17th TechNet Conference

Panama City, Panama | October 16-19, 2023

Immunization Programmes That Leave No One Behind

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Leveraging microarray patch (MAP) technology for vaccine delivery

Anna-Lea Kahn, WHO

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Jennifer Foster, Shamim Omar, Priscilla Kwarteng, and Stella Wanjiru, PATH

October 17, 2023

Vaccine microarray patches: an alliance to achieve impact

Courtney Jarrahian, PATH

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VIPS VACCINE INNOVATION PRIORITISATION STRATEGY

The Vaccine Innovation Prioritisation Strategy (VIPS) is a global partnership between the **Gavi Secretariat,** World Health Organization (WHO), **United Nations Children's Fund** (UNICEF), **Bill & Melinda Gates Foundation,** and **PATH** – known as the VIPS Alliance – to **prioritize and drive vaccine product innovation** to increase equitable vaccine coverage **in low- and middle-income countries** and contribute to global health security.

Gavi The Vaccine Alliance

World Health Organization

BILL & MELINDA GATES foundation

PATH

unicef

VIPS has prioritized three innovations with the broadest public health benefits that can help better meet country needs and contribute to coverage and equity goals

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VIPS VACCINE INNOVATION PRIORITISATION STRATEGY

2018–2020

PRIORITIZATION

Current

ACCELERATION

Long-term impact

INCREASED EQUITABLE COVERAGE and PANDEMIC RESPONSE

Prioritized innovations

Microarray patches

Heat-stable and controlled temperature chain (CTC) qualified vaccines

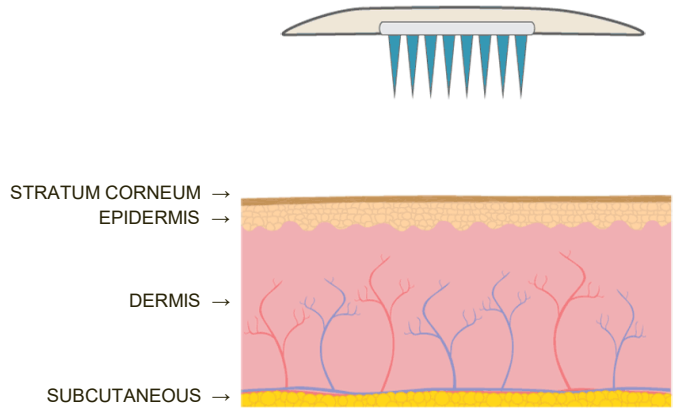
Barcodes on primary packaging

MAP technology overview

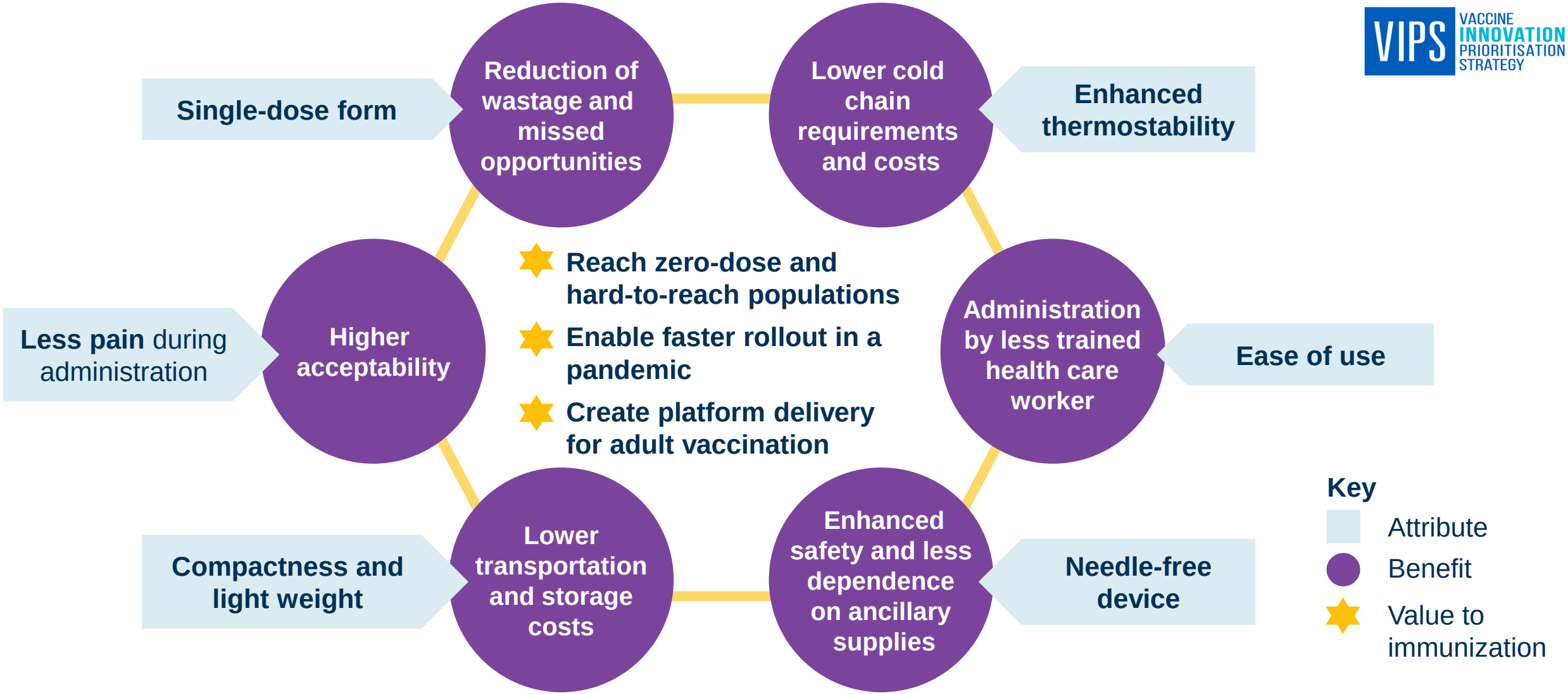
- A patch may have **hundreds or thousands of tiny projections.**
- The projections can be **coated with or composed of a vaccine** (dry formulation).
- **The patch is applied to the skin and pressed down** so that the projections penetrate the top of the skin. After a few seconds or minutes, the vaccine dissolves in the skin and the patch can be removed.
- The projections only **penetrate the top layers of the skin** to deliver the vaccine.
- It is typically perceived as **less painful than an injection.**
- Some platforms require an **applicator** for delivery (integrated or separate).

Micron MAP

Vaxxas MAP

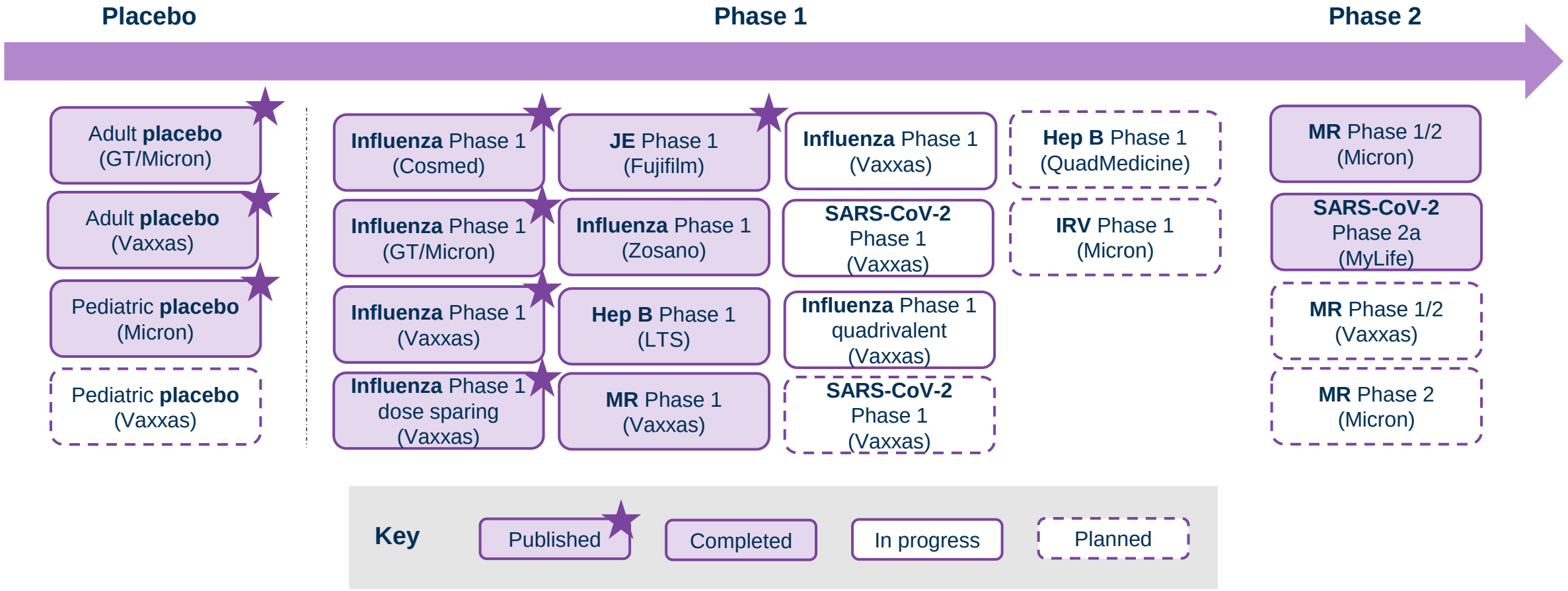


Vaccine MAPs could transform immunization delivery



The clinical evidence base for vaccine MAPs is expanding

Results are published or anticipated for measles-rubella (MR), influenza, SARS-CoV-2, Hep B, and Japanese encephalitis (JE) in Phase 1, as well as for Phase 2 results for MR.



First clinical proof of concept of vaccine MAPs in infants

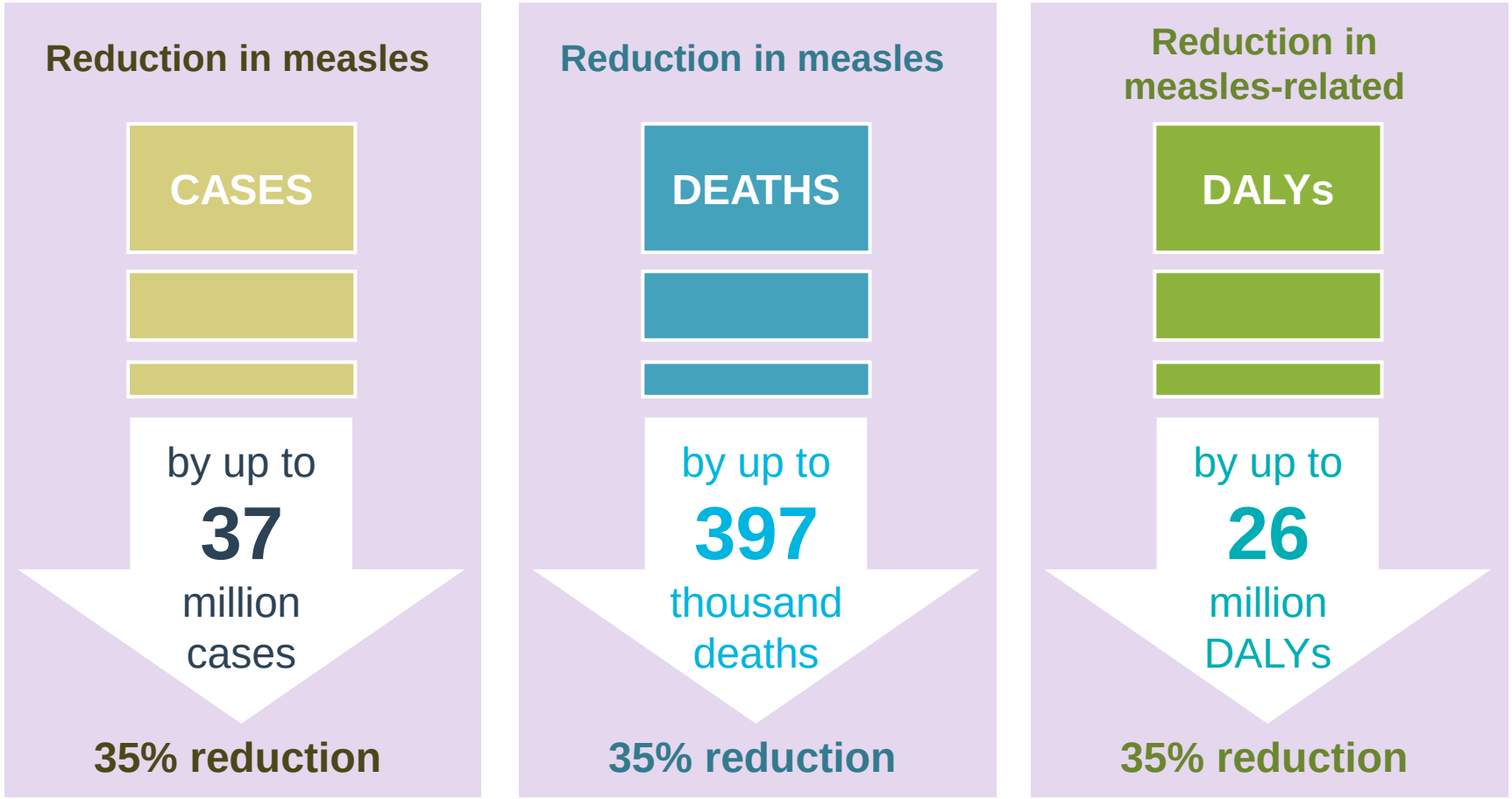
Photo: Micron Biomedical

Micron Biomedical Announces Positive Measles and Rubella Vaccination Results from First Clinical Trial of Microarray Injection-Free Vaccine Delivery in Children

- **First completed Phase 1 & 2 clinical trial in unprimed 9-month-olds** with a **MAP for measles-rubella vaccine** in The Gambia, a country where measles is endemic.
- **High and similar seroprotection and seroconversion rates for MR** in all cohorts for both the MAP and SC injection.
- **Vaccination by MAP was safe and well tolerated,** with no allergic reactions or related serious adverse events.
- **Over 90% of the parents of toddlers and infants** enrolled in the trial who **took part in an acceptability survey** said that the **MAP technology would be better than SC injection.**

MR MAPs could reduce measles burden by 35% and reach 80 million more children between 2030 and 2040

VIPS VACCINE INNOVATION PRIORITISATION STRATEGY

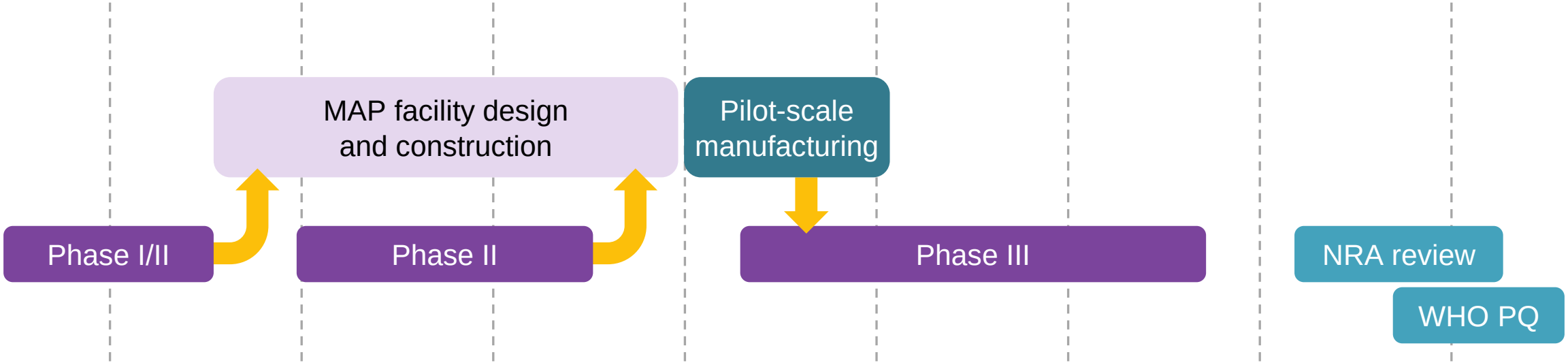


MR MAPs could reach an estimated 80–110 million more children (8–11%) between 2030 and 2040 than would be reached using needle and syringe presentation alone

Source: MR MAPs initial Full Value of Vaccine Assessment - UNICEF

Acceleration of product development to speed introduction timeline

Next steps include construction of manufacturing facilities, finalization of design attributes, and Phase 3 clinical research.



VIPS Alliance partners are working to address evidence gaps to accelerate MAPs

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VIPS VACCINE INNOVATION PRIORITISATION STRATEGY

	Demand uncertainty	High upfront costs	Technical and regulatory risks
Challenges			
Activities	**Priority vaccines** **Global health impact** **Demand sizing** **Market incentives** **Country engagement** **Implementation research needs**	**Risk-sharing approaches** for R&D and manufacturing **COGS** assessment and impact of **scale** **Cost-effectiveness**	**Regulatory pathways** **Manufacturing scale-up** **Clinical data** **Human factors evaluation** **Thermostability**

Assessing the supply chain costs of microarray patches

Shan Hsu and Mercy Mvundura, PATH

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Vaccine Technology Impact Assessment (VTIA) model

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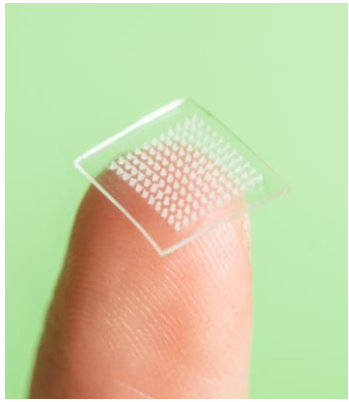
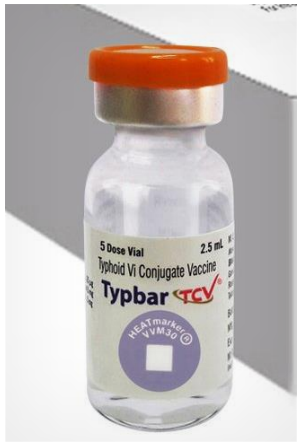
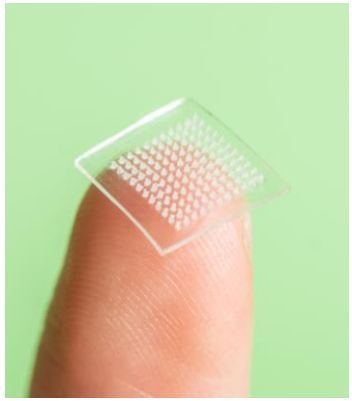
- VTIA model provides a **comparative economic evaluation** of the **commodity and delivery costs** for current vaccine/technology presentation(s) compared with new/ innovative presentation(s).
- Costs are evaluated from the **health system perspective for a cohort to be vaccinated**.
- The model has been used to evaluate numerous delivery technologies, including **microarray patches (MAPs)**, dual-chamber devices, intradermal adapters, jet injectors, compact prefilled auto-disable devices, etc., compared to single- and multidose vials.
- Includes **country-specific inputs** such as salaries, electricity, and fuel prices; target populations; and number of facilities at each level of the supply chain; but **some inputs do not vary by country**.
- We seek to understand how **key input variables that differ across the technologies** (e.g., price of the vaccine, thermostability, and cold chain volume) **drive the cost estimates**.
- Key metric estimated is the **cost per dose administered.**



Objective of the analysis

- We evaluated the commodity and delivery costs for **MAP** presentations **compared to vial** presentations for:
  - **Measles-rubella (MR) vaccine in** 10- and 5-dose vials.
  - **Typhoid conjugate vaccine (TCV)** in 5-dose vials.





Cost components and delivery strategies included in the analysis

Costs included in all use cases and strategies:

Vaccine procurement costs, accounting for wastage and international shipping costs

Syringes (if needed) **and safety boxes**, accounting for wastage and international shipping costs

Cold chain costs at each level of the supply chain, driven by packaged volume (cm^3)

Transport costs between supply chain levels; driven by packaged volume (cm^3)

HR costs for logistics at each supply chain level; assumed as fixed % of time; cost per dose then depends on quantities of vaccines handled

Additional costs – fixed post delivery

HCW time costs for vaccine administration (time use at fixed posts)

Additional costs – outreach by HCW

- **HCW time costs** for conducting outreach
- **Transport costs** for traveling to outreach locations

Additional costs – outreach and community delivery by CHW

- **CHW time costs** for conducting outreach
- **Transport costs** for traveling to outreach locations

Abbreviations: HCW, health care worker; CHW, community health care worker.

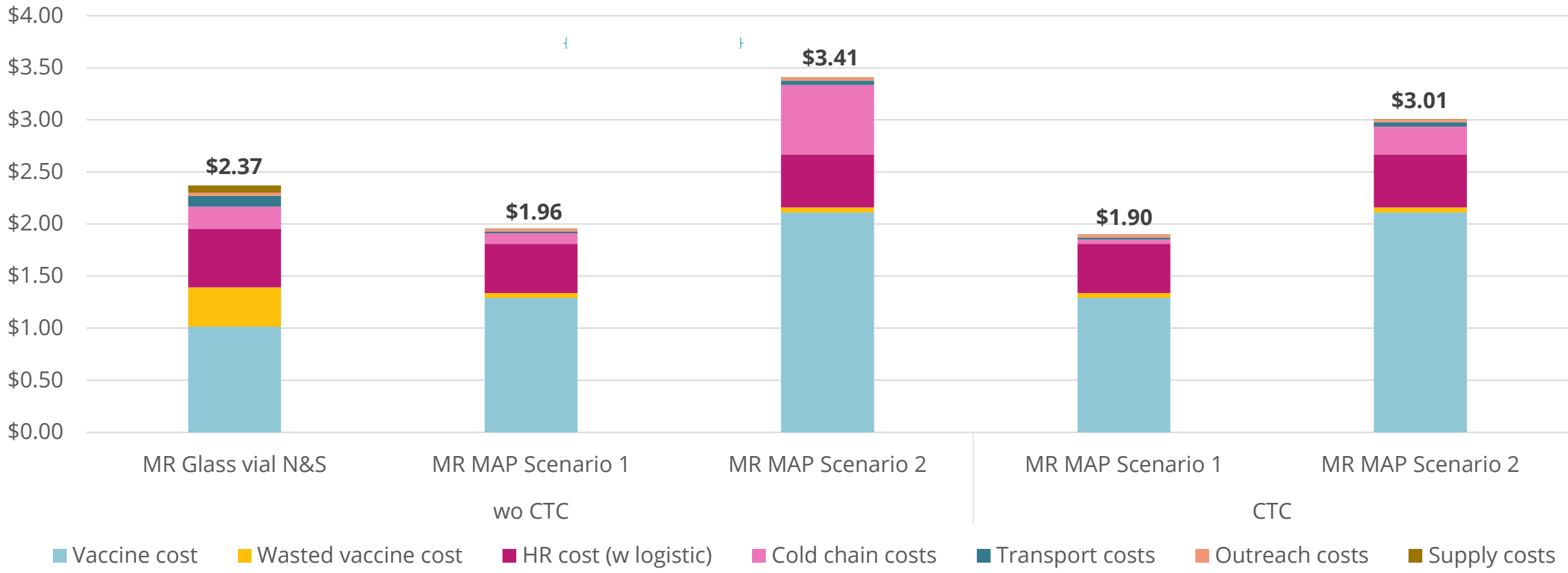
Vaccine technology–specific model assumptions

	MR 5-dose vial	MR 10-dose vial	MR MAP—Scenario 1	MR MAP—Scenario 2	TCV 5-dose vial	TCV MAP—Scenario 1	TCV MAP—Scenario 2
Price per dose	$0.90	$0.72	$1.29	$2.11	$1.50	$2.25	$3.00
Doses per vial	5	10	1	1	5	1	1
Volume of the vaccine per dose (cm^3)	4.2	2.1	3	20	2.9	5	20
Volume of diluent per dose (cm^3)	5.5	3.1	0	0	0	0	0
Vaccine wastage rate (routine settings)	15%	40%	1%	1%	10%	1%	1%
Volume of injection syringe (cm^3)	43	43	0	0	43	0	0
Volume of reconstitution syringe (cm^3)	34	34	0	0	0	0	0
Human resource time use (in seconds) for vaccine administration	35	21	20	200	17	20	200

Abbreviations: MR, measles-rubella; MAP, microarray patches; TCV, typhoid conjugate vaccine.

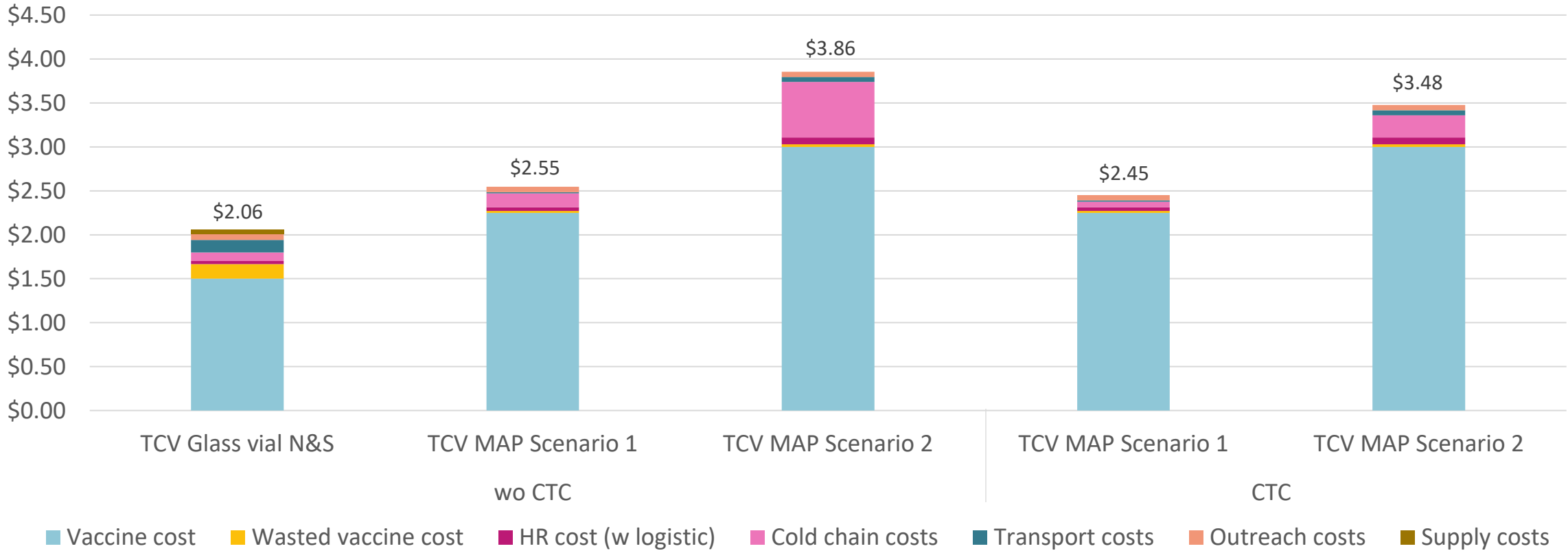
Summary of the weighted average cost per dose administered—routine immunization with MR MAPs

Technology inputs	MR in 5-dose vial	MR in 10-dose vial	MR MAP scenario 1	MR MAP scenario 2
Price per dose	$ 0.90	$ 0.72	$1.29	$2.11
Volume per dose (cm^3)	4.2	2.1	3	20
Administration HR time	35s	21s	20s	200s



Summary of the weighted average cost per dose administered—routine immunization with TCV MAPs

Technology inputs	TCV in 5-dose vial	TCV MAP scenario 1	TCV MAP scenario 2
Price per dose	$1.50	$2.25	$3.00
Volume per dose (cm^3)	2.9	5	20
Administration HR time	17s	20s	200s



Summary from delivery cost estimates

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Significant drivers of cost per dose administered estimate

- **Vaccine price** is an important driver of delivery cost differentials between MAPs and vials.
- **Programmatic wastage** could be a saving resulting from moving to a single-dose presentation with MAPs, especially for vaccines with higher wastage, such as MR.

Delivery cost drivers

- For MAPs, **cold chain volume and human resource time for outreach and mobile delivery** have the **most impact on delivery costs**.

Thermostability

- Use of MAPs in **CTC would provide some savings in delivery costs,** but not enough to overcome the price premium.

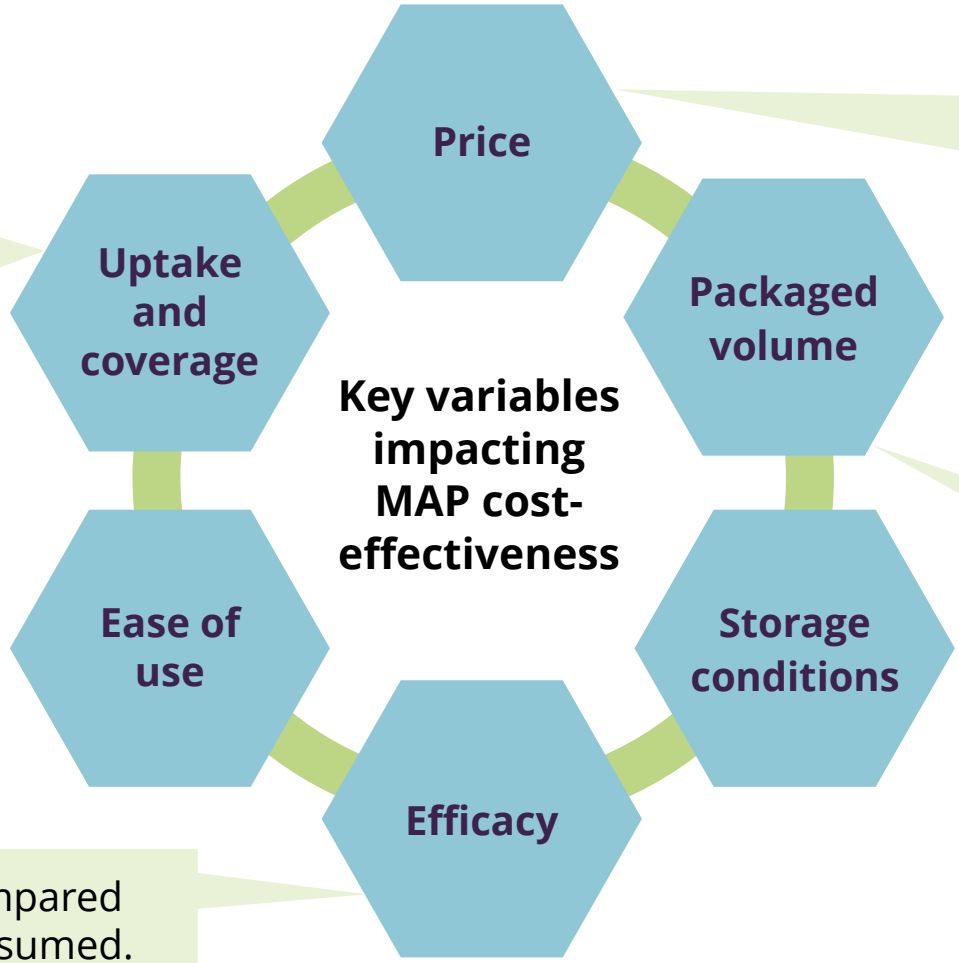
Implications of potential expanded reach and cost-effectiveness of MAPs

- In general, reaching hard-to-reach populations through outreach and mobile delivery **will increase delivery costs in most MAP scenarios.**
- Incremental gains in coverage for these populations through use of MAPs can be explored through **cost-effectiveness analyses** that evaluate the benefit of the extended reach versus increased delivery costs and MAP price premium.

 CTC, controlled temperature chain; MAP, microarray patches, MR, measles-rubella.

Factors impacting the potential cost-effectiveness of MAPs

Enabling new uptake or increase in coverage is critical across all use cases, especially if MAPs come with price premium.



Impact of price premium varies by vaccine product and use case; for some, only marginal price increases allow cost-effectiveness.

MAP packaging size has a big impact on delivery costs.

Non-inferior efficacy compared to current products is assumed.

Human factors evaluation of two measles and rubella vaccine MAPs in Kenya

Jennifer Foster, Shamim Omar, Priscilla Kwarteng, and Stella Wanjiru, PATH

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Introduction

PATH is leading a human factors evaluation of two MR MAP candidates.

This evaluation has two components:

1. A **pretest** to evaluate the instructions for use (IFU) and training procedures (Kenya, 2022).
2. A **main evaluation** to collect feedback from end users in three countries on these devices.

Measles-rubella MAPs

- Measles and rubella (MR) are two serious vaccine-preventable diseases that are endemic to many low- and middle-income countries.
- Although MR vaccines have been available for a long time, many children are still not vaccinated, especially in hard-to-reach areas.
- MR MAPs possess attributes that could make vaccinations easier and help vaccinate more children not being reached by existing methods.
- MR MAPs are the furthest along in clinical development among vaccine MAPs.

Photos: PATH and BD

MR MAP human factors: Main evaluation

Objective

This evaluation is assessing the usability, acceptability, and programmatic fit of two MR MAP candidates in three countries.

Methods

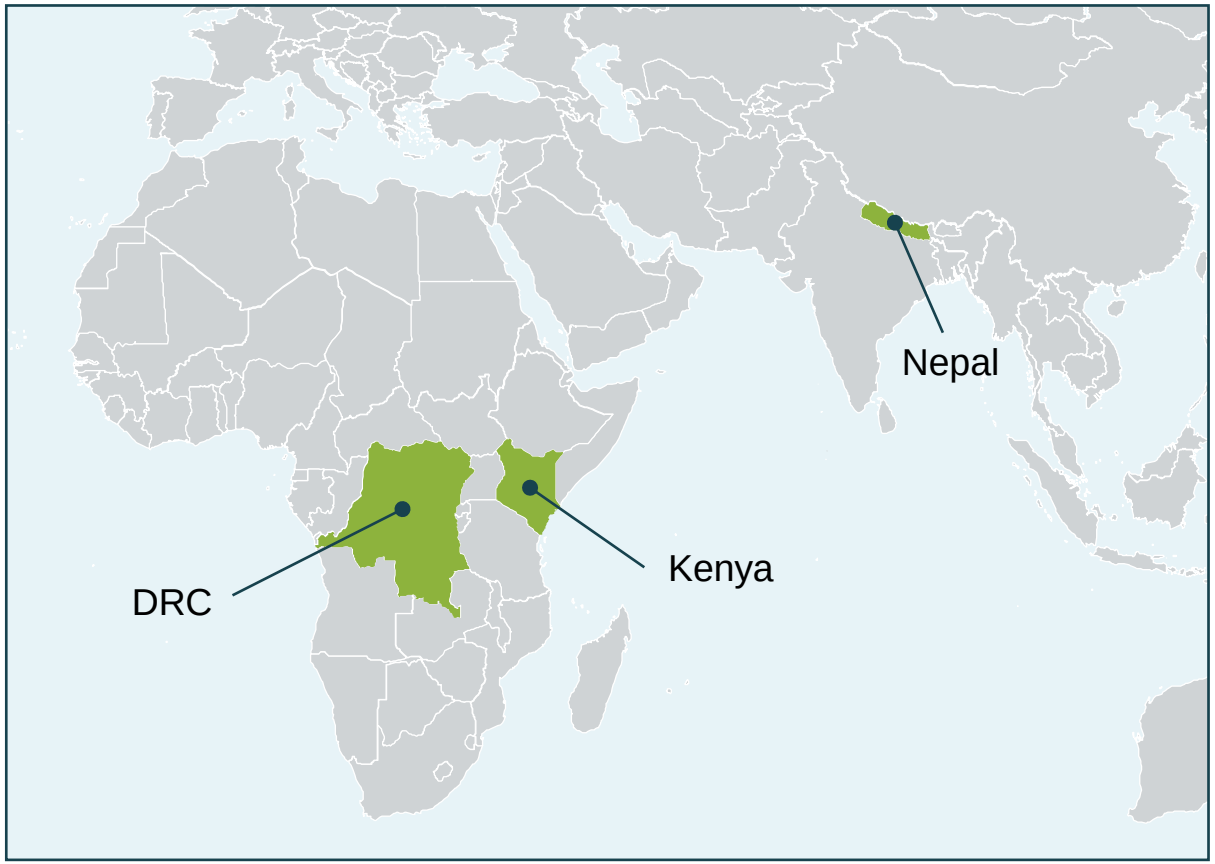
Simulated use with target end users and stakeholder interviews.

Locations

DRC, Kenya, Nepal.

Timing—simulated use:

- Kenya (completed July–Sept 2023)
- Nepal (ongoing)
- DRC (planned launch Nov 2023)



Main evaluation overview

Participants

Health care providers (HCPs) who regularly provide immunization services and community health workers (CHWs) who do not regularly provide immunization.

Sample size

Up to 32 participants per country.

Training

Training procedures for the main evaluation were revised to incorporate recommendations and learnings from the pretest.

Data

This presentation focuses on preliminary data from the simulated use and interviews conducted among HCPs and CHWs in Kenya.

Pretest: Overview

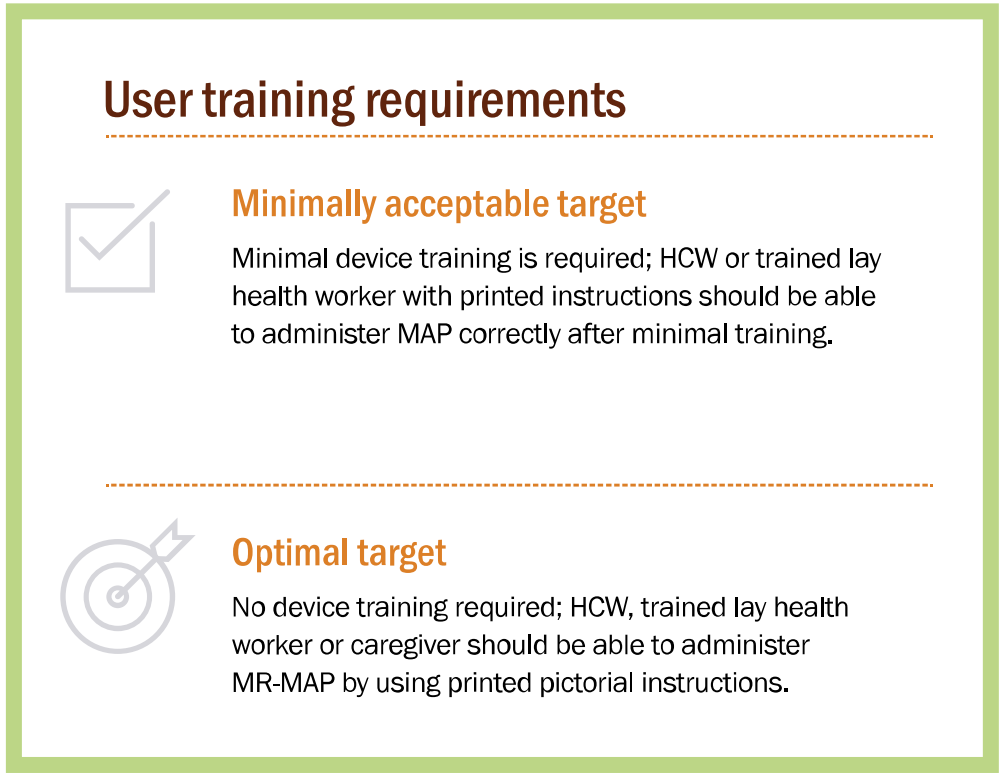
Overview

Two rounds of data collection were conducted with potential end users.

Minimal training was provided:

- **Round 1:** Verbal step-by-step explanation of instructions for use. MAP sample displayed but not activated.
- **Round 2:** Participants were given IFU and asked to deliver a mock immunization.

WHO/UNICEF MR MAP target product profile (June 2019)



Measles-rubella microarray patch (MR MAP) target product profile

Pretest: Key findings

While participants expressed confidence in using the MAPs, **most participants made multiple use errors that could have been averted by training that incorporates adult learning principles**, including experiential learning and practical skills building.

Topic	Insight for both MAPs
Successful MAP delivery	Only a few participants completed all distinct actions needed for correct MAP use.
Expressed confidence in using MAPs	Most participants expressed confidence in using the MAPs.
Usability observations	Some participants made use errors that could be attributed primarily to the minimal or no training provided for a new device.

Interim results: Simulated use activity in Kenya

Sample size

32 participants:

- Kisumu county (urban): 8 HCPs, 8 CHWs
- Turkana county (rural): 8 HCPs, 8 CHWs

Minimal training included a full **demonstration** (using a manikin and IFU) followed by a **guided practice**, where the trainer walked participants through the IFU.

Study procedures

Study introduction → **Device 1**
- Training
- Mock immunization
- Interview

→ **Device 2**
- Training
- Mock immunization
- Interview

→ **Closing questions**

Interim analysis: Kenya simulated use

Topic	Insights for both MAPs
Expressed ease of use	**Most participants found the MAPs easy to use**, especially compared with needle and syringe. A few concerns were raised about hurting the child during the application process and patience during hold time.
Expressed confidence in using MAPs	**Participants expressed confidence in using the MAPs**, saying they are easy to use, they eliminate potential use errors (depth of injection, dosage measurements), and that confidence would increase with practice.
Feedback on site of administration	**Participants noted that the proposed administration sites were acceptable**, although they noted factors, such as the need to undress the baby and familiarity of immunization, that might impact perceptions of other providers and caregivers.
Feedback on wear time	**Participants preferred the shortest possible wear time**, especially in the context of crowded immunization sessions, where a minute (or more) adds up.

Interim analysis: Kenya simulated use

As a result of the revised training procedures, almost all participants in Kenya were able to successfully use the MAPs to deliver a mock immunization to a manikin.

Topic	Insights for both MAPs
Successful MAP delivery	Almost all **participants were able to successfully deliver a mock immunization**.
Use errors	**Use errors were infrequent, and mainly related to the need to hold the MAP in place following activation** (after hearing the "click"). One participant did not apply enough pressure to hear the click.
Other usability observations	Other **use deviations were related to the ordering of steps in the instructions that were not aligned with usual practices**; for example, most participants started with prepping the "child" / interacting with the caregiver and then moved on to the steps required for application.

MR MAP human factors: Next steps

- PATH will also be collecting additional human factors data from caregivers of participants in the upcoming Phase 2 clinical trials planned in The Gambia.
- In addition to informing product development, these results, along with other inputs (such as country consultations and cost analyses), will inform country introduction strategies and training plans and will identify implementation research needs.

Thank You!

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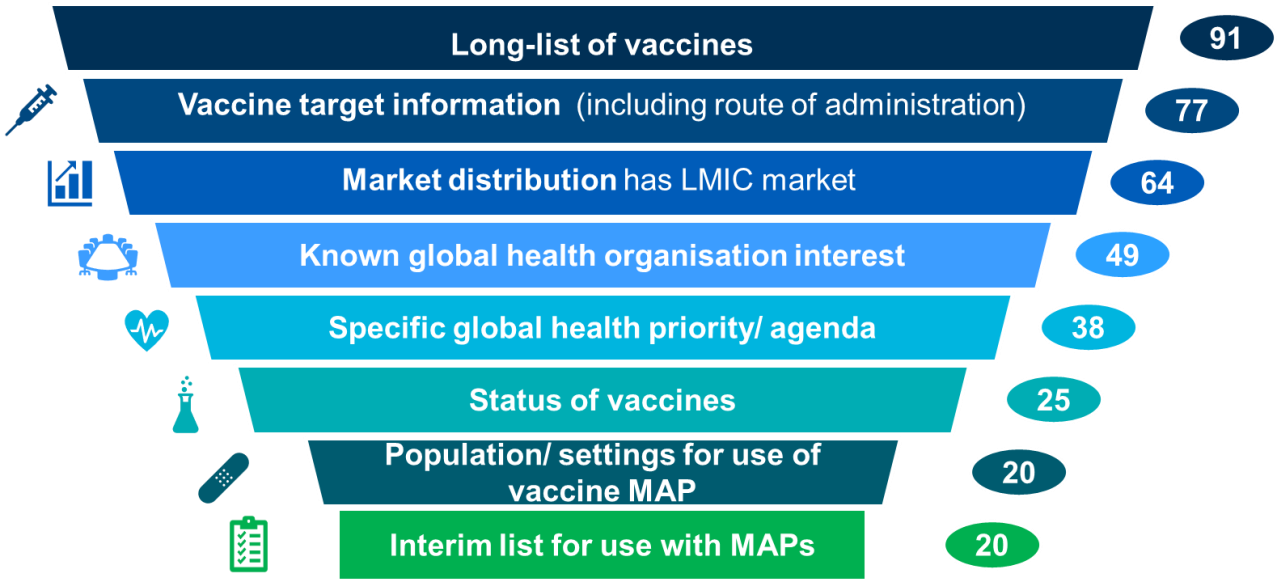
Proposed priority list of vaccine targets for use with MAPs

Share your feedback through TechNet-21 consultation



VIPS VACCINE INNOVATION PRIORITISATION STRATEGY

	PRIORITY LIST of vaccine targets for MAPs
Priority 1 group	Hepatitis B virus
	Measles, rubella (MR)/measles, mumps and rubella (MMR) viruses
	Human papillomavirus
	Rabies virus
	Yellow fever
	Influenza virus, seasonal and pandemic
	SARS-CoV-2
Priority 2 group	Group B *Streptococcus* (GBS), *S. agalactiae*
	Neisseria meningitidis A,C,W,Y,(X)
	Salmonella Typhi
	Streptococcus pneumoniae

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