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Health and economic benefits of improving efficiencies in product development for neglected diseases, emerging infectious diseases, and maternal health

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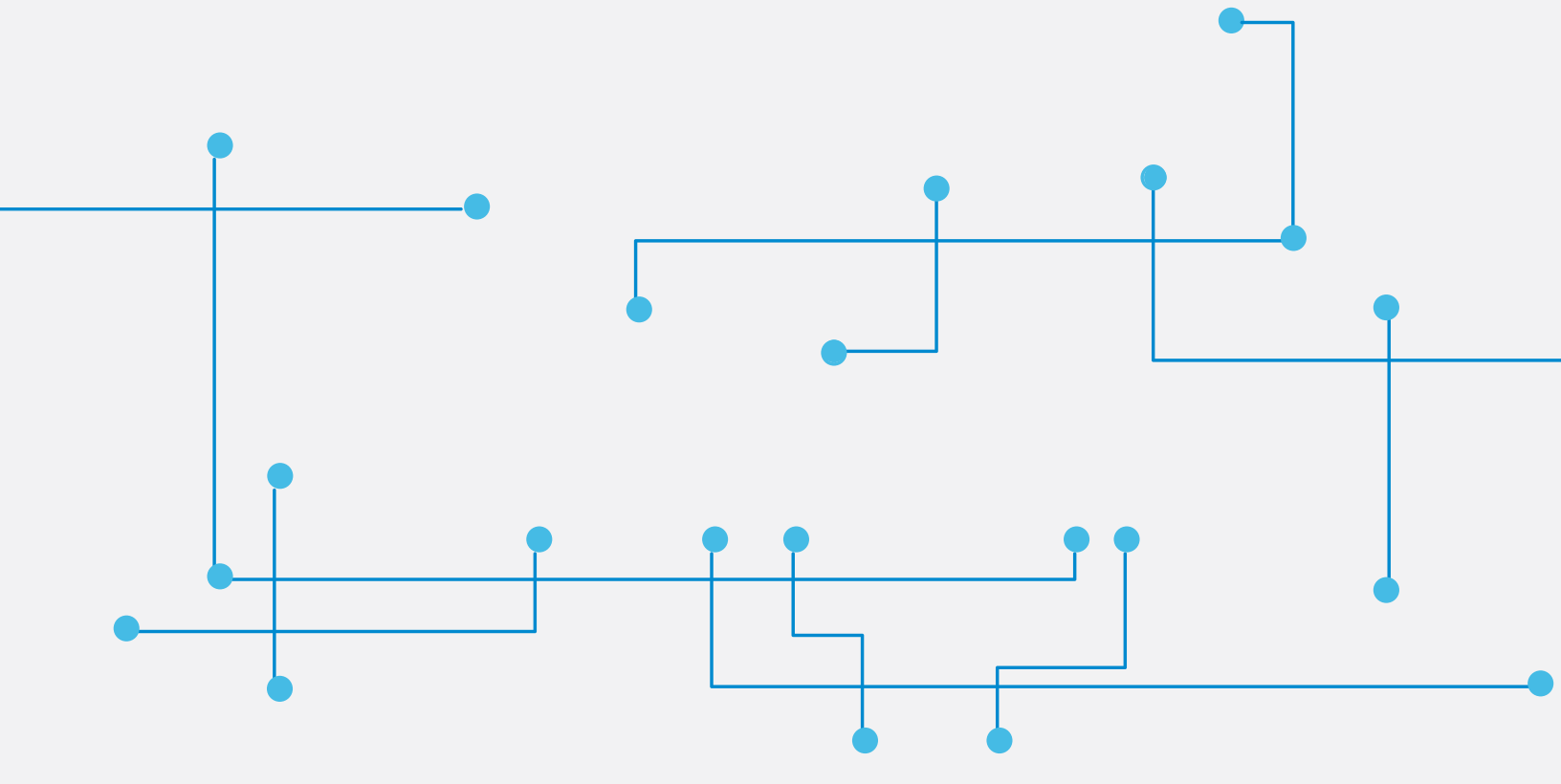


EXECUTIVE SUMMARY

Over the past 20 years, investments in global health research and development (R&D) have led to launches of many effective products that have saved lives in low- and middle-income countries. These investments have also led to a much more robust product development pipeline for neglected diseases (NDs), emerging infectious diseases (EIDs), and maternal health (MH). Twenty years ago, for example, we had no malaria vaccine, and the only available tuberculosis (TB) vaccine was of low efficacy—today, we have two malaria vaccines and three TB vaccine candidates are in phase 3 clinical trials.

However, these successes are threatened in the post-COVID era by reduced availability of funds and increased competition for scarce global health resources. The good news is that recent innovations in the R&D ecosystem, such as artificial intelligence (AI), smarter clinical trials, lower manufacturing costs, and faster market entry, could significantly improve the efficiency of global health product development over the next 20 years.

In this study, we assessed the potential efficiency gains from these game-changing innovations in the global health product development ecosystem. We interviewed experts, policymakers, and other stakeholders to understand and quantify the expected changes to the R&D ecosystem (see accompanying report for details). We then developed quantitative models to assess the health and economic impact of these innovations.

Our unit of analysis was the product portfolio. Adopting the disease categories used by Policy Cures Research's G-FINDER online repository, and three product archetypes (vaccines, therapeutics, and diagnostics), we grouped the 1,498 candidate products in the current product pipeline into 153 product portfolios (38 ND vaccines portfolios, 38 ND therapeutics portfolios, 38 ND diagnostics portfolios, 9 EID vaccines portfolios, 9 EID therapeutics portfolios, 9 EID diagnostics portfolios, 6 MH therapeutics portfolios, and 6 MH diagnostics portfolios).

We compared four alternative scenarios: (i) a reference case where investments in the current pipeline continue as usual, (ii) a coordinated investments scenario with targeted investments to guarantee at least one product launch in each product portfolio, (iii) an AI and smarter clinical trials scenario, and (iv) a shortened market entry and lower manufacturing costs scenario. We compared each scenario with a "do nothing" scenario to estimate the incremental costs and benefits from that scenario. We then compared these across all scenarios to assess which provided better net benefits.

We adopted two perspectives for our analysis: a health systems perspective and a societal perspective. For both perspectives, we measured health gains as deaths averted and disability-adjusted life-years (DALYs) lost averted. The health system perspective included preclinical and clinical research costs, product procurement costs (manufacturing and delivery), and treatment costs. In contrast, the societal costs included all the costs from the health system's perspective and economic productivity loss. We computed costs and benefits over a 22-year period from 2023 to 2044. We compared scenarios using incremental cost-effectiveness ratio (ICER) per death averted, ICER per DALY averted, and net monetary benefits (NMBs).

Our modeling suggests that investments in the current product pipeline, assuming no efficiency improvements, will lead to successful launches from 59 product portfolios, leaving 94 product portfolios with no successful product launch. From these 59 portfolios with product launches, we expect 39 vaccines for NDs, 52 ND therapeutics, 148 ND diagnostics, 12 EID vaccines, 17 EID therapeutics, 64 EID diagnostics, 55 MH therapeutics, and 66 MH diagnostics. The 94 product portfolios without a successful launch include 31 ND vaccines portfolios, 33 ND therapeutics portfolios, 11 ND diagnostics portfolios, 6 EID vaccines portfolios, 5 EID therapeutics portfolios, 3 EID diagnostics portfolios, 2 MH therapeutics portfolios, and 3 MH diagnostics portfolios.

Additional funding will be needed to guarantee at least one product launch from each product portfolio. To estimate this funding gap, we compared current annual funding to the estimated annual funding required to guarantee missing product launches. We assumed a best-case scenario where the current pipeline is replenished with simple candidate products and a worst-case scenario where the current pipeline is replenished with complex candidate products that take longer to develop, are more expensive, and have lower probabilities of success. Our estimates suggest that over the next ten years, an additional $1.4 billion to $7 billion will be needed annually for product development, depending on the complexity of the product candidates. This will close the funding gap in the ND, EID, and MH product pipelines. This annual product development funding gap comprises $1.1 billion to $5.9 billion for NDs, $143 million to $794 million for EIDs, and $191 million to $256 million for MH products.

Closing this funding gap will strengthen the current product pipeline and provide positive health and economic benefits to society. In addition to guaranteeing at least one successful product launch in each of the 94 portfolios with missing products, we expect the number of product portfolios yielding positive NMBs to society to increase from 42 to 106. ICER per DALY averted will be cost-saving for fifteen ND vaccines portfolios and one EID vaccines portfolio. In contrast, ICERs per DALY averted for the other portfolios will range from $6 for the tapeworm therapeutics portfolio to over $400 million for vaccines or therapeutics portfolios for mycetoma (a low-prevalence, low-mortality condition).

We quantified gains from efficiency improvements as cost savings, reduction in average cost-per-launch (CPL), and increase in the number of portfolios that provide positive NMBs to society. We estimated that advancements in AI and the adoption of smarter clinical trials could reduce the total cost of ND product development from $40.2 billion to $33.6 billion, EID development from $8.8 billion to $7.5 billion, and MH product development from $3.9 billion to $3.1 billion. These cost savings would translate to a 26% to 39% reduction in the average CPL across all product portfolios, with diagnostics portfolios seeing CPL reductions of up to $8 million, therapeutics portfolios up to $52 million, and vaccines portfolios up to $122 million.

To identify priority products for development, we used a multi-criteria approach that includes NMBs to assess economic efficiencies from a societal perspective and ICER per death averted and ICER per DALY averted to assess economic efficiencies from a health system perspective. Using these metrics, we found that investing in 15 ND vaccine portfolios and one EID vaccine portfolio would lead to cost savings for the health system and positive NMBs to society. These include portfolios for *S. pneumoniae*, multiple diarrheal diseases, typhoid and paratyphoid, *P. falciparum*, multiple/other malaria strains, tuberculosis, rotavirus, *N. meningitidis*, HIV/AIDS, dengue, hepatitis B, multiple Salmonella infections, strongyloidiasis, cryptococcal meningitis, rheumatic fever, and Zika.

In addition, 15 other ND vaccine portfolios, one other EID vaccine portfolio, 29 ND therapeutics portfolios, 30 ND diagnostic portfolios, and 3 EID diagnostic portfolios will have positive NMBs. All six MH therapeutics and six MH diagnostic portfolios will yield positive NMBs. We report the overall rankings and also rank products by disease category and product archetype.

In our interactions with policymakers and other stakeholders, they were quick to highlight that factors beyond economic considerations influence their prioritization and decision-making process. These factors include equity considerations, political feasibility, national security, etc. Our rankings did not include these factors, thus our results should be interpreted strictly in economic terms. Nevertheless, our analysis presents a strong economic case for future investments in product portfolios that are both cost-saving to the health system and yield positive NMBs to society.

SECTION 1

BACKGROUND

BACKGROUND

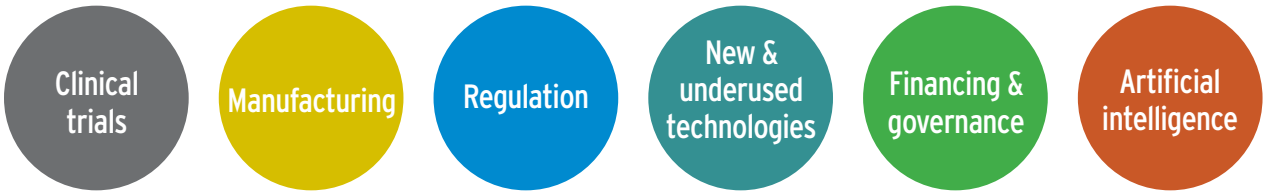
In this working paper, we provide estimates of the potential health and economic benefits of investing in global health product development. We wstimated the health and economic benefit under different assumptions about the potential efficiency gains from various research and development (R&D) ecosystem shifts (e.g., trial networks and regulatory harmonization). We focused on three major categories of products:

(i) neglected diseases (NDs)

(ii) emerging infectious diseases (EIDs)

(iii) maternal health (MH)

Our report builds on formative work detailed in our accompanying working paper: "Reforming the research and development ecosystem for neglected diseases, emerging infectious diseases, and maternal health." We adopted an analytic framework that included six key components of the R&D ecosystem:



We conducted an extensive review of existing research on each topic, held a validation workshop to get inputs from over 30 policymakers, and conducted over 120 key informant interviews with experts worldwide.

We found opportunities for major improvements in efficiencies across all six domains. For example, establishing trial networks and data sharing could reduce clinical trial costs by 20% – 40%; regulatory harmonization can reduce approval times from over three years to less than one year; artificial intelligence (AI) can significantly reduce discovery time and costs; and modular mRNA manufacturing can reduce manufacturing costs by over 60%.

To assess the health and economic benefits of these potential efficiency gains, we developed a reference case to model the current R&D ecosystem (i.e., without efficiencies from changing the R&D ecosystem). Then, we modeled three "efficiency gains" scenarios and compared the potential costs and benefits to the reference case. We provide details in the sections that follow. Section 2 describes our methods, including approaches to estimating costs and valuing health benefits. Section 3 describes the current pipeline with and without replenishments. Section 4 provides estimates of required costs and funding gap for product development. Section 5 describes the health and economic benefits from successful product launches. Section 6 describes the potential costs and benefits of efficiency gains. Finally, Section 7 discusses the top priority products based on value for money indicators from a health system and a societal perspective.

Regulatory harmonization can reduce approval times from over three years to less than one year; artificial intelligence (AI) can significantly reduce discovery time and costs

Establishing trial networks and data sharing could reduce clinical trial costs by 20% – 40%

SECTION 2

ANALYTIC APPROACH

We conducted our analyses in two stages. In the first stage, we estimated the likely product launches from the product development pipeline and the costs of R&D to achieve these product launches. Then, in the second stage, we estimated the post-launch costs, health benefits, and economic benefits for product portfolios with a successful product launch.

Our unit of analysis was the product portfolio. Adopting the disease categories used by Policy Cures Research's G-FINDER online repository, and three product archetypes (vaccines, therapeutics, and diagnostics), we grouped the 1,498 candidate products in the current product pipeline into 153 product portfolios (38 ND vaccines portfolios, 38 ND therapeutics portfolios, 38 ND diagnostics portfolios, 9 EID vaccines portfolios, 9 EID therapeutics portfolios, 9 EID diagnostics portfolios, 6 MH therapeutics portfolios, and 6 MH diagnostics portfolios). The model structure, variables, and parameters used for the study can be found in Appendix section A1. Actual values for parameters and variables are in an **online supplementary appendix**.

2.1 Analytic perspectives, time horizon, and discount rates

We adopted two perspectives for our analysis: a societal perspective and a health systems perspective (Table 1). We defined the societal perspective as the total costs and benefits that accrue to society from investments in the product-pipeline development value chain. We included preclinical research costs, clinical trial costs, manufacturing costs, and treatment costs. For benefits, we included the number of successful product launches, deaths averted from a successful product launch, disability-adjusted life years (DALYs) averted from a successful product launch, and productivity benefits from deaths and DALYs averted.

We defined the health systems perspective as the potential health benefits to society and financial benefits to the health system that result from investing health system funds in product pipeline R&D, manufacturing, delivery, and treatment of conditions. We included the costs of conducting preclinical research and clinical trials and the costs of manufacturing successful products, costs of delivering new products, and costs of providing treatment for the condition. For benefits, we included the number of product launches and deaths/DALYs averted because of a successful product launch.

Our analysis covered a 22-year period from 2023 to 2044, and we applied a 0% annual discount rate to costs.

Table 1: Perspectives adopted

Perspective	Costs included	Benefits included*	Estimates reported
Societal perspective	1. Preclinical and clinical trial costs 2. Manufacturing costs 3. Product delivery/ administration costs 4. Treatment costs**	Product launches Health gains 1. Deaths averted 2. DALYs averted Economic gains 1. Productivity benefits from health gains	1. Net monetary benefits to society
Health systems perspective	1. Preclinical and clinical trial costs 2. Manufacturing costs 3. Product delivery/ administration costs 4. Treatment costs**	Launches Health gains 1. Deaths averted 2. DALYs averted	1. Incremental cost per death averted 2. Incremental cost per DALY averted

NOTES:
* DALYs are disability-adjusted life years.
** Treatment costs comprise the total cost of treating an episode of the disease; this includes drug costs, health worker fees, health facility fees, diagnostic costs, etc.

2.2 Analytics and assumptions

We adopted a portfolio approach to model expected product launches from each product portfolio. The portfolio approach allows for modeling of several products in a single portfolio to assess the likelihood of a successful product launch, the expected number of product launches from each portfolio, and the expected launch year for each product launch. However, this approach cannot specify which particular products in the pipeline will be successful. Depending on the current location of each candidate product in the pipeline, progress to the next stage was determined by the product archetype, expected duration of clinical trials, and the expected probability of trial success. We considered a portfolio to have a successful launch if the value of expected product launches was greater than 1.

We modelled the health and economic benefits of each product portfolio. separately. For each scenario, we estimated costs and benefits from a health system's perspective and a societal perspective (Table 1). From a health system's perspective, we estimated the incremental cost-effectiveness ratios (ICERs) per death averted and per DALY averted. We calculated ICERs as the difference between investing in R&D and not investing in R&D (Appendix A2). From a societal perspective, we estimated net monetary benefits (NMBs) as a function of health benefits, gross domestic product per capita, costs of preclinical/clinical trials, manufacturing costs, and treatment costs (Appendix A2).

To enable easy comparison across product archetypes and disease categories, we made a few simplifying assumptions about the effect of each product archetype. We assume that vaccines reduce incidence, therapeutics reduce mortality and disease duration when treated, and diagnostics increase treatment uptake. We also assume that vaccine coverage at baseline is 0% for all disease/conditions and vaccine campaigns are targeted, with maximum vaccinations at two times the annual incidence.

Upon successful launch of a product, we assume a three-year delay before market entry, and then a 5 percentage point increase in product uptake per year, up to a maximum of 95% uptake, over the period of our analysis.

For scenarios where we assume a replenishment of the pipeline to guarantee a product launch, we calculated the number of products needed for replenishment using the current probabilities of success for clinical trials.

Costs were estimated and adjusted to 2023 USD. Pre-clinical and clinical trial costs data were obtained from the Portfolio-to-Impact (P2I) tool, while product manufacturing, product delivery, and treatment cost data were obtained from expert interviews and published peer-reviewed papers.

To assess efficiency gains, we compared ICERs and NMBs across all four scenarios. We considered any scenario with more successful launches with a positive NMB than the reference group as an efficiency gain from a societal perspective (See section 6).

We used a multicriteria approach, using three measures, to rank candidate product portfolios:

(i) NMBs,	(ii) ICER per DALY averted, and	(iii) ICER per death averted.

NMBs are able to quantify the overall value of benefits to society. ICERs per DALY averted can assess efficiency, but this metric favors conditions that affect younger age groups. ICERs per death averted are not age-biased but do not quantify non-fatal benefits. Combining all three measures allowed us to take advantage of the strengths of each measure. Candidates that ranked in the top five for all three were considered higher priority based on the metrics selected (see Section 7).

SECTION

3

CURRENT PRODUCT DEVELOPMENT PIPELINE

CURRENT PRODUCT DEVELOPMENT PIPELINE

Our analysis included all 1,498 candidate products in the current pipeline for NDs, EIDs, and MH (Table 2). There are 691 candidate products in the ND pipeline: 38% (264) are vaccines, 37% (255) are therapeutics, and 25% (172) are diagnostics. Two hundred and forty-two candidate products are in the preclinical phase, 158 in Phase 1, 175 in Phase 2, and 116 in Phase 3. There are 278 candidate products in the EID pipeline; 40% (110) are vaccines, 33% (92) are therapeutics, and 27% (96) are diagnostics. Of these candidate products, 177 are in the preclinical phase, 35 in Phase 1, 19 in Phase 2, and 47 in Phase 3.

There are 529 candidate products in the MH pipeline; 65% (346) are therapeutics and 35% (183) are diagnostics. Of these products, 342 are in the preclinical phase, 23 in Phase 1, 108 in Phase 2, and 55 in Phase 3.

Table 2. Current candidate product pipeline

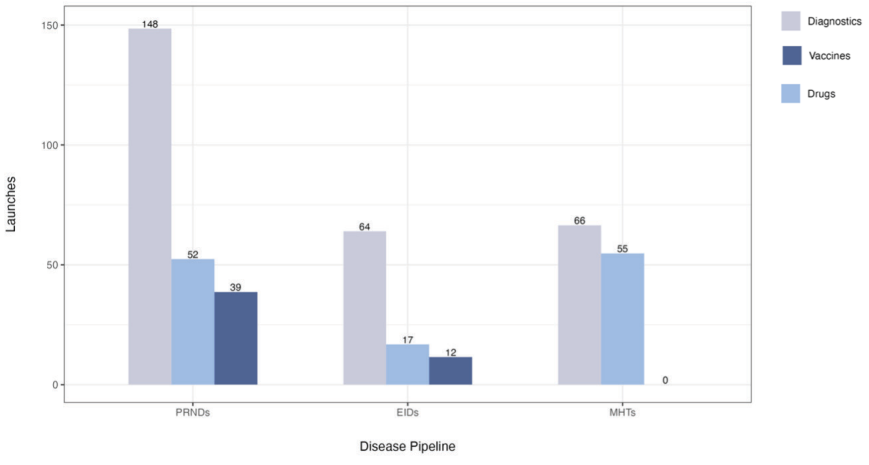
Disease-product-archetype*	Preclinical	Phase 1	Phase 2	Phase 3	All phases
ND vaccines	113	85	45	21	264
ND therapeutics	78	62	92	23	255
ND diagnostics	51	11	38	72	172
All ND products	**242**	**158**	**175**	**116**	**691**
EID vaccines	73	27	7	3	110
EID therapeutics	80	8	3	1	92
EID diagnostics	24	0	9	43	76
All EID products	177	35	19	47	278
MH therapeutics	183	23	85	55	346
MH diagnostics	160	0	23	0	183
All MH products**	343	23	108	55	529

NOTES:
* There are no vaccines in the maternal health technologies category.
** We did not include nutritional products in the maternal health technologies category.

3.1 Expected product launches

Investing in R&D to advance the current candidates in the product pipeline would yield 453 successful launches from 59 product portfolios over the period 2023 to 2024. (Fig. 1). Across all three health/disease conditions, there would be more diagnostic launches, followed by therapeutics, while vaccines would have the fewest launches. Our model predicts that there will be successful launches of 39 vaccines for NDs, 52 ND therapeutics, 148 ND diagnostics, 12 EID vaccines, 17 EID therapeutics, 64 EID diagnostics, 55 MH therapeutics, and 66 MH diagnostics. All three major categories (NDs, EIDs, and MH) are expected to have at least one successful product launch by 2028.

Figure 1. Distribution of potential product launches from the current product development pipeline (2023 to 2044), assuming no replenishment



In the NDs category, six diseases would account for over half of the successful launches: tuberculosis (49), malaria (38), HIV (22), dengue (15), and typhoid/paratyphoid (11) (Appendix A3.1). In the EID category, two-thirds of the product launches would be for Ebola (26), chikungunya (18), and Lassa fever (17) (Appendix A3.2). In the MHT category, 93% of the launches would be for three diseases/conditions: preeclampsia/eclampsia (50), preterm labor and birth (39), and intrauterine growth restriction (24) (Appendix A3.3).

3.2 **Missing product launches**

If only the candidate products in the current pipeline are funded (without replenishment), there would be no successful product launches for 94 product portfolios including 31 ND vaccines portfolios, 33 ND therapeutics portfolios, 11 ND diagnostics portfolios, 6 EID vaccines portfolios, 5 EID therapeutics portfolios, 3 EID diagnostics portfolios, 2 MH therapeutics portfolios, and 3 MH diagnostics portfolios (Table 3).

Viewed from a disease perspective rather than a product portfolio perspective, it appears that some diseases are more "neglected" than others. For example, 10 NDs, cryptococcal meningitis, cryptosporidiosis, enterotoxigenic *E.coli* (ETEC), hookworm, multiple salmonella infections, multiple helminth infections, mycetoma, non-typhoidal Salmonella (NTS), rheumatic fever, and trachoma, will have no successful vaccine, therapeutic, or diagnostic launch (Appendix Table A3.4). Similarly, 18 NDs will have at least one diagnostic product launch but no launch of a vaccine or a therapeutic candidate.

In the EID category, there would be no successful launch of a vaccine, therapeutic, or diagnostic for Nipah and Zika. There will be successful launches of diagnostics for Crimean-Congo Hemorrhagic Fever, Ebola, and Marburg, but no successful launch of a vaccine or therapeutic. For maternal health technologies (MHTs), there are no expected launches of a diagnostic or therapeutic for both fetal distress and maternal deficiency anemia (Appendix Table A3.4).

Table 3. Disease categories that will not have successful product launches without replenishment of the current product pipeline

Disease-product-archetype[1]	Diseases/Conditions without a launch
ND vaccines	Buruli ulcer, Chagas disease, cholera, cryptococcal meningitis, cryptosporidiosis, dengue, enterotoxigenic *E.coli* (ETEC), hepatitis B, hepatitis C, histoplasmosis, hookworm, leishmaniasis, leprosy, leptospirosis, lymphatic filariasis, multiple/other malaria strains, multiple Salmonella infections, multiple diarrheal diseases, multiple helminth infections, mycetoma, non-typhoidal Salmonella (NTS), onchocerciasis, *P. vivax*, rheumatic fever, scabies, schistosomiasis, shigellosis, sleeping sickness, strongyloidiasis, tapeworm, trachoma (31 product portfolios)
ND therapeutics	Buruli ulcer, Chagas disease, cholera, cryptococcal meningitis, cryptosporidiosis, dengue, ETEC, histoplasmosis, hookworm, leishmaniasis, leprosy, leptospirosis, lymphatic filariasis, multiple Salmonella infections, multiple diarrheal diseases, multiple helminth infections, mycetoma, *N. meningitidis*, NTS, onchocerciasis, *P. falciparum*, *P. vivax*, rheumatic fever, *S. pneumoniae*, scabies, schistosomiasis, shigellosis, sleeping sickness, strongyloidiasis, tapeworm, rotavirus, trachoma, typhoid and paratyphoid (33 product portfolios)
ND diagnostics	Cryptococcal meningitis, cryptosporidiosis, ETEC, hookworm, multiple Salmonella infections, multiple helminth infections, mycetoma, NTS, rheumatic fever, rotavirus, trachoma (11 product portfolios)
EID vaccines	Crimean-Congo hemorrhagic fever, Ebola, Marburg, Nipah, Rift Valley fever, Zika (6 product portfolios)
EID therapeutics	Crimean-Congo hemorrhagic fever, Ebola, Marburg, Nipah, Zika (5 product portfolios)
EID diagnostics	Middle East respiratory syndrome, Nipah, Zika (3 product portfolios)
MH therapeutics	Fetal distress, maternal iron deficiency anemia (2 product portfolios)
MH diagnostics	Fetal distress, maternal enteric microbiome, maternal iron deficiency anemia (3 product portfolios)

SECTION

4

PRODUCT DEVELOPMENT COSTS AND FUNDING GAP

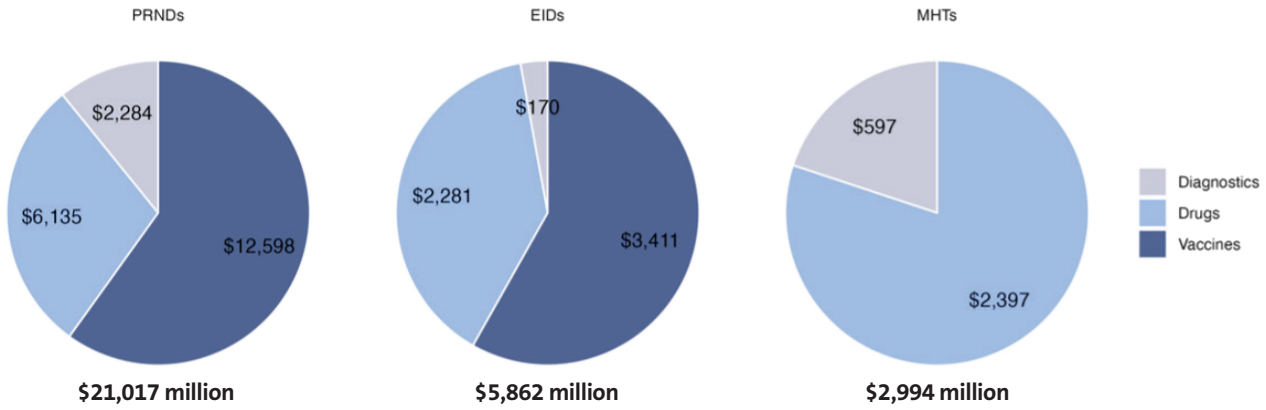
PRODUCT DEVELOPMENT COSTS AND FUNDING GAP

The research and development costs of advancing all candidates in the product development pipeline include costs of preclinical research and clinical trial phases 1, 2, and 3. We estimated these costs for the current pipeline and compared them to the current annual funding for each disease-product-archetype to estimate a funding gap.

4.1 Research and development costs

Almost thirty billion US dollars will be needed for research and development to advance the candidate products in the current product development pipeline. Of these costs, NDs will require about $21 billion, EIDs $5.9 billion, and MH $3 billion. Further breakdown of ND costs shows that $12.6 billion, $6.1 billion, and 2.3 billion will be needed for ND vaccines, ND therapeutics, and ND diagnostics, respectively. For EIDs, $3.4 billion will be needed for EID vaccines, $2.3 billion for EID therapeutics, and $170 million for EID diagnostics. MH therapeutics will require $2.4 billion while MH diagnostics will require $597 million (Fig. 2)

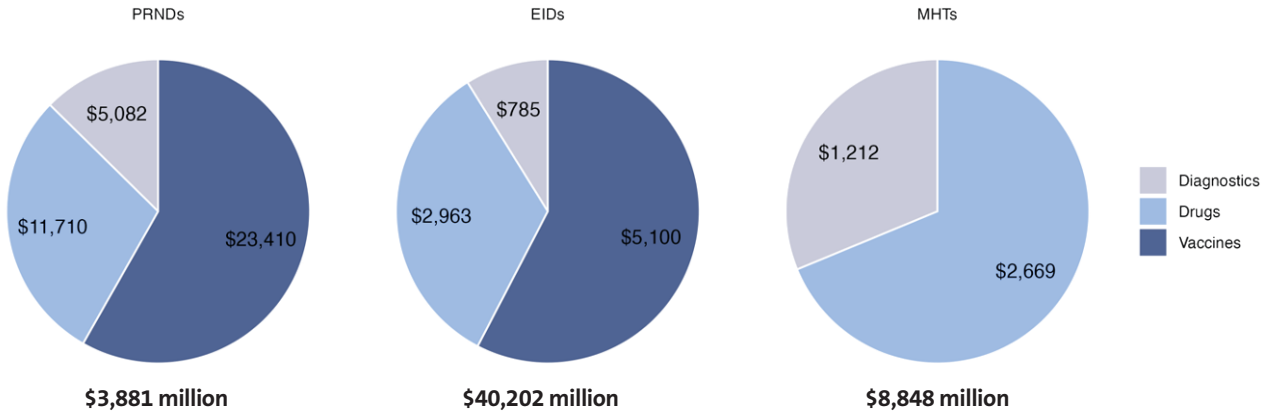
Figure 2. Breakdown of research and development costs for the current product development pipeline (no replenishment for missing product launches). Costs are in million USD



$21,017 million **$5,862 million** **$2,994 million**

If the current pipeline is replenished through coordinated targeted investments to guarantee at least one product launch in each product portfolio, the total costs needed for product development increases to $52.9 billion. NDs will require $40.2 billion, which includes $23.4 billion for ND vaccines development, $11.7 billion for the development of ND therapeutics, and $5.1 billion for the development of ND diagnostics. EIDs will require $8.8 billion, with EID vaccines needing $5.1 billion, EID therapeutics needing $3 billion, and EID diagnostics needing $785 million. MH products will require about $3.9 billion, with MH therapeutics needing $2.7 billion and MH diagnostics needing $1.2 billion (Figure 3)..

Figure 3. Breakdown of research and development costs with coordinated investments to replenish current pipeline for missing product launches. Costs are in million USD



$3,881 million **$40,202 million** **$8,848 million**

4.2 Annual research and development funding gap

We assessed the annual funding gaps for three scenarios:

(i) the current pipeline without replenishment,

(ii) a best-case replenishment scenario, where the current pipeline is replenished with simple product candidates to guarantee a product launch in each product portfolio, and

(iii) worst-case replenishment scenario, where the current pipeline is replenished with enough complex product candidates to guarantee a product launch in each product portfolio.

On average, complex product candidates have lower probabilities of success, longer clinical trial durations, and higher clinical trial costs. Therefore, the required costs for product development will be higher for complex products than for simple products.

To estimate the annual funding gap, we assumed that based on the current rates at which products advance along the product development pipeline, most product development costs will be incurred in the first 10 years. So, we divided the total costs needed for development over the period by 10 years to arrive at annual costs, which we compared with the current annual funding reported in the G-FINDER database for the portfolios included in our analysis.[1]

Over the next 10 years, an additional $1.4 billion to $7 billion will needed annually for product development, depending on the complexity of the product candidates.

Table 4 summarizes the annual funding gap, while Appendix Table A4.1 provides details by disease-product-archetype category. The current annual funding for all ND products included in our analysis is $2.9 billion, for EID products is $742 million, and for MH products is $197 million. Although current annual funding projected to the future might cover product development costs for NDs and EIDs if the current pipeline is not replenished, an additional $102 million will be needed annually for MH product development of the current pipeline without replenishment.

For the replenishment scenarios, over the next 10 years, an additional $1.4 billion to $7 billion will needed annually for product development, depending on the complexity of the product candidates. This will close the funding gap needed to advance the ND, EID, and MH product pipeline. This annual product development funding gap comprises $1.1 billion to $5.9 billion for NDs, $143 million to $794 million for EIDs, and $191 million to $256 million for MH products.

Table 4. Annual funding gap by disease archetype, over next 10 years

Disease-product-archetype	Available funding (in million USD)	Funding of current pipeline **without** replenishment (in million USD)		**Best-case replenishment**: funding with replenishment of pipeline with **simple products** (in million USD)		**Worst-case replenishment**: funding with replenishment of pipeline with **complex products**	
		Annual need	Funding gap	Annual need	Funding gap	Annual need	Funding gap
All ND products	$2,908	$2,102	-$806	$4,020	$1,112	$8,841	$5,933
All EID products	$742	$586	-$156	$885	$143	$1,536	$794
All MH products	**$197**	**$299**	**$102**	**$388**	**$191**	**$453**	**$256**
All products	**$3,847**	**$2,987**	**-$860**	**$5,293**	**$1,446**	**$10,830**	**$6,983**

* Negative values indicate that needed funding is met, thus no funding gap exists

SECTION

5

HEALTH AND ECONOMIC BENEFITS FROM SUCCESSFUL PRODUCT LAUNCHES

Each successful product launch is expected to have a health and economic impact on the population. We considered each product portfolio as independent and so we estimated the potential health and economic impacts separately. Therefore, our results may show the independent effect of a malaria vaccine launch or a malaria therapeutic launch, but not the joint effect of both launches.

5.1 Distribution of product-portfolios by net monetary benefits to society

Net monetary benefits (NMB) were calculated as the difference between the economic value of the health benefits from a successful product launch and the incremental costs associated with launching and getting the launched products to people who need them (Appendix section A2). The incremental costs include R&D costs, product manufacturing costs, and treatment costs. A positive NMB indicates that the economic benefits to society from a successful product launch are larger than the incremental costs society has to bear to achieve the product launch. By contrast, a negative NMB indicates that the economic benefits to society from a successful product launch are smaller than the incremental costs society bears to achieve that launch.

If the current product development pipeline is replenished in order to guarantee at least one product launch in each product portfolio, 30 of 38 ND vaccine portfolios would yield positive NMBs and eight negative NMBs (Table 5). Similarly, ND therapeutics and ND diagnostics will have more portfolios yielding positive NMBs than negative NMBs. ND therapeutics will have 29 portfolios with a positive NMB and nine portfolios with a negative NMB, while ND diagnostics will have 30 portfolios with a positive NMB and eight with a negative NMB.

Two EID vaccine portfolios would have positive NMBs, while seven will have negative NMBs. Three EID diagnostic portfolios will have a positive NMB, while six will have a negative NMB. No EID therapeutics portfolio would have a positive NMB. All six MH therapeutics and maternal health diagnostics portfolios will have positive NMBs (Table 5).

Table 5. Distribution of product portfolios with at least one product launch by net monetary benefits to society

Product portfolios	Net monetary benefits[1]	
	Positive[2]	Negative[3]
ND vaccines	30	8
ND therapeutics	29	9
ND diagnostics	30	8
EID vaccines	2	7
EID therapeutics	0	9
EID diagnostics	3	6
MH therapeutics	6	0
MH diagnostics	6	0

NOTES
1. The unit of analysis is the disease group, as listed in G-FINDER. We included 153 product portfolios in our analysis. Net monetary benefits (NMB) were calculated as the economic value of health benefits minus the sum of R&D costs, manufacturing costs, and treatment costs. See Section 2.4.
2. A positive NMB implies that if health benefits are translated into monetary terms, society will benefit from the investment.
3. A negative NMB implies that if health benefits are translated to monetary terms, society will lose more from the investment than it will gain. This could occur if there are investments in clinical trials that do not lead to a successful product launch, or there are investments that lead to a successful launch but the economic value of the health benefits gained are less than the value of the investments.

5.2 Cost-effectiveness of investing in the current pipeline with replenishment to guarantee at least one product launch in each product portfolio

The health and economic benefits that would accrue from investing in research and development to advance the current product pipeline over the period 2023 to 2044 are summarized in Table 6. Fifteen ND vaccine portfolios will be cost-saving from a health systems perspective, while the ICERs of the other 23 ND vaccine portfolios ranged from $128 for the shigella vaccines portfolio to $472 million for mycetoma vaccines portfolio, a low-prevalence, low-mortality condition. ICERs for ND therapeutics and ND diagnostics ranged from $6 (tapeworm) to $413 million (mycetoma), and $24 (typhoid and paratyphoid) to $73 million (mycetoma). NMBs for ND vaccines, therapeutics, and diagnostics ranged from -$177 billion to 48,700 billion.

In the EID category, investments in the Zika vaccine portfolio would be cost-saving, while ICERs per DALY averted for the other vaccine portfolios range from $3,000 to $245,000. Other ICERs per DALY averted ranged from $4,800 to $5 million for EID therapeutics and $600 to $4 million for EID diagnostics. In both EID therapeutics and diagnostic categories, Lassa fever had the lowest ICERs, while Zika had the highest ICERs. NMBs for all EID products ranged from -$5.4 billion to $0.6 billion.

Fifteen ND vaccines will be cost-saving from a health systems perspective.

ICERs per DALY averted for MH therapeutics ranged from $23 for preeclampsia/eclampsia to $117 for maternal enteric microbiome, while for maternal health diagnostics, ICERs ranged from$25 for preeclampsia/eclampsia to $148 for maternal enteric microbiome. NMBs for MH products were all positive. NMBs for maternal health therapeutics ranged from $24 billion for fetal distress to $550 billion for preeclampsia/eclampsia, while NMBs for MH diagnostics ranged from $52 billion for intrauterine growth restriction to $481 billion for maternal iron deficiency anemia.

Table 6. Economic value of investing in product portfolios, assessed from the health systems and societal perspectives

	Health systems perspective (lowest to highest)[1]	Societal perspective (lowest to highest)[2]
Disease-product-archetype	Incremental cost per DALY averted (range in USD)	Net monetary benefits (range in billion USD)
ND vaccines	Cost-saving (for 15 vaccines) to $472 million (mycetoma)	-$3 (scabies) to $48,700 (*S. pneumoniae*)
ND therapeutics	$6 (tapeworm) to $413 million (mycetoma)	-$43 (tuberculosis) to $6,000 (multiple diarrheal diseases)
ND diagnostics	$24 (typhoid and paratyphoid) to $73 million (mycetoma)	-$177 (scabies) to $24,000 (multiple diarrheal diseases)
EID vaccines	Cost-saving (Zika) to $245,000 (MERS)	-$0.50 (Ebola) to $0.25 (Zika)
EID therapeutics	$4,800 (Lassa fever) to $5 million (Zika)	-$2.35 (Zika) to -$0.02 (Lassa fever)
EID diagnostics	$600 (Lassa fever) to 4 million (Zika)	-$5.4 (Zika) to $0.6 (Lassa fever)
MH therapeutics	$23 (preeclampsia/eclampsia) to $117 (maternal enteric microbiome)	$24 (Fetal distress) to $550 (preeclampsia/eclampsia)
MH diagnostics	$25 (preeclampsia/eclampsia) to $148 (maternal enteric microbiome)	$52 (intrauterine growth restriction) to $481 (maternal iron deficiency anemia)

NOTES:
1. Lower incremental cost-effectiveness ratios (ICERs) are preferred as they indicate more health benefits per dollar spent and, thus, more efficient resource use. Negative ICERs indicate that in addition to an increase in benefits, there is also a cost saving.
2. Higher net monetary benefits (NMBs) are preferred as they indicate that society benefits more (or loses less, in the case of negative NMBs) from the intervention.

SECTION

6

EFFICIENCY GAINS

Against the backdrop of inadequate resources for product development and a decreasing rate of successful product launches, several recent innovations promise positive shifts in the R&D landscape for NDs, EIDs, and maternal health technologies.[1] In our accompanying report, we described these shifts in detail.[2] Here, we provide quantitative estimates for some of these shifts.

6.1 Reference case and efficiency gains scenarios

We modeled four scenarios: a reference case and three efficiency gains scenarios (Table 7). In the first scenario (our reference case), we assumed that candidate products in the current pipeline would be funded with no replenishments; we included pre-clinical and clinical trial costs; and we assumed that success rates would be similar to the success rates in the P2I model, time to market introduction would be three years post-launch, and production costs would reflect current estimates.

In the second scenario, we modeled coordinated investments in missing products; we assumed that costs, success rates, and market entry would mirror the reference case, and we modeled coordinated investment in the pipeline to guarantee at least one launch for each product portfolio.

In the third scenario, we modeled improved clinical trial efficiencies from AI and smarter clinical trials. We assumed similar parameters to the second scenario. In addition, based on advice from experts, we also assumed a 60% reduction in pre-clinical research costs, a 25% reduction in clinical trial costs, and a 10-percentage point increase in trial success rates. The fourth scenario was similar to the third scenario, but in addition, we assumed market entry was shortened from three years to one year, and production costs were reduced by 20%.

We assumed a uniform baseline "do-nothing" for all scenarios in which no further investments in product-pipeline R&D occur after 2023. Therefore, the estimated health and economic benefits for each scenario are the difference between that scenario and the assumed baseline.

Table 7. Description of the reference case and efficiency gains scenarios included in the analyses

Scenario[1]	Pipeline replenishment[2]	Pre-clinical and clinical trial research costs[3]	Phase time and success rates[4]	LMIC market introduction[5] (In years post-launch)	Production costs[6]
0. Reference case	No	P2I estimates[7]	P2I estimates[7]	3 years	Current costs
1. Coordinated investments in missing products	Yes	P2I estimates[7]	P2I estimates[7]	3 years	Current costs
2. #1 plus improved clinical trial efficiencies	Yes	60% reduction in preclinical research costs[8] 25% reduction in clinical trial costs[9]	10%-point increase in success rates[10]	3 years	Current costs
3. #2 plus shortened market entry and lower production costs	Yes	60% reduction in preclinical research costs[8] 25% reduction in clinical trial costs[9]	10%-point increase in success rates[10]	1 year	20% reduction

NOTES:
1. We did not include the investment costs needed to achieve the efficiency gains.
2. We expect coordinated R&D investment to address pipeline gaps and key missing products. We also expect that AI will lower costs and time for discovery and preclinical research, leading to a more robust pipeline.
3. Lower R&D costs will result from smarter trial designs, synthetic control arms, better prediction of trial failures, and the use of AI.
4. Using AI to conduct comprehensive screening of candidates will yield better quality of candidates and shorten phase times.
5. Regulatory harmonization in low and middle income countries (LMICs) could reduce market-entry delays from three years to one-year post-launch.

6. Opportunities for production cost savings include the use of modular sites, optimized mRNA production, and market shaping.
7. The P2I model assumes clinical trial costs of $3M - $21.6M for preclinical research, $2M - $100M for phase 1, $3M - $13.9M for phase 2, and $17.6M - $133.3M for phase 3 clinical trials. It also assumes an average phase length of 1-3.4 years for preclinical research, 1.3-2.5 years for phase 1, 1.3-4.2 years for phase 2, and 2.1-3.5 years for phase 3 clinical trials. For success rates, P2I assumes 41%-77% for preclinical research, 50%-100% for phase 1, 19.7%-100% for phase 2, and 40.3%-70.92% for phase 3 clinical trials. Details can be found in the appendix.
8. Rationale for selecting 60% reduction was based on expert opinion.
9. Rationale for selecting 25% reduction was based on expert opinion.
10. Rationale for selecting 10%-point increase in success rates was based on expert opinion.

We measured the gains from efficiency using several indicators, including cost savings, reductions in average cost per launch (CPL) of a successful candidate, increase in the number of product launches, and shift in the number of product portfolios that yield positive net monetary benefits.

6.2 Combined efficiency gains: Better returns on investments across different product portfolios

We assessed combined efficiency gains by estimating the difference in the number of product portfolios that yield a positive NMB in an "efficiency gains" scenario compared to the reference case. Table 8 summarizes the results of the NMB comparisons.

Table 8. Efficiency gains from across scenarios, measured as the number of disease-product-archetype portfolios that shift from negative to positive net monetary benefits

Disease-product-archetype	Positive net monetary benefits[1]			
	#1	#2	#3	#4
	Reference case	#1 + Coordinated investments to include missing products[2] Number (Difference, #2 – #1)	#2 + Improved efficiency of preclinical/clinical trials[3] Number (Difference, #3 – #1)	#3 + shortened market entry and decreased production costs[4] Number (Difference, #4 – #1)
ND vaccines	7	30 (23)	32 (25)	34 (27)
ND therapeutics	3	29 (26)	30 (27)	31 (28)
ND diagnostics	21	30 (9)	30 (9)	30 (9)
EID vaccines	1	2 (1)	2 (1)	4 (3)
EID therapeutics	0	0 (0)	1 (1)	1 (1)
EID diagnostics	3	3 (0)	3 (0)	3 (0)
MH therapeutics	4	6 (2)	6 (2)	6 (2)
MH diagnostics	3	6 (3)	6 (3)	6 (3)

NOTES:
1. The unit of analysis is the disease group, as listed in G-FINDER. We included 38 NDs and 9 EIDs in our analysis. Net monetary benefits (NMB) were calculated as the economic value of health benefits minus the sum of R&D costs, manufacturing costs, and treatment costs. See Section 2.4.
2. Coordinated investments comprise replenishment of pipeline at preclinical phase to ensure at least one launch for products without a launch in the reference case.
3. Includes a 60% reduction in preclinical research costs, a 25% reduction in clinical research costs, a 10 percentage point increase in preclinical and clinical success rates, and a reduction in preclinical phase duration to 1.5 years.
4. Includes decrease in LMIC market introduction from 3 years post-launch to 1.5 years post-launch, 20% reduction in vaccine unit cost, and 10% reduction in disease treatment unit cost.

When compared to the reference case, all three "efficiency gains" scenarios will increase the number of product portfolios that yield positive NMBs for ND vaccines, ND therapeutics, and ND diagnostics. The coordinated investments for the missing products scenario (#2 in Table 8) will increase the number of ND vaccine portfolios with positive NMBs by 23, the number of positive NMB ND therapeutics portfolios by 26, and the number of positive NMB ND diagnostic portfolios by 9. Similarly, the improved efficiencies scenario (#3 in Table 8) will increase the number of positive NMB ND vaccine portfolios by 25, the number of positive NMB ND therapeutics portfolios by 27, and the number of positive NMB ND diagnostic portfolios by 9. Also, the shortened market entry and decreased production costs scenario (#4 in Table 8) will increase the number of positive NMB ND vaccine portfolios by 27, the number of positive NMB ND therapeutics portfolios by 28, and the number of positive NMB ND diagnostic portfolios by nine.

The efficiency gains are less promising for EIDs. Our coordinated investments for missing products scenario will increase the number of positive EID vaccine portfolios by one, but will not make any EID therapeutics or EID diagnostics portfolios become positive. The improved clinical trial efficiencies and shortened market entry scenarios will make one and three additional EID vaccine portfolios yield positive NMBs, respectively. In addition, both scenarios will make one additional EID therapeutics portfolio yield positive NMBs but no EID diagnostics portfolio.

For MH portfolios, all three efficiency gains scenarios have similar positive effects compared to the reference case. They increase the number of positive NMB therapeutic portfolios by two and the number of positive NMB diagnostics portfolios by two.

In addition to the shifts from negative to positive NMBs that occur for all scenarios, specific benefits occur within the product-pipeline development stage that increase the number of product launches and reduce costs. We describe these in the following sections under efficiency-gains scenarios #1 & #2.

6.4 Efficiency gains scenario #1: Increase in the number of successful product launches

Compared to the reference case, the number of successful product launches with coordinated investments will increase. In previous work, we showed that coordinated investment mechanisms such as pooled funding for late-stage clinical trials can be cost-effective both at the global and country levels.[3,4] In this analysis, we focused on the increase in the number of portfolios with a product launch.

In the reference case, 10 NDs will have no successful vaccine, therapeutic, or diagnostic launch. Eighteen NDs will have successful diagnostic launches but no successful launches of a vaccine or a therapeutic candidate. In the EID category, there would be no successful launch of a vaccine, therapeutic, or diagnostic for Nipah and Zika. There will be successful launches of diagnostics for Crimean-Congo hemorrhagic fever, Ebola, and Marburg, but no successful launches of vaccines or therapeutics. For MH, there are no expected launches of a diagnostic or therapeutic for both fetal distress and maternal deficiency anemia.

These gaps could be filled through coordinated investment strategies.

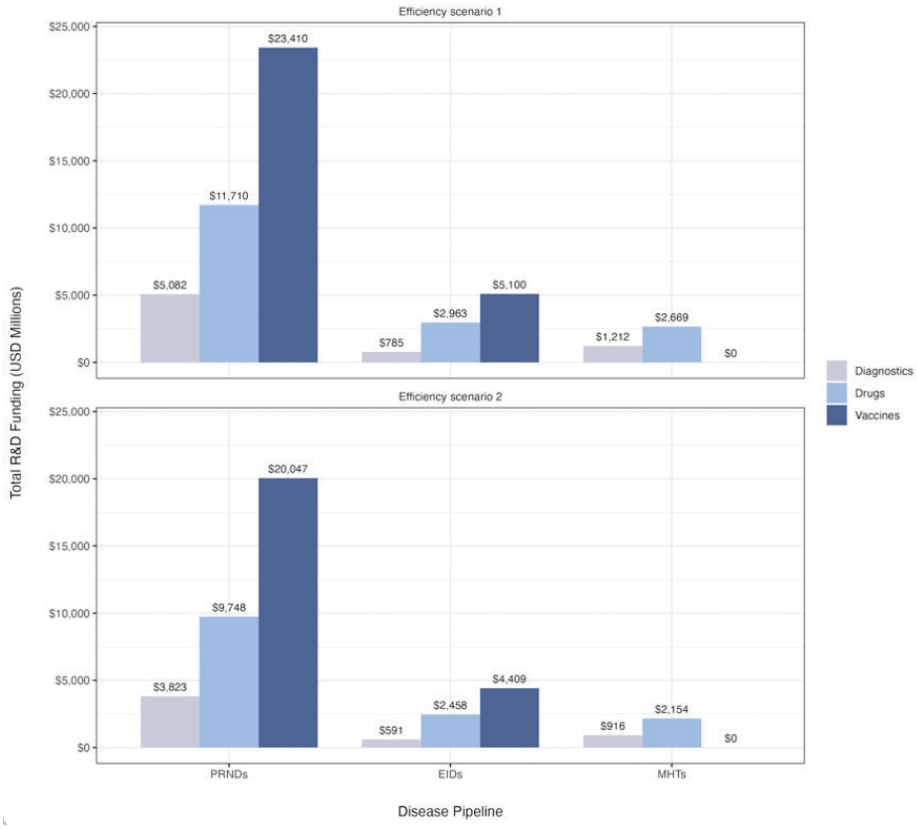
6.5 Efficiency gains scenario #2: Cost savings and reductions in cost per launch (CPL) from artificial intelligence and smarter clinical trials

AI and clinical trial innovations are driving significant positive shifts in the product development ecosystem. We have provided details in the accompanying report.[2] To summarize, we expect that AI will lower costs and time for discovery and preclinical research, leading to a more robust pipeline. We also expect that AI will help conduct comprehensive screening of candidates, yielding better quality of candidates and shortening phase times. Using smarter trial designs, such as synthetic control arms and better prediction of trial failures (also influenced by AI), will lead to lower R&D costs.

Based on expert opinion, we assume that AI and smarter clinical trial designs will reduce preclinical research costs by up to 60%, reduce clinical trial costs by up to 25%, and increase clinical trial success rates by up to 10 percentage points.

The reductions in average cost per launch (CPL) from AI and smarter clinical trials will range from 3 million to 8 million for diagnostics portfolios, and will exceed 100 million for ND vaccines and EID vaccines portfolios.

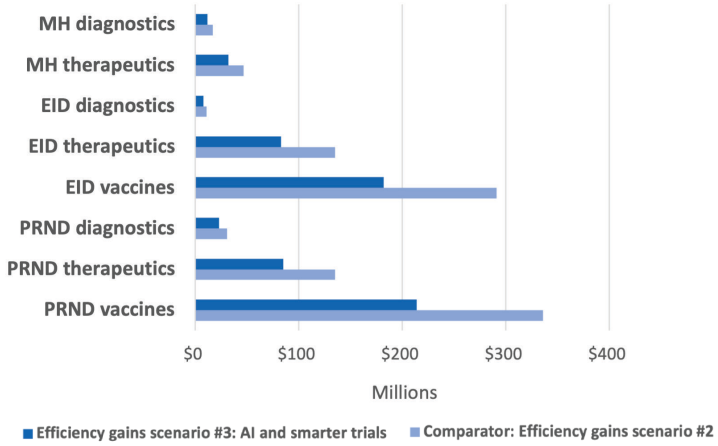
Figure 5. Comparison of product development costs for effciency gains scenarios #2 and #3



Our results show that AI and smarter clinical trials will significantly reduce product development costs for candidate products, including candidates in the current pipeline and replenishments (Fig. 5). The total cost of ND development will fall from $40.2 billion to $33.6 billion, EID development from $8.8 billion to $7.5 billion, and MH product development from $3.9 billion to $3.1 billion. Vaccines, followed by therapeutics, will see the largest cost savings, while diagnostics will see the least.

The abovementioned cost savings will translate to significant reductions in CPL (Fig 6). In absolute terms, the reductions in average cost per launch (CPL) from AI and smarter clinical trials will range from 3 million to 8 million for diagnostics portfolios, and will exceed 100 million for ND vaccines and EID vaccines portfolios (Fig 6 and Appendix Table A6.1). CPL for ND therapeutics and EID therapeutics will fall by $50 to $52 million. In percentage terms, we expect CPL to fall by 26 to 39 percent (Appendix Table A6.1). The smallest percentage reductions will be seen in the diagnostics categories (26 to 29% reductions), while the largest percentage reductions will be seen in the vaccines and therapeutics categories (32 to 39% reductions).

Figure 6. Product development costs per successful launch



SECTION

7

PRIORITY PRODUCTS

We ranked all products included in our analysis using three value for money indicators: ICER per death averted, ICER per DALY averted, and incremental NMB. We ranked products from a global and three regional perspectives (Africa, Asia, and Latin America and the Caribbean). Global rankings assume a global burden of disease, and a global distribution of costs and benefits, while regional rankings assume a regional burden of disease and regional distribution of costs and benefits.

Although our prioritization emphasizes economic value, investors, policymakers, and other stakeholders use additional prioritization criteria such as equity, political feasibility, national security, and duration of investment. We did not include these in our prioritization, and we note that they are important. Thus, our prioritization should only be interpreted in financial/economic terms.

We present the overall top products and the top five for each category in this section and include the full rank list in Appendix Tables A5.1, A5.2, and A5.3. Regional rankings (Africa, Asia, and Latin America) are presented in Appendix Tables A7.1, A7.2, and A7.3 along with a summary of the expressed priorities of stakeholders in each region.

7.1 Overall top products for global prioritization

Table 9. Disease-product-archetype portfolios that are cost-saving to the health system and will yield positive net monetary benefits to society

Societal perspective (Positive net monetary benefits)	
Rank	Disease Portfolio (Vaccines)
1	*S. pneumoniae* vaccine ($48,679 B)
2	Multiple diarrheal diseases vaccine ($6,518 B)
3	Typhoid and paratyphoid vaccine ($2,740 B)
4	*P. falciparum* vaccine ($311 B)
5	Multiple / other malaria strains vaccine ($126 B)
6	Tuberculosis vaccine ($118 B)
7	Rotavirus vaccine ($96 B)
8	*N. meningitidis* vaccine ($63 B)
9	HIV/AIDS vaccine ($53 B)
10	Dengue vaccine ($39 B)
11	Hepatitis B vaccine ($28 B)
12	Multiple Salmonella infections vaccine ($17 B)
13	Strongyloidiasis and other vaccine ($15 B)
14	Cryptococcal meningitis ($9 B)
15	Rheumatic fever ($7 B)
16	Zika ($0.25 B)

Of all the product portfolios included in our analysis, 16 vaccine portfolios (15 ND vaccines portfolios and one EID vaccines portfolio) will be cost-saving from a health systems perspective and yield positive NMBs (Table 9). They include vaccine portfolios for *S. pneumoniae*, multiple diarrheal diseases, typhoid and paratyphoid, *P. falciparum*, multiple/ other malaria strains, tuberculosis, rotavirus, *N. meningitidis*, HIV/AIDS, dengue, hepatitis B, multiple Salmonella infections, strongyloidiasis and other, cryptococcal meningitis, rheumatic fever, and Zika. The NMBs for these product portfolios range from $0.25 billion to $48,679 billion and are expected to accrue over the period 2023 to 2044.

NOTE: All product portfolios listed in this table are cost-saving from the health system perspective.
* We assume 0% coverage of vaccines at baseline for all vaccinations.
* Zika yields positive NMB based on the latest (2019) GBD global prevalence estimates. At lower prevalence estimates it yields negative NMBs. Prevalence has reduced since 2019 but there are no global estimates.

7.2 Top five ND products for global prioritization

Table 10 lists the top five product portfolios for each ND product archetype, ranked by highest contributors to NMB, and the best ICERs per death averted and ICERs per DALY averted. From a societal perspective, the top five ND vaccines portfolios with the potential for the highest NMBs to society are *S. pneumoniae* ($48,679 B), multiple diarrheal diseases ($6,518 B), typhoid and paratyphoid ($2,740 B), *P. falciparum* ($311 B), and multiple/other malaria strains ($126 B). However, from a health systems perspective, the top five that will lead to the most cost-saving are tuberculosis, *N. meningitidis*, multiple Salmonella infections, dengue, and HIV/AIDS. All these also contribute positive NMB to society but do not rank in the top 5 positive NMBs.

Table 10. Top five priority ND product portfolios for each product-archetype

Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in billion USD)
Vaccines		
1. Tuberculosis (cost-saving) 2. *N. meningitidis* (cost-saving) 3. Multiple Salmonella infections (cost-saving) 4. HIV/AIDS (cost-saving 5. Dengue (cost-saving)	1. Tuberculosis (cost-saving) 2. *N. meningitidis* (cost-saving) 3. Multiple Salmonella infections (cost-saving) 4. Dengue (cost-saving) 5. HIV/AIDS (cost-saving)	1. *S. pneumoniae* ($48,679 B) 2. Multiple diarrheal diseases ($6,518 B) 3. Typhoid and paratyphoid ($2,740 B) 4. *P. falciparum* ($311 B) 5. Multiple / other malaria strains ($126 B)
Therapeutics		
1. Tapeworm ($315) 2. *S. pneumoniae* ($1,137) 3. Typhoid and paratyphoid ($1,350) 4. *P. vivax* ($4,790) 5. Cholera ($5,767)	1. Tapeworm ($6) 2. Multiple helminth infections ($8 3. Schistosomiasis ($19) 4. Hookworm ($22) 5. Typhoid and paratyphoid ($24)	1. Multiple diarrheal diseases ($6,002 B) 2. *S. pneumoniae* ($3,354 B) 3. Multiple / other malaria strains ($840 B 4. Typhoid and paratyphoid ($761 B) 5. HIV/AIDS ($460 B)
Diagnostics		
1. Typhoid and paratyphoid ($1,333 2. Tapeworm ($1,350) 3. Cholera ($1,998) 4. *S. pneumoniae* ($2,506) 5. *P. vivax* ($3,366)	1. Typhoid and paratyphoid ($24) 2. Tapeworm ($27) 3. Cholera ($48) 4. Schistosomiasis ($68) 5. *P. vivax* ($73)	1. Multiple diarrheal diseases ($24,296 B) 2. *S. pneumoniae* ($17,075 B) 3. Typhoid and paratyphoid ($3,748 B) 4. Multiple / other malaria strains ($1,655 B) 5. *P. falciparum* ($1,194 B)

The top five ND therapeutics portfolios with the potential for the highest NMBs to society are multiple diarrheal diseases ($6,002 B), *S. pneumoniae* ($3,354 B), multiple/other malaria strains ($840 B), typhoid and paratyphoid ($761 B), and HIV/AIDS ($460 B). Of these, only typhoid and paratyphoid ranks in the top five for ICERs per death averted and ICERs per DALY averted. S. pneumonia ranks in the top five of ICERs per death averted but not ICERs per DALY averted.

The top five ND diagnostics portfolios with the potential for the highest NMBs to society are multiple diarrheal diseases ($24,296 B), *S. pneumoniae* ($17,075 B), typhoid and paratyphoid ($3,748 B), multiple/other malaria strains ($1,655 B), and *P. falciparum* ($1,194 B). Of these, only the typhoid parathyphoid portfolio ranks in the top five for ICERs per death averted and ICERs per DALY averted. S. pneumonia is in the top five of ICERs per death averted but not I ICERs per DALY averted, while tapeworm, cholera, and *P. Vivax* rank in the top five of ICERs per death averted or ICERs per DALY averted.

7.3 Top EID products for global prioritization

Table 11 lists the top five product portfolios for each EID product archetype, ranked by highest contributors to NMB, and the best ICERs per death averted and ICERs per DALY averted. The top five EID vaccine portfolios measured by NMBs are Zika, Lassa fever, chikungunya, Rift Valley fever, and Nipah. Of these, only Zika ($0.25 B), and lassa fever ($.20 B) will yield positive NMBs to society. Zika, Lassa fever and chikungunya also rank in the top five of ICERs per death averted and ICER per DALY averted, with Zika being cost-saving for both indicators. Ebola and Crimean-Congo hemorrhagic fever rank in the top five from a health system perspective, but they both have ICERs per DALY averted that exceed $10,000.

Table 11. Top five priority EID product portfolios for each product-archetype

Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in billion USD)
Vaccines		
1. Zika (cost-saving) 2. Lassa fever ($132,773) 3. Chikungunya ($397,638) 4. Ebola ($440,302) 5. CCHF (Crimean-Congo Hemorrhagic Fever) ($1,253,038)	1. Zika (cost-saving) 2. Lassa fever ($3,128) 3. Chikungunya ($6,290) 4. Ebola ($10,480) 5. CCHF ($29,607)	1. Zika ($.25 B) 2. Lassa fever ($.20 B) 3. Chikungunya (-$.20 B) 4. RVF (Rift Valley fever) (-$.26 B) 5. Nipah (-$.27 B)
Therapeutics		
1. Lassa fever ($204,511) 2. RVF ($529,660) 3. Ebola ($1,071,550) 4. Chikungunya ($2,047,996) 5. CCHF ($2,337,336)	1. Lassa fever ($4,774) 2. RVF ($12,599) 3. Chikungunya ($25,271) 4. Ebola ($25,484) 5. CCHF ($54,843)	1. Lassa fever (-$0.02 B) 2. RVF (-$0.09 B) 3. Nipah (-$0.13 B) 4. Marburg (-$0.28 B) 5. MERS (-$0.32 B)
Diagnostics		
1. Lassa fever ($25,624) 2. Ebola ($36,869) 3. Marburg ($69,731) 4. CCHF ($298,977) 5. RVF ($410,459)	1. Lassa fever ($598) 2. Ebola ($877) 3. Marburg ($1,660) 4. CCHF ($7,015) 5. RVF ($9,763)	1. Lassa fever ($0.58 B) 2. Ebola ($0.41 B) 3. Marburg ($0.02 B) 4. RVF (-$0.03 B) 5. CCHF (-$0.07 B)

* Red indicate negative net monetary benefits to society.

None of the top five EID therapeutics portfolios will yield positive NMB to society. However, from a health systems perspective, the top five product portfolios in this category are Lassa fever, Rift Valley fever, Chikungunya, Ebola, and Crimean-Congo hemorrhagic fever.

The top five EID diagnostics portfolios measured as NMBs to society are Lassa fever, Ebola, Marburg, Rift Valley fever, and Crimean-Congo hemorrhagic fever. Of these, only Lassa fever, Ebola, and Marburg have positive NMBs. All three of them also rank in the top five when assessed from a health systems perspective, using ICER per death averted and ICER per DALY averted.

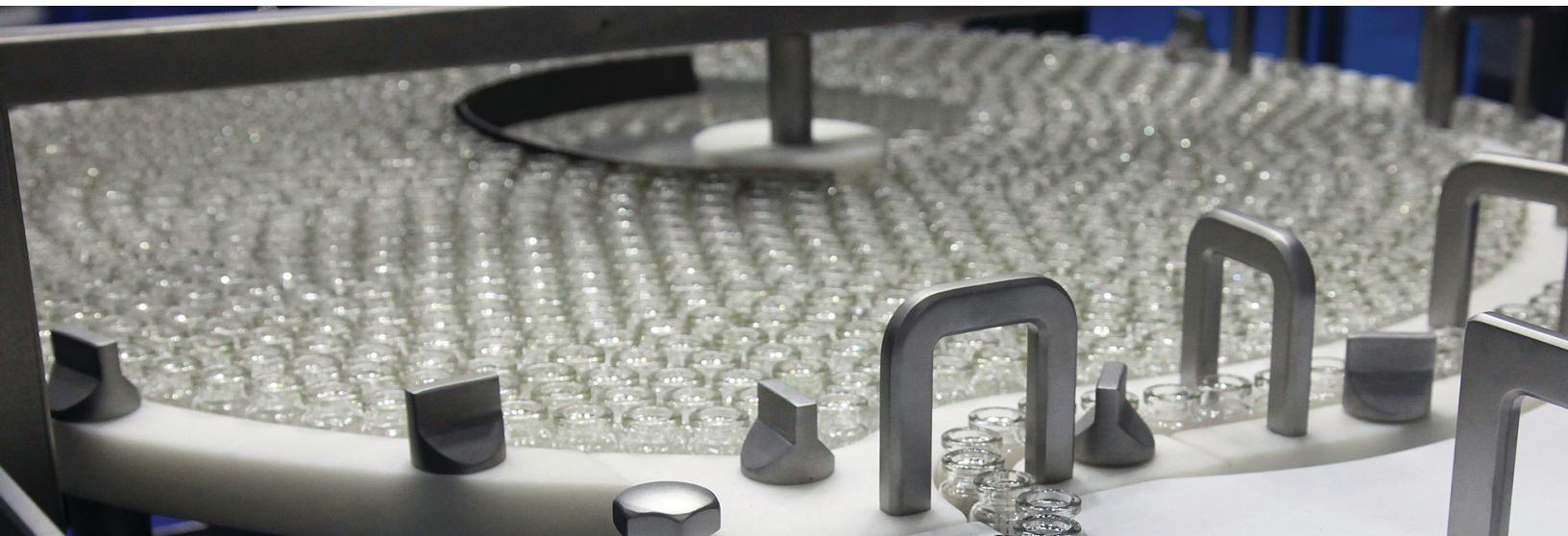
7.4 Ranking of the top maternal health products for global prioritization

Table 12 lists the top five product portfolios for each maternal health product archetype, ranked by highest contributors to NMB, and the best ICERs per death averted and ICERs per DALY averted. The top five MH therapeutics portfolios with the potential for the highest NMBs to society are preeclampsia/eclampsia, preterm labor/birth, maternal enteric microbiome, maternal iron deficiency anemia, and intrauterine growth restriction. All five will have positive NMBs that range from $132 billion to $550 billion.

The top five MH diagnostics portfolios with the potential for the highest NMBs to society are maternal iron deficiency anemia, preeclampsia/eclampsia, preterm labor/birth, maternal enteric microbiome, and fetal distress. All five will have positive NMBs that range from $66 billion to $481 billion.

Table 12. Top five priority maternal health product portfolios for each product-archetype

Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in billion USD)
Vaccines		
1. Preeclampsia/eclampsia (PE/E) ($1,079) 2. Maternal iron deficiency anemia ($2,132) 3. Preterm labor/birth (PTL/PTB) ($5,466) 4. Intrauterine growth restriction (IUGR) ($5,708) 5. Maternal enteric microbiome (MEM) ($6,503)	1. Preeclampsia/eclampsia (PE/E) ($23) 2. Maternal iron deficiency anemia ($44) 3. Preterm labor/birth (PTL/PTB) ($70) 4. Intrauterine growth restriction (IUGR) ($85) 5. Fetal distress ($99)	1. Preeclampsia/eclampsia (PE/E) ($550) 2. Preterm labor/birth (PTL/PTB) ($454) 3. Maternal enteric microbiome (MEM) ($216) 4. Maternal iron deficiency anemia ($180) 5. Intrauterine growth restriction (IUGR) ($132)
Therapeutics		
1. 1. Preeclampsia/eclampsia (PE/E) ($1,191) 2. Maternal iron deficiency anemia ($2,544) 3. Preterm labor/birth (PTL/PTB) ($6,217 4. Intrauterine growth restriction (IUGR) ($7,017) 5. Fetal distress ($7,050)	1. Preeclampsia/eclampsia (PE/E) ($25) 2. Maternal iron deficiency anemia ($53) 3. Preterm labor/birth (PTL/PTB) ($79) 4. Intrauterine growth restriction (IUGR) ($104) 5. Fetal distress ($105)	1. Maternal iron deficiency anemia ($481) 2. Preeclampsia/eclampsia (PE/E) ($216) 3. Preterm labor/birth (PTL/PTB) ($178) 4. Maternal enteric microbiome (MEM) ($83) 5. Fetal distress ($66)



SECTION

8

SUMMARY AND CONCLUSIONS

SUMMARY AND CONCLUSIONS

We estimated the costs, health benefits, and economic benefits of investing in global health R&D for NDs, EIDs, and MH product portfolios. We found that over the next ten years, an additional $1.4 billion to $7 billion will be needed annually for product development, depending on the complexity of the product candidates. We also estimated potential gains from adopting game-changing efficiency improvement innovations to the R&D ecosystem.

Our results show that efficiency gains from coordinated investments to guarantee product launches in each portfolio, adoption of AI, faster market entry, and lower manufacturing costs will yield positive benefits from 2023 to 2040. Coordinated investments could lead to product launches in 94 product portfolios that would not be possible otherwise. Using AI and smarter clinical approaches could save over $9 billion and reduce the average cost per launch by up to $100 million.

Furthermore, all these efficiency innovations would increase the number of product portfolios that yield positive NMB to society, strengthening the economic case for future product development. The reductions in average CPL from the efficiency innovations could potentially reduce the current annual funding gap, as it will be possible to conduct more trials with current funding levels.

Our prioritization of candidate product portfolios by three value for money indices showed that 15 ND vaccine portfolios and one EID vaccine portfolio would be cost saving from a health system perspective and yield positive NMBs to society that range from $0.25 billion to $48,679 billion.

This analysis yielded some additional important findings.

1. All the MH diagnostics and therapeutics portfolios included in our analysis had favorable ICERs from a health system perspective and very high positive NMBs, implying significant benefits from a societal perspective.

2. Most EID product portfolios tended to have negative NMBs, suggesting that the investments needed to develop these products will surpass the economic value of any health gains anticipated for society. This phenomenon is partly driven by the low prevalence of the EIDs, which makes it difficult to offset the massive costs of product development.

2. The effect of prevalence extends beyond EIDs. High-prevalence conditions are more likely to yield positive NMBs, while low-prevalence, low-mortality conditions are more likely to yield negative NMBs. For example, mycetoma is a low-prevalence low-mortality condition with less than 200 expected annual cases and less than 1% mortality.[5,6] At an expected CPL of $336 million for a mycetoma vaccine launch, the ICER per death averted will exceed $336 million for any vaccine with less than 50% efficacy and less than 100% coverage.

The position of the different candidates in the product development pipeline and the subsequent effect on the product launch year influenced the NMBs. It seems counter-intuitive that a diagnostics portfolio will yield more NMBs than a vaccines or therapeutics portfolio. However, this can be explained by the length of time each launched product spent on the market and the assumed product uptake during the time horizon of our study (2023 to 2044). For example, the expected launch of a new dengue vaccine ($39 billion NMB) is in 2036, allowing it to spend five years on the market following a three-year regulatory delay. In contrast, the expected launch of a new dengue diagnostic ($225 billion NMB) is 2025, which will allow it to spend 16 years on the market following a three-year regulatory delay. This additional time that a diagnostic spends on the market can be used to drive uptake of existing dengue case management approaches.

Our results should be interpreted in light of the study's limitations. We modeled the independent effect of each portfolio and the health and economic effects of the first product launch for each portfolio. We did not model the joint effects of a vaccine and a therapeutic launch for the same disease. We also did not account for the substitution effects that might occur when more than one product is launched in a single product portfolio.

Our model closely linked the health and economic benefits of each product launch to assumed health system capacity. We assumed that product uptake would be five percentage points per year up to a maximum of 95% coverage. This is achievable for some health systems but might be out of reach for others. While this might affect the precision of our estimates, it does not affect the conclusions reached from our comparison of different scenarios and product portfolios. Further research will be needed to address scale-up and other health system efficiency issues.

The lack of reliable disease burden data, especially for EIDs, should be addressed. Incidence and prevalence estimates of EIDs are difficult to find at the global and country levels. This influenced the results for EIDs with rapidly changing transmission dynamics. For example, the Global Burden of Disease estimate for the incidence of Zika was 3.44 per 100,000 in 2019.[7] However, recent country-level estimates suggest a significant reduction in incidence since 2019.[8] Using the latest (2019) global estimates, we found that investments in developing the Zika vaccines portfolio will yield a positive NMB, but at lower incidence rates, these investments would yield negative NMBs.

In sum, our results highlight the significant positive benefits that will accrue to society from investing in several ND, EID, and MH product portfolios. We also show that game-changing efficiency gains are possible with innovations from AI and smarter product development approaches. Although we did not estimate the actual costs of implementing these innovations, the estimated potential cost savings that will accrue from these investments provide a ballpark estimate of the amount society should be willing to invest in these innovations.

Finally, the local context should always be considered as regional and country-level R&D priorities might differ from global R&D priorities. The prioritization differences might reflect variations in disease burden, costs, equity considerations, political feasibility, or other factors. Efforts to advance global health R&D must acknowledge and address these factors to be successful.

Image generated by Adobe Firefly AI

APPENDIX A1

Analytic approach

This section provides details of the methods used in our analysis.

Unit of analysis

Our unit of analysis was the product portfolio. We adopted the disease categories used by Policy Cures Research's G-Finder online repository and three product archetypes (vaccines, therapeutics, and diagnostics) to create 153 product portfolios (38 ND vaccines portfolios, 38 ND therapeutics portfolios, 38 ND diagnostics portfolios, 9 EID vaccines portfolios, 9 EID therapeutics portfolios, 9 EID diagnostics portfolios, 6 MH therapeutics portfolios, and 6 MH diagnostics portfolios). We then grouped the 1,498 candidate products in the current product pipeline into these 153 product portfolios.

Inclusion/exclusion criteria

We included vaccines, therapeutics, and diagnostics in this analysis. We excluded vector control products, dietary supplements, and devices. We also excluded non-active products (i.e., products without any R&D activity in over three years). We included products in the pre-clinical and clinical phases I, II, and III. We excluded products in the discovery stage or the post-market surveillance phase (Phase IV).

Estimating product development and launches

For each product portfolio, we estimated the expected number of product launches, the likely launch year, and expected total R&D costs. The variables and parameters used for the analysis are listed in Table A1.1.

We adopted a portfolio approach to modeling the progress of candidate products along the product development pipeline. Details of this approach have been described extensively by Paul et al, and in previous work conducted by our team.[9,10,11] In sum, this approach takes the product portfolio as the unit of analysis. It then estimates the expected number of candidates that will advance to the next trial phase based on probabilities of trial success. In this approach, it is possible to know the expected number that transitions from one phase to another and the years of success, but it is not possible to determine the likelihood that a specific candidate will be successful.

Candidate products were allowed to progress to the end of the pipeline; portfolios with expected launches of less than one were regarded as portfolios with missing launches, while product portfolios with expected launches greater than one were regarded as product portfolios with a launch.

We used equation 1.1 to estimate the number of missing products to replenish product portfolios without a successful launch. Replenishments were added to the preclinical stage.

Number of missing products to replenish= 1/(preclinical success rate*Phase 1 success rate*Phase 2 success rate*Phase 3 success rate),(Eq 1.1)

Table A1.1. Variables and parameters used to estimate progress in the product development pipeline

	Vaccines		New chemical entity		Drug-repurposed		Biologic		Diagnostic	
	Simple	Complex	Simple	Complex	Simple	Complex	Simple	Complex	Assay development	Simple platform development
Cost (USD millions)										
Preclinical	6.66	16.63	5.00	10.00	NA	5.00	10.79	21.59	3.00	NA
Phase I	2.25	2.47	2.21	7.44	NA	2.21	2.41	7.65	2.00	100.00
Phase II	13.22	13.88	5.81	6.39	5.81	5.81	7.53	8.28	3.50	3.50
Phase III	111.10	133.32	32.82	36.10	17.61	17.61	54.12	59.53	NA	NA
Length (years)										
Preclinical	3.36	3.33	2.49	2.87	NA	NA	3.29	3.24	1.00	NA
Phase I	1.57	1.97	1.80	1.93	NA	NA	1.62	1.49	1.25	NA
Phase II	2.23	3.71	3.38	3.51	2.14	2.14	2.47	4.16	1.33	2.50
Phase III	2.33	3.50	3.18	2.80	2.14	2.14	2.10	3.38	NA	2.00
Probability of success										
Preclinical	0.410	0.410	0.650	0.550	NA	0.750	0.750	0.770	0.500	NA
Phase I	0.684	0.500	0.597	0.572	NA	0.585	0.662	0.696	1.000	0.750
Phase II	0.459	0.216	0.388	0.197	0.457	0.457	0.443	0.322	1.000	1.000
Phase III	0.708	0.636	0.691	0.403	0.681	0.681	0.709	0.625	NA	NA

APPENDIX A2

For product portfolios with a successful product launch, we estimated the health and economic benefits to the health system and society. Table A2.1 lists the variables used for the health impact analysis. The actual estimates used in our analysis can be found in the **online data repository**.

Table A2.1 Variables used for the health and economic impact assessment

Variable	Definition
Incidence rate	New cases of disease per year per 100,000 population
Existing cases at baseline	The of sum of annual incident and annual prevalent cases
Duration of disease with treatment	Duration (in years) of disease symptoms among individuals who received care
Duration of disease without treatment	Duration (in years) of disease symptoms among individuals who did not receive care
Case fatality rate with treatment	Proportion of prevalent cases who received care that died
Case fatality rate without treatment	Proportion of prevalent cases who did not receive care that died
Disability weight with treatment	Numerical representation of the severity of health loss associated with the disease among people who received care
Disability weight without treatment	Numerical representation of the severity of health loss associated with the disease among people who did not receive care
Vaccine efficacy	Proportion of vaccinated individuals who do not develop the disease
Diagnostic efficacy	Percent increase in the likelihood of receiving treatment if diagnosed with the disease
Vaccine unit cost	Vaccine price per dose plus the delivery cost per dose
Treatment unit cost	Health system cost of providing care to one case of the disease
Diagnostic unit cost	Cost per diagnostic procured
Base year vaccine coverage	Proportion of individuals vaccinated at baseline
Base year treatment coverage	Proportion of cases on treatment at baseline
Base year diagnostic coverage	Proportion of cases diagnosed at baseline
Population average life expectancy	Life expectancy at the average age of death for a disease
Fraction of affected population of employment age	Proportion of cases within the age range 15 to 69 years
Time horizon	Timeframe of analysis for which health and economic benefits and costs are measured
Employment rate	Proportion of population employed
Annual increase in vaccine coverage	Percentage point increase in vaccine coverage per year
Annual increase in treatment coverage	Percentage point increase in treatment coverage per year
Annual increase in diagnostic coverage	Percentage point increase in diagnostic coverage per year
Maximum vaccine coverage	Maximum proportion of population that can be reached for vaccination
Maximum treatment coverage	Maximum proportion of population that can be reached for treatment
Annual minimum wage	Average annual minimum wage across low- and middle-income countries
Discount rate	**That annual rate at which future benefits and costs are discounted to reflect their present values**
Market entry delay	**The duration (in years) between product launch and product entry into the market**
ICER threshold	**The threshold below which the ICER is deemed cost-effective**

Key assumptions of the effect of vaccines, therapeutics, and diagnostics

We made a few simplifying assumptions to enable easy comparison across product portfolios and regions.

We assumed that vaccines would reduce incidence, therapeutics would reduce case-fatality rates, disease duration, and disability weights when treated, and diagnostics would increase treatment uptake.

We assumed portfolio-specific baseline coverage rates for diagnostics and therapeutics. Data on baseline vaccine coverage rates were difficult to find, so we assumed 0% vaccine baseline coverage rates for all scenarios.

Health impact assessment

We assessed health impact as disability-adjusted life years (DALYs) and deaths using the equations below.

$$Prevalent\ Cases_t = Unresolved\ Cases_{t-1} + Incident\ Cases_t, \quad (Eq\ 2.1)$$

$$Incident\ Cases_t = Population_t * Incidence\ rate\ , (Eq\ 2.2)$$

$$\begin{aligned} Incident\ Cases\ with\ Vaccination_t \\ = Population_t \\ * \Big(incidence\ rate \\ * \Big(\big(Vax\ Coverage_t * (1 - Vax\ Effectiveness)\big) \\ + (1 - Vax\ Coverage_t)\Big)\Big), (Eq\ 2.3) \end{aligned}$$

$$\begin{aligned} Deaths\ in\ treated_t \\ = Prevalenct\ Cases_t * Treatment\ Coverage_t \\ * Case\ fatality\ rate\ with\ treatment, (Eq. 2.4) \end{aligned}$$

$$\begin{aligned} Deaths\ in\ untreated_t \\ = Prevalenct\ Cases_t * Treatment\ Coverage_t \\ * Case\ fatality\ rate\ without\ treatment, (Eq. 2.5) \end{aligned}$$

$$\begin{aligned} YLD\ in\ treated_t \\ = Prevalenct\ cases_t * Treatment\ coverage_t \\ * Disability\ weight\ with\ treatment \\ * Disease\ duration\ with\ treatment, (Eq. 2.6) \end{aligned}$$

$$\begin{aligned} YLD\ in\ untreated_t \\ = Prevalenct\ cases_t * (1 - Treatment\ coverage_t) \\ * Disability\ weight\ without\ treatment \\ * Disease\ duration\ without\ treatment, (Eq. 2.7) \end{aligned}$$

$$YLL_t = Deaths_t * Average\ population\ life\ expectancy\ at\ time\ of\ death_t, (Eq. 2.8)$$

$$DALYs_t = \sum_{t=2023}^{2044} YLL_t + YLD\ in\ treated_t + YLD\ in\ untreated_t\ , (Eq. 2.9)$$

Costs assessment

We collected data on costs of treatment for each disease, manufacturing costs, and delivery costs. Product costs were estimated as a function of number of products delivered and the product unit cost. Treatment costs estimates included the total cost of treatment, not just drug costs. This included health worker costs, fees paid, drug costs, diagnostics costs, etc. All costs were adjusted for inflation and reported in USD.

Assessment of ICERs

We assessed incremental cost effectiveness ratios using the equations below:

$$Incremental\ cost = Costs_{scenario\ s} - Costs_{do\ nothing}, (Eq\ 2.10)$$

$$Deaths\ averted = Deaths_{do\ nothing} - Deaths_{scenario\ s}, (Eq\ 2.11)$$

$$DALYs\ averted = DALYs_{do\ nothing} - DALYs_{scenario\ s}, (Eq\ 2.12)$$

$$ICER\ per\ DALY\ averted = \frac{Incremental\ costs}{DALYs\ averted}\ (Eq\ 2.13)$$

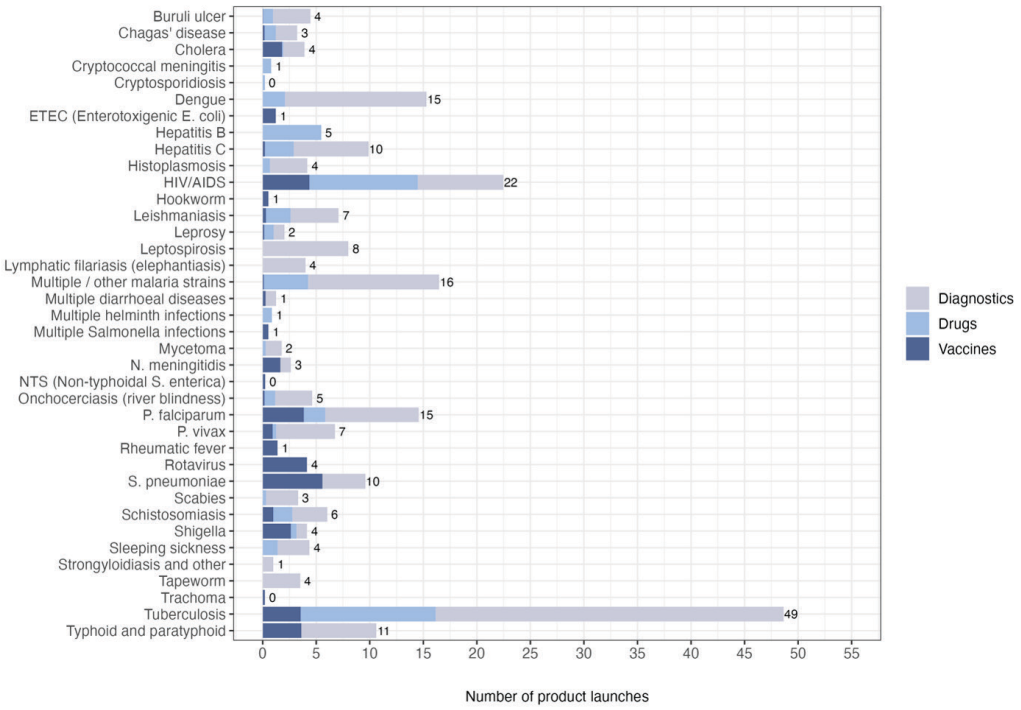
$$ICER\ per\ Death\ averted = \frac{Incremental\ costs}{Deaths\ averted}\ (Eq\ 2.14)$$

Assessment of NMBs

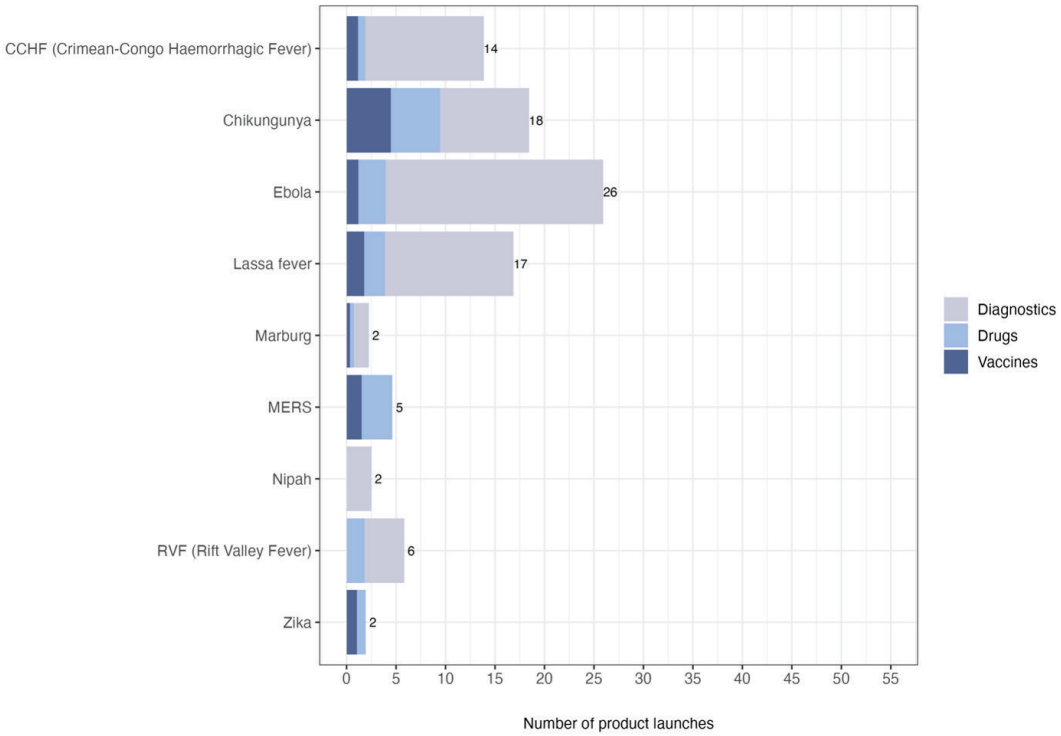
$$Net\ Monetary\ Benefits = (DALYs\ averted * GDP\ threshold) - Incremental\ costs, (Eq. 2.15)$$

Details of reference case product launches

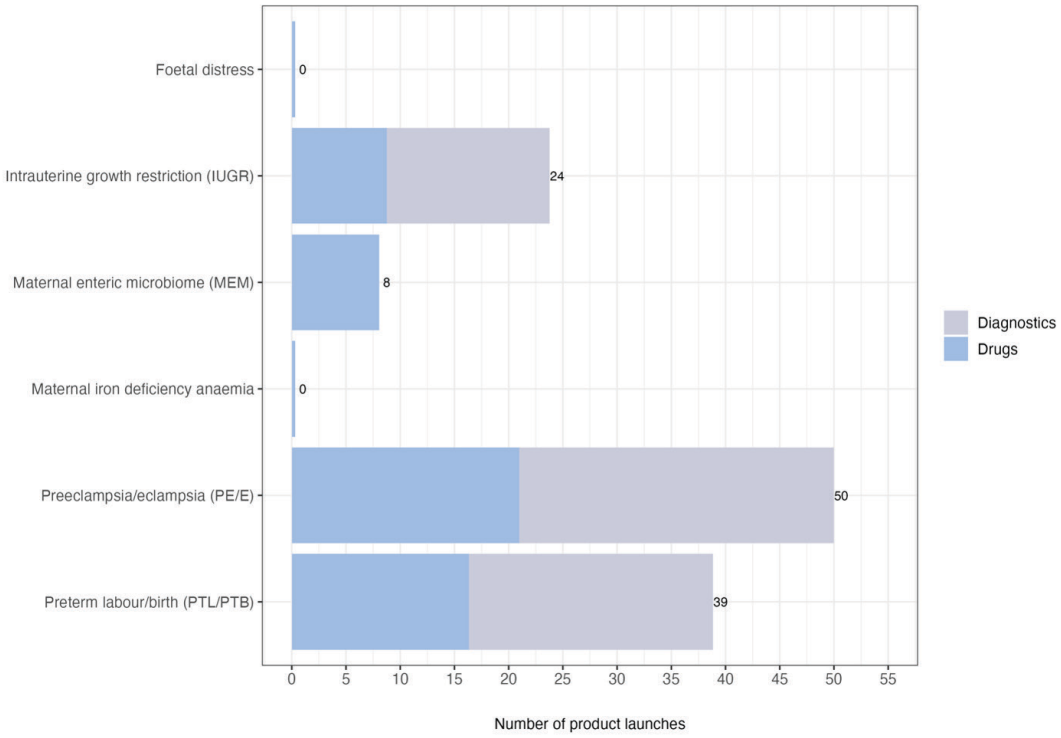
A3.1. Poverty-related neglected diseases (NDs)



A3.2. Emerging Infectious Diseases (EIDs)



A3.3. Maternal Health



Appendix Table A3.4. Disease categories that will not have successful product launches without replenishment of the current product pipeline

	Diseases categories
NDs with no expected launches for all three product archetypes (vaccines, therapeutics, and diagnostics)	Cryptococcal meningitis, cryptosporidiosis, ETEC, hookworm, multiple salmonella infections, multiple helminth infections, mycetoma, NTS, rheumatic fever, trachoma (10 disease categories, 30 product portfolios)
NDs with no expected launches for two product archetypes (vaccines and therapeutics) but expected launches of diagnostics	Buruli ulcer, Chagas disease, cholera, dengue, histoplasmosis, leishmaniasis, leprosy, leptospirosis, lymphatic filariasis, multiple diarrheal diseases, onchocerciasis, *P. vivax*, scabies, schistosomiasis, shigella, sleeping sickness, strongyloidiasis, tapeworm (18 disease categories, 36 product portfolios)
No expected launch of a ND vaccine	Hepatitis B, hepatitis C, multiple/other malaria strains (3 disease categories, 3 product portfolios)
No expected launch of a ND therapeutic	*N. meningitidis*, *P. falciparum*, *S. pneumoniae*, typhoid and paratyphoid, rotavirus (5 disease categories, 5 product portfolios)
No expected ND diagnostic	Rotavirus (1 disease category, 1 product portfolio)
EIDs with no expected launches for all three product archetypes (vaccines, therapeutics, and diagnostics)	Nipah, Zika (2 disease categories, 6 product portfolios)
EIDs with no expected launches for two product archetypes (vaccines and therapeutics) but expected launch of diagnostics	Crimean-Congo hemorrhagic fever, Ebola, Marburg (3 disease categories, 6 product portfolios)
No expected launch of an EID vaccine	Rift Valley fever (1 disease category, 1 product portfolio)
No expected launch of an EID diagnostic	Middle East respiratory syndrome (1 disease category, 1 product portfolio)
No expected launch of an MH therapeutic	Fetal distress, maternal iron deficiency anemia (2 disease categories, 2 product portfolios)
No expected launch of an MH diagnostic	Fetal distress, maternal enteric microbiome, maternal iron deficiency anemia (3 disease categories, 3 product portfolios)

APPENDIX A4

Table A4.1. Annual funding gap by disease-product-archetype, over the next 10 years

Disease-product-archetype		Reference case		Replenishment with simple products		Replenishment with complex products	
	Available funding (in million USD)	Needed funding (USD millions)	Funding gap (USD millions)	Needed funding (USD millions)	Funding gap (USD millions)	Needed funding (USD millions)	Funding gap (USD millions)
ND vaccines	$1,308	$1,260	-$48	$2,341	$1,033	$4,909	$3,601
ND therapeutics	$1,436	$613	-$823	$1,171	-$265	$3,688	$2,252
ND diagnostics	**$164**	**$228**	**$64**	**$508**	**$344**	**$244**	**$80**
All ND products	**$2,908**	**$2,102**	**-$806**	**$4,020**	**$1,112**	**$8,841**	**$5,933**
EID vaccines	**$274**	**$341**	**$67**	**$510**	**$236**	**$911**	**$637**
EID therapeutics	**$422**	**$228**	**-$194**	**$296**	**-$126**	**$604**	**$182**
EID diagnostics	**$46**	**$17**	**-$29**	**$79**	**$33**	**$20**	**-$26**
All EID products	**$742**	**$586**	**-$156**	**$885**	**$143**	**$1,536**	**$794**
MH vaccines*	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**	**$0**
MH therapeutics	**$154**	**$240**	**$86**	**$267**	**$113**	**$390**	**$236**
MH diagnostics	**$43**	**$60**	**$17**	**$121**	**$78**	**$63**	**$20**
All MH products	**$197**	**$299**	**$102**	**$388**	**$191**	**$453**	**$256**

* There are no vaccines in the maternal health technologies category

NOTES:
- Needed funding is total R&D funding / 10 years.
- Available funding is from GFINDER data portal (latest year available)
- Negative values indicate that needed funding is met, thus no funding gap exists

APPENDIX A5

Table A5.1. Development of vaccines

Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per DALY averted (in USD)*	Net monetary benefits (in billions USD)
	NDs	
1	Tuberculosis (cost-saving)	*S. pneumoniae* ($48,679 B)
2	*N. meningitidis* (cost-saving)	Multiple diarrheal diseases ($6,518 B)
3	Multiple Salmonella infections (cost-saving)	Typhoid and paratyphoid ($2,740 B)
4	Dengue (cost-saving)	*P. falciparum* ($311 B)
5	HIV/AIDS (cost-saving)	Multiple / other malaria strains ($126 B)
6	Rotavirus (cost-saving)	Tuberculosis ($118 B)
7	Cryptococcal meningitis (cost-saving)	Rotavirus ($96 B)
8	Strongyloidiasis and other (cost-saving)	Multiple helminth infections ($74 B)
9	*P. falciparum* (cost-saving)	*N. meningitidis* ($63 B)
10	Rheumatic fever (cost-saving)	HIV/AIDS ($53 B)
11	Multiple / other malaria strains (cost-saving)	Tapeworm ($49 B)
12	Hepatitis B (cost-saving)	Dengue ($39 B)
13	Typhoid and paratyphoid (cost-saving)	Schistosomiasis ($30 B)
14	Multiple diarrheal diseases (cost-saving)	Hepatitis B ($28 B)
15	*S. pneumoniae* (cost-saving)	Multiple Salmonella infections ($17 B)
16	Shigella ($128)	Shigella ($16 B)
17	Tapeworm ($131)	Strongyloidiasis and other ($15 B)
18	NTS (Non-typhoidal *S. enterica*) ($179)	*P. vivax* ($12 B)
19	Leptospirosis ($200)	Hookworm ($10 B)
20	ETEC (Enterotoxigenic *E. coli*) ($238)	Cryptococcal meningitis ($9 B)
21	*P. vivax* ($252)	NTS (Non-typhoidal *S. enterica*) ($9 B)
22	Schistosomiasis ($310)	Lymphatic filariasis (elephantiasis) ($8 B)
23	Trachoma ($479)	Rheumatic fever ($7 B)
24	Hepatitis C ($514)	Leptospirosis ($5 B)
25	Lymphatic filariasis (elephantiasis) ($529)	Cholera ($5 B)
26	Cholera ($628)	Hepatitis C ($4 B)
27	Hookworm ($847)	Trachoma ($4 B)
28	Multiple helminth infections ($949)	ETEC (Enterotoxigenic *E. coli*) ($4 B)
29	Onchocerciasis (river blindness) ($1,033)	Onchocerciasis (river blindness) ($1 B)
30	Cryptosporidiosis ($2,019)	Cryptosporidiosis ($1 B)
31	Histoplasmosis ($7,855)	Histoplasmosis (-$.13 B)
32	Leishmaniasis ($7,918)	Leishmaniasis (-$.18 B)
33	Scabies ($8,230)	Sleeping sickness (-$.28 B)

Continued: Table A5.1. Development of vaccines:

34	Chagas disease ($16,999)	Mycetoma (-$.35 B)
35	Sleeping sickness ($23,121)	Leprosy (-$.37 B)
36	Leprosy ($151,279)	Buruli ulcer (-$.38 B)
37	Buruli ulcer ($777,160)	Chagas disease (-$.40 B)
38	Mycetoma ($472,737,652)	Scabies (-$3 B)
	EIDs	
1	Zika (cost-saving)	Zika ($.25 B)
2	Lassa fever ($3,128)	Lassa fever ($.20 B)
3	Chikungunya ($6,290)	Chikungunya (-$.20 B)
4	Ebola ($10,480)	RVF (Rift Valley fever) (-$.26 B)
5	CCHF (Crimean-Congo haemorrhagic fever) ($29,607)	Nipah (-$.27 B)
6	RVF (Rift Valley Fever) ($57,729)	MERS (-$.41 B)
7	Marburg ($99,837)	Marburg (-$.46 B)
8	Nipah ($126,530)	CCHF (Crimean-Congo haemorrhagic fever) (-$.50 B)
9	MERS ($245,251)	Ebola (-$.50 B)

* Negative ICERs imply that a successful launch will lead to cost savings. Negative net monetary benefits imply that in economic terms, the costs of investing in product development are higher than the economic value of expected health benefits.

Table A5.2. Development of therapeutics

Incremental cost-effectiveness ratios and net-monetary benefits for investing in therapeutics development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category

Rank	Incremental cost per DALY averted (in USD)*	Net monetary benefits (in billions USD)
	NDs	
1	Tapeworm ($6)	Multiple diarrheal diseases ($6,002 B)
2	Multiple helminth infections ($8)	*S. pneumoniae* ($3,354 B)
3	Schistosomiasis ($19)	Multiple / other malaria strains ($840 B)
4	Hookworm ($22)	Typhoid and paratyphoid ($761 B)
5	Typhoid and paratyphoid ($24)	HIV/AIDS ($460 B)
6	*S. pneumoniae* ($38)	Multiple helminth infections ($251 B)
7	Lymphatic filariasis (elephantiasis) ($56)	*P. falciparum* ($131 B)
8	*P. vivax* ($104)	Tapeworm ($126 B)
9	Multiple / other malaria strains ($108)	Schistosomiasis ($99 B)
10	Cholera ($137)	Hepatitis B ($77 B)
11	NTS (Non-typhoidal *S. enterica*) ($193)	Dengue ($50 B)
12	*P. falciparum* ($198)	Strongyloidiasis and other ($44 B)
13	Strongyloidiasis and other ($204)	Hookworm ($37 B)
14	Multiple diarrheal diseases ($265)	*P. vivax* ($29 B)
15	Trachoma ($269)	Rheumatic fever ($19 B)
16	Cryptococcal meningitis ($606)	Lymphatic filariasis (elephantiasis) ($16 B)
17	HIV/AIDS ($633)	Cryptococcal meningitis ($12 B)
18	Rheumatic fever ($645)	Cholera ($10 B)
19	Onchocerciasis (river blindness) ($669)	NTS (Non-typhoidal *S. enterica*) ($8 B)
20	Leptospirosis ($704)	Multiple Salmonella infections ($4 B)

Continued: Table A5.2. Development of therapeutics :

21	Dengue ($740)	Onchocerciasis (river blindness) ($4 B)
22	Hepatitis B ($1,962)	Trachoma ($3 B)
23	Chagas' disease ($2,036)	*N. meningitidis* ($2 B)
24	Cryptosporidiosis ($2,557)	Chagas' disease ($2 B)
25	Multiple Salmonella infections ($2,932)	Leptospirosis ($2 B)
26	*N. meningitidis* ($3,090)	Cryptosporidiosis ($1 B)
27	Histoplasmosis ($3,501)	Shigella ($.99 B)
28	Shigella ($4,202)	Histoplasmosis ($.07 B)
29	Leishmaniasis ($4,332)	Leishmaniasis ($.02 B)
30	Hepatitis C ($4,755)	Sleeping sickness (-$.09 B)
31	Rotavirus ($6,405)	Mycetoma (-$.19 B)
32	Sleeping sickness ($7,143)	Buruli ulcer (-$.22 B)
33	ETEC (Enterotoxigenic *E. coli*) ($7,776)	Leprosy (-$.23 B)
34	Tuberculosis ($8,333)	Hepatitis C (-$3 B)
35	Scabies ($16,002)	Rotavirus (-$5 B)
36	Buruli ulcer ($430,461)	ETEC (Enterotoxigenic *E. coli*) (-$6 B)
37	Mycetoma ($412,936,555)	Scabies (-$11 B)
38	Leprosy (NA)**	Tuberculosis (-$43 B)
	NDs	
1	Lassa fever ($4,774)	Lassa fever (-$.02 B)
2	RVF (Rift Valley Fever) ($12,599)	RVF (Rift Valley Fever) (-$.09 B)
3	Chikungunya ($25,271)	Nipah (-$.13 B)
4	Ebola ($25,484)	Marburg (-$.28 B)
5	CCHF (Crimean-Congo Haemorrhagic Fever) ($54,843)	MERS (-$.32 B)
6	MERS ($117,493)	CCHF (Crimean-Congo Haemorrhagic Fever) (-$.33 B)
7	Marburg ($180,470)	Ebola (-$.58 B)
8	Nipah ($187,198)	Chikungunya (-$.87 B)
9	Zika ($5,065,397)	Zika (-$2.35 B)
	MH	
1	Preeclampsia/eclampsia (PE/E) ($23)	Preeclampsia/eclampsia (PE/E) ($550 B)
2	Maternal iron deficiency anaemia ($44)	Preterm labour/birth (PTL/PTB) ($454 B)
3	Preterm labour/birth (PTL/PTB) ($70)	Maternal enteric microbiome (MEM) ($216 B)
4	Intrauterine growth restriction (IUGR) ($85)	Maternal iron deficiency anaemia ($180 B)
5	Fetal distress ($99)	Intrauterine growth restriction (IUGR) ($132 B)
6	Maternal enteric microbiome (MEM) ($117)	Fetal distress ($24 B)

* Negative ICERs imply that a successful launch will lead to cost savings. Negative net monetary benefits imply that in economic terms, the costs of investing in product development are higher than the economic value of expected health benefits.
** Treatment for Leprosy in the base year already exceeds 95% so no analysis was conducted for scale-up of Leprosy treatment from a drug launch.

Table A5.3. Development of diagnostics

Incremental cost-effectiveness ratios and net-monetary benefits for investing in diagnostics development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category

Rank	Incremental cost per DALY averted (in USD)*	Net monetary benefits (in billions USD)
	NDs	
1	Typhoid and paratyphoid ($24)	Multiple diarrheal diseases ($24,296 B)
2	Tapeworm ($27)	*S. pneumoniae* ($17,075 B)
3	Cholera ($48)	Typhoid and paratyphoid ($3,748 B)
4	Schistosomiasis ($68)	Multiple / other malaria strains ($1,655 B)
5	*P. vivax* ($73)	*P. falciparum* ($1,194 B)
6	*P. falciparum* ($81)	Multiple helminth infections ($780 B)
7	*S. pneumoniae* ($83)	Tapeworm ($651 B)
8	Strongyloidiasis and other ($94)	HIV/AIDS ($467 B)
9	Multiple / other malaria strains ($94)	Schistosomiasis ($451 B)
10	Sleeping sickness ($117)	*P. vivax* ($242 B)
11	Lymphatic filariasis (elephantiasis) ($138)	Dengue ($227 B)
12	NTS (Non-typhoidal *S. enterica*) ($153)	Strongyloidiasis and other ($180 B)
13	Hookworm ($181)	Hookworm ($122 B)
14	Rheumatic fever ($186)	Lymphatic filariasis (elephantiasis) ($103 B)
15	Onchocerciasis (river blindness) ($211)	Rheumatic fever ($62 B)
16	Trachoma ($225)	Cholera ($42 B)
17	Multiple helminth infections ($267)	Onchocerciasis (river blindness) ($38 B)
18	Multiple diarrheal diseases ($285)	Cryptococcal meningitis ($31 B)
19	Leptospirosis ($309)	*N. meningitidis* ($23 B)
20	Leishmaniasis ($331)	NTS (Non-typhoidal *S. enterica*) ($21 B)
21	Cryptococcal meningitis ($492)	Hepatitis B ($18 B)
22	Chagas disease ($501)	Multiple Salmonella infections ($11 B)
23	HIV/AIDS ($666)	Leptospirosis ($9 B)
24	Dengue ($726)	Trachoma ($7 B)
25	Histoplasmosis ($943)	Leishmaniasis ($3 B)
26	*N. meningitidis* ($962)	Cryptosporidiosis ($2 B)
27	Hepatitis B ($1,998)	Histoplasmosis ($1 B)
28	Multiple Salmonella infections ($2,943)	Sleeping sickness ($.59 B)
29	Cryptosporidiosis ($3,449)	Chagas' disease ($.46 B)
30	Shigella ($4,449)	Shigella ($.22 B)
31	Hepatitis C ($4,975)	Buruli ulcer (-$.01 B)
32	Rotavirus ($6,819)	Leprosy (-$.03 B)
33	Tuberculosis ($8,137)	Hepatitis C (-$.06 B)
34	Buruli ulcer ($8,193)	Mycetoma (-$.25 B)
35	ETEC (Enterotoxigenic *E. coli*) ($8,239)	Rotavirus (-$15 B)
36	Scabies ($49,576)	ETEC (Enterotoxigenic *E. coli*) (-$17 B)
37	Mycetoma ($73,391,445)	Tuberculosis (-$33 B)
38	Leprosy (N/A)**	Scabies (-$177 B)

Continued: Table A5.3. Development of diagnostics

EIDs		
1	Lassa fever ($598)	Lassa fever ($.58 B)
2	Ebola ($877)	Ebola ($.41 B)
3	Marburg ($1,660)	Marburg ($.02 B)
4	CCHF (Crimean-Congo haemorrhagic fever) ($7,015)	RVF (Rift Valley Fever) (-$.03 B)
5	RVF (Rift Valley fever) ($9,763)	CCHF (Crimean-Congo haemorrhagic fever) (-$.07 B)
6	Chikungunya ($20,262)	Nipah (-$.21 B)
7	Nipah ($72,828)	MERS (-$.22 B)
8	MERS ($199,736)	Chikungunya (-$.39 B)
9	Zika ($4,177,530)	Zika (-$5 B)
MH		
1	Preeclampsia/eclampsia (PE/E) ($25)	Maternal iron deficiency anaemia ($481 B)
2	Maternal iron deficiency anaemia ($53)	Preeclampsia/eclampsia (PE/E) ($216 B)
3	Preterm labour/birth (PTL/PTB) ($79)	Preterm labour/birth (PTL/PTB) ($178 B)
4	Intrauterine growth restriction (IUGR) ($104)	Maternal enteric microbiome (MEM) ($83 B)
5	Fetal distress ($105)	Foetal distress ($66 B)
6	Maternal enteric microbiome (MEM) ($148)	Intrauterine growth restriction (IUGR) ($52 B)

* Negative ICERs imply that a successful launch will lead to cost savings. Negative net monetary benefits imply that in economic terms, the costs of investing in product development are higher than the economic value of expected health benefits.
** Treatment for Leprosy in the base year already exceeds 95% so no analysis was conducted for scale-up of Leprosy treatment from a diagnostic launch.

APPENDIX A6

A6.1 Efficiency gains from AI and smarter clinical trials, measured as product development costs per launch

Disease-product-archetype	Cost per launch (USD Millions)			
	Comparator: Efficiency gains scenario #2	Efficiency gains scenario #3: AI and smarter trials	Absolute difference	Percent reduction
ND vaccines	$336	$214	-$122	-36%
ND therapeutics	$135	$85	-$50	-37%
ND diagnostics	$31	$23	-$8	-26%
EID vaccines	$291	$182	-$109	-37%
EID therapeutics	$135	$83	-$52	-39%
EID diagnostics	$11	$8	-$3	-27%
MH therapeutics	$47	$32	-$15	-32%
MH diagnostics	$17	$12	-$5	-29%

Appendix 7.1 – Sub-Saharan Africa: priority medicines, vaccines, and diagnostics needed by the region

We conducted key informant (KI) interviews to understand which products were of high priority to stakeholders in Latin America. The regional assessment involved interviews with key stakeholders in the R&D ecosystem in Africa. These KIs included heads and key personnel in science, regulatory, funding, manufacturing organizations, and conveners of innovators in Africa. They included representatives of the South African Health Products Regulatory Authority, AfricaBio (an independent non-profit stakeholders' association that represents Africa's biotechnology sector), the Drugs for Neglected Diseases Initiative, Institut Pasteur de Dakar, the Science for Africa Foundation, Amref Health Innovations, the African Union COVID-19 Commission, Africa CDC, and Ghana's Food and Drugs Authority. Although we explained to the KIs that our study focus was NDs, EIDs, and MH, nevertheless they mentioned the need for new technologies for other conditions, including non-communicable diseases (NCDs).

Lack of a cohesive priority-setting process

KIs reported the lack of cohesive and structured processes to determine priorities for health product development. At best, stakeholders have been able to reach some consensus on priority diseases, but consensus tends to happen as a reaction to crises and varies depending on the interests of conveners and participants. As a result, there is no reputable platform currently known to facilitate such proceedings for the continent of Africa, particularly when one considers a forward-looking perspective to planning.

Priority diseases

KIs mentioned that infectious diseases and NCDs are a current and future priority. Infectious diseases are of greater concern for the stakeholders in Africa interviewed for this study, and viral infections were particularly foremost in the minds of stakeholders. Another priority is to have products that can be developed in preparation for future pandemics—the efforts to build bio-manufacturing capability in preparation for future pandemics is considered a positive outcome of the COVID-19 era. However, much work is still needed in mapping pathogens that constitute a threat to future outbreaks.

- **Medicines, vaccines, and diagnostics for HIV, TB, and malaria**. KIs in Southern Africa said that diseases such HIV, TB and malaria are considered a huge burden to the public health system and argued that HIV curative therapy and an HIV vaccine are important. Shorter TB regimens have become available in the last few years, but KIs said that tackling drug-resistant TB is a priority. Malaria is still highly prevalent in certain parts of the Southern African Development Community, and although two malaria vaccines have been launched (RTS,S and R21), KIs expressed concern about the relatively low efficacy of the vaccines. In West Africa, stakeholders also considered malaria products—medicines, vaccines, and diagnostics—as very important, as the disease causes a huge burden on the public health system. They also welcomed the malaria vaccine, which has started being rolled out in Benin, Liberia, and Sierra Leone, but said that a much more effective vaccine is needed.

- **Products for neglected febrile illnesses, diarrheal diseases, viral hemorrhagic fevers, and arboviruses**. West African KIs highlighted the need for products for diseases of poverty and neglected febrile illnesses, diarrheal diseases, viral hemorrhagic fevers (VHFs), and arboviruses. KIs specifically mentioned the need to develop products for those arboviruses that tend to induce fever (Lassa, dengue, Zika, Chikungunya). These viruses are particularly problematic because there are no point-of-care diagnostics. Typically, if a patient presents with fever, they will be tested with a malaria rapid diagnostic test, and if they are found to be negative, the diagnostic assessment reaches a dead end. A number of prevalent arboviruses are not diagnosed because the

tools are not available to detect them. These patients end up being admitted for observation or sent home with supportive treatment.

West African KIs also prioritized products for VHFs in the region, such as Ebola and Marburg. While recognizing that some progress has been made with the Ebola vaccine, KIs said there was an urgent need for medical countermeasures against VHFs in West and Central Africa. Although KIs mentioned polio as a priority among diarrheal diseases, their focus was on addressing declines in uptake rather than a lack of products. During COVID-19, we saw declines in the uptake of a number of vaccines in SSA, resulting in new outbreaks of diseases such as measles. KIs made the point that the focus should not only be on developing new vaccines but on ensuring (i) vaccine uptake, especially in the context of distrust of vaccines and products, and (ii) the right infrastructure for these products, such as cold chains. The need for multiplex diagnostic tools was also stated several times by KIs to assist with detection and surveillance.

- **NCDs**. In three regions—West, Southern and East Africa—KIs expressed concern about the increased burden of NCDs, especially cardiovascular diseases, hypertension, diabetes, cancer, and mental illness. The discussion by the KIs of products needed for these conditions was complex, as KIs recognized that effective products do exist, but there are challenges with uptake, regimens, and formulations. KIs discussed NCD risk factors, and the need for a more promotional and preventive approach over the current curative, reactive approach to healthcare. KIs also raised concerns about multi-morbidity, where people present with multiple problems concurrently, in which case the synergetic effect of the co-morbid conditions can lead to a detrimental health outcome more rapidly. KIs highlighted the convergence of infectious diseases and NCDss, including with relevance to cancers (e.g. HPV can cause multiple cancers).

- **EIDs prioritized by Africa CDC**. East African KIs that we interviewed mentioned that Africa CDC is the source of guidance for priority health conditions, including EIDs. A recent prioritization exercise, based on a review of Africa CDC's Event Based Surveillance (EBS) database from 2020 to 2021, identified 18 diseases for prioritization: pandemic influenza, COVID-19, meningococcal disease (Neisseria meningitidis), measles, vaccine-derived polio, cholera, Lassa fever, rabies, anthrax, plague, Mpox, yellow fever, dengue fever, Rift Valley fever, Chikungunya, Crimean-Congo hemorrhagic fever, Ebola, and disease X (an EID due to an unknown pathogen).[12]

- **DNDi's priorities for SSA**. DNDi has been working with industry partners on products for (i) dengue—repurposed compounds and new chemical entities (AT-752, JNJ-1802, NITF-688); (ii) rabies—a monoclonal antibody cocktail (RVC 20/58; (iii) schistosomiasis, (iv) snakebite (varespladib); and chronic leukemia.

- **Maternal and child health**. Most KIs did not refer to maternal and child health priorities, although these priorities can be found in the AUDA-NEPAD (African Union Development Agency) health strategy document, "Health Research and Innovation Strategy for Africa (HRISA):2018-2030)."[13] This document also makes reference to the growing problem of NCDs.

The results of our analyses of the product portfolios for the African region are contained in Tables A7.1.1, A7.1.2, and A7.1.3.

Table A7.1.1 Ranking of product portfolios for vaccines development – sub-Saharan Africa

Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
		NDs	
1	Tuberculosis (Cost-saving)	Tuberculosis (Cost-saving)	*S. pneumoniae* ($6,002 B)
2	*N. meningitidis* (Cost-saving)	*N. meningitidis* (Cost-saving)	Multiple diarrheal diseases ($704 B)
3	HIV/AIDS (Cost-saving)	HIV/AIDS (Cost-saving)	*P. falciparum* ($136 B)
4	Rotavirus (Cost-saving)	Rotavirus (Cost-saving)	Typhoid and paratyphoid ($130 B)
5	Dengue (Cost-saving)	Dengue (Cost-saving)	Multiple / other malaria strains ($56 B)
6	Cryptococcal meningitis (Cost-saving)	Cryptococcal meningitis (Cost-saving)	Tuberculosis ($31 B)
7	*P. falciparum* (Cost-saving)	*P. falciparum* (Cost-saving)	Rotavirus ($22 B)
8	Multiple / other malaria strains (Cost-saving)	Multiple / other malaria strains (Cost-saving)	HIV/AIDS ($18 B)
9	Typhoid and paratyphoid (Cost-saving)	Multiple diarrheal diseases (Cost-saving)	Tapeworm ($18 B)
10	Multiple diarrheal diseases (Cost-saving)	*S. pneumoniae* (Cost-saving)	*N. meningitidis* ($17 B)
11	*S. pneumoniae* (Cost-saving)	Typhoid and paratyphoid (Cost-saving)	Schistosomiasis ($11 B)
12	Hepatitis B ($2,909)	Hepatitis B ($64)	Multiple helminth infections ($6 B)
13	Tapeworm ($6,280)	Tapeworm ($131)	Cryptococcal meningitis ($5 B)
14	Leptospirosis ($9,706)	NTS (Non-typhoidal S. enterica) ($175)	Hepatitis B ($3 B)
15	Strongyloidiasis and other ($10,946)	Strongyloidiasis and other ($193)	NTS (Non-typhoidal S. enterica) ($3 B)
16	NTS (Non-typhoidal S. enterica) ($11,051)	Leptospirosis ($230)	Shigella ($2 B)
17	Multiple Salmonella infections ($13,723)	Schistosomiasis ($305)	Dengue ($2 B)
18	Shigella ($23,356)	Multiple Salmonella infections ($325)	Leptospirosis ($2 B)
19	Trachoma ($23,683)	Rheumatic fever ($488)	Strongyloidiasis and other ($1 B)
20	Cholera ($36,000)	Shigella ($506)	Lymphatic filariasis (elephantiasis) ($1 B)
21	Hepatitis C ($43,460)	Trachoma ($557)	Trachoma ($971 M)
22	Rheumatic fever ($51,752)	Lymphatic filariasis (elephantiasis) ($694)	Rheumatic fever ($881 M)
23	Cryptosporidiosis ($117,627)	Onchocerciasis (river blindness) ($849)	Cholera ($766 M)
24	Onchocerciasis (river blindness) ($126,565)	Cholera ($855)	Multiple Salmonella infections ($510 M)
25	ETEC (Enterotoxigenic *E. coli*) ($141,642)	Multiple helminth infections ($974)	Onchocerciasis (river blindness) ($398 M)
26	Hookworm ($270,527)	Hepatitis C ($1,077)	Hookworm ($316 M)
27	*P. vivax* ($369,462)	Hookworm ($1,299)	Hepatitis C ($311 M)
28	Histoplasmosis ($454,466)	Cryptosporidiosis ($2,151)	ETEC (Enterotoxigenic *E. coli*) (-$150 M)
29	Lymphatic filariasis (elephantiasis) ($497,389)	ETEC (Enterotoxigenic *E. coli*) ($2,268)	Cryptosporidiosis (-$193 M)
30	Schistosomiasis ($599,287)	*P. vivax* ($7,963)	Histoplasmosis (-$264 M)
31	Chagas' disease ($1,326,026)	Histoplasmosis ($10,729)	Sleeping sickness (-$335 M)
32	Sleeping sickness ($2,219,211)	Chagas' disease ($13,785)	Mycetoma (-$349 M)
33	Multiple helminth infections ($3,550,210)	Sleeping sickness ($44,966)	Buruli ulcer (-$379 M)
34	Leishmaniasis ($5,568,338)	Leishmaniasis ($48,855)	Leprosy (-$387 M)
35	Leprosy ($33,843,437)	Leprosy ($300,308)	Leishmaniasis (-$450 M)
36	Buruli ulcer ($96,692,806)	Buruli ulcer ($746,505)	Chagas' disease (-$482 M)
37	Mycetoma (NA)	Mycetoma (NA)	*P. vivax* (-$629 M)
38	Scabies (NA)	Scabies (NA)	Scabies (-$1 B)

EIDs			
1	Lassa fever ($106,865)	Lassa fever ($2,518)	Lassa fever (-$151 M)
2	Marburg ($3,368,784)	Marburg ($80,240)	RVF (Rift Valley Fever) (-$280 M)
3	RVF (Rift Valley Fever) ($14,666,136)	RVF (Rift Valley Fever) ($349,122)	Marburg (-$470 M)
4	CCHF (Crimean-Congo Hemorrhagic Fever) ($16,660,372)	CCHF (Crimean-Congo Hemorrhagic Fever) ($393,648)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$602 M)
5	Ebola ($29,512,452)	Ebola ($702,461)	Zika (-$630 M)
6	Zika ($2,275,775,344)	Zika ($28,351,837)	Ebola (-$880 M)
7	Chikungunya (Not applicable)*	Chikungunya (Not applicable) *	-
8	MERS (Not applicable) *	MERS (Not applicable) *	-
9	Nipah (Not applicable) *	Nipah (Not applicable) *	-

Note:
* Incidence of disease not reported

Table A7.1.2 Ranking of product portfolios for therapeutics development – sub-Saharan Africa
Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
NDs			
1	Tapeworm ($319)	Tapeworm ($6)	Multiple diarrheal diseases ($580 B)
2	*S. pneumoniae* ($1,151)	Multiple helminth infections ($15)	*S. pneumoniae* ($420 B)
3	Typhoid and paratyphoid ($1,724)	Schistosomiasis ($18)	Multiple / other malaria strains ($341 B)
4	Cholera ($7,228)	Typhoid and paratyphoid ($31)	HIV/AIDS ($91 B)
5	Multiple / other malaria strains ($8,502)	*S. pneumoniae* ($38)	*P. falciparum* ($52 B)
6	Multiple diarrheal diseases ($9,462)	Hookworm ($77)	Tapeworm ($47 B)
7	NTS (Non-typhoidal S. enterica) ($12,082)	Lymphatic filariasis (elephantiasis) ($103)	Schistosomiasis ($40 B)
8	Trachoma ($13,065)	Multiple / other malaria strains ($109)	Multiple helminth infections ($39 B)
9	*P. falciparum* ($13,631)	Cholera ($172)	Typhoid and paratyphoid ($37 B)
10	Strongyloidiasis and other ($15,182)	NTS (Non-typhoidal S. enterica) ($191)	Cryptococcal meningitis ($5 B)
11	Hookworm ($20,557)	*P. falciparum* ($198)	Hookworm ($4 B)
12	Cryptococcal meningitis ($24,603)	Strongyloidiasis and other ($262)	Strongyloidiasis and other ($3 B)
13	Onchocerciasis (river blindness) ($30,579)	Multiple diarrheal diseases ($266)	Lymphatic filariasis (elephantiasis) ($3 B)
14	Leptospirosis ($32,490)	Trachoma ($305)	NTS (Non-typhoidal S. enterica) ($3 B)
15	Schistosomiasis ($37,793)	Cryptococcal meningitis ($585)	Cholera ($3 B)
16	HIV/AIDS ($38,340)	HIV/AIDS ($637)	Rheumatic fever ($2 B)
17	*P. vivax* ($39,603)	Onchocerciasis (river blindness) ($653)	Onchocerciasis (river blindness) ($1 B)
18	Dengue ($45,866)	Rheumatic fever ($693)	Trachoma ($929 M)
19	Lymphatic filariasis (elephantiasis) ($60,562)	Leptospirosis ($747)	Dengue ($857 M)
20	Multiple helminth infections ($78,971)	*P. vivax* ($856)	Leptospirosis ($351 M)
21	Rheumatic fever ($80,563)	Dengue ($1,155)	*P. vivax* ($202 M)
22	Hepatitis B ($93,156)	Hepatitis B ($2,021)	Histoplasmosis (-$143 M)

23	Cryptosporidiosis ($133,745)	Chagas' disease ($2,449)	Mycetoma (-$192 M)
24	*N. meningitidis* ($140,616)	Cryptosporidiosis ($2,621)	Sleeping sickness (-$204 M)
25	Multiple Salmonella infections ($143,277)	*N. meningitidis* ($3,236)	Buruli ulcer (-$223 M)
26	Histoplasmosis ($182,259)	Multiple Salmonella infections ($3,393)	Leprosy (-$226 M)
27	Hepatitis C ($184,449)	Shigella ($4,273)	Chagas' disease (-$302 M)
28	Shigella ($191,277)	Histoplasmosis ($4,349)	Leishmaniasis (-$423 M)
29	Chagas' disease ($256,872)	Hepatitis C ($4,772)	Multiple Salmonella infections (-$546 M)
30	Rotavirus ($299,725)	Rotavirus ($6,460)	Cryptosporidiosis (-$565 M)
31	ETEC (Enterotoxigenic *E. coli*) ($449,316)	ETEC (Enterotoxigenic *E. coli*) ($8,023)	*N. meningitidis* (-$1 B)
32	Sleeping sickness ($645,238)	Tuberculosis ($8,630)	Scabies (-$2 B)
33	Leishmaniasis ($2,872,616)	Sleeping sickness ($13,872)	ETEC (Enterotoxigenic *E. coli*) (-$3 B)
34	Tuberculosis ($4,536,645)	Leishmaniasis ($20,114)	Hepatitis B (-$3 B)
35	Buruli ulcer ($23,738,119)	Buruli ulcer ($412,784)	Shigella (-$4 B)
36	Leprosy (NA)	Leprosy (NA)	Rotavirus (-$6 B)
37	Mycetoma (NA)	Mycetoma (NA)	Hepatitis C (-$14 B)
38	Scabies (NA)	Scabies (NA)	Tuberculosis (-$24 B)
EIDs			
1	Lassa fever ($168,532)	Lassa fever ($3,934)	RVF (Rift Valley Fever) (-$137 M)
2	RVF (Rift Valley Fever) ($3,238,870)	RVF (Rift Valley Fever) ($77,042)	Lassa fever (-$205 M)
3	Marburg ($6,070,446)	Marburg ($144,552)	Marburg (-$281 M)
4	CCHF (Crimean-Congo Hemorrhagic Fever) ($27,002,675)	CCHF (Crimean-Congo Hemorrhagic Fever) ($633,591)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$321 M)
5	Ebola ($70,541,963)	Ebola ($1,677,638)	Zika (-$533 M)
6	Zika ($5,853,169,389)	Zika ($52,081,659)	Ebola (-$692 M)
7	Chikungunya (Not applicable) *	Chikungunya (Not applicable) *	-
8	MERS (Not applicable) *	MERS (Not applicable) *	-
9	Nipah (Not applicable) *	Nipah (Not applicable) *	-
MH			
1	Preeclampsia/eclampsia (PE/E) ($1,021)	Preeclampsia/eclampsia (PE/E) ($22)	Preeclampsia/eclampsia (PE/E) ($252 B)
2	Maternal iron deficiency anemia ($2,351)	Maternal iron deficiency anemia ($49)	Preterm labor/birth (PTL/PTB) ($71 B)
3	Preterm labor/birth (PTL/PTB) ($6,210)	Preterm labor/birth (PTL/PTB) ($79)	Maternal enteric microbiome (MEM) ($34 B)
4	Intrauterine growth restriction (IUGR) ($6,811)	Intrauterine growth restriction (IUGR) ($101)	Maternal iron deficiency anemia ($30 B)
5	Maternal enteric microbiome (MEM) ($7,072)	Maternal enteric microbiome (MEM) ($128)	Intrauterine growth restriction (IUGR) ($21 B)
6	fetal distress ($8,900)	fetal distress ($132)	fetal distress ($4 B)

Note:
* Incidence of disease not reported

Table A7.1.3 Ranking of product portfolios for diagnostics development – sub-Saharan Africa

Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
		NDs	
1	Tapeworm ($1,383)	Typhoid and paratyphoid ($26)	Multiple diarrheal diseases ($2,145 B)
2	Typhoid and paratyphoid ($1,469)	Tapeworm ($28)	*S. pneumoniae* ($1,935 B)
3	Cholera ($2,000)	Cholera ($48)	Multiple / other malaria strains ($640 B)
4	*S. pneumoniae* ($2,527)	Schistosomiasis ($70)	*P. falciparum* ($454 B)
5	*P. vivax* ($3,970)	*P. falciparum* ($82)	Tapeworm ($226 B)
6	*P. falciparum* ($5,435)	*S. pneumoniae* ($84)	Typhoid and paratyphoid ($169 B)
7	Strongyloidiasis and other ($5,678)	*P. vivax* ($86)	Schistosomiasis ($164 B)
8	Multiple / other malaria strains ($7,385)	Multiple / other malaria strains ($95)	Multiple helminth infections ($104 B)
9	Sleeping sickness ($9,652)	Strongyloidiasis and other ($98)	HIV/AIDS ($90 B)
10	NTS (Non-typhoidal S. enterica) ($9,756)	Lymphatic filariasis (elephantiasis) ($144)	Lymphatic filariasis (elephantiasis) ($17 B)
11	Multiple diarrheal diseases ($10,163)	NTS (Non-typhoidal S. enterica) ($154)	Strongyloidiasis and other ($14 B)
12	Trachoma ($11,206)	Sleeping sickness ($208)	Onchocerciasis (river blindness) ($14 B)
13	Leptospirosis ($13,588)	Hookworm ($209)	Cryptococcal meningitis ($12 B)
14	Onchocerciasis (river blindness) ($14,326)	Onchocerciasis (river blindness) ($214)	Hookworm ($11 B)
15	Cryptococcal meningitis ($20,470)	Rheumatic fever ($217)	Cholera ($11 B)
16	Rheumatic fever ($24,412)	Trachoma ($262)	Rheumatic fever ($9 B)
17	Dengue ($33,826)	Multiple helminth infections ($273)	NTS (Non-typhoidal S. enterica) ($7 B)
18	HIV/AIDS ($40,017)	Multiple diarrheal diseases ($285)	Dengue ($6 B)
19	Histoplasmosis ($41,679)	Leptospirosis ($312)	*P. vivax* ($3 B)
20	*N. meningitidis* ($43,477)	Cryptococcal meningitis ($486)	Leptospirosis ($2 B)
21	Hookworm ($53,891)	Leishmaniasis ($547)	*N. meningitidis* ($2 B)
22	Leishmaniasis ($73,089)	HIV/AIDS ($665)	Trachoma ($2 B)
23	Chagas' disease ($85,689)	Dengue ($852)	Histoplasmosis ($166 M)
24	Lymphatic filariasis (elephantiasis) ($90,259)	Chagas' disease ($869)	Leishmaniasis ($133 M)
25	Hepatitis B ($95,536)	*N. meningitidis* ($994)	Sleeping sickness ($96 M)
26	Multiple Salmonella infections ($135,723)	Histoplasmosis ($994)	Chagas' disease ($27 M)
27	Schistosomiasis ($143,186)	Hepatitis B ($2,072)	Leprosy (-$15 M)
28	Cryptosporidiosis ($178,145)	Multiple Salmonella infections ($3,214)	Buruli ulcer (-$17 M)
29	Hepatitis C ($192,382)	Cryptosporidiosis ($3,492)	Hepatitis C (-$169 M)
30	Shigella ($199,321)	Shigella ($4,453)	Mycetoma (-$254 M)
31	Rotavirus ($318,148)	Hepatitis C ($4,977)	Hepatitis B (-$865 M)
32	ETEC (Enterotoxigenic *E. coli*) ($469,929)	Rotavirus ($6,857)	Multiple Salmonella infections (-$1 B)
33	Buruli ulcer ($491,969)	Tuberculosis ($8,212)	Cryptosporidiosis (-$3 B)
34	Multiple helminth infections ($1,376,699)	Buruli ulcer ($8,310)	ETEC (Enterotoxigenic *E. coli*) (-$8 B)
35	Tuberculosis ($4,320,200)	ETEC (Enterotoxigenic *E. coli*) ($8,391)	Shigella (-$16 B)
36	Leprosy (NA)	Leprosy (NA)	Tuberculosis (-$17 B)
37	Mycetoma (NA)	Mycetoma (NA)	Rotavirus (-$18 B)
38	Scabies (NA)	Scabies (NA)	Scabies (-$21 B)

EIDs			
1	Lassa fever ($25,554)	Lassa fever ($596)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$34 M)
2	Marburg ($60,403)	Marburg ($1,438)	Ebola (-$66 M)
3	CCHF (Crimean-Congo Hemorrhagic Fever) ($811,463)	CCHF (Crimean-Congo Hemorrhagic Fever) ($19,040)	Lassa fever ($189 M)
4	Ebola ($1,799,069)	Ebola ($42,786)	Marburg ($2 M)
5	RVF (Rift Valley Fever) ($2,546,345)	RVF (Rift Valley Fever) ($60,569)	RVF (Rift Valley Fever) (-$45 M)
6	Zika ($1,298,041,432)	Zika ($11,550,008)	Zika (-$315 M)
7	MERS (Not applicable)*	MERS (Not applicable) *	-
8	Nipah (Not applicable)*	Nipah (Not applicable) *	-
9	Chikungunya (Not applicable)*	Chikungunya (Not applicable)*	-
MH			
1	Preeclampsia/eclampsia (PE/E) ($1,155)	Preeclampsia/eclampsia (PE/E) ($25)	Preeclampsia/eclampsia (PE/E) ($97 B)
2	Maternal iron deficiency anemia ($2,670)	Maternal iron deficiency anemia ($55)	Maternal iron deficiency anemia ($77 B)
3	Preterm labor/birth (PTL/PTB) ($6,784)	Preterm labor/birth (PTL/PTB) ($87)	Preterm labor/birth (PTL/PTB) ($27 B)
4	Intrauterine growth restriction (IUGR) ($8,131)	Intrauterine growth restriction (IUGR) ($121)	Maternal enteric microbiome (MEM) ($13 B)
5	fetal distress ($8,282)	fetal distress ($123)	fetal distress ($10 B)
6	Maternal enteric microbiome (MEM) ($9,007)	Maternal enteric microbiome (MEM) ($162)	Intrauterine growth restriction (IUGR) ($8 B)

Note:
* Incidence of disease not reported

Appendix A 7.2 – Asia Pacific: priority medicines, vaccines, and diagnostics needed by the region

We conducted key informant (KI) interviews to understand which products were of high priority to stakeholders in the Asia Pacific region (APR). We conducted interviews with 30 KIs from a wide range of sectors. About half were from leading pharmaceutical and biotech companies, including major domestic and multinational firms in China and across the Asia Pacific region (APR). Interviewees were also from governmental agencies, such as China's National Med¬ical Products Administration (the country's national regulatory agency), and from national level specialized organiza¬tions, such as the Chinese Center for Disease Control and Prevention (which reports to the cabinet-level National Health Commission).

Other stakeholders represented international, regional, and Chinese domestic not-for-profit organizations, industrial as¬sociations, and public institutions—including APACMed (the Asia Pacific Medical Technology Association, based in Singa¬pore); the Chinese Preventive Medicine Association; the Global Health Drug Discovery Institute; and the China Chamber of Commerce for Import and Export of Medicines and Health Products. Finally, we interviewed infectious disease experts from hospitals in the Philippines and scholars from think tanks and universities in the region, including KIs in India and South Korea. Although we explained to the KIs that our study focus was NDs, EIDs, and MH, nevertheless they mentioned the need for new technologies for other conditions, including non-communicable diseases (NCDs).

- **Vaccines**. The vaccines that were most likely to be prioritized by KIs were vaccines for COVID-19, dengue, Ebola, hepatitis B, HPV malaria, meningitis (a heat resistant vaccine is needed), MERS, and schistosomiasis. KIs also said that the APR needs to develop mRNA, nanoparticle, and hexavalent vaccines; one KI specifically mentioned the need for Paramyxoviridae and Arenaviridae mRNA vaccines.
- **Medicines**. The KIs argued that the most needed medicines for the APR were new arteminisin derivatives for malaria, single dose curative treatments for malaria, smaller combination antiretroviral therapy tablets, improved treatments for TB and MDR-TB, improved antiretroviral therapies, better COVID-19 and influenza antivirals, and treatments for

three NDs: filariasis, river blindness, and schistosomiasis. One KI said that the APR needs to develop "innovative and biosimilar drugs, small molecule drugs, monoclonal antibodies, and dual antibodies."

- **Diagnostics**. The diagnostics that were most likely to be prioritized by KIs were new high-sensitivity diagnostic technologies for malaria, intelligent sensory diagnostics, "more convenient, faster, and more accurate tools for diagnosing HIV" (including using saliva or urine), and better and lower cost TB diagnostics (reaching a price of 10 RMB per person). They also said there is a need for the APR to develop new diagnostics that are rapid tests, PCR tests (including room temperature PCR), self-tests, nucleic acid or immunoassay point of care tests, AI-based diagnostics, and disposable contact testing devices. One KI stressed the need for diagnostics for vector borne diseases "with a focus on technologies or products that can be tested on-site, are low-cost, and are easy to transport and store, such as point-of-care nucleic acid or immunological testing products."

The results of our analyses of the product portfolios for the Asian region are contained in Tables A7.2.1, A7.2.2, and A7.2.3.

Table A7.2.1 Ranking of product portfolios for vaccines development – Asia
Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
	NDs		
1	Tuberculosis (Cost-saving)	Tuberculosis (Cost-saving)	*S. pneumoniae* ($9,477 B)
2	*N. meningitidis* (Cost-saving)	*N. meningitidis* (Cost-saving)	Multiple diarrheal diseases ($4,320 B)
3	Dengue (Cost-saving)	Dengue (Cost-saving)	Typhoid and paratyphoid ($2,595 B)
4	Rotavirus (Cost-saving)	Rotavirus (Cost-saving)	Tuberculosis ($83 B)
5	Strongyloidiasis and other (Cost-saving)	Strongyloidiasis and other (Cost-saving)	Multiple helminth infections ($53 B)
6	Typhoid and paratyphoid (Cost-saving)	Typhoid and paratyphoid (Cost-saving)	Rotavirus ($42 B)
7	Multiple diarrheal diseases (Cost-saving)	Multiple diarrheal diseases (Cost-saving)	Dengue ($39 B)
8	*S. pneumoniae* (Cost-saving)	*S. pneumoniae* (Cost-saving)	*N. meningitidis* ($38 B)
9	Hepatitis B ($931)	Hepatitis B ($21)	Hepatitis B ($21 B)
10	Leptospirosis ($9,665)	Multiple / other malaria strains ($212)	*P. falciparum* ($20 B)
11	Tapeworm ($12,524)	Rheumatic fever ($215)	Hookworm ($18 B)
12	Multiple / other malaria strains ($14,108)	Leptospirosis ($229)	Tapeworm ($16 B)
13	Cryptococcal meningitis ($14,256)	Tapeworm ($262)	Strongyloidiasis and other ($15 B)
14	Rheumatic fever ($22,781)	Cryptococcal meningitis ($338)	Lymphatic filariasis (elephantiasis) ($14 B)
15	*P. falciparum* ($25,670)	*P. falciparum* ($468)	Multiple / other malaria strains ($12 B)
16	Shigella ($27,175)	Lymphatic filariasis (elephantiasis) ($544)	Schistosomiasis ($11 B)
17	*P. vivax* ($34,099)	Shigella ($588)	Shigella ($10 B)
18	Hepatitis C ($35,327)	Schistosomiasis ($639)	HIV/AIDS ($9 B)
19	Trachoma ($49,194)	*P. vivax* ($735)	Leptospirosis ($8 B)
20	HIV/AIDS ($50,930)	HIV/AIDS ($829)	Rheumatic fever ($7 B)
21	Cholera ($88,683)	Hookworm ($863)	*P. vivax* ($7 B)
22	Cryptosporidiosis ($114,158)	Hepatitis C ($876)	Hepatitis C ($4 B)
23	Hookworm ($179,786)	Multiple helminth infections ($976)	Cryptococcal meningitis ($4 B)
24	ETEC (Enterotoxigenic *E. coli*) ($299,457)	Trachoma ($1,156)	Cryptosporidiosis ($3 B)
25	Histoplasmosis ($371,208)	Cryptosporidiosis ($2,087)	Trachoma ($3 B)
26	Lymphatic filariasis (elephantiasis) ($389,932)	Cholera ($2,107)	Cholera ($2 B)

27	Leishmaniasis ($882,127)	ETEC (Enterotoxigenic *E. coli*) ($4,795)	ETEC (Enterotoxigenic *E. coli*) ($396 M)
28	Schistosomiasis ($1,255,357)	Leishmaniasis ($7,740)	Leishmaniasis (-$7 M)
29	Multiple helminth infections ($3,558,259)	Histoplasmosis ($8,763)	Histoplasmosis (-$40 M)
30	NTS (Non-typhoidal S. enterica) ($3,904,634)	NTS (Non-typhoidal S. enterica) ($61,759)	Sleeping sickness (-$346 M)
31	Leprosy ($32,346,013)	Leprosy ($287,020)	Mycetoma (-$349 M)
32	Sleeping sickness ($51,754,708)	Sleeping sickness ($1,048,651)	Leprosy (-$379 M)
33	Onchocerciasis (river blindness) ($194,505,272)	Onchocerciasis (river blindness) ($1,305,329)	Buruli ulcer (-$381 M)
34	Buruli ulcer ($725,683,650)	Buruli ulcer ($5,602,550)	NTS (Non-typhoidal S. enterica) (-$387 M)
35	Chagas' disease (NA)	Chagas' disease (NA)	Onchocerciasis (river blindness) (-$410 M)
36	Multiple Salmonella infections (NA)	Multiple Salmonella infections (NA)	Multiple Salmonella infections (-$486 M)
37	Mycetoma (NA)	Mycetoma (NA)	Chagas' disease (-$545 M)
38	Scabies (NA)	Scabies (NA)	Scabies (-$2 B)
		EIDs	
1	MERS (Cost saving)	MERS (-$144)	MERS ($1 B)
2	Nipah ($512,563)	Nipah ($12,204)	Nipah (-$106 M)
3	CCHF (Crimean-Congo Hemorrhagic Fever) ($2,157,220)	CCHF (Crimean-Congo Hemorrhagic Fever) ($50,970)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$506 M)
4	Chikungunya ($48,346,576)	Chikungunya ($764,729)	Chikungunya (-$1 B)
5	Ebola (Not applicable)*	Ebola (Not applicable)*	-
6	Lassa fever (Not applicable)*	Lassa fever (Not applicable)*	-
7	Marburg (Not applicable)*	Marburg (Not applicable)*	-
8	RVF (Rift Valley Fever) (Not applicable)*	RVF (Rift Valley Fever) (Not applicable)*	-
9	Zika (Not applicable)*	Zika (Not applicable)*	-

Note:
* Incidence of disease not reported

Table A7.2.2 Ranking of product portfolios for therapeutics development – Asia
Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
		NDs	
1	*S. pneumoniae* ($1,190)	Multiple helminth infections ($16)	Multiple diarrheal diseases ($4,086 B)
2	Typhoid and paratyphoid ($1,396)	Hookworm ($24)	Typhoid and paratyphoid ($717 B)
3	Tapeworm ($1,588)	Typhoid and paratyphoid ($25)	*S. pneumoniae* ($650 B)
4	Hookworm ($6,450)	Tapeworm ($31)	Multiple helminth infections ($160 B)
5	*P. vivax* ($6,979)	*S. pneumoniae* ($40)	HIV/AIDS ($104 B)
6	Multiple diarrheal diseases ($9,458)	Schistosomiasis ($60)	Multiple / other malaria strains ($83 B)
7	Multiple / other malaria strains ($11,358)	Lymphatic filariasis (elephantiasis) ($60)	Hepatitis B ($78 B)
8	Strongyloidiasis and other ($12,365)	Multiple / other malaria strains ($146)	Dengue ($58 B)
9	Cholera ($15,422)	*P. vivax* ($151)	Hookworm ($57 B)
10	Trachoma ($25,587)	Strongyloidiasis and other ($213)	Strongyloidiasis and other ($47 B)
11	Dengue ($30,669)	Multiple diarrheal diseases ($266)	Tapeworm ($41 B)
12	Leptospirosis ($32,447)	Cholera ($367)	Schistosomiasis ($36 B)
13	Lymphatic filariasis (elephantiasis) ($35,341)	Trachoma ($598)	Lymphatic filariasis (elephantiasis) ($25 B)

14	Cryptococcal meningitis ($36,472)	Rheumatic fever ($665)	Rheumatic fever ($21 B)
15	HIV/AIDS ($42,401)	*P. falciparum* ($681)	*P. vivax* ($18 B)
16	*P. falciparum* ($46,968)	HIV/AIDS ($704)	Hepatitis C ($16 B)
17	Rheumatic fever ($77,275)	Leptospirosis ($746)	*P. falciparum* ($9 B)
18	Multiple helminth infections ($85,036)	Dengue ($772)	Cryptococcal meningitis ($5 B)
19	Hepatitis B ($92,058)	Cryptococcal meningitis ($866)	Shigella ($5 B)
20	Schistosomiasis ($124,942)	Hepatitis B ($1,997)	Cholera ($5 B)
21	Cryptosporidiosis ($132,210)	Cryptosporidiosis ($2,591)	Cryptosporidiosis ($3 B)
22	*N. meningitidis* ($139,810)	*N. meningitidis* ($3,217)	*N. meningitidis* ($3 B)
23	Histoplasmosis ($158,162)	Histoplasmosis ($3,774)	Leptospirosis ($3 B)
24	Hepatitis C ($184,176)	Leishmaniasis ($4,257)	Trachoma ($2 B)
25	Shigella ($192,008)	Shigella ($4,289)	Rotavirus ($632 M)
26	Rotavirus ($306,331)	Hepatitis C ($4,765)	Leishmaniasis ($438 M)
27	ETEC (Enterotoxigenic *E. coli*) ($466,694)	Rotavirus ($6,602)	Histoplasmosis ($247 M)
28	Leishmaniasis ($607,275)	ETEC (Enterotoxigenic *E. coli*) ($8,333)	NTS (Non-typhoidal S. enterica) (-$122 M)
29	NTS (Non-typhoidal S. enterica) ($1,727,818)	Tuberculosis ($8,385)	Multiple Salmonella infections (-$169 M)
30	Tuberculosis ($4,409,820)	NTS (Non-typhoidal S. enterica) ($27,329)	ETEC (Enterotoxigenic *E. coli*) (-$186 M)
31	Sleeping sickness ($14,976,524)	Sleeping sickness ($321,990)	Mycetoma (-$192 M)
32	Onchocerciasis (river blindness) ($17,461,458)	Onchocerciasis (river blindness) ($373,124)	Buruli ulcer (-$220 M)
33	Chagas' disease ($146,483,748)	Chagas' disease ($1,402,063)	Sleeping sickness (-$226 M)
34	Buruli ulcer ($175,852,918)	Buruli ulcer ($3,056,329)	Leprosy (-$226 M)
35	Leprosy (NA)	Leprosy (NA	Onchocerciasis (river blindness) (-$238 M)
36	Multiple Salmonella infections (NA)	Multiple Salmonella infections (NA)	Chagas' disease (-$294 M)
37	Mycetoma (NA)	Mycetoma (NA)	Scabies (-$4 B)
38	Scabies (NA)	Scabies (NA)	Tuberculosis (-$5 B)
		EIDs	
1	MERS ($656,442)	MERS ($15,611)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$313 M)
2	Nipah ($768,476)	Nipah ($18,286)	Chikungunya (-$293 M)
3	CCHF (Crimean-Congo Hemorrhagic Fever) ($3,793,754)	CCHF (Crimean-Congo Hemorrhagic Fever) ($89,017)	MERS (-$3 B)
4	Chikungunya ($47,499,498)	Chikungunya ($586,126)	Nipah (-$80 M)
5	Ebola (Not applicable)*	Ebola (Not applicable)*	-
6	Lassa fever (Not applicable)*	Lassa fever (Not applicable)*	-
7	Marburg (Not applicable)*	Marburg (Not applicable)*	-
8	RVF (Rift Valley Fever) (Not applicable)*	RVF (Rift Valley Fever) (Not applicable)*	-
9	Zika (Not applicable)*	Zika (Not applicable)*	-
		MH	
1	Preeclampsia/eclampsia (PE/E) ($993)	Preeclampsia/eclampsia (PE/E) ($21)	Preeclampsia/eclampsia (PE/E) ($1,265 B)
2	Maternal iron deficiency anemia ($2,333)	Maternal iron deficiency anemia ($48)	Preterm labor/birth (PTL/PTB) ($354 B)
3	Preterm labor/birth (PTL/PTB) ($6,119)	Preterm labor/birth (PTL/PTB) ($78)	Maternal enteric microbiome (MEM) ($176 B)
4	Intrauterine growth restriction (IUGR) ($6,616)	Intrauterine growth restriction (IUGR) ($98)	Maternal iron deficiency anemia ($144 B)
5	Maternal enteric microbiome (MEM) ($6,989)	Maternal enteric microbiome (MEM) ($126)	Intrauterine growth restriction (IUGR) ($108 B)
6	fetal distress ($8,719)	fetal distress ($130)	fetal distress ($20 B)

Note:
* Incidence of disease not reported

Table A7.2.3 Ranking of product portfolios for diagnostics development – Asia

Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
NDs			
1	Typhoid and paratyphoid ($1,347)	Typhoid and paratyphoid ($24)	Multiple diarrheal diseases ($16,912 B)
2	Tapeworm ($1,389)	Tapeworm ($28)	Typhoid and paratyphoid ($3,601 B)
3	Cholera ($1,997)	Cholera ($48)	*S. pneumoniae* ($3,393 B)
4	*S. pneumoniae* ($2,503)	Schistosomiasis ($72)	Multiple helminth infections ($517 B)
5	*P. vivax* ($3,399)	*P. vivax* ($73)	Dengue ($266 B)
6	Strongyloidiasis and other ($5,376)	*S. pneumoniae* ($83)	Tapeworm ($216 B)
7	*P. falciparum* ($6,148)	Strongyloidiasis and other ($93)	Hookworm ($195 B)
8	Multiple / other malaria strains ($7,768)	*P. falciparum* ($93)	Strongyloidiasis and other ($191 B)
9	Multiple diarrheal diseases ($10,154)	Multiple / other malaria strains ($100)	Multiple / other malaria strains ($167 B)
10	Leptospirosis ($13,504)	Lymphatic filariasis (elephantiasis) ($138)	Schistosomiasis ($166 B)
11	Trachoma ($20,019)	Hookworm ($181)	Lymphatic filariasis (elephantiasis) ($166 B)
12	Rheumatic fever ($21,901)	Rheumatic fever ($195)	*P. vivax* ($157 B)
13	Cryptococcal meningitis ($24,531)	Multiple helminth infections ($268)	HIV/AIDS ($107 B)
14	Dengue ($29,164)	Multiple diarrheal diseases ($285)	*P. falciparum* ($86 B)
15	Histoplasmosis ($39,980)	Leptospirosis ($310)	Rheumatic fever ($67 B)
16	HIV/AIDS ($40,153)	Leishmaniasis ($327)	Cholera ($21 B)
17	*N. meningitidis* ($41,869)	Trachoma ($468)	*N. meningitidis* ($19 B)
18	Leishmaniasis ($43,692)	Cryptococcal meningitis ($583)	Hepatitis B ($19 B)
19	Hookworm ($46,470)	HIV/AIDS ($667)	Shigella ($17 B)
20	Lymphatic filariasis (elephantiasis) ($86,483)	Dengue ($734)	Cryptococcal meningitis ($15 B)
21	Hepatitis B ($94,017)	Histoplasmosis ($954)	Leptospirosis ($14 B)
22	Schistosomiasis ($147,713)	*N. meningitidis* ($958)	Cryptosporidiosis ($8 B)
23	Sleeping sickness ($170,903)	Hepatitis B ($2,040)	Leishmaniasis ($5 B)
24	Cryptosporidiosis ($176,435)	Cryptosporidiosis ($3,458)	Trachoma ($4 B)
25	Hepatitis C ($192,268)	Sleeping sickness ($3,676)	Histoplasmosis ($2 B)
26	Shigella ($199,152)	Shigella ($4,449)	Rotavirus ($1 B)
27	Rotavirus ($321,347)	Hepatitis C ($4,974)	Hepatitis C ($186 M)
28	Onchocerciasis (river blindness) ($359,806)	Onchocerciasis (river blindness) ($5,555)	Sleeping sickness ($12 M)
29	ETEC (Enterotoxigenic *E. coli*) ($478,523)	Rotavirus ($6,926)	Onchocerciasis (river blindness) ($8 M)
30	NTS (Non-typhoidal S. enterica) ($955,035)	Tuberculosis ($8,128)	Buruli ulcer (-$6 M)
31	Multiple helminth infections ($1,352,566)	ETEC (Enterotoxigenic *E. coli*) ($8,544)	Chagas' disease (-$7 M)
32	Buruli ulcer ($1,462,950)	NTS (Non-typhoidal S. enterica) ($15,106)	Leprosy (-$17 M)
33	Tuberculosis ($4,277,866)	Buruli ulcer ($24,696)	NTS (Non-typhoidal S. enterica) (-$127 M)
34	Chagas' disease ($16,706,336)	Chagas' disease ($170,483)	Multiple Salmonella infections (-$254 M)
35	Leprosy (NA)	Leprosy (NA)	Mycetoma (-$254 M)
36	Multiple Salmonella infections (NA)	Multiple Salmonella infections (NA)	ETEC (Enterotoxigenic *E. coli*) (-$656 M)
37	Mycetoma (NA)	Mycetoma (NA)	Tuberculosis (-$3 B)
38	Scabies (NA)	Scabies (NA)	Scabies (-$46 B)

EIDs			
1	Nipah ($297,944)	Nipah ($7,090)	Nipah ($17 M)
2	CCHF (Crimean-Congo Hemorrhagic Fever) ($325,347)	CCHF (Crimean-Congo Hemorrhagic Fever) ($7,634)	CCHF (Crimean-Congo Hemorrhagic Fever) ($0 M)
3	MERS ($687,230)	MERS ($16,343)	MERS (-$1 B)
4	Chikungunya ($1,641,665)	Chikungunya ($20,258)	Chikungunya (-$4 M)
5	Ebola (Not applicable)*	Ebola (Not applicable)*	-
6	Lassa fever (Not applicable)*	Lassa fever (Not applicable)*	-
7	Marburg (Not applicable)*	Marburg (Not applicable)*	-
8	RVF (Rift Valley Fever) (Not applicable)*	RVF (Rift Valley Fever) (Not applicable)*	-
9	Zika (Not applicable)*	Zika (Not applicable)*	-
MH			
1	Preeclampsia/eclampsia (PE/E) ($1,127)	Preeclampsia/eclampsia (PE/E) ($24)	Preeclampsia/eclampsia (PE/E) ($499 B)
2	Maternal iron deficiency anemia ($2,642)	Maternal iron deficiency anemia ($55)	Maternal iron deficiency anemia ($391 B)
3	Preterm labor/birth (PTL/PTB) ($6,678)	Preterm labor/birth (PTL/PTB) ($85)	Preterm labor/birth (PTL/PTB) ($139 B)
4	Intrauterine growth restriction (IUGR) ($7,882)	Intrauterine growth restriction (IUGR) ($117)	Maternal enteric microbiome (MEM) ($68 B)
5	fetal distress ($8,060)	fetal distress ($120)	fetal distress ($54 B)
6	Maternal enteric microbiome (MEM) ($8,854)	Maternal enteric microbiome (MEM) ($160)	Intrauterine growth restriction (IUGR) ($43 B)

Note:
* Incidence of disease not reported

Appendix A 7.3 – Latin America: priority medicines, vaccines, and diagnostics needed by the region

We conducted key informant (KI) interviews to understand which products were of high priority to stakeholders in Latin America. The regional assessment involved consultations with stakeholders from 10 countries (Argentina, Bolivia, Brazil, Colom¬bia, Costa Rica, Ecuador, Mexico, Panama, Peru, Uruguay). It also included consultations with representatives from two major regional organizations: the Pan American Health Organization (PAHO) and the Latin American Federation of the Pharmaceutical Industry (FIFARMA). Consultations were conducted with policymakers and technical experts from gov¬ernment, public sector institutions (e.g., ministries of health, national institutes of health), national regulatory authori¬ties (NRAs), industry, academia, multilateral institutions, and civil society. Although we explained to the KIs that our study focus was NDs, EIDs, and MH, nevertheless they mentioned the need for new technologies for other conditions, including non-communicable diseases (NCDs).

KIs argued that new health technologies should be developed with the mindset that they should be readily usable at the primary care level and at the point of care.

- **Vaccines**. The vaccines that were most likely to be prioritized by KIs were vaccines for dengue, other arboviruses (e.g. Zika, Chikungunya, Oropouche, Mayaro), malaria, tuberculosis (key informants highlighted the M72 vaccine and the need for an adolescent TB vaccine), single dose HPV, gastroenteric diseases, pneumonias, RSV (particularly maternal immunization), vaccines for elderly people (RSV, herpes simplex virus, pneumococcal 20-valent conjugate vaccine), leishmaniasis, cholera, and parasites.
- **Diagnostics**. KIs argued that the region needs improve accessed to better diagnostics, especially molecular tests that are faster to perform. Currently, the region is highly dependent on imported diagnostics. KIs also highlighted the need for self-administered tests, rapid tests, multipurpose diagnostics, and more integrated diagnostics. The diagnostics that were most likely to be prioritized by KIs were diagnostics for dengue, malaria, TB (rapid tests), Chagas disease, leptospirosis, leishmaniasis, anemia, metabolic diseases in children, autoimmune diseases, and fasciolasis.

- **Medicines**: The medicines that were most likely to be prioritized by KIs were newer TB treatments that have improved adherence rates, medicines for multi-drug resistant TB, new malaria treatments, treatments for Chagas, broad spectrum antibiotics that are simpler to prescribe and take, antivirals, leishmaniasis treatments, treatments for fascioliasis, single-dose treatments for enteroparasites, and monoclonal antibodies for cancer.

Our analysis of the product portfolios for Latin America and the Caribbean region are contained in Tables A7.3.1, A7.3.2, and A7.3.3.

Table A7.3.1 Ranking of product portfolios for vaccines development – Latin America and the Caribbean
Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
		NDs	
1	Tuberculosis (Cost-saving)	Tuberculosis (Cost-saving)	Multiple diarrheal diseases ($876 B)
2	*N. meningitidis* (Cost-saving)	*N. meningitidis* (Cost-saving)	*S. pneumoniae* ($372 B)
3	Dengue (Cost-saving)	Dengue (Cost-saving)	Multiple helminth infections ($43 B)
4	Multiple diarrheal diseases (Cost-saving)	Multiple diarrheal diseases (Cost-saving)	*N. meningitidis* ($21 B)
5	*S. pneumoniae* ($453)	*S. pneumoniae* ($15)	Schistosomiasis ($14 B)
6	Rotavirus ($9,125)	Rotavirus ($188)	Rotavirus ($14 B)
7	Typhoid and paratyphoid ($29,947)	Typhoid and paratyphoid ($530)	Typhoid and paratyphoid ($13 B)
8	Trachoma ($39,591)	Schistosomiasis ($613)	Dengue ($6 B)
9	Strongyloidiasis and other ($43,388)	Strongyloidiasis and other ($765)	HIV/AIDS ($5 B)
10	Hepatitis B ($72,544)	Trachoma ($931)	Hookworm ($5 B)
11	Cryptococcal meningitis ($89,571)	Multiple helminth infections ($999)	Trachoma ($4 B)
12	*P. vivax* ($116,139)	Hookworm ($1,510)	Strongyloidiasis and other ($3 B)
13	Multiple / other malaria strains ($118,264)	Hepatitis B ($1,602)	*P. vivax* ($2 B)
14	HIV/AIDS ($140,374)	Multiple / other malaria strains ($1,774)	Multiple / other malaria strains ($2 B)
15	Tapeworm ($205,718)	Cryptococcal meningitis ($2,122)	Hepatitis B ($2 B)
16	Hepatitis C ($217,335)	HIV/AIDS ($2,285)	Tuberculosis ($1 B)
17	Hookworm ($314,610)	*P. vivax* ($2,503)	Cryptococcal meningitis ($1 B)
18	Multiple Salmonella infections ($321,469)	Tapeworm ($4,296)	Tapeworm ($418 M)
19	Shigella ($345,569)	Hepatitis C ($5,388)	Rheumatic fever ($386 M)
20	Cholera ($369,465)	Rheumatic fever ($6,030)	Hepatitis C ($377 M)
21	ETEC (Enterotoxigenic *E. coli*) ($451,309)	ETEC (Enterotoxigenic *E. coli*) ($7,227)	Shigella ($269 M)
22	*P. falciparum* ($589,648)	Shigella ($7,483)	ETEC (Enterotoxigenic *E. coli*) ($204 M)
23	Rheumatic fever ($639,594)	Multiple Salmonella infections ($7,607)	Multiple Salmonella infections ($97 M)
24	Schistosomiasis ($1,204,338)	Cholera ($8,776)	Cholera ($48 M)
25	Cryptosporidiosis ($1,237,433)	*P. falciparum* ($10,748)	Lymphatic filariasis (elephantiasis) (-$167 M)
26	Leptospirosis ($1,343,215)	Lymphatic filariasis (elephantiasis) ($17,561)	Cryptosporidiosis (-$218 M)
27	Chagas' disease ($1,967,017)	Chagas' disease ($20,449)	*P. falciparum* (-$224 M)
28	NTS (Non-typhoidal S. enterica) ($2,296,561)	Cryptosporidiosis ($22,625)	Leptospirosis (-$246 M)
29	Histoplasmosis ($2,609,236)	Leptospirosis ($31,804)	Histoplasmosis (-$290 M)
30	Multiple helminth infections ($3,642,261)	Leishmaniasis ($34,365)	Chagas' disease (-$298 M)
31	Leishmaniasis ($3,916,766)	NTS (Non-typhoidal S. enterica) ($36,324)	Onchocerciasis (river blindness) (-$322 M)

32	Onchocerciasis (river blindness) ($6,345,299)	Onchocerciasis (river blindness) ($42,583)	NTS (Non-typhoidal S. enterica) (-$328 M)
33	Lymphatic filariasis (elephantiasis) ($12,578,953)	Histoplasmosis ($61,596)	Leishmaniasis (-$336 M)
34	Leprosy ($113,581,140)	Leprosy ($1,007,855)	Mycetoma (-$349 M)
35	Buruli ulcer (NA)	Buruli ulcer (NA)	Sleeping sickness (-$349 M)
36	Mycetoma (NA)	Mycetoma (NA)	Buruli ulcer (-$381 M)
37	Scabies (NA)	Scabies (NA)	Leprosy (-$394 M)
38	Sleeping sickness (NA)	Sleeping sickness (NA)	Scabies (-$914 M)
		EIDs	
1	Chikungunya ($483,814)	Chikungunya ($7,653)	Chikungunya ($161 M)
2	CCHF (Crimean-Congo Hemorrhagic Fever) ($16,311,163)	CCHF (Crimean-Congo Hemorrhagic Fever) ($385,397)	Nipah (-$280 M)
3	Marburg ($52,981,544)	Marburg ($1,261,951)	MERS (-$418 M)
4	Nipah ($67,179,701)	Nipah ($1,599,495)	Marburg (-$476 M)
5	MERS ($131,260,038)	MERS ($3,124,159)	Zika (-$532 M)
6	Zika ($323,414,628)	Zika ($4,029,132)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$590 M)
7	Ebola (Not applicable)*	Ebola (Not applicable)*	-
8	Lassa fever (Not applicable)*	Lassa fever (Not applicable)*	-
9	RVF (Rift Valley Fever) (Not applicable)*	RVF (Rift Valley Fever) (Not applicable)*	-

Note:
* Incidence of disease not reported

Table A7.3.2 Ranking of product portfolios for therapeutics development – Latin America and the Caribbean
Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
		NDs	
1	*S. pneumoniae* ($2,971)	Multiple helminth infections ($23)	Multiple diarrheal diseases ($834 B)
2	Multiple diarrheal diseases ($9,512)	Schistosomiasis ($57)	Multiple helminth infections ($129 B)
3	*P. vivax* ($14,993)	*S. pneumoniae* ($99)	Schistosomiasis ($47 B)
4	Strongyloidiasis and other ($20,086)	Hookworm ($102)	HIV/AIDS ($36 B)
5	Trachoma ($20,891)	Multiple diarrheal diseases ($267)	*S. pneumoniae* ($25 B)
6	Typhoid and paratyphoid ($23,802)	*P. vivax* ($324)	Multiple / other malaria strains ($16 B)
7	Hookworm ($27,413)	Strongyloidiasis and other ($347)	Hookworm ($16 B)
8	Multiple / other malaria strains ($27,572)	Multiple / other malaria strains ($354)	Strongyloidiasis and other ($9 B)
9	Tapeworm ($40,834)	Typhoid and paratyphoid ($422)	Dengue ($9 B)
10	Dengue ($54,297)	Trachoma ($488)	*P. vivax* ($7 B)
11	HIV/AIDS ($54,591)	Tapeworm ($809)	Hepatitis B ($7 B)
12	Cholera ($58,962)	HIV/AIDS ($906)	Chagas' disease ($5 B)
13	Cryptococcal meningitis ($74,207)	Rheumatic fever ($1,079)	Hepatitis C ($4 B)
14	Schistosomiasis ($118,173)	Dengue ($1,367)	Typhoid and paratyphoid ($4 B)
15	Multiple helminth infections ($122,483)	Cholera ($1,403)	Trachoma ($3 B)
16	Rheumatic fever ($125,356)	Cryptococcal meningitis ($1,763)	Rheumatic fever ($3 B)
17	Hepatitis B ($129,249)	Chagas' disease ($2,108)	*N. meningitidis* ($2 B)

18	*N. meningitidis* ($151,185)	Hepatitis B ($2,804)	Tapeworm ($2 B)
19	Hepatitis C ($189,210)	*N. meningitidis* ($3,478)	Cryptococcal meningitis ($2 B)
20	Chagas' disease ($220,559)	Lymphatic filariasis (elephantiasis) ($4,885)	Cholera ($1 B)
21	Shigella ($250,808)	Hepatitis C ($4,895)	Shigella ($561 M)
22	Multiple Salmonella infections ($266,731)	Shigella ($5,603)	Rotavirus ($360 M)
23	Rotavirus ($338,177)	Multiple Salmonella infections ($6,317)	Lymphatic filariasis (elephantiasis) ($154 M)
24	ETEC (Enterotoxigenic *E. coli*) ($483,329)	Rotavirus ($7,289)	Multiple Salmonella infections ($147 M)
25	Onchocerciasis (river blindness) ($602,713)	ETEC (Enterotoxigenic *E. coli*) ($8,630)	ETEC (Enterotoxigenic *E. coli*) ($123 M)
26	*P. falciparum* ($631,614)	*P. falciparum* ($9,163)	*P. falciparum* ($12 M)
27	Cryptosporidiosis ($659,430)	Onchocerciasis (river blindness) ($12,881)	Onchocerciasis (river blindness) (-$70 M)
28	Histoplasmosis ($818,092)	Cryptosporidiosis ($12,924)	NTS (Non-typhoidal S. enterica) (-$72 M)
29	NTS (Non-typhoidal S. enterica) ($1,019,177)	Tuberculosis ($13,951)	Cryptosporidiosis (-$84 M)
30	Leptospirosis ($2,042,434)	Leishmaniasis ($14,439)	Histoplasmosis (-$104 M)
31	Leishmaniasis ($2,059,927)	NTS (Non-typhoidal S. enterica) ($16,121)	Leptospirosis (-$136 M)
32	Lymphatic filariasis (elephantiasis) ($2,863,379)	Histoplasmosis ($19,520)	Leishmaniasis (-$167 M)
33	Tuberculosis ($7,336,801)	Leptospirosis ($46,956)	Mycetoma (-$192 M)
34	Buruli ulcer (NA)	Buruli ulcer (NA)	Buruli ulcer (-$220 M)
35	Leprosy (NA)	Leprosy (NA)	Leprosy (-$226 M)
36	Mycetoma (NA)	Mycetoma (NA)	Sleeping sickness (-$231 M)
37	Scabies (NA)	Scabies (NA)	Tuberculosis (-$961 M)
38	Sleeping sickness (NA)	Sleeping sickness (NA)	Scabies (-$2 B)
		EIDs	
1	Chikungunya ($2,130,658)	Chikungunya ($26,292)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$317 M)
2	CCHF (Crimean-Congo Hemorrhagic Fever) ($26,560,461)	CCHF (Crimean-Congo Hemorrhagic Fever) ($623,215)	Chikungunya (-$616 M)
3	MERS ($54,883,997)	MERS ($1,305,169)	MERS (-$291 M)
4	Marburg ($95,830,513)	Marburg ($2,281,959)	Marburg (-$283 M)
5	Nipah ($99,424,387)	Nipah ($2,365,805)	Nipah (-$136 M)
6	Zika ($1,362,800,871)	Zika ($12,126,239)	Zika (-$734 M)
7	Ebola (Not applicable)*	Ebola (Not applicable)*	-
8	Lassa fever (Not applicable)*	Lassa fever (Not applicable)*	-
9	RVF (Rift Valley Fever) (Not applicable)*	RVF (Rift Valley Fever) (Not applicable)*	-
		MH	
1	Preeclampsia/eclampsia (PE/E) ($2,447)	Preeclampsia/eclampsia (PE/E) ($52)	Preeclampsia/eclampsia (PE/E) ($226 B)
2	Maternal iron deficiency anemia ($4,545)	Maternal iron deficiency anemia ($94)	Preterm labor/birth (PTL/PTB) ($58 B)
3	Maternal enteric microbiome (MEM) ($12,375)	Preterm labor/birth (PTL/PTB) ($177)	Maternal enteric microbiome (MEM) ($31 B)
4	Preterm labor/birth (PTL/PTB) ($13,856)	Maternal enteric microbiome (MEM) ($223)	Maternal iron deficiency anemia ($26 B)
5	Intrauterine growth restriction (IUGR) ($16,733)	Intrauterine growth restriction (IUGR) ($249)	Intrauterine growth restriction (IUGR) ($19 B)
6	fetal distress ($31,086)	fetal distress ($462)	fetal distress ($3 B)

Note:
* Incidence of disease not reported

Table A7.3.3 Ranking of product portfolios for diagnostics development – Latin America and the Caribbean

Incremental cost-effectiveness ratios and net-monetary benefits for investing in vaccines development (Assumes replenishment of current pipeline to guarantee at least one launch in each disease-product-archetype category)

Rank	Incremental cost per death averted (in USD)	Incremental cost per DALY averted (in USD)	Net monetary benefits (in millions or billions USD)
NDs			
1	Cholera ($1,998)	Cholera ($48)	Multiple diarrheal diseases ($3,447 B)
2	*S. pneumoniae* ($2,541)	Tapeworm ($56)	Multiple helminth infections ($418 B)
3	Tapeworm ($2,808)	Schistosomiasis ($72)	Schistosomiasis ($216 B)
4	*P. vivax* ($3,524)	*P. vivax* ($76)	*S. pneumoniae* ($134 B)
5	Strongyloidiasis and other ($5,543)	*S. pneumoniae* ($84)	*P. vivax* ($58 B)
6	Typhoid and paratyphoid ($8,642)	Strongyloidiasis and other ($96)	Hookworm ($53 B)
7	Multiple diarrheal diseases ($10,155)	Multiple / other malaria strains ($136)	Dengue ($41 B)
8	Multiple / other malaria strains ($10,523)	Typhoid and paratyphoid ($153)	Strongyloidiasis and other ($39 B)
9	Trachoma ($16,546)	Hookworm ($215)	HIV/AIDS ($34 B)
10	*P. falciparum* ($21,154)	Lymphatic filariasis (elephantiasis) ($261)	Multiple / other malaria strains ($33 B)
11	Onchocerciasis (river blindness) ($26,896)	Multiple helminth infections ($270)	Typhoid and paratyphoid ($19 B)
12	Dengue ($35,683)	Multiple diarrheal diseases ($285)	*N. meningitidis* ($11 B)
13	Cryptococcal meningitis ($37,768)	*P. falciparum* ($321)	Tapeworm ($10 B)
14	HIV/AIDS ($39,581)	Trachoma ($387)	Rheumatic fever ($10 B)
15	*N. meningitidis* ($42,148)	Rheumatic fever ($401)	Trachoma ($7 B)
16	Rheumatic fever ($44,997)	Onchocerciasis (river blindness) ($417)	Cholera ($6 B)
17	Chagas' disease ($50,382)	Leishmaniasis ($446)	*P. falciparum* ($6 B)
18	Hookworm ($55,236)	Chagas' disease ($513)	Cryptococcal meningitis ($5 B)
19	Leishmaniasis ($59,592)	HIV/AIDS ($658)	Shigella ($3 B)
20	Histoplasmosis ($71,305)	Cryptococcal meningitis ($897)	Lymphatic filariasis (elephantiasis) ($2 B)
21	Leptospirosis ($85,301)	Dengue ($898)	Leishmaniasis ($2 B)
22	Hepatitis B ($138,955)	*N. meningitidis* ($964)	Hepatitis B ($2 B)
23	Schistosomiasis ($147,523)	Histoplasmosis ($1,701)	Onchocerciasis (river blindness) ($1 B)
24	Lymphatic filariasis (elephantiasis) ($163,839)	Leptospirosis ($1,961)	Rotavirus ($975 M)
25	Hepatitis C ($192,272)	Hepatitis B ($3,014)	Chagas' disease ($857 M)
26	Shigella ($199,472)	Shigella ($4,456)	Multiple Salmonella infections ($604 M)
27	Multiple Salmonella infections ($203,088)	Multiple Salmonella infections ($4,810)	Histoplasmosis ($364 M)
28	Rotavirus ($338,927)	Hepatitis C ($4,974)	ETEC (Enterotoxigenic *E. coli*) ($298 M)
29	Cryptosporidiosis ($372,947)	Rotavirus ($7,305)	Leptospirosis ($140 M)
30	ETEC (Enterotoxigenic *E. coli*) ($487,729)	Cryptosporidiosis ($7,310)	Tuberculosis ($136 M)
31	NTS (Non-typhoidal S. enterica) ($565,114)	Tuberculosis ($8,513)	Cryptosporidiosis ($128 M)
32	Multiple helminth infections ($1,362,701)	ETEC (Enterotoxigenic *E. coli*) ($8,709)	Hepatitis C ($47 M)
33	Tuberculosis ($4,480,513)	NTS (Non-typhoidal S. enterica) ($8,939)	NTS (Non-typhoidal S. enterica) ($11 M)
34	Buruli ulcer (NA)	Buruli ulcer (NA)	Buruli ulcer (-$7 M)
35	Leprosy (NA)	Leprosy (NA)	Leprosy (-$8 M)
36	Mycetoma (NA)	Mycetoma (NA)	Sleeping sickness (-$11 M)
37	Scabies (NA)	Scabies (NA)	Mycetoma (-$254 M)
38	Sleeping sickness (NA)	Sleeping sickness (NA)	Scabies (-$20 B)

EIDs			
1	CCHF (Crimean-Congo Hemorrhagic Fever) ($751,148)	CCHF (Crimean-Congo Hemorrhagic Fever) ($17,625)	Marburg (-$5 M)
2	Marburg ($825,450)	Marburg ($19,656)	CCHF (Crimean-Congo Hemorrhagic Fever) (-$18 M)
3	Chikungunya ($1,641,734)	Chikungunya ($20,258)	MERS (-$206 M)
4	Nipah ($37,942,038)	Nipah ($902,831)	Nipah (-$220 M)
5	MERS ($97,982,377)	MERS ($2,330,069)	Chikungunya (-$238 M)
6	Zika ($586,693,537)	Zika ($5,220,415)	Zika (-$890 M)
7	Ebola (Not applicable)*	Ebola (Not applicable)*	-
8	Lassa fever (Not applicable)*	Lassa fever (Not applicable)*	-
9	RVF (Rift Valley Fever) (Not applicable)*	RVF (Rift Valley Fever) (Not applicable)*	-
MH			
1	Preeclampsia/eclampsia (PE/E) ($2,181)	Preeclampsia/eclampsia (PE/E) ($47)	Preeclampsia/eclampsia (PE/E) ($89 B)
2	Maternal iron deficiency anemia ($3,758)	Maternal iron deficiency anemia ($78)	Maternal iron deficiency anemia ($70 B)
3	Preterm labor/birth (PTL/PTB) ($12,213)	Preterm labor/birth (PTL/PTB) ($156)	Preterm labor/birth (PTL/PTB) ($23 B)
4	Maternal enteric microbiome (MEM) ($16,101)	Intrauterine growth restriction (IUGR) ($262)	Maternal enteric microbiome (MEM) ($12 B)
5	Intrauterine growth restriction (IUGR) ($17,606)	fetal distress ($287)	fetal distress ($9 B)
6	fetal distress ($19,336)	Maternal enteric microbiome (MEM) ($290)	Intrauterine growth restriction (IUGR) ($8 B)

Note:
* Incidence of disease not reported

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