supporting
Herpes simplex types 1 and 2
HIV-1
Influenza
Mycobacterium tuberculosis **(TB)**
Neisseria gonorrhoeae
Plasmodium falciparum
Respiratory syncytial virus (RSV) – *scores for "Unmet needs for prevention and treatment" updated in September 2023 due to new product licensures*
Salmonella **(non-typhoidal)**
Shigella **spp**
Streptococcus agalactiae **(group B streptococcus)**
Streptococcus pyogenes **(group A streptococcus)**

PDVAC Vaccine Value Profiles
Chikungunya virus
Cytomegalovirus
Hookworm
Intestinal pathogenic *E. coli* (InPEC)
Leishmania **spp**
Norovirus
Salmonella Paratyphi
Schistosomes

Other pathogens in scope
Chlamydia trachomatis – *added in December 2022 per regional advice*
Extra-intestinal pathogenic *E. coli* (ExPEC)
Hepatitis C virus – *added in December 2022 per regional advice*
Klebsiella pneumoniae
Mycobacterium leprae
Pseudomonas aeruginosa – *dropped in August 2023 due to lack of pipeline activity*
Staphylococcus aureus
Dengue – *added in October PDVAC meeting because epidemiology is expanding, and current vaccines do not meet public health need*

26 pathogens

The list has evolved since we began this exercise and is dynamic; recent PDVAC meeting requested that Dengue be added to the analysis

Process to identify regional and global priorities

Mid 2022

1. Review the landscape

- Understand existing priorities
- Learn from previous prioritization exercises
- **Define criteria for prioritisation**
- Define pathogens in scope

- **8 criteria for prioritization** defined based on best practices and relevant precedents
- Refined by PDVAC and other experts in July 2022

Criteria	Definition
Annual deaths in children under 5	Deaths attributable to the pathogen in both sexes, < 5 years old
Annual deaths in people older than 5	Deaths attributable to the pathogen in both sexes, ≥ 5 years old
Years lost to disability (all ages)	Years of healthy life lost each year due to disability or ill-health caused by the pathogen
Social and economic burden per case	Reflects individual social and economic impact such as stigma and the costs of prevention, health care, and lost productivity.
Disruption due to outbreaks	Reflects societal impact due to outbreaks and epidemics, including social disruption; impact on healthcare systems, trade or tourism; and the cost of containment measures
Contribution to inequity	Reflects disproportionate impact on socially and economically disadvantaged groups, including women
Contribution to antimicrobial resistance (AMR)	Reflects the threat of resistance, based on current levels of resistance, contribution to antibiotic use, and designation as an AMR priority
Unmet needs for prevention and treatment	Reflects the effectiveness and suitability of alternative measures

MCDA: Multi-criteria decision analysis, PDVAC: Product Development for Vaccines Advisory Committee, IVB: WHO Headquarters Immunization, Vaccines, and Biologicals

Process to identify regional and global priorities

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Nov 2022– May 2023

2. Synthesize Data

- Each pathogen scored **region-by-region** as Very low, Low, Medium, High, or Very high for each of the 8 criteria
- Quantitative criteria scored using Global Burden of Diseases 2019 data
- Qualitative criteria scored based on literature searches, Vaccine Value Profiles, using a scoring rubric
- Scores reviewed by at least 2 regional experts and 1 disease expert
- Significant effort to ensure that scores were harmonised, systematic, and informed by the most recent and relevant data.

Pathogen	1 Annual deaths in children under 5	2 Annual deaths in people 5 and older	3 Annual years lived with disability (all ages)	4 Social and economic burden per case	5 Disruption due to outbreaks	6 Contribution to inequity	7 Contribution to antimicrobial resistance	8 Unmet needs for prevention & treatment
Mycobacterium tuberculosis (TB)	Very high	Very high	Very high	Very high	Very high	Very high	Very high	High
Human immunodeficiency virus 1 (HIV-1)	Very low	Low	High	Very high	High	Very high	Very high	High
Klebsiella pneumoniae	Very high	Very high	Very low	High	Low	Low	Very high	High
Staphylococcus aureus	High	Very high	Very low	High	Very low	Medium	Very high	High
Group A streptococcus (Streptococcus pyogenes)	Very low	Very high	Very high	High	Very low	High	High	High
Extra-intestinal pathogenic E. coli (ExPEC)	High	Very high	Very low	Medium	Low	Medium	Very high	Medium
Respiratory syncytial virus	High	Low	Very low	Medium	High	Medium	High	High
Shigella	Very low	Very low	Low	High	Medium	High	Very high	High
Hepatitis C virus	Very low	High	Very low	Very high				
Dengue virus	Very low	Very low	Medium	Medium				
Group B streptococcus (Streptococcus agalactiae)	High	Low	Very low	High				
Leishmania	Very low	Very low	Very low	Very high				
Influenza	Very low	Low	Very low	Low				
Plasmodium falciparum (malaria)	Low	Very low	Low	High				
Mycobacterium leprae (leprosy)	Very low	Very low	Very low	Very high				
Norovirus	Very low	Low	Very low	Medium				
Intestinal pathogenic E. coli (InPEC)	Very low	Very low	Very low	Medium				
Neisseria gonorrhoeae	Very low	Very low	Very low	Medium				
Cytomegalovirus	Very low	Low	Medium	High				
Chikungunya virus	Very low	Very low	Very low	Medium				
Chlamydia trachomatis	Very low	Very low	Very low	Very high				
Salmonella Paratyphi	Very low	Very low	Very low	Low				
Herpes simplex types 1 and 2	Very low	Very low	Very low	High				
Non-typhoidal Salmonella	Very low	Very low	Very low	Low				
Schistosomes	Very low	Very low	Very low	Low				
Hookworm	Very low	Very low	Low	Low				

ARTICLE IN PRESS

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Value profile for respiratory syncytial virus vaccines and monoclonal antibodies

ARTICLE INFO

ABSTRACT

Process to identify regional and global priorities

Nov 2022– May 2023

3. Conduct survey

We carried out a multi-criteria decision analysis (MCDA) survey involving policy makers and other stakeholders to develop a top 10 pathogen list for each region, and combine to create a Global Pathogen Priority List.

Why use MCDA?

- Designed for complex decisions with diverse perspectives
- Has been used by IOM, CEPI, and WHO to define R&D priorities
- Endorsed by IVIR-AC for prioritization of health interventions and research
- Non-biased approach to value criteria to prioritize pathogens, it does not require pathogen knowledge to participate
- Results give insight into what people value
- Pathogen data can be updated as new information emerges

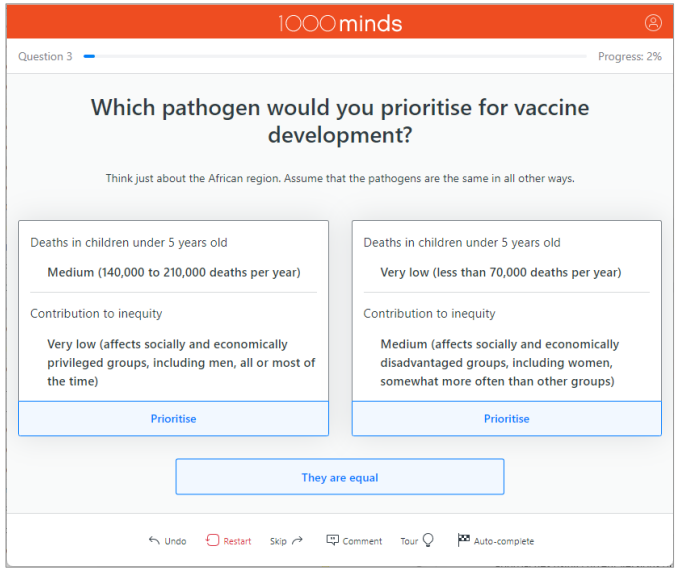
Process to identify regional and global priorities

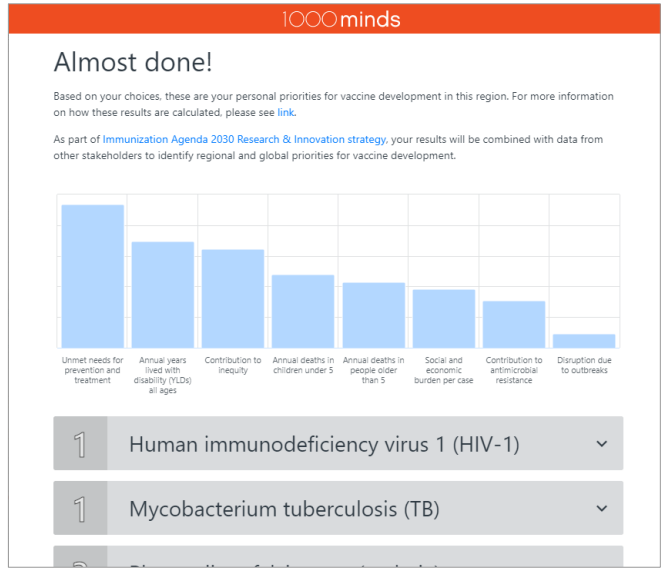
Nov 2022– May 2023

3. Conduct survey

- Surveys built using the 1000minds tool, populated with pathogens scores for each of the WHO regions, and translated into the major languages for each region
- Targeted dissemination by email to policy makers, health practitioners, and others from November 2022 to April 2023
- Participants carried out the survey without any pathogen names being present, they were asked to choose between hypothetical pathogens and values for their region.
- The tool calculated weights for criteria, multiplied by pathogen scores, to calculate the list of top 10 pathogens for each region.

Discrete choices





Criteria weights

Pathogen ranks

Compile global priority list

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May 2023 - December 2023

4. Identify pathogen priorities

- The Global priority pathogen list was created by bringing together all the pathogens that were identified by regions (**17 pathogens**).
- The Global List is robust: increasing the number of responses, dividing responses into clusters, and omitting selected criteria had no effect on its composition.
- Like IA2030, **these pathogens are diverse**
  - Reflect priorities of *all* regions
  - Affect people of all ages and all income levels

Global priority pathogens for new vaccine R&D (alphabetical)

Cytomegalovirus

Dengue

Extra-intestinal pathogenic *E. coli* (ExPEC)

Hepatitis C virus

HIV-1

Influenza

Klebsiella pneumoniae

Leishmania spp

Mycobacterium tuberculosis (TB)

Norovirus

Plasmodium falciparum

Respiratory syncytial virus (RSV)

Salmonella (non-typhoidal)

Shigella spp

Staphylococcus aureus

Streptococcus agalactiae (group B streptococcus)

Streptococcus pyogenes (group A streptococcus)

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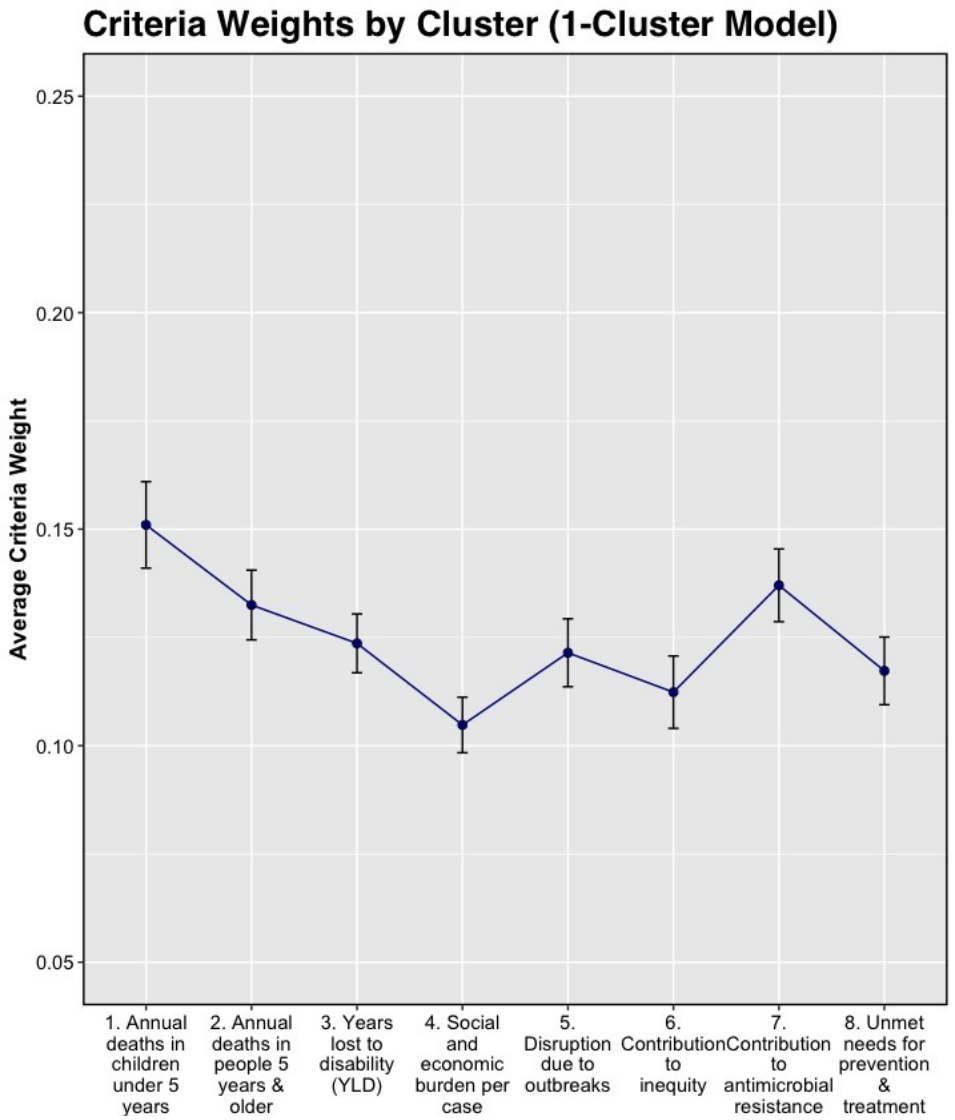
What do people value?

May 2023 - December 2023

4. Identify pathogen priorities

- The importance of criteria (weights) was evaluated across all regions.
- The 8 criteria have similar importance, they range from 11% to 15%
- The most important criteria were annual deaths in children under 5, contribution to AMR, and annual deaths in people 5 years and older



Next steps for supporting regions in developing R&D agendas

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IVB can support the development of regional R&D agendas

July 2023 onwards

4a. Support regional R&D agendas

Americas

- Presentation to regional team.

African

- Invitation to present at RITAG in June 2024
- Broader discussions regarding joint research agenda with interest from funder
- Socialization with Africa CDC

European

- Presented to RITAG in December 2023

Eastern Mediterranean

- Socialization of approach but have not yet presented to regional team or RITAG

South-east Asia

- Presentation to ITAG in September 2023

Western Pacific

- Socialization of approach but have not yet presented to regional team or ITAG

map from: https://apps.who.int/iris/bitstream/handle/10665/163468/9789241564946_eng.pdf;sequence=1

Proposal for IA2030 SP 7.2 M&E

2024 onwards

5. Monitor and update

Approach	Rationale
• Compile **global pathogen list** from regional pathogen priorities	• Anchor on regional R&D priorities • Consistent with IA2030 SP7 M&E guidance [a]
• Identify key **vaccine use cases** for each pathogen	• Multiple vaccines may be needed to address a particular pathogen • Most advanced use case may not be the most important one for public health (e.g. TB vaccines)

• Monitor progress at 2 points:
  • Entry of candidates into Phase 3 trials
  • WLA licensure and policy recommendation
	• First milestone reflects investment in large-scale efficacy trials
	• Second milestone reflects success in vaccine R&D

a. IA2030 SP7 M&E: https://www.immunizationagenda2030.org/images/documents/IA2030_Annex_FrameworkForActionv04.pdf
b. GVAP Lessons Learned: https://apps.who.int/iris/rest/bitstreams/1255869/retrieve

Identify unmet "Use Cases" for each pathogen

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Definition

- The intended target population and outcome to be achieved by use of the vaccine or monoclonal antibody

Approx. 40 unmet use cases identified for pathogens on the global list

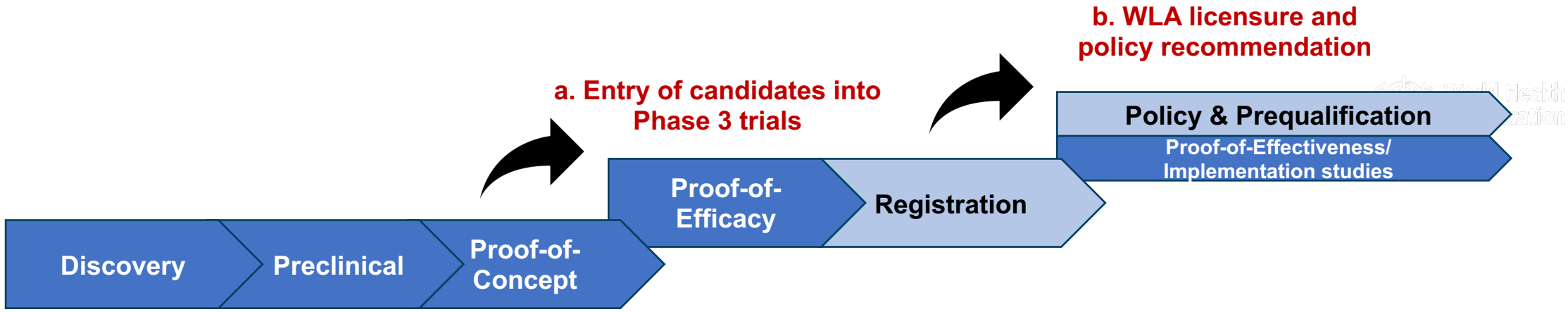
Approach

- Compiled from existing PPCs, TPPs, published literature, developer strategies
- Focus on unmet needs
- Reviewed by IVB experts and PDVAC members
- For M&E purposes; is not WHO guidance
- Living document, will evolve as R&D progresses

Examples

- **Preventing dengue fever**: vaccine for dengue naïve and immune individuals, to prevent dengue febrile illness induced by any dengue serotype
- **Maternal group B streptococcus (GBS) vaccines**: for maternal immunization during pregnancy to prevent GBS-related stillbirth and invasive GBS disease in neonates and young infants
- **Pediatric respiratory syncytial virus (RSV) vaccines**: for active immunization of infants, to prevent RSV disease in infants and young children

Monitor progress in meeting the use cases



Indicator	Definition
SP 7.2 a	% of use cases that have vaccines or monoclonal antibodies (mAbs) in Phase 3 trials
SP 7.2 b	% of use cases with licensed vaccines or mAbs that have supportive or permissive policy recommendations Use case: the intended target population and outcome to be achieved by use of the new vaccine or mAb Licensed: by a WHO-listed authority (WLA) of maturity level 3 or above, or transitional WLA Policy recommendations: by SAGE if within SAGE scope, by a national immunization technical advisory group if not in SAGE scope

Figure adapted from Hutubessy R, Lauer JA, Giersing B, Sim SY, Jit M, Kaslow D, et al. The Full Value of Vaccine Assessments (FVVA): a framework for assessing and communicating the value of vaccines for investment and introduction decision-making. BMC Med 2023;21:229. https://doi.org/10.1186/s12916-023-02929-0.

From Analyses to Actions

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What can stakeholders do to accelerate progress?

Research

- **Definition**: Few candidates in development, substantial technical challenges
- **Stakeholder actions needed**: Develop tools to assess and improve feasibility, such as immunological assays, preclinical models, correlates of protection
- **IVB/PDVAC role**: Horizon scanning to evaluate progress in biological feasibility and other technical hurdles

Advance R&D

- **Definition**: Strong development pipeline with promising candidates
- **Stakeholder actions needed**: Facilitate translational research and accelerate candidates to clinical proof-of-concept, create consensus on pathway to regulatory approval
- **IVB/PDVAC role**: Provide guidance such as Preferred Product Characteristics (PPCs), Target Product Profiles (TPPs), technical R&D Roadmaps and Full Value of Vaccine Assessments (FVVA) to inform product development and clinical trial design

Prepare for Uptake

- **Definition**: Candidates have a high potential for licensure in the near future
- **Stakeholder actions needed**: Prepare for policy decisions and implementation
- **IVB/PDVAC role**: Provide guidance such as Evidence Considerations for Vaccine Policy (ECVP) and Implementation preparedness frameworks

Conclusions

- As a global health community we must focus our **efforts on developing vaccines** for the pathogens that most impact communities across the world.
- It is the right thing to do. And to do this right we need to **work together with regions and countries**. Too often decisions on the vaccines to prioritise have been taken only at a global level.
- The Priority Pathogen list is an example of how we can work to be **country led** which is a core principle of the Immunization Agenda 2030.
- Working with regions and countries has provided other valuable insights and opportunities that can support the vaccine development community: **need for combination vaccines, improving existing vaccines, or enhancing regional research capacity**.
- The overall priority pathogen list was created by bringing together **all the pathogens that were identified by regions**.
- The list is not intended to be restrictive, it is the result of a robust survey process with regions but **should be read alongside** other evidence and considerations e.g. feasibility of vaccine development, existing R&D strategies.

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PDVAC: WHO Product Development Vaccines Advisory Committee, SAGE: WHO Strategic Advisory Group of Experts on Immunization

Highlight shows SP7 WG members (prior and current)

Thank You

Backup

Q & A 1

Who "owns" these priorities?	These are global priorities under Immunization Agenda 2030 (IA2030), a global strategy to leave no-one behind. They were developed according to IA2030 core principles of "People-centred, partnership-based, data-guided and country-owned" WHO led the identification of these priorities, based on the perspectives of experts at the country and regional levels, and with input from global experts in vaccine R&D
How do these priorities differ from previous prioritization efforts?	Previous prioritization efforts relied heavily on the opinions of pathogen experts In contrast, these priorities are based on regional surveys of policy makers and health practitioners. The surveys were 'pathogen agnostic', and captured how stakeholders in each region value 8 different criteria for prioritization These criteria addressed deaths, disability, burden per case, inequity, outbreaks, contribution to antimicrobial resistance, and unmet needs for prevention and treatment
What about other important research and R&D areas?	Priorities in other areas, such as combination vaccines, improved administration technologies, and implementation research are critically important but outside the scope of this project They are being addressed through other projects to consider needs and align stakeholders around shared strategies

Q & A 2

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How does a pathogen get on a Top 10 list?	Out of over 150 potential pathogens, the prioritization focused on 27 endemic pathogens with candidates in clinical development, for human use. (Epidemic pathogens are being prioritized separately.) Regional stakeholders can suggest additional pathogens to include in the prioritization Regional values for 8 criteria for prioritization were applied to the latest regional evidence for those 27 pathogens to arrive at regional Top 10 lists
Are you ranking the pathogens? **Which is #1?**	We are not ranking these pathogens. Many pathogens on the list appeared on the survey for multiple regions, indicating that these are common; others featured on only 1 or 2 regional lists, however, and each of these pathogens is crucially important somewhere
Are these the priorities for each region?	While these lists were based on regional surveys, the regional priorities are being set and are owned by regional entities. WHO will work as needed with stakeholders in each region to inform their priority-setting processes and R&D agendas

Q & A 3

Don't we already have vaccines for some of these pathogens?	Yes, but for those pathogens the current vaccines do not meet the needs of particular target populations. For example, we still need TB vaccines for adults and adolescents, and dengue vaccines for dengue-naïve individuals. For that reason, we have included those pathogens in this prioritization exercise
Other pathogens merit attention, why are they not on this list?	Because this list is of priority endemic pathogens for new vaccine R&D, important pathogens that have vaccines in routine use, such as measles and rotavirus, are not included Emerging infectious diseases (EIDs) are not included because they require different criteria for prioritization. The R&D Blueprint project is currently setting priorities for vaccine R&D for EIDs
Are pathogens not on this list unimportant? **Will WHO stop supporting R&D for other pathogens?**	This list is meant to inform stakeholder strategies, especially for pathogens where the need is less widely recognized or where R&D is particularly challenging Vaccines are an incredibly powerful tool for public health, and new vaccines are needed for many pathogens not on this list Given its focus on equity and vulnerable populations, WHO will continue to enable vaccine R&D and access for many pathogens not on this list, particularly those that afflict low- and middle-income countries

Q & A 4

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Where does the Global List come from?	The pathogens on the regional Top 10 lists together make up the Global List
How does the Global List relate to previously defined priorities?	This list complements previously defined priorities by providing regional, evidence-driven perspectives While many of the pathogens on the list, such as HIV and TB, are longstanding global priorities, other pathogens on the list, such as *Leishmania* and cytomegalovirus, have garnered less attention
Does this set the agenda for WHO?	This list will be monitored for IA2030. WHO's immunization department will support the development of vaccines on this list for which there is a public health need in low- and middle-income countries
How does the global list relate to Gavi's Vaccine Investment Strategy (VIS) short list?	Gavi's VIS and this project differ in scope and in purpose. Gavi's VIS focuses on vaccines with expected licensure by 2030 and sets priorities for Gavi investment. This Global List includes pathogens with vaccines in earlier stages of R&D, to inform R&D stakeholder strategies and IA2030 monitoring
Are these priorities static or a "living document"? How will they be updated?	The Global List of priority endemic pathogens for new vaccine R&D is a living document and can be updated as the context and evidence evolve We anticipate that the biennial progress reviews will consider whether an update is warranted. Updates would be made using the same method used to generate the original list

Q & A 5

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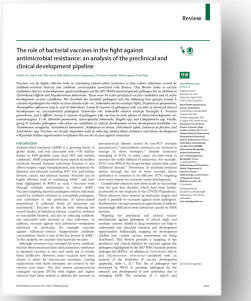
So what?	IA2030 will use this Global List in monitoring progress in vaccine Research & Development (R&D) between now and 2030. It's intended to measure progress of vaccine R&D in general This list is meant to inform strategies for the many stakeholders involved in new vaccine R&D, from research to product development to policy making
What should I do with this list?	Specific actions would depend on the context for each stakeholder
What will you do with this list?	For example, WHO will focus on advancing vaccines against pathogens that primarily afflict low- and middle-income countries. For many of these pathogens, WHO has led the development of Vaccine Value Profiles that summarize the current state of vaccine R&D, as well as other guidance documents such as Preferred Product Characteristics Specific actions also depend on the current R&D landscape for the pathogen. Some have candidates in late-stage clinical trials while others only have candidates early in development.

Existing feasibility assessments

Key resources for scoring using the VVP framework

Vaccines to tackle drug resistant infections: an evaluation of R&D opportunities

- 2018 report by BCG and Wellcome ("BCG/WT")[a]
- Assessed the potential of vaccines against antimicrobial-resistant (AMR) pathogens
- Combination of literature review, expert interviews, and modeling



The role of bacterial vaccines in the fight against antimicrobial resistance: an analysis of the preclinical and clinical development pipeline

- 2023 pipeline review by Frost et al.[b]
- Pathogen and vaccine experts reviewed analysis and scoring
- Detailed scores by PATH, epidemiologists at the London School of Hygiene and Tropical Medicine (LSHTM), and WHO obtained from study team

Vaccine Value Profiles (VVPs)

- Series of review articles for upcoming *Vaccine* supplement
- Authored by leading subject matter experts for each pathogen
- Lessons of COVID-19 factored into analysis

a. BCG/WT: Vaccines for AMR report.
b. Frost I, Sati H, Garcia-Vello P, Hasso-Agopsowicz M, Lienhardt C, Gigante V, Beyer P. The role of bacterial vaccines in the fight against antimicrobial resistance: an analysis of the preclinical and clinical development pipeline. Lancet Microbe. 2023 Feb;4(2):e113-e125. doi: 10.1016/S2666-5247(22)00303-2. Epub 2022 Dec 14. PMID: 36528040; PMCID: PMC9892012.

Why focus on endemic pathogens?

Epidemic threats require deep pathogen expertise and different criteria

WHO R&D Blueprint for Epidemics

Targeting research on diseases of greatest epidemic and pandemic threat

With the aim of strengthening global preparedness and response of any future epidemics and pandemics, the R&D Blueprint continues with its mandate to accelerate research on diseases threats before they emerge and to shorten the timeline in developing safe and effective curative and preventive medical countermeasures (diagnostics, treatments and vaccines) – a mandate endorsed by Member States during the 68th WHA.

In order to focus research efforts, an official WHO list of priority pathogens of epidemic and pandemic potential is generated and published based on an independent, open and multidisciplinary prioritization process, using rigorous and transparent methods.

The last prioritization exercise was conducted in 2018. WHO has recently launched a global scientific process to update the list.

The prioritization exercise will draw on the lessons from COVID-19 and ensure that trust, equity and access for those at highest risk is central to future R&D efforts. It will adopt a viral family approach to identify representative viruses (or prototypes) within a viral family as a pathfinder in generating science, evidence and filling knowledge gaps that may then be applicable to other viruses of threat in the same family. In recent years there has been growing support for this approach as it offers a framework to fast-track research and encourages research efforts on entire classes of viruses (e.g. flaviviruses), instead of just individual strains (e.g. zika virus), thus improving the capability to respond to unforeseen strains, zoonotic viruses (an animal virus that could jump to humans) and the potential threat of a Disease X.

To support this effort the R&D Blueprint will convene 20-25 viral family groups of experts to independently review the science and to shortlist viruses of concern. A bacterial group will be added to ensure this effort considers the risks of naturally occurring bacterial threats. These groups will represent a knowledge pool of over 300 international and independent experts and generate in a first phase of work, a shortlist of priority viral families, prototype viruses and bacteria, and Disease X recommendations to be carried forward for further prioritization. During a second phase of work, the shortlist will undergo a deeper review, considering both scientific and public health criteria (public health impact, health equity, economic and societal impact). An independent Prioritization Advisory Committee (PAC) will be established to conduct the final prioritization following a multi-criteria decision analysis (MCDA) approach.

The revised list is expected to be publicly release in the first half of 2023 and will guide targeted efforts by the R&D Blueprint, together with the global scientific community, to develop global R&D roadmaps for each priority pathogens and to develop Target Product Profiles (TPPs) that will guide developers on the ideal attributes of the medical countermeasures.

- **R&D Blueprint** is identifying priority and prototype pathogens from 26 viral families
- **Blueprint priorities will inform R&D of countermeasures**, including vaccines, diagnostics and treatments
- **Deep pathogen expertise needed** in microbiology of severe diseases, clinical management of severe infections, epidemiology and evolutionary biology, and animal health
- **Criteria for prioritization** must consider *potential* risk and impact, rather than current burden and impact

https://www.who.int/teams/blueprint/who-r-and-d-blueprint-for-epidemics,
https://www.who.int/news-room/articles-detail/open-call-for-experts-to-serve-on-time-limited-viral-family-working-groups,
https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6106429/bin/17-1427-Techapp-s2.pdf

Top 10 pathogens in each region

World Health Organization

African (N=55)	Americas (N=45)	E. Med. (N=38)	European (N=26)	SE Asian (N=44)	W. Pacific (N=65)	Global survey [a]
TB	**HIV-1**	**TB**	***Staph aureus***	**TB**	**TB**	**TB**
P falciparum (malaria)	***Staph aureus***	***Staph aureus***	**TB**	**HIV-1**	***Staph aureus***	**HIV-1**
HIV-1	***Klebsiella pneumoniae***	***Klebsiella pneumoniae***	**HIV-1**	***Klebsiella pneumoniae***	**HIV-1**	*P falciparum* (malaria)
Klebsiella pneumoniae	**ExPEC**	**HIV-1**	**ExPEC**	***Staph aureus***	GAS	***Staph aureus***
Staph aureus	**TB**	Leishmania	***Klebsiella pneumoniae***	GAS	***Klebsiella pneumoniae***	***Klebsiella pneumoniae***
Shigella	GAS	**ExPEC**	GAS	**ExPEC**	**ExPEC**	**ExPEC**
Non-typhoidal Salmonella (NTS)	*Shigella*	*Shigella*	Cytomegalo-virus	RSV	Influenza	GAS
Extra-intestinal pathogenic *E coli* (ExPEC)	RSV	Hepatitis C virus	RSV	*Shigella*	RSV	*Shigella*
Respiratory syncytial virus (RSV)	Influenza	GAS	Hepatitis C virus	Hepatitis C virus	Hepatitis C virus	RSV
Group B streptococcus	Hepatitis C virus	Norovirus	*Shigella*	Dengue virus	Cytomegalo-virus	NTS

a. 45 responses were received on the global survey

Pathogen Updates

- Removed *P aeruginosa* from scope due to lack of pipeline activity
- Added Dengue virus to scope due to unmet need for vaccines for dengue-naïve individuals (scores under review)
- Updated scores for RSV (Unmet needs for prevention and treatment) due to new product licensures

Effects on Top 10 lists

- Additions highlighted in red
- Total of **17 pathogens** across the 6 regions

Key

Top 10 in all regions
Top 10 in some regions
Addition to Top 10