# One Health and Vaccines

Australian Vaccinology Course
29 August 2025

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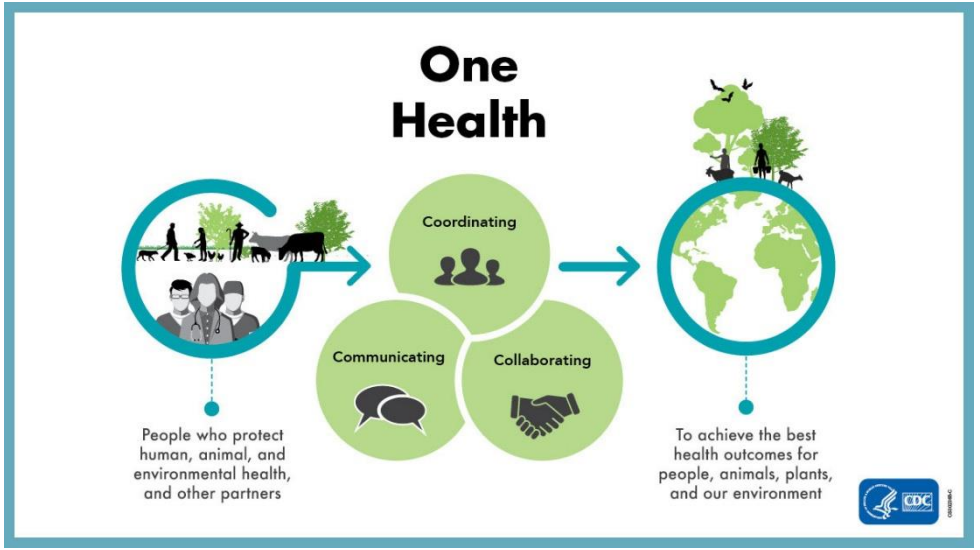
Declaration of Interests

- Current Advisory Committee Roles
  - Co-Chair Immunization Agenda 2030 SP7 (Research and Innovation)/ Member of DSUWG
  - Immunization and Vaccine Implementation Research Advisory Committee (IVIRAC)
  - Immunization Agenda 2030 Data Use and Strengthening Working Group
  - WHO Public Health And Emergency Response Workforce
- Consultant to World Health Organization/ GOARN
- Presenting in personal capacity

# One Health

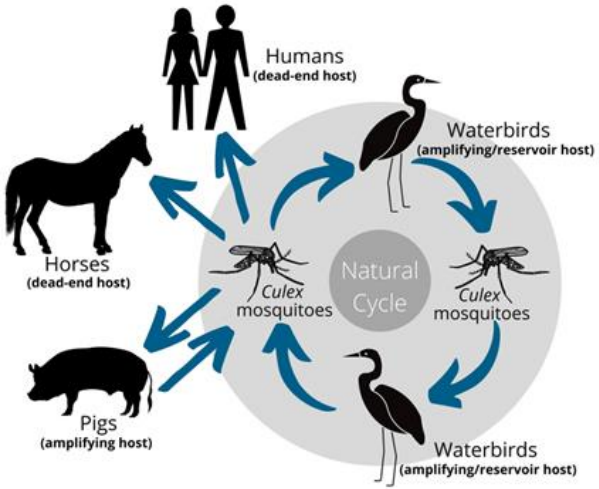
Integrated, unifying approach that aims to sustainably balance and optimise the health of people, animals and ecosystems.



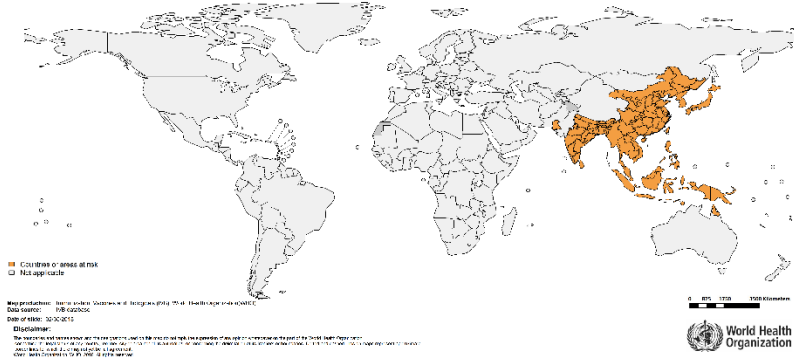
# One Health and Vaccines

- Zoonotic infections
- Anti-microbial resistance

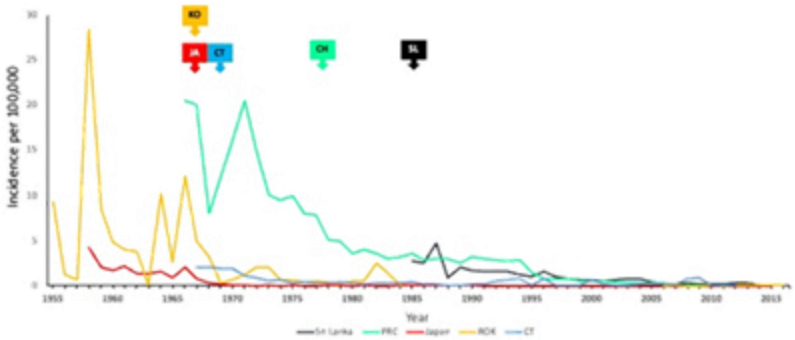
# Japanese Encephalitis




**Countries/ areas of risk, 2018**




**Impact of vaccination against Japanese encephalitis in endemic countries**




National or sub-national programs

(Leston et al, 2024, PLoS NTD; Vannice et al, 2021, npj vaccines)

# 2022 JEV outbreak in Australia

Warning about mosquito-borne viruses in SA, Victoria and NSW after one person dies and seven sent to hospital

By Eugene Boisvert | By Eden Hynninen | By Charmayne Allison | Insects

Mon 28 Feb 2022

People are urged to use

This article is more than 3 years old

Three people in Victoria in hospital with Japanese encephalitis after virus found in pigs

Victoria reports four cases of virus that spreads through mosquito bites and cannot be caught by eating pig product

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Japanese encephalitis virus situation declared a Communicable Disease Incident of National Significance

Dr Mark Schipp, Australia's Chief Veterinary Officer and Dr Sonya Bennet, Australia's Acting Chief Medical Officer have today declared the Japanese encephalitis virus situation a Communicable Disease Incident of National Significance (CDINS).

Date published: 4 March 2022

The NEW ENGLAND JOURNAL of MEDICINE

CURRENT ISSUE SPECIALTIES TOPICS

CORRESPONDENCE

## Japanese Encephalitis in Australia — A Sentinel Case

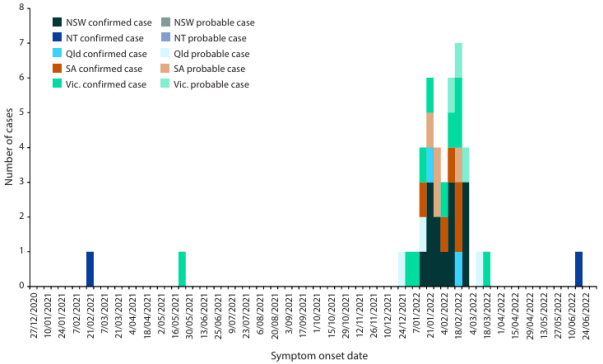
Published August 17, 2022 | N Engl J Med 2022;387:661-662 | DOI: 10.1056/NEJMc2207004 | VOL. 387 NO. 7



TO THE EDITOR:

On March 4, 2022, Japanese ence
of national significance" in Austr
encephalitis virus (JEV) in mumn
commercial piggeries across four
recognition of human cases of Ja
of infection that had led to 5 deat

**Figure 1: Japanese encephalitis virus cases (confirmed and probable) in Australia by jurisdiction of residence and symptom onset week,[a,b] 1 January 2021 – 30 June 2022**

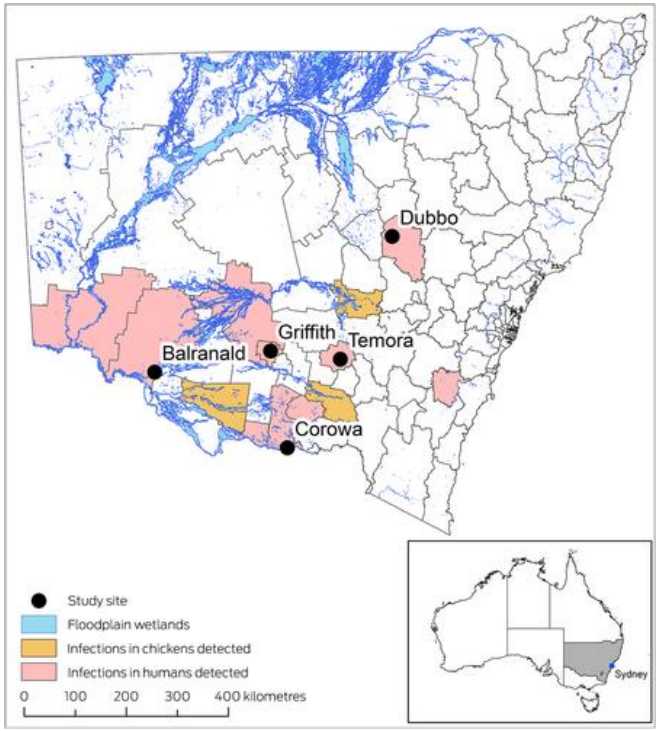



a Source: Australian Government Department of Health and Aged Care Japanese Encephalitis Virus Outbreak REDCap Database.
b Date of symptom onset or date of first specimen collection if date of symptom onset is missing.

https://www.health.gov.au/news/japanese-encephalitis-virus-situation-declared-a-communicable-disease-incident-of-national-significance

Commun Dis Intell (2018) 2025;49 (https://doi.org/10.33321/cdi.2025.49.005)

# 2022 JEV outbreak in New South Wales, Australia




The University of Sydney

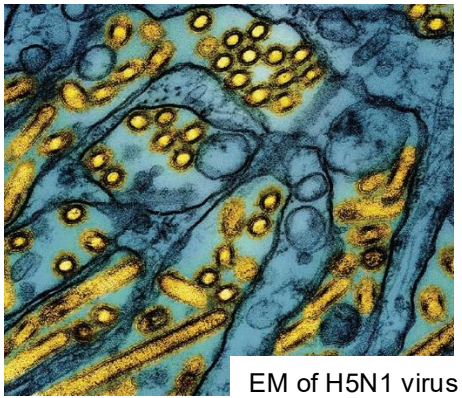
**The seroprevalence of antibodies to Japanese encephalitis virus in five New South Wales towns at high risk of infection, 2022: a cross-sectional serosurvey**

Zoe Baldwin, Linda Hueston, April Roberts-Witteveen, Priscilla Stanley, Meru Sheel, Noni Winkler, Archana Koirala, Kristine Macartney, Jennifer Case, Kirsty Hope, Keira M Glasgow

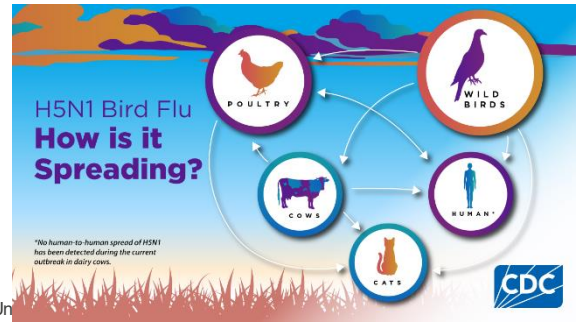
- 1/11 serosurvey participants from 5 regional NSW towns were at risk on ecological grounds, were seropositive for JEV-specific antibody, presumably reflecting non-clinical JEV during the preceding arbovirus season
- Vaccination against JEV in areas of NSW at particular risk of JEV accompanied with mosquito control & communication campaigns
- One Health approach

Current recommendations: high-risk & travellers
https://immunisationhandbook.health.gov.au/contents/vaccine-preventable-diseases/japanese-encephalitis

# Avian influenza



EM of H5N1 virus particles




## Human infection with avian influenza A(H5) viruses

### Human infection with avian influenza A(H5N1) virus

From 15 to 21 Aug 2025, **no new case** of human infection with avian influenza A(H5N1) virus were reported to WHO in the Western Pacific Region. The last case was reported from Takeo Province, Cambodia with onset of symptoms on 27 July. The case had exposure to sick and dead poultry.

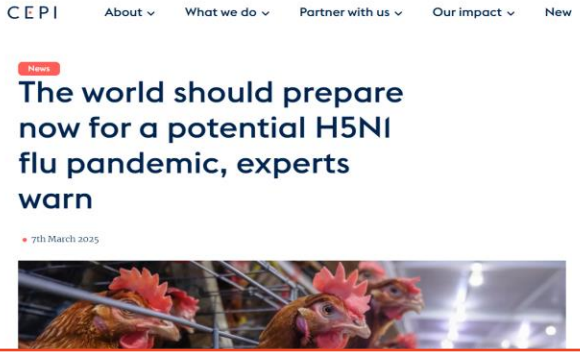
From 1 January 2003 to 1 July 2025, a total of 474 cases of human infection with avian influenza A(H5N1) virus have been reported from six countries within the Western Pacific Region (Table 1). Of these cases, 316 were fatal, resulting in a case fatality rate (CFR) of 66.7%.

Table 1: Cumulative number of laboratory-confirmed human cases (C) and deaths (D) of influenza A(H5N1) virus infection reported to WHO, by date of onset (1 January 2003 to 1 July 2025), Western Pacific Region

| Country | 2003-2009 | | 2010-2014 | | 2015-2019 | | 2020-2024 | | 2025 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | C | D | C | D | C | D | C | D | C | D | C | D |
| Australia | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 1 | 0 |
| Cambodia | 9 | 7 | 47 | 30 | 0 | 0 | 16 | 6 | 11 | 6 | 83 | 49 |
| China | 38 | 25 | 9 | 5 | 6 | 1 | 3 | 1 | 1 | 0 | 57 | 32 |
| Indonesia | 162 | 134 | 35 | 31 | 3 | 3 | 0 | 0 | 0 | 0 | 200 | 168 |
| Lao PDR | 2 | 2 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 3 | 2 |
| Viet Nam | 112 | 57 | 15 | 7 | 0 | 0 | 2 | 1 | 1 | 0 | 130 | 65 |
| **Total** | **323** | **225** | **106** | **73** | **9** | **4** | **23** | **8** | **13** | **6** | **474** | **316** |

*Source: Confirmed human cases for avian influenza A(H5N1) reported to WHO, 2003-2025*

# Vaccines



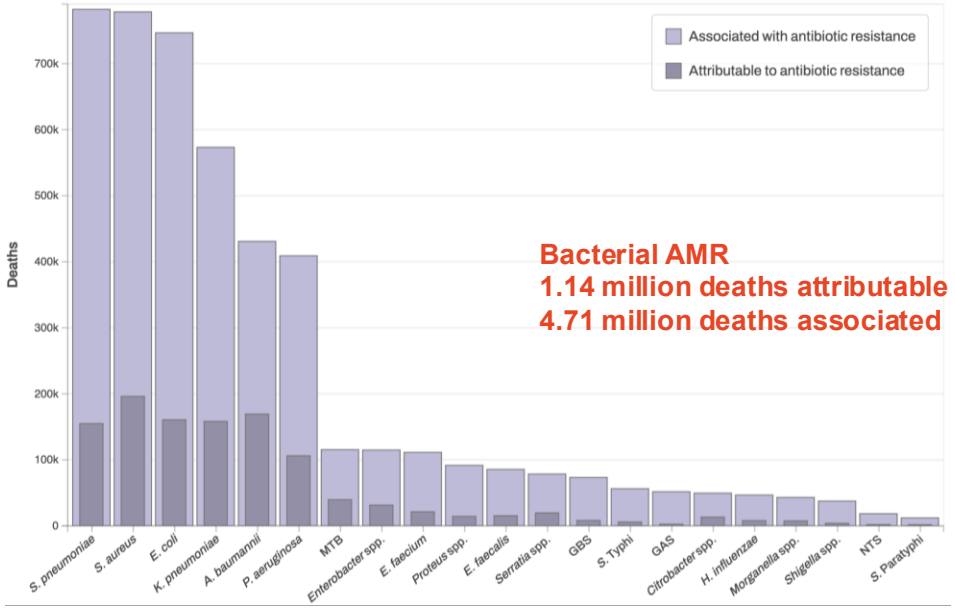


- Pandemic preparedness – multi-sectoral responses
- Rapid scalable vaccines along with therapeutics, diagnostics, PPE
- Deployment plan including communication plans using behavioural science
- Agricultural readiness

- Inactivated H5 bird flu vaccine from Zoetis – under trial by CSIRO
- Evaluate the safety and efficacy of this vaccine in small Australian bird species -> support emergency use

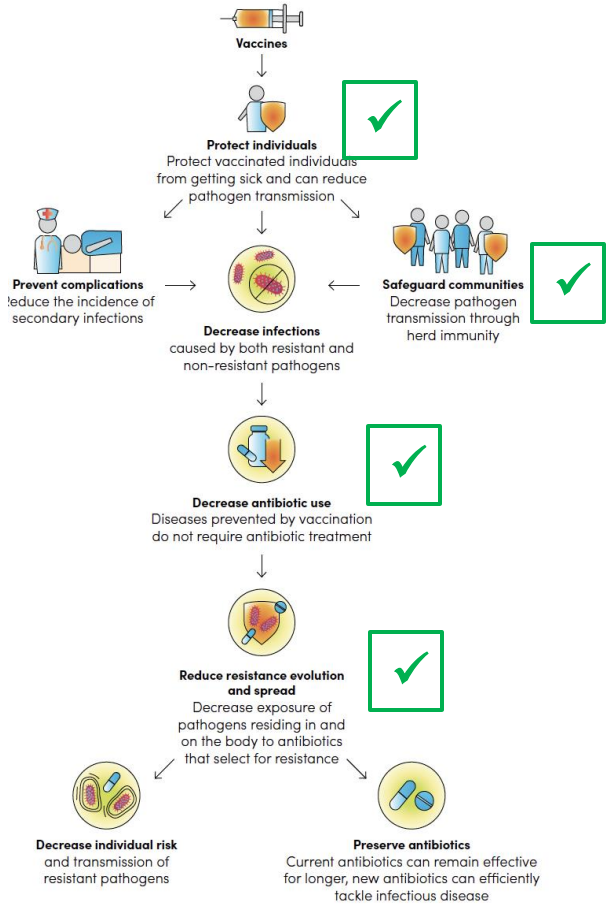
# AMR and Vaccines

**The number of deaths associated and attributable to resistance by pathogen, in 2021**




**Bacterial AMR**
**1.14 million deaths attributable**
**4.71 million deaths associated**

## How do vaccines reduce AMR?



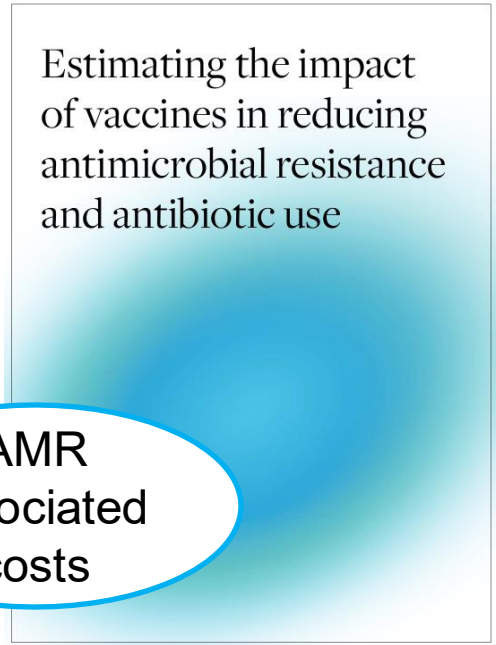



Acknowledgement: Dr Hasso-Agopsowicz

# WHO report: Estimating the impact of vaccines in reducing antimicrobial resistance and use

- Vaccines in early and late-stage clinical development have the potential to annually avert up to:
- **515,000 deaths**
- **28 million DALYs**
- **US $30 billion in hospital costs**
- **US $20 billion in productivity losses**

- These vaccines could also help to reduce antibiotic use by **2.5 billion doses**




AMR associated costs

AMR, antimicrobial resistance; DALY, disability-adjusted life years

World Health Organization (WHO), 2024. Estimating the impact of vaccines in reducing antimicrobial resistance and antibiotic use

Acknowledgement: Dr Hasso-Agopsowicz

# PCV and rotavirus vaccines reduce *antibiotic use* in children in LMICs

Analysis of Demographic Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS)

**VACCINE IMPACT WITH RECENT COVERAGE**

**PCV prevents 23.8 million antibiotic treated episodes annually**

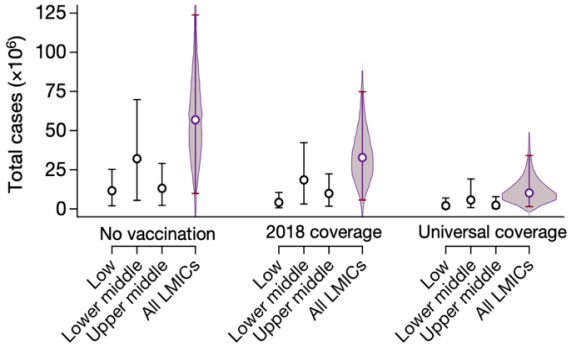
**Rotavirus vaccine prevents 13.7 million antibiotic treated episodes annually**

**VACCINE IMPACT WITH 90% COVERAGE**

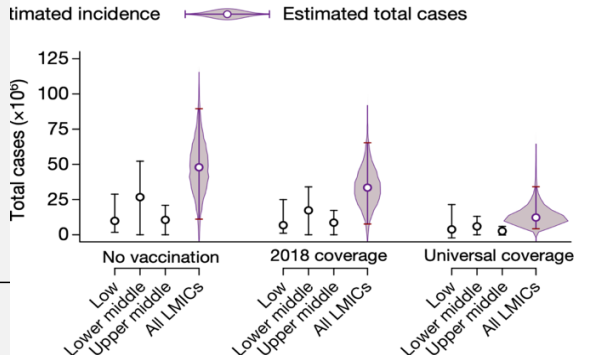
**PCV could avert additional 21.7 million antibiotic treated episodes**

**Rotavirus vaccines could avert additional 18.3 million antibiotic treated episodes**

**Total PCV10/13 vaccine-preventable antibiotic consumption and incidence, children 24-59 months**




**Total rotavirus vaccine-preventable antibiotic consumption and incidence, children 0-23 months**

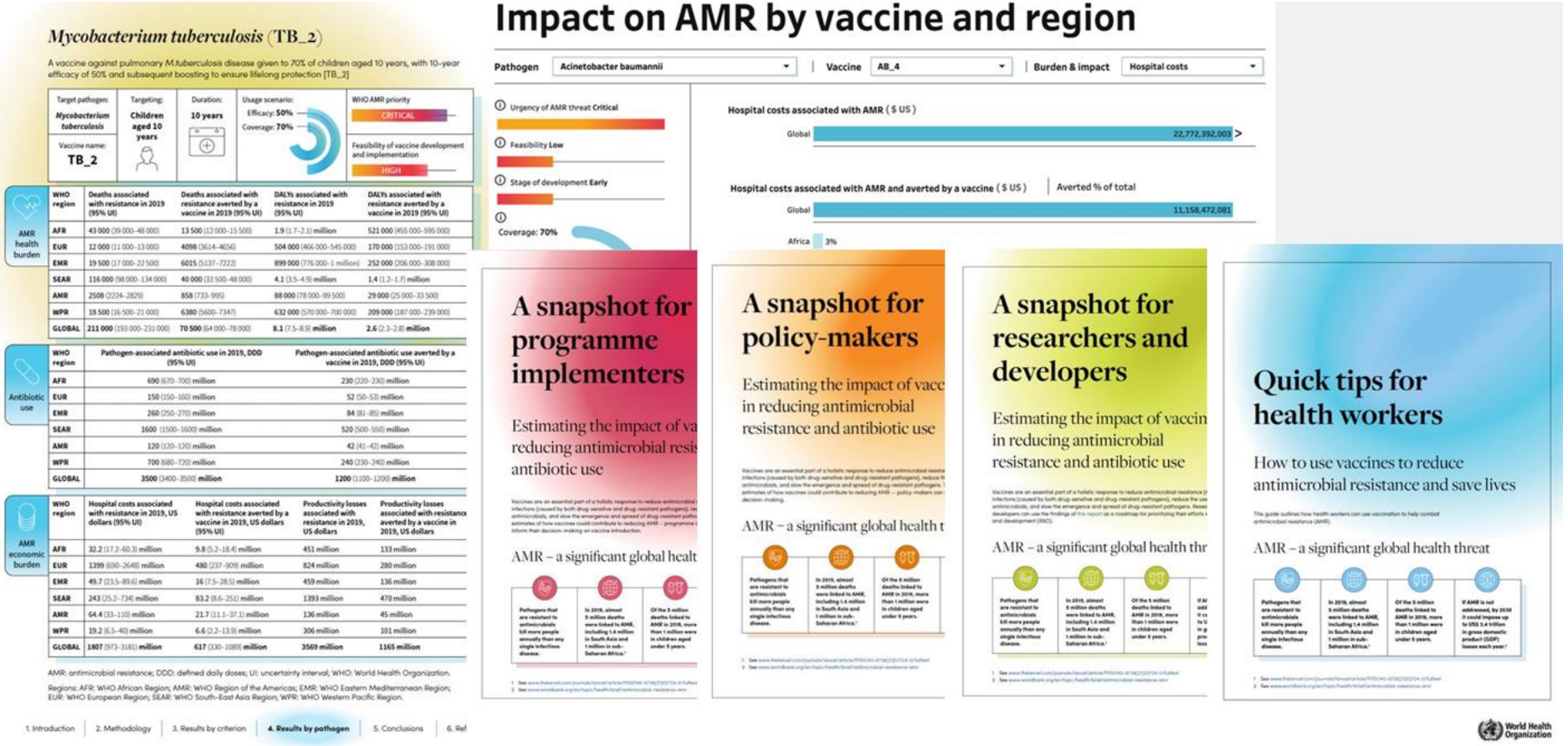



*https://www.nature.com/articles/s41586-020-2238-4*

Estimating the Impact of Vaccines in Reducing Antimicrobial Resistance and Antibiotic Use

Acknowledgement: Dr Hasso-Agopsowicz

# Many emerging resources



*Mycobacterium tuberculosis* (TB_2)

A vaccine against pulmonary *M.tuberculosis* disease given to 70% of children aged 10 years, with 10-year efficacy of 50% and subsequent boosting to ensure lifelong protection [TB_2]

| Target pathogen: | Targeting: | Duration: | Usage scenario: | WHO AMR priority |
|---|---|---|---|---|
| *Mycobacterium tuberculosis* | Children aged 10 years | 10 years | Efficacy: 50%<br>Coverage: 70% | CRITICAL |
| Vaccine name: TB_2 | | | | Feasibility of vaccine development and implementation: HIGH |

AMR health burden

| WHO region | Deaths associated with resistance in 2019 (95% UI) | Deaths associated with resistance averted by a vaccine in 2019 (95% UI) | DALYs associated with resistance in 2019 (95% UI) | DALYs associated with resistance averted by a vaccine in 2019 (95% UI) |
|---|---|---|---|---|
| AFR | 43 000 (39 000–48 000) | 13 500 (12 000–15 500) | 1.9 (1.7–2.1) million | 521 000 (455 000–595 000) |
| EUR | 12 000 (11 000–13 000) | 4098 (3614–4656) | 504 000 (466 000–545 000) | 170 000 (153 000–191 000) |
| EMR | 19 500 (17 000–22 500) | 6015 (5137–7222) | 899 000 (776 000–1 million) | 252 000 (206 000–308 000) |
| SEAR | 116 000 (98 000–134 000) | 40 000 (33 500–48 000) | 4.1 (3.5–4.9) million | 1.4 (1.2–1.7) million |
| AMR | 2508 (2224–2829) | 858 (733–995) | 88 000 (78 000–99 500) | 29 000 (25 000–33 500) |
| WPR | 18 500 (16 500–21 000) | 6380 (5600–7347) | 632 000 (570 000–700 000) | 209 000 (187 000–239 000) |
| GLOBAL | 211 000 (193 000–231 000) | 70 500 (64 000–78 000) | 8.1 (7.5–8.9) million | 2.6 (2.3–2.8) million |

Antibiotic use

| WHO region | Pathogen-associated antibiotic use in 2019, DDD (95% UI) | Pathogen-associated antibiotic use averted by a vaccine in 2019, DDD (95% UI) |
|---|---|---|
| AFR | 690 (670–700) million | 230 (220–230) million |
| EUR | 150 (150–160) million | 52 (50–53) million |
| EMR | 260 (250–270) million | 84 (81–85) million |
| SEAR | 1600 (1500–1600) million | 520 (500–550) million |
| AMR | 120 (120–120) million | 42 (41–42) million |
| WPR | 700 (680–720) million | 240 (230–240) million |
| GLOBAL | 3500 (3400–3500) million | 1200 (1100–1200) million |

AMR economic burden

| WHO region | Hospital costs associated with resistance in 2019, US dollars (95% UI) | Hospital costs associated with resistance averted by a vaccine in 2019, US dollars (95% UI) | Productivity losses associated with resistance in 2019, US dollars | Productivity losses associated with resistance averted by a vaccine in 2019, US dollars |
|---|---|---|---|---|
| AFR | 32.2 (17.2–60.3) million | 9.8 (5.2–18.4) million | 451 million | 133 million |
| EUR | 1399 (690–2648) million | 480 (237–909) million | 824 million | 280 million |
| EMR | 49.7 (23.5–89.6) million | 16 (7.5–28.5) million | 459 million | 136 million |
| SEAR | 243 (25.2–734) million | 83.2 (8.6–251) million | 1393 million | 470 million |
| AMR | 64.4 (33–110) million | 21.7 (11.1–37.1) million | 136 million | 45 million |
| WPR | 19.2 (6.5–40) million | 6.6 (2.2–13.9) million | 306 million | 101 million |
| GLOBAL | 1807 (973–3181) million | 617 (330–1089) million | 3569 million | 1165 million |

AMR: antimicrobial resistance; DDD: defined daily doses; UI: uncertainty interval; WHO: World Health Organization.

Regions: AFR: WHO African Region; AMR: WHO Region of the Americas; EMR: WHO Eastern Mediterranean Region; EUR: WHO European Region; SEAR: WHO South-East Asia Region; WPR: WHO Western Pacific Region.

1. Introduction | 2. Methodology | 3. Results by criterion | 4. Results by pathogen | 5. Conclusions | 6. Ref

## Impact on AMR by vaccine and region

Pathogen: Acinetobacter baumannii | Vaccine: AB_4 | Burden & impact: Hospital costs

Urgency of AMR threat: Critical

Feasibility: Low

Stage of development: Early

Coverage: 70%

Hospital costs associated with AMR ($ US)

Global: 22,772,392,003

Hospital costs associated with AMR and averted by a vaccine ($ US) | Averted % of total

Global: 11,158,472,081

Africa: 3%

## A snapshot for programme implementers

Estimating the impact of va
reducing antimicrobial resis
antibiotic use

AMR – a significant global healt

## A snapshot for policy-makers

Estimating the impact of vacc
in reducing antimicrobial
resistance and antibiotic use

AMR – a significant global health t

## A snapshot for researchers and developers

Estimating the impact of vaccin
in reducing antimicrobial
resistance and antibiotic use

AMR – a significant global health thr

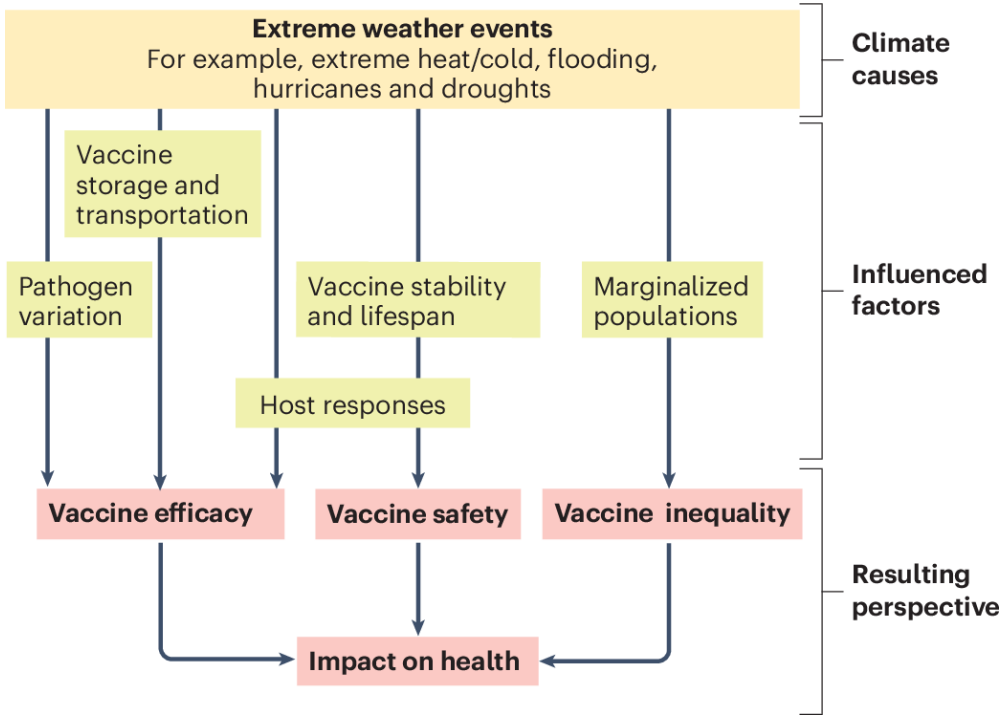
## Quick tips for health workers

How to use vaccines to reduce antimicrobial resistance and save lives

AMR – a significant global health threat

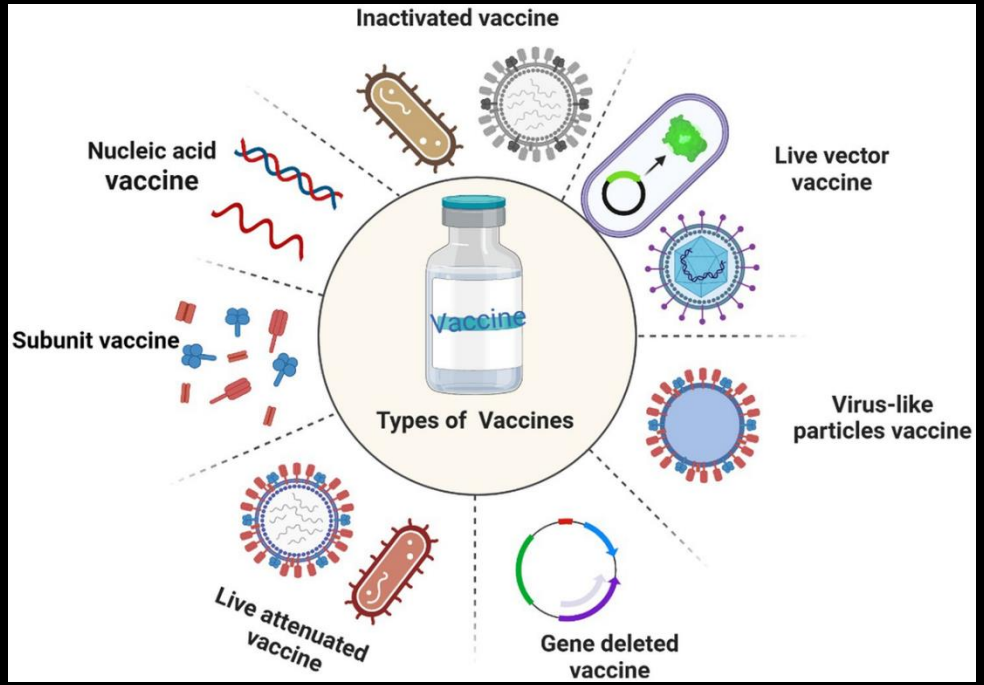
World Health Organization

# Climate change, vaccines & immunisation – the next challenge




Zhang et al, 2024, Nature climate change

# Combination Vaccines



# Combination Vaccines

- A single shot containing antigens that protect against more than one vaccine-preventable disease.

- How many vaccines visits does a parent have to make to be fully immunised?

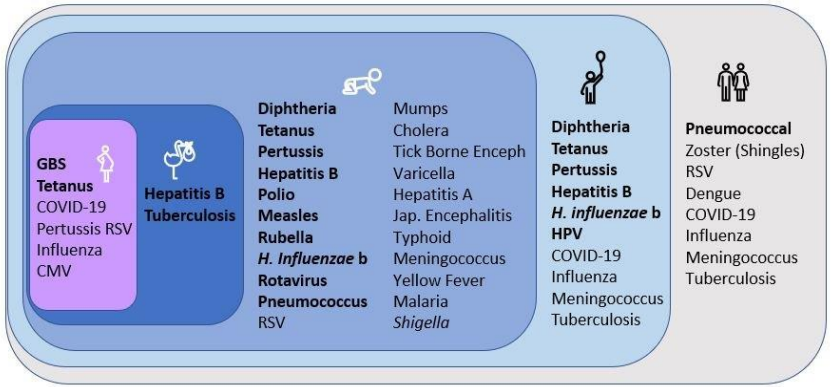
# Increasingly crowded schedule

| | 1984 | 2010 | 2023 | 2030 |
|---|---|---|---|---|
| Maternal | .. | 1 | 1 +1 or more regional vaccines | 2 +1 or more regional vaccines |
| Birth | 1 | 2 | 2 | 2 |
| Infant (aged 6 weeks to 6 months; 2 or 3 visits within 14 weeks) | 2 | 3–5 | 3–6* +1 or more regional vaccines | 3–6* +1 or more regional vaccines |
| 6 months | .. | .. | +1 or more regional vaccines | +1 or more regional vaccines |
| 7 months | .. | .. | +1 or more regional vaccines | +1 or more regional vaccines |
| 9 months | 1 | 2 +1 or more regional vaccines | 2 +1 or more regional vaccines | 2 +1 or more regional vaccines |
| 15 months | .. | 1 | 1 +1 or more regional vaccines | 1 +1 or more regional vaccines |
| 12–23 months | .. | 2–4 | 1–4 +1 or more regional vaccines | 1–4 +1 or more regional vaccines |
| Childhood (24 months to 8 years) | .. | 2–4 | 1–4 +1 or more regional vaccines | 1–4 +1 or more regional vaccines |
| Adolescents (aged ≥9 years) | .. | 3–5 | 2–5 +1 or more regional vaccines | 2–5 +1 or more regional vaccines |
| Adults | .. | +1 or more regional vaccines | +1 or more regional vaccines | +1 or more regional vaccines |
| Older adults (aged ≥65 years) | .. | .. | +1 or more regional vaccines | +1 or more regional vaccines |

This table reflects the number of separate administrations, per visit, of vaccines recommended globally by WHO;[3] we also note at which visits one or more additional vaccines are recommended for high-burden regions or populations at high risk (termed regional vaccines). The specific vaccines underlying these numbers are shown in the appendix (p 2). Not all vaccines are administered parenterally. For clarity, the 2030 column only depicts the additional vaccines that we anticipate to be recommended in addition to those shown in 2023. *In some cases, up to five or six vaccines are recommended but generally no more than four parenteral vaccines would be administered in a single visit.

***Table*: The evolution in number of vaccines recommended both globally and regionally at different visits**

**By 2030, there could be vaccines available for up to 30 diseases, with the majority recommended for infants and toddlers.**




**Increasing number of shots and visits**
**4 in 1984**
**>15 in 2023 region dependent**



Hausdorff, Lancet Global Health
https://pubmed.ncbi.nlm.nih.gov/38636529/

# Combination vaccines are not new

- Existing combination vaccines……..

## National Immunisation Program Schedule

### Childhood vaccination

(also see vaccination for people with medical risk conditions)

| Age | Diseases | Vaccine Brand |
|---|---|---|
| **Birth** | Hepatitis B (usually offered in hospital) | H-B-Vax® II Paediatric or Engerix B® Paediatric |
| **2 months** (can be given from 6 weeks of age) | Diphtheria, tetanus, pertussis (whooping cough), hepatitis B, polio, *Haemophilus influenzae* type b (Hib)<br>Rotavirus<br>Pneumococcal<br>Meningococcal B (Aboriginal and Torres Strait Islander children) | Infanrix® hexa or Vaxelis®<br>Rotarix®<br>Prevenar 13®<br>Bexsero® |
| **4 months** | Diphtheria, tetanus, pertussis (whooping cough), hepatitis B, polio, *Haemophilus influenzae* type b (Hib)<br>Rotavirus<br>Pneumococcal<br>Meningococcal B (Aboriginal and Torres Strait Islander children) | Infanrix® hexa or Vaxelis®<br>Rotarix®<br>Prevenar 13®<br>Bexsero® |
| **6 months** | Diphtheria, tetanus, pertussis (whooping cough), hepatitis B, polio, *Haemophilus influenzae* type b (Hib)<br>Pneumococcal (Children with specified medical risk conditions)<br>Pneumococcal (Aboriginal and Torres Strait Islander children in WA, NT, SA, Qld)<br>Meningococcal B (Aboriginal and Torres Strait Islander children with specified medical risk conditions) | Infanrix® hexa or Vaxelis®<br>Prevenar 13®<br>Prevenar 13®<br>Bexsero® |
| **6 months to <5 years** (annually) | Influenza | Age appropriate |
| **12 months** | Meningococcal ACWY<br>Measles, mumps, rubella<br>Pneumococcal<br>Meningococcal B (Aboriginal and Torres Strait Islander children) | Nimenrix®<br>M-M-R® II or Priorix®<br>Prevenar 13®<br>Bexsero® |

Ministry of Health & Medical Services - Fiji
27 Jun ·

🩺 Fiji Introduces Hexavalent Vaccine to Enhance Infant Immunization Program🌟

In a significant update to its vaccination strategy, Fiji has officially introduced the hexavalent vaccine for young infants. This new vaccine replaces the previous pentavalent vaccine and the inactivated
o vaccine, streamlining the immunization
cess for newborns. 👶✨

hexavalent vaccine will be administered in
e doses at 6 weeks, 10 weeks, and 14 weeks
ge. Parents are urged to plan for their infants'
cinations as they approach these milestones.
litionally, for children who have reached one
r of age, a booster dose of the hexavalent
cine will replace both the DTP vaccine and the
tivated polio vaccine. Caregivers are reminded
ncorporate vaccination schedules into their
birthday celebrations! 🎉🥰

s initiative is a result of significant
ancements in vaccine development, ensuring
Fijian infants benefit from the latest global
ovations. Local medical experts have
iculously monitored international vaccination
ds and combined this knowledge with a
rough understanding of the local health

The U

# And new vaccines in the pipeline…..

Identifying WHO global priority endemic pathogens for vaccine research and development (R&D) using multi-criteria decision analysis (MCDA): an objective of the Immunization Agenda 2030

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[c]Angela Hwang Consulting, Albany, CA, USA
[d]Department of International Health, Bloomberg School of Public Health, Johns Hopkins University, USA
[e]Hilleman Laboratories, Singapore
[f]Kintampo Health Research Centre, Ghana Health Service, Kintampo North Municipality, Ghana
[g]Sydney School of Public Health, Faculty of Medicine and Health, The University of Sydney, Australia

eBioMedicine 2024;■: 105424
Published Online XXX
https://doi.org/10.1016/j.ebiom.2024.105424

**Summary**

**Background** To date, global priorities for new vaccine R&D have not been systematically identified for endemic pathogens. As part of Immunisation Agenda 2030 (IA2030), we have systematically identified priority endemic pathogens for new vaccine R&D based on country and regional stakeholder values to address this need.

**Methods** MCDA surveys targeting policy makers and immunisation stakeholders in each World Health Organization (WHO) region were used to weight eight criteria for prioritisation. Applying those weights to regional pathogen data yielded regional top ten pathogen lists, which are intended to inform regional deliberations on R&D priorities. The regional top ten lists were combined into an IA2030 global priority list. To inform R&D, use cases for new vaccines and monoclonal antibodies were identified, then categorized in terms of the activities needed to accelerate progress.

**Findings** In five out of six WHO regions, *Annual deaths in children under-five* and *Contribution to antimicrobial resistance* were the most heavily weighted criteria. How participants weighted the criteria was not associated with their region, biographical characteristics, or areas of expertise. Five pathogens were common priorities across all regions: *M tuberculosis*, HIV-1, *K pneumoniae*, *S aureus*, and Extra-intestinal pathogenic *E coli*. Six pathogens were priorities in single regions. Combining regional top ten lists provided a global list of 17 priority pathogens for new vaccine R&D. Thirty-four distinct use cases were identified for new products targeting these pathogens. While most are in the "Advance product development" category, ten are in the "Research" category and seven are in the "Prepare to implement" category.

**Interpretation** These priorities for new vaccine R&D will help stakeholders better respond to regional and country needs. The use cases will inform R&D and enable monitoring of R&D under IA2030.

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**Keywords:** Vaccines; Priorities; Research; Development; IA2030

**Introduction**

Immunization has had an unparalleled impact on global morbidity and mortality, but because vaccine development is technically and commercially challenging, we lack vaccines against many pathogens that continue to impose a substantial public health burden.[1] Prioritization of pathogen targets for vaccine R&D is therefore crucial for the efficient use of limited resources, to

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Hasso-Agopsowicza, Hwang, Hollm-Delgadoa, Umbelino-Walkerb, Karron, Rao, Asante, Sheel, Sparrow, Giersing; Lancet eBioMedicine


*Provisional result due to lack of systematic burden data

# Do combination vaccines offer a solution….

## Pros

- >timeliness of vaccination; acceptability by end users and health-care providers
- Higher and more equitable vaccination coverage
- Greater, more equitable impact
- Facilitates targeting less prevalent but still important pathogens
- Allows possibility of a syndromic combination—ie, a combination vaccine targeting pathogens causing same clinical syndrome
- Reduced clinical waste – syringes etc (sustainability)
- >demand for combination than individual components, leading to economies of scale and reduced cost of goods

## Challenges

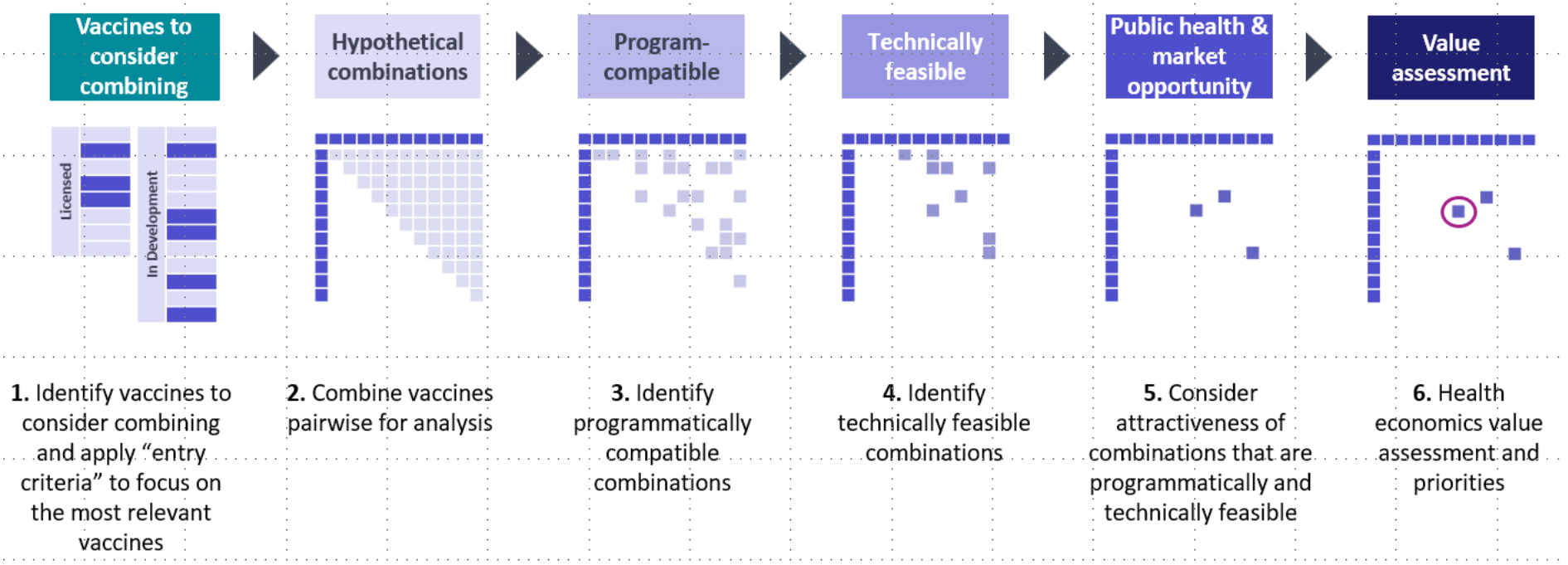
- Value of overall combination compared with stand-alone components?
- Monitoring safety signal per component
- Cost to procure than each component vaccines, even if less expensive to deliver
- Policy making – limited guidance on how to introduce into schedule or use
- Greater risk of failure due to immunological interference or unacceptable reactogenicity
- More complex, lengthy, and expensive clinical development pathway
- Market forces – pharma, IP, manufacturing agreements

Hausdorff, Lancet Global Health
https://pubmed.ncbi.nlm.nih.gov/38636529/

# Obstacles to development

- Traditionally approach – combining individual vaccines
- No priorities for combination vaccines R&D.
- Limited guidance from regulatory agencies.
- No guidance about policy decisions.
- Lack of comprehensive evaluations of the benefits and risks of combination vaccines.

# Development of Combo Vaccine Policy Framework



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# Conclusion

- The current public health immunisation paradigm is centered around vaccines targeting single pathogens
- Need better policy and frameworks to expedite development
- Early consideration around introduction and implementation
- Full value assessment – health, economic and social