

Costs of delivering COVID-19 vaccines in 133 COVAX economies

Presented by Stephen Resch, PhD MPH

November 1, 2022



COVAX Working Group on Delivery Costs

Cross-organizational working group supporting **planning, budgeting, fundraising** and **financing of COVID-19 vaccine delivery** for AMC92 economies



BILL & MELINDA
GATES foundation



WORLD BANK GROUP



THINKWELL

Several iterations of rapid response

- First meeting with COVAX in Summer 2020.
 - Tasked with developing an *ex ante costing model* for delivery cost of COVID19 vaccines in COVAX Advance Market Commitment countries (AMC92)
 - Initial estimates (**Version 1**) in Sept 2020.
- Refined January 2021 and published as **Version 2**.
 - Extensive review of existing delivery cost data
 - Leveraging Thinkwell Immunization Delivery Cost Catalog (IDCC) and previous analysis of variation in routine immunization cost.
 - Incorporation of PATH estimates of cold chain requirements and WHO estimates of TA cost
- **Version 3** for COVAX 2022 strategy (Oct. 2021)
 - Expanded to 133 LMICs
 - Considers vaccination progress so far
 - Human resources 'surge' and economic opportunity cost (WHO's HR model)
 - Updated mix of delivery modalities
 - Booster doses added
 - Minor tweaks to unit costs.

COVAX Working Group on Delivery Costs

Cross-organizational working group supporting **planning, budgeting, fundraising** and **financing of COVID-19 vaccine delivery** for AMC92 economies



BILL & MELINDA
GATES foundation



WORLD BANK GROUP



T
H
N
K
S
E
L

Current Version 4

- Simplified population subgroup prioritization
 - Total population, and high-risk population (HRP) (informed by Clark et al.)
- Flexible duration of 5 time periods to accommodate scenarios with different time horizon
- Ability to use national coverage targets for primary vaccination
- Added detail on vaccination progress so far (first dose, 'full vax' with primary doses, booster doses)
- Allows assumptions for booster coverage targets separate from primary coverage.
- Allows countries' vaccination rate (doses per month) to be a constraint on the time required to reach coverage targets.
- Revised social mobilization costs informed by early primary costing studies
- Added ability to consider "last mile" costs (additional cost per dose) for scenarios specifying very high coverage in HRP.
- Added ability to include a multiplier on facility- and country-level recurrent costs in scenarios that involve an accelerated pace of scale-up

Model Structure & Function: Cost Detail Breakdown

COST CATEGORIES

- Human Resources for Delivery
- Syringes & safety boxes
- Protective Personal Equipment (PPE)
- Hand hygiene
- Per diem for service delivery and supervision
- Transportation for outreach (delivery, supervision)
- Training
- Planning and coordination
- Social mobilization
- Cold chain
- Technical Assistance
- Waste management
- Vaccination certificates
- Pharmacovigilance
- Last Mile

All calculations reported for each country and as aggregate totals for country groups (e.g. Gavi-eligible, AMC92).

Variable Cost per Dose

- Recurrent Cost at Facility-level per period
- Recurrent Cost at Country-level per period
- Fixed Startup at Facility-level
- Fixed Startup at Country-level

Cost Breakdown by Line Item and Cost Category						
Category	Recurrent by Dose	Recurrent by Facility	Recurrent by Country	Startup by Facility	Fixed Startup by Country	Total Cost
Human Resources for Delivery	#####	\$0	\$0	\$0	\$0	#####
Syringes & safety boxes	#####	\$0	\$0	\$0	\$0	\$361,781,531
Protective Personal Equipmen	\$41,183,516	\$0	\$0	\$0	\$0	\$41,183,516
Hand hygiene	#####	\$0	\$0	\$2,068,443	\$0	\$125,909,051
Per diem for service delivery a	#####	\$0	\$0	\$0	\$0	\$575,236,094
Transportation for outreach (s	#####	\$0	\$0	\$0	\$0	\$200,078,627
Training	\$0	\$10,972,678	\$0	\$6,168,529	\$0	\$17,141,206
Planning and coordination	\$0	\$0	\$53,050,000	\$0	\$25,016,653	\$78,066,653
Social mobilization	\$0	#####	\$63,873,644	\$77,566,606	\$9,077,216	\$316,476,906
Cold chain	\$70,789,856	\$0	\$0	\$0	\$37,605,401	\$108,395,257
Technical Assistance	\$0	\$0	\$113,225,000	\$0	\$0	\$113,225,000
Waste management	#####	\$0	\$0	\$0	\$0	\$162,445,785
Vaccination certificates	#####	\$0	\$0	\$0	\$0	\$192,819,842
Pharmacovigilance	\$0	\$13,239,253	\$0	\$6,187,800	\$0	\$19,427,053
Other 1	\$0	\$0	\$0	\$0	\$0	\$0
Other 2	#####	\$0	\$0	\$0	\$0	\$408,322,913
Total	#####	#####	\$230,148,644	\$91,991,378	\$71,699,270	#####
Pct Total	94.1%	1.9%	2.3%	0.9%	0.7%	

Example of breakdown of unit cost inputs by level

Costs incurred per dose (differs by delivery method)		Costs incurred every quarter		Costs incurred one time only ("startup")	
Fixed Site	Outreach	Facility	National	Facility	National
<ul style="list-style-type: none"> • PPE • Sanitizer • Cold chain ops • Vaccine Transpo • Waste Mgmt 	<ul style="list-style-type: none"> • PPE • Sanitizer • Cold chain ops • Vaccine Transpo • Waste Mgmt • Per diem • Outreach transport 	<ul style="list-style-type: none"> • Training • Social mob • Pharmacovig 	<ul style="list-style-type: none"> • Planning & Coordination • Social mob • TA 	<ul style="list-style-type: none"> • Training • Wash station • Social mob • Pharmacovig 	<ul style="list-style-type: none"> • Planning & Coordination • Social mob • TA

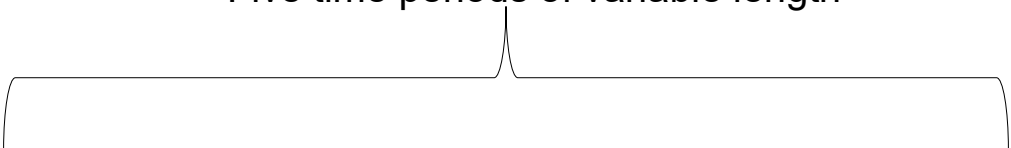
Model Structure & Function: Country-specific variation in unit costs

- Several cost inputs were adjusted to be country-specific
- Wage rates for line items involving labor (Human Resources for Delivery, Social Mobilization, Training)
 - WHO model included country-specific estimates of health worker salaries
- We used country variation in RI delivery cost from Portnoy et al. to adjust Transportation and Per Diem cost
- Cold Chain capital costs were also country specific in the PATH model
- Some costs varied by country group (based on size and conflict/crisis context): TA, Planning



Model Structure & Function: Time horizon

Five time periods of variable length



Time period	T0	T1	T2	T3	T4	T5
Period end date	30-Jun-22	30-Dec-22	30-Mar-23	30-Jun-23	30-Sep-23	30-Dec-23
Period duration (months)	0	6	3	3	3	3

Model Structure & Function: Delivery modalities

1. **Fixed Site**
2. **Outreach**
3. **Campaign/Mass Vaccination**
4. **Option for 4th modality (not used)**

Delivery modality mix is country-specific and can vary for primary vaccination and boosters

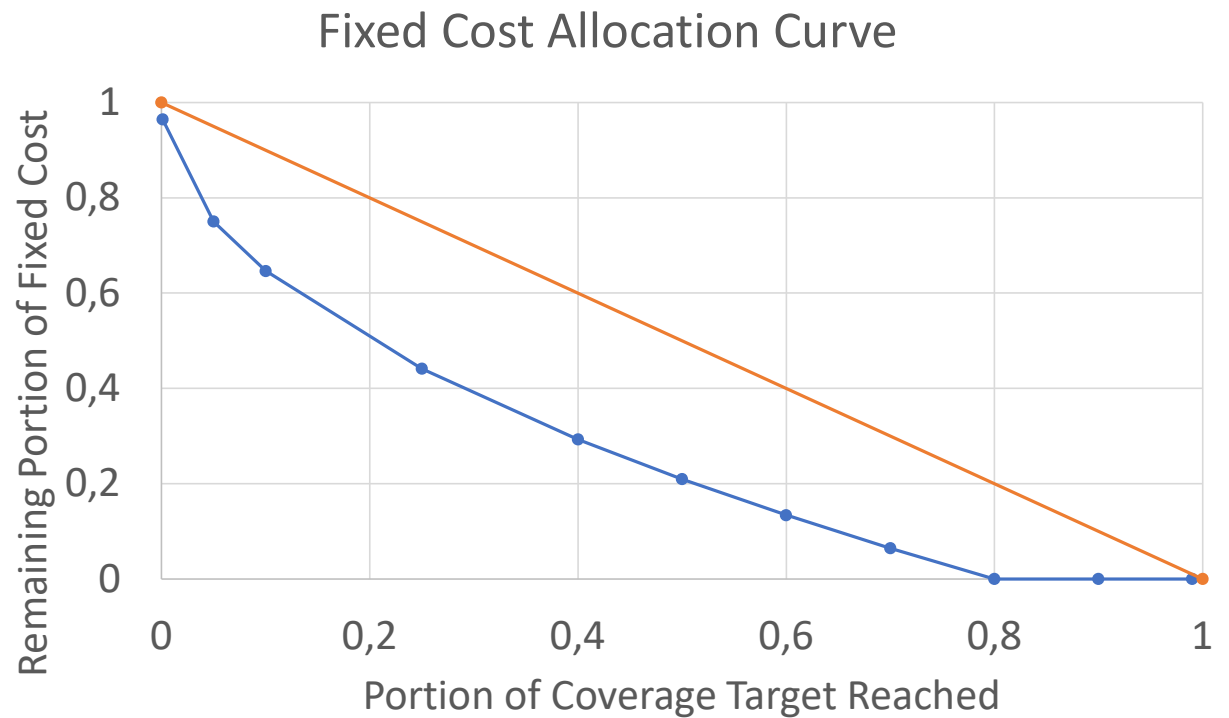
Delivery modality affects variable cost per dose, and HRH costs

Model Structure & Function: Dealing with Vaccination Progress

Impacts on modeled scenarios:

- Non-zero “starting” coverage
- Fraction of fixed costs spent
- Mix of delivery modalities
- Observed pace of vaccination

Front-loading fixed costs



Data gathering to inform cost inputs

- Other modeling teams for specific areas (CC, TA, HRH)
- Country budgeting (WHO CVIC Tool, and NVDPs)
- Literature review (e.g. studies in Thinkwell's IDCC)
- Thinkwell's ongoing campaign costing work
- Expert opinion gathered in model review meetings and consultations (esp. Social Mobilization)
- Later, primary costing studies of Covid19 vaccine delivery (e.g. Village Reach)



Example source date: Cost per dose for vaccine certificates

Data source	Cost per dose (US\$ 2020)
Campaign budgets	
Ethiopia, yellow fever	0.16
India, measles-rubella campaign	0.08
Sierra Leone, measles-rubella catch-up campaign	0.03
IDCC campaign costing literature	
Bangladesh, oral cholera vaccine campaign	0.03
Mozambique, oral cholera vaccine campaign	0.02
Median: 0.03	



Transport cost per dose for service delivery, supervision and monitoring activities

Data source	Cost per dose (US\$ 2020)
Polio house to house campaign budgets (with adjusted session size)	
Benin	0.18
Equatorial Guinea	2.71
Iraq – April 2019	2.18
Iraq – Sept 2019	2.21
Mali	0.48
Papua New Guinea	2.98
South Sudan	0.29
Syria	0.60
Studies reporting on the cost of routine outreach	
Indonesia	0.24
Tanzania	0.25
Campaign budget data	
DRC, measles follow-up campaign	0.12
Ethiopia, yellow fever campaign	0.18
Sierra Leone, measles-rubella catch-up campaign	0.50
IDCC campaign costing literature	
Bangladesh, oral cholera vaccine campaign	1.58
<i>Median for adjusted session size: US\$ 0.49</i>	

Adjusted per diem, transport, training using IDCC- RI ratio

- For some costs that are largely non-tradable, we assumed cost would vary across countries.
- We used the variation in unit cost of routine immunization from Portnoy et al. 2020* as the basis for adjustment
- Line items adjusted this way:
 - Vaccine transport
 - Personnel transport for outreach
 - Per diem for outreach
 - Training
- **Portnoy A, Vaughan K, Clarke-Deelder E, Suharlim C, Resch SC, Brenzel L, Menzies NA. Producing Standardized Country-Level Immunization Delivery Unit Cost Estimates. Pharmacoeconomics. 2020 Sep;38(9):995-1005.*

Example of Social Mobilization line Items that varied at facility and country level

Level	Activity	Cost in countries with population < 10 million	Cost in countries with population > 10 million / conflict zones
Country	Behavioral and social data collection	60,000	150,000
Country	Social media listening (annual cost of 1 M&E officer per 10mil pop)	Varies by Country based on size and labor rates	Varies by Country based on size and labor rates
Facility	Social mobilization 'new vaccine introduction' activities	750	750

Originally generated country-specific wages using Serje et al. 2018

WHO Health Care Worker Wages as Multiple of GDP per capita	MD	RN	Other	Weighted Average
High income	1.9	1.5	0.9	1.2
Upper middle income	2.7	2.2	1.3	1.75
Lower middle income	5.1	4.2	2.4	3.3
Low income	7.8	6.4	3.7	5.05
Weight	0	0.5	0.5	

Serje J, Bertram MY, Brindley C, Lauer JA. Global health worker salary estimates: an econometric analysis of global earnings data. *Cost Eff Resour Alloc*. 2018 Mar 9;16:10

In V4 replaced with country-specific wage rates in WHO HRH model

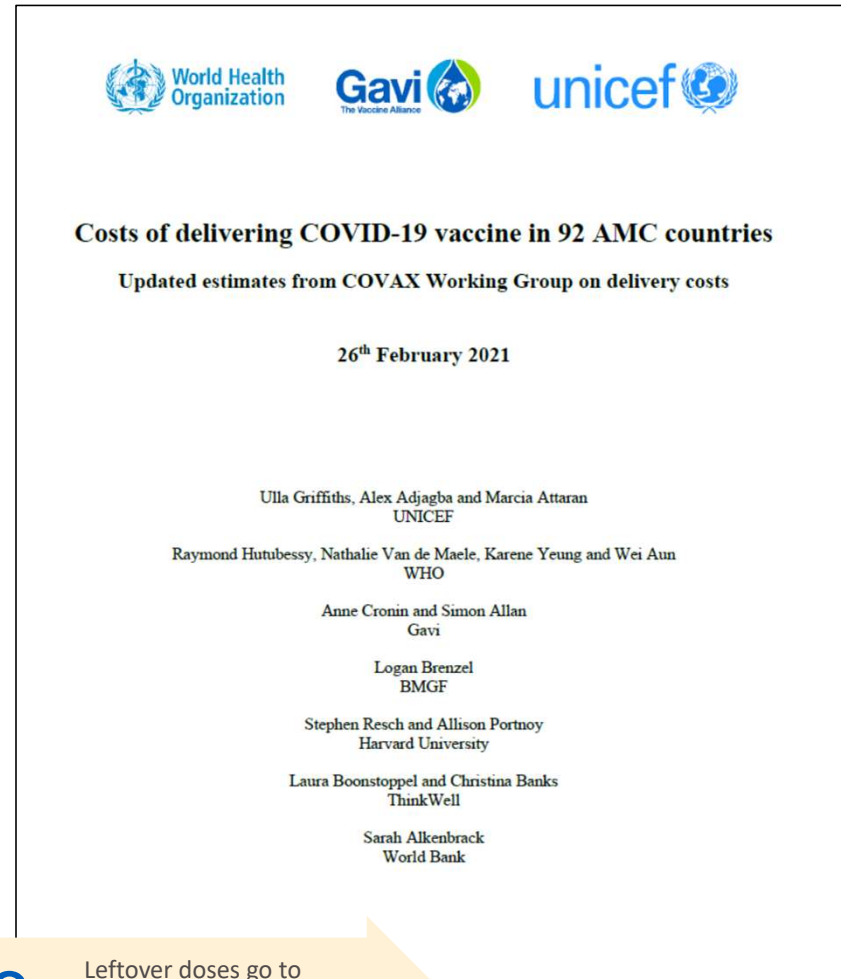


V2 Analysis (Jan 2021)

What is the cost of delivering 1.22 billion doses in the COVAX AMC countries?

Scenario Details:

- 92 AMC countries
- Coverage Target: ~20% of the total population (9% in India)
- Cascading prioritization
- 2 doses per person
- Delivery timeframe: Q2 2021 - Q2 2022



The cover page features logos for the World Health Organization, Gavi (The Vaccine Alliance), and UNICEF at the top. The title is 'Costs of delivering COVID-19 vaccine in 92 AMC countries', followed by the subtitle 'Updated estimates from COVAX Working Group on delivery costs' and the date '26th February 2021'. The authors are listed as Ulla Griffiths, Alex Adjagba and Marcia Attaran (UNICEF); Raymond Hutubessy, Nathalie Van de Maele, Karene Yeung and Wei Aun (WHO); Anne Cronin and Simon Allan (Gavi); Logan Brenzel (BMGF); Stephen Resch and Allison Portnoy (Harvard University); Laura Boonstoppel and Christina Banks (ThinkWell); and Sarah Alkenbrack (World Bank).

1

Core health workers through fixed site delivery

2

Elderly (65 years and above) through outreach

3

Leftover doses go to pop aged 50-64

Total cost of delivering 1.2 billion doses in 92 AMC countries

	Total (US\$ millions)	US\$ per dose supplied	US\$ per person vaccinated with 2 doses	Percent of total
Gavi eligible (n= 57)	951	1.39	3.11	55%
India	283	1.07	2.39	16%
Gavi transitioned (n=12)	250	1.66	3.70	13%
Non-Gavi (n=22)	238	1.97	4.39	14%
Technical Assistance	198	0.16	0.36	10%
Global and regional	98	0.08	0.18	5%
Total	2,018	1.66	3.70	100%

Notes on V2:

- No HRH for delivery included
- No country-specific coverage targets
- Scenario focused on original COVAX plan for about 1.2billion doses allocated to countries in proportion to population size.
- Starting from zero coverage.

Version 4: sample results to illustrate reporting detail in current model

(See later presentation for results for specific policy scenarios)

Number of Countries Included	133
------------------------------	-----

Progress so Far	Outcomes				
	Primary Doses	FV primary	Primary Coverage	Booster Doses	Booster Coverage
TOTAL	5,298,885,535	2,505,508,836	50.4%	588,605,786	11.9%
Gavi-eligible	1,159,594,666	557,838,050	30.8%	126,013,716	7.0%
Graduated from Gavi	485,031,634	221,073,875	54.8%	63,873,290	15.8%
Non-Gavi	315,006,738	151,761,570	47.1%	29,744,727	9.2%
India	1,902,333,671	903,877,224	65.5%	54,180,061	3.9%
FSF	1,436,918,826	670,958,117	64.0%	314,793,992	30.0%

Forward-looking scenario	Outcomes				
	Doses	newly FV	new boosters	Primary Coverage Reached	Booster Coverage Reached
TOTAL	3,691,949,660	918,962,959	2,213,246,370	69%	56%
Gavi-eligible	1,211,721,434	440,038,801	438,312,484	55%	31%
Graduated from Gavi	339,518,566	88,503,463	206,896,949	77%	67%
Non-Gavi	271,693,170	76,880,261	140,432,970	71%	53%
India	1,194,699,326	151,220,400	1,000,917,563	76%	76%
FSF	674,317,164	162,320,033	426,686,405	80%	71%

Cost Estimates								Last Mile Premium Cost
Total Base Cost	Base Cost per Dose	HR-surge	HR-reassign	HR-total	HR-surge per dose	HR-total per dose		
\$2,720,509,433	\$0.74	\$306,908,413	\$6,818,159,253	\$7,125,067,666	\$0.08	\$1.93		\$408,322,913
\$1,156,831,277	\$0.95	\$194,625,436	\$1,540,490,170	\$1,735,115,606	\$0.16	\$1.43		\$131,819,461
\$205,847,675	\$0.61	\$54,970,891	\$465,459,877	\$520,430,767	\$0.16	\$1.53		\$30,649,564
\$245,734,616	\$0.90	\$51,332	\$1,085,034,070	\$1,085,085,401	\$0.00	\$3.99		\$37,520,431
\$665,042,644	\$0.56	\$0	\$1,217,437,991	\$1,217,437,991	\$0.00	\$1.02		\$117,610,578
\$447,053,221	\$0.66	\$57,260,754	\$2,509,737,146	\$2,566,997,900	\$0.08	\$3.81		\$90,722,879