Analysis of Pandemic Preparedness and Response (PPR) architecture and financing needs and gaps

Prepared for the Task Force meeting of the G20 Health and Finance track

Paper prepared by World Bank and World Health Organization

Draft version, Feb 10th 2022

G20 INDONESIA 2022

Key messages:

1. A global **Pandemic Preparedness and Response (PPR) architecture consists of five sub-systems** that are interwoven and must be deployed at national, regional and global level:
    - Surveillance, collaborative intelligence, and early warning
    - Prioritized research and equitable access to medical countermeasures and essential supplies
    - Public health and social measures and engaged, resilient communities
    - Lifesaving, safe and scalable health interventions, and resilient health systems
    - PPR strategy, coordination, and emergency operations

2. The investment case for investing in PPR is clear. **Frequency and impact** of pandemic prone **pathogens is increasing**, while **modest investments in PPR** capacities can **prevent and contain** disease outbreaks, thereby drastically **reducing the cost of response** and the broader economic and social impacts of a pandemic or large-scale outbreak. They will also help address "slow-burn" challenges that are key drivers of mortality today, including HIV/AIDS, TB, Malaria and AMR.

3. The total financing need for the future PPR system is **estimated at US$ 31.1 billion annual investment**, consistent with the estimate of the G20 High-Level Independent Panel. Considering current and expected domestic and international financing for PPR, it is estimated that **at least an additional US$ 10.5 billion per year in international financing** will be needed.

    a. At national level, the **largest PPR capacity gaps can be found in countries with the least fiscal space to address them**: LICs and LMICs, for which national needs are estimated at around US$ 16.2 billion per year, with a gap of at least **US$ 7.0 billion** to be covered by international financing.

    b. The international financing gap at global and regional level is estimated to be at least **US$ 3.5 billion per year**.

4. The COVID-19 crisis revealed that the magnitude of financing and capacity to coordinate **funds to fill critical gaps** are currently **not adequate. Three high-level options** provide possible solutions to fund prioritized gaps:
    a. Selectively augment resources for existing institutions to support PPR priorities;
    b. Establish a new, dedicated stream of additional international financing for PPR that can be channelled flexibly through existing institutions to further strengthen PPR in a way that brings the most added value for both contributors and recipients (e.g., 'fund of funds');
    c. Consolidate PPR functions of existing agencies, funds & programs (unworkable option at this stage).

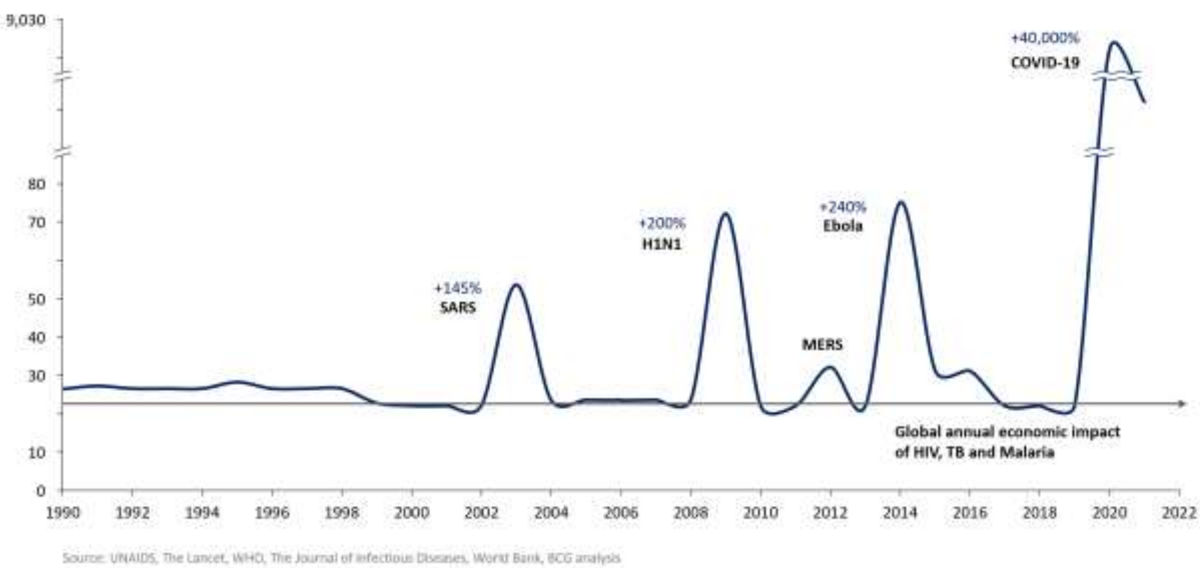
A | Context and scope

This non-paper has been prepared pursuant to a request by the G20 Finance and Health Task Force to identify financing needs and gaps for Pandemic Preparedness and Response.

Pathogens will emerge and re-emerge with the potential to cause disease, death, and disruption of a magnitude equal or greater than SARS-CoV-2. Outbreaks of infectious pathogens have been a defining feature of human history, and any analysis of prevailing trends strongly suggests that outbreaks of pathogens of pandemic potential are set to continue to increase in frequency for the foreseeable future.

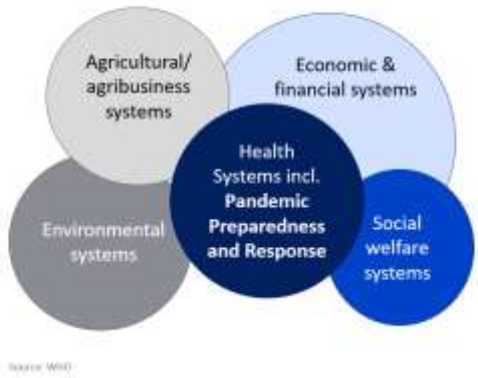
We may also be certain that, unless swift and coordinated action is taken to strengthen the global architecture for pandemic preparedness and response, backed by the necessary financing, the costs of the next pandemic are likely to exceed those of COVID-19 (figure 1).

Figure 1. Economic impact of selected outbreaks over past 30 years (in US$ billion)



The increasingly diverse origins and complexity of epidemics and pandemics are mirrored by the complexity and diversity of their effects on societies and economies. Effective pandemic preparedness and response, although anchored in the health sector, intersects with every area of national and global governance (figure 2).

Figure 2. Multi-sectoral pandemic preparedness and response (PPR)



COVID-19 has highlighted the weaknesses and gaps in the world's collective pandemic defenses. A large body of reviews and reports examining both the response to COVID-19 and the state of pandemic preparedness that preceded it have now been completed, yielding more than 200 individual recommendations. In broad terms these recommendations can be mapped to the three pillars of the global architecture of pandemic preparedness and response: systems, finance, and governance. The experience of COVID-19 has shown that each of these three pillars must be built on the foundational principles of equity and solidarity.

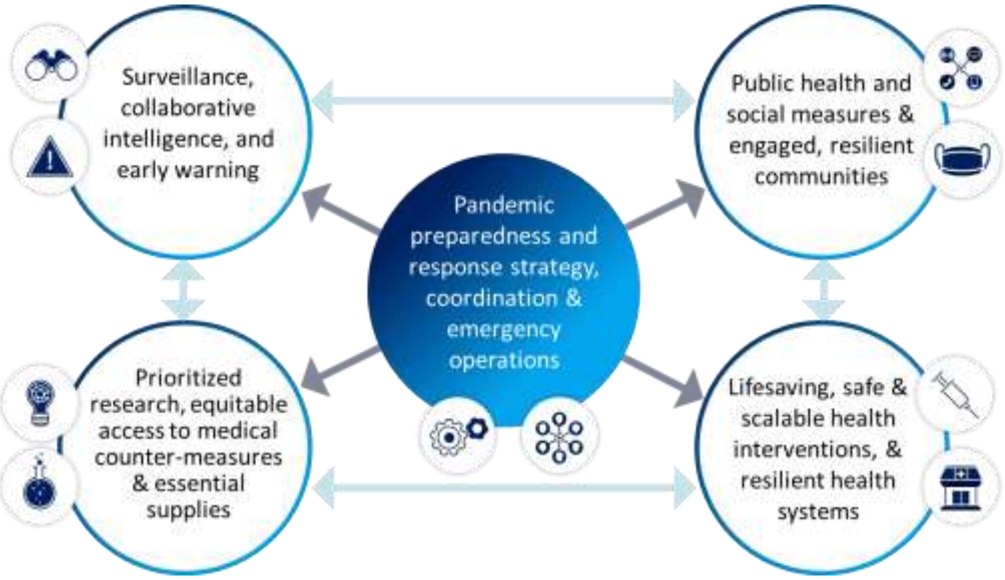
The initial analyses of financing needs and gaps presented in part C of this paper are intended to help frame future discussions on potential financing modalities for a strengthened and sustainable global architecture for pandemic preparedness and response. As such, a detailed appraisal of the systems and governance aspects of global pandemic preparedness and response are beyond the scope of this document. It is useful, however, to briefly consider the systems of pandemic preparedness and response architecture as they stand, and as they may evolve, in order to better inform any discussion around sustainably financing the pandemic preparedness and response architecture of the future.

B | Pandemic preparedness and response: systems and architecture

Conceptually, we can consider a simplified global pandemic preparedness and response system as five core elements (figure 3):

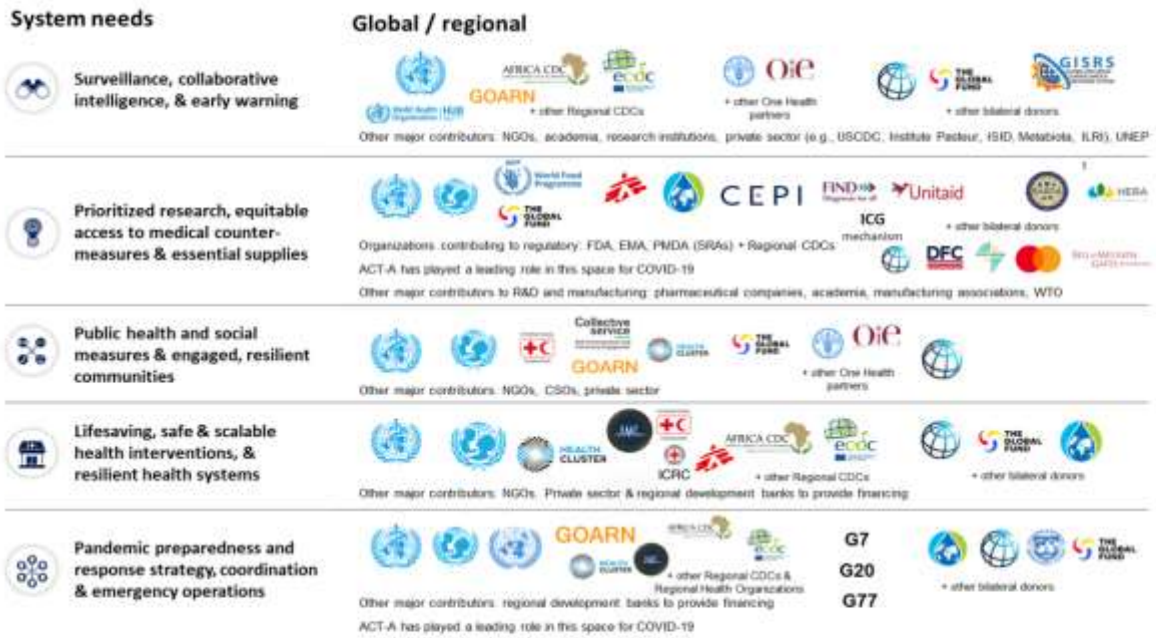
- Surveillance, collaborative intelligence, and early warning
- Prioritized research and equitable access to medical countermeasures and essential supplies
- Public health and social measures and engaged, resilient communities
- Lifesaving, safe and scalable health interventions, and resilient health systems
- Pandemic preparedness and response strategy, coordination & emergency operations

Figure 3. Five core elements of pandemic preparedness and response (PPR)



As COVID-19 has demonstrated, each of these core elements must be linked together horizontally at local, national, and regional/global level, and vertically integrated between each level of geographical organization (figure 4). Local and global pandemic preparedness and response are indivisible. No person, community or country can be safe until all are safe. Pandemic preparedness and response depend on national capacities supported and catalyzed by regional and global structures for governance and oversight, norms and standard setting, and long-term and emergency financing, where needed.

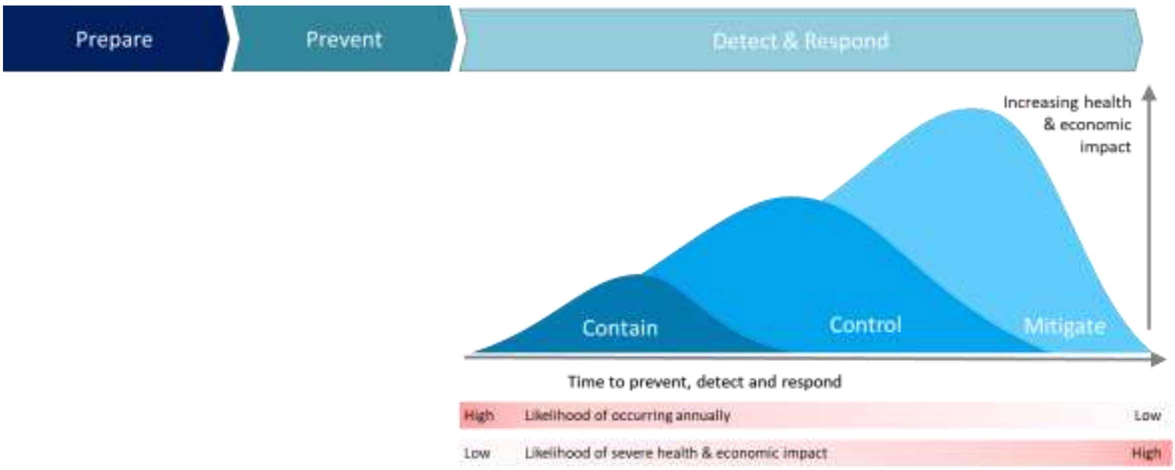
Figure 4. Preliminary mapping of the pandemic preparedness and response ecosystem (preliminary and non-exhaustive)



There is also a temporal dimension: the constituent parts of each core element take on different roles and functions at each step of the health emergency continuum from preparedness, through prevention, readiness, detection, and response. Response may be further subdivided into several phases depending on context, from investigation and containment to control and mitigation.

In many cases, the essential parts of these core elements already exist; but COVID-19 highlighted deficiencies in the way these parts were networked, integrated, and financed. The experience of the past two years has taught us that these deficiencies produced a pandemic preparedness and response ensemble which dilutes the value of its components. COVID-19 also exposed the absence of essential systemic elements that required urgent *ad hoc* solutions, and which now need to be refined based on the lessons of the pandemic, made sustainable, and integrated into a strengthened overarching system. Figure 4 shows a preliminary mapping of the key global institutes and national/local entities with a remit in each of the five core pandemic and preparedness elements.

Figure 5. Continuum of outbreak, epidemics and pandemics: from prepare & prevent to detect & respond



A brief description of each of the five essential subsystems for pandemic preparedness and response at the global/regional and national/local level is given in Annex A. Figure 4 shows a preliminary mapping of the pandemic preparedness and response ecosystem.

C. PPR FINANCING NEEDS AND GAPS

COVID-19 has demonstrated beyond doubt what previous outbreaks and epidemics had already shown: global pandemic preparedness and response depends on strong local and national capacities. Effective response is dependent on dynamic knowledge of what to respond to, where, and at what scale. The COVID-19 pandemic exposed weaknesses in many aspects of disease surveillance in almost all countries. Transforming fragmented and often antiquated public health surveillance systems into a modern and globally networked system will require substantial long-term investments in laboratory capacities; digitization; standardization of data collection methods; and an extension of disease surveillance beyond the intersection of human, animal and environmental health founded on the principle of One Health. Key investments in health systems and communities, and strong, effective national preparedness and response coordination, are not only vital investments in global health security but also yield resilience dividends that accrue far beyond preparedness and response. In all cases, dedicated investments will be needed to ensure that high-risk populations, especially in humanitarian contexts, are not excluded from improved pandemic preparedness and response.

C1. Local and national level needs and gaps

The 5 subsystems framework proposed by WHO builds upon the IHR (2005)

PPR capacities at local and national level play a critical role in preventing, detecting, and responding to disease outbreaks. Moreover, given the potential for disease outbreaks to spread across borders, national capacities have important spill over benefits at regional and global level. The WHO Benchmarks for International Health Regulations (IHR) Capacities define 18 technical areas across the areas of prevention, detection, response, and broader health hazards[1]. These benchmarks – and in some cases other related standards – form the basis for assessing both technical gaps in countries capacities and associated financing gaps. To reflect on the learnings of the last 17 years of outbreaks and pandemics, WHO has updated the thinking of IHR to propose the new 5 subsystem description of Pandemic PPR.

Assessing country financing needs from the bottom up

One approach to assessing financing needs is to build on country-level PPR assessments (Joint External Evaluations (JEE) and IHR State Party Self-Assessment Annual Reports (SPAR)), and the associated processes to cost investments and activities required to address critical gaps.

---

[1] The 18 technical areas in the WHO Benchmarks for International Health Regulations (IHR) Capacities ("Benchmark areas") were: 1) National legislation, policy, and financing, 2) IHR coordination, communication and advocacy and reporting, 3) Antimicrobial resistance (AMR), 4) Zoonotic disease, 5) Food safety, 6) Immunization, 7) National laboratory system, 8) Biosafety and biosecurity, 9) Surveillance, 10) Human Resources, 11) Emergency preparedness, 12) Emergency response operations, 13) Linking public health and security authorities, 14) Medical countermeasures and personnel deployment, 15) Risk communication, 16) Points of entry, 17) Chemical events, and 18) Radiation emergencies.

The resultant *National Action Plans for Health Security*, which have been prepared in many countries, focus on the incremental cost to achieve a JEE benchmark of "demonstrated capacity" relative to the current baseline. These costed plans provide a useful reference point, demonstrating how different baselines and country contexts can result in significant differences in financing need, and highlighting the that recurrent costs comprise a large part of financing needs in many countries (see Table 1).

Table 1: Estimates of PPR financing needs based on NAPHS in selected countries

	Capital (US$ pc)				Annual recurrent (US$ pc / year)			
	Kenya	Nigeria	Cameroon	Liberia	Kenya	Nigeria	Cameroon	Liberia
Cost of achieving core PPR capacities, including expanded workforce	0.02	0.07	0.19	5.29	4.35	2.95	3.01	7.35

Source: Compiled by the WB based on data from publicly available NAPHS

From country assessments to aggregate to PPR financing needs

Costed NAPHS provide useful insights but are not available for every country and have limitations. Hence, to arrive at aggregate estimates of financing needs (globally and for country groupings), researchers and practitioners have used available data on PPR gaps and costs to estimate financing needs to achieve benchmark levels of PPR capacity. The resultant studies differ in scope, methods, and assumptions, and hence offer a range of estimates of cost. Yet, based on a recent systematic review of ten key studies of the cost of improving PPR, several important conclusions emerge.[2] In particular:

- The estimated cost per capita per year to achieve benchmark levels range from less than US$1 for studies focused on a narrow set of capacities, to a range of US$3 to US$5 for studies that considered capacities across the full spectrum of prevention, detection, and response.
- In the short term, per capita costs are higher in LICs and LMICs than higher-income countries given lower baseline capacities and associated needs for frontloaded capital investments.
- Most cost estimates are based on a One Health approach but with a limited scope of activities related to zoonotic disseats. A more comprehensive approach that includes addressing deforestation, wild meat trade and other risks would be associated with significantly higher costs.
- The largest cost drivers included zoonotic disease, human resources, national laboratory systems, and surveillance.

[2] Clarke, Lorcan, Edith Patouillard, Andrew J. Mirelman, Zheng Jie Marc Ho, Tessa Tan-Torres Edejer, and Nirmal Kandel. "The costs of improving health emergency preparedness: A systematic review and analysis of multi-country studies." *eClinicalMedicine* 44 (2022): 101269.

Building on this review and prior costing exercise, this non-paper leverages the in-depth costing work that was done for the G20 High-Level Independent Panel report "Financing the Global Commons for PPR" published in June 2021, as well as the McKinsey & Company publication "Not the last pandemic: Investing now to reimagine public-health systems" from May 2021, to provide estimates of costs for the five PPR subsystems outlined above. In some cases, estimates were revised to reflect additional learnings from the ACT-Accelerator, or to incorporate recently published data. Certain costs were removed, introducing a first level of prioritization. Detailed breakdown of the five systems and what is included after prioritization can be seen in Annex A.

US$ 26.4 billion per annum PPR total financing needs at country-level identified

Based on the adjustments above to the selected papers, the revised country-level PPR financing needs are US$ 26.4 billion per year (see Table 2 below).[3] These costs are largely driven by critical investments needs for "surveillance, collaborative intelligence, and early warning" (US$ 10.4 billion), "engaged and empowered communities with trust in / understanding of public health and population measures" (US$ 6.5 billion), and "lifesaving, safe & scalable clinical care and resilient health systems" (US$ 5.4 billion). Additionally, smaller investments of US$ 2.0 billion each are needed for "equitable access to specialist medical supplies and countermeasures" and "globally coordinated emergency operations centers for preparedness and response". The US$ 26.4 billion need is unevenly distributed across income groups (see Table 3).

Table 2: High level preliminary estimation of national needs

	PPR framework subsystems	National level priority needs
1)	Surveillance, collaborative intelligence and early warning	$ 10.4 billion
2)	Prioritized research and equitable access to medical countermeasures and essential supplies	$ 2.0 billion
3)	Public health and social measures and engaged, resilient communities	$ 6.5 billion
4)	Lifesaving, safe and scalable health interventions and resilient health systems	$ 5.4 billion
5)	PPR strategy, coordination & emergency operations	$ 2.0 billion
	TOTAL	**$ 26.4 billion**

[3] These estimates are in line with the values outlines in the G20 HLIP and within the range of costs that emerge from the review of a broader set of costing studies and NAPHSs. For instance, using an estimate of $1 per capita for investment and $3 per capita for recurrent costs, the total financing need for LICs and LMICs is $16 billion.

Table 3: Funding needs on national level

	LIC	LMIC	UMIC	Total
National-level financing needs	$ 2.7 billion	$ 13.5 billion	$ 10.2 billion	$ 26.4 billion

Current levels of domestic PPR financing are modest relative to estimated costs

As with the estimation of PPR costs, data limitations make the estimation of PPR financing challenging. In the case of domestics financing, National Health Accounts currently do not identify PPR spending as part of broader health spending and is also not set up to capture important PPR spending by ministries and agencies outside the health sector, such as Ministries of Agriculture and Ministries of Environment (see Box 1). Nonetheless, it is possible to get some indication of domestic spending levels by looking at available data on government health spending and using available information on the share of government health spending that is oriented to preparedness, which suggests a range of 1-5%.[4]

Table 4: National health and PPR spending estimates

Income group	Dom. govt. exp. on health, US$ pc	Domestic PPR spending pc	
		1% of dom. health exp.	3% of dom. health exp.
Low income	10.2	0.1	0.3
Lower middle income	35.4	0.4	1.1
Upper middle income	296.8	3.0	8.9
High income	3486.4	34.9	104.6

Source: National Health Accounts from World Development Indicators

[4] This range is consistent with a review by McKinsey & Company. Similarly, in the context of Vietnam, a comprehensive estimate of domestic health security expenditures at both national and sub-national level accounts for only around 3% of total government health expenditures.

Based on these data, estimates of current levels of PPR spending in LICs and LMICs range from US$1.2 billion (low) to US$3.7 billion (high), falling well short of the estimated financing needs for investments and recurrent spending. These estimates can be considered lower bounds given that some non-PPR health system spending is supportive of stronger PPR capacity. Nonetheless, even with increased prioritization of health in budgets, significant gaps will remain over the medium term, in particular in the current fiscal context.

BOX 1: Embedding the monitoring of domestic spending on health security and prevention preparedness and response within wider statistical frameworks measuring health expenditure

To make sure that spending on health security and prevention preparedness and response is not diverted from spending on treatment and health system strengthening, any monitoring exercise should best be embedded in existing systems that track health spending. ***A System of Health Accounts*** (SHA) is the global standard used by many OECD and WHO countries to annually track health expenditure. At its core, the SHA framework is based on a three-dimensional accounting approach classifying health spending by type of service ("function"), provider of service ("provider") and the payer of the service ("financing scheme"). Within the classification of functions spending is grouped into curative care, long-term care, medical goods, preventive care and governance, and health system and financing administration, with more detail on the level of sub-functions.

Due to differences in the scope of activities but also the level of detail included in its classifications, spending on health security and prevention preparedness and response cannot be directly identified within SHA-based health expenditure. However, work has commenced to adjust the existing accounting framework to cater for the emerging needs to monitor the resources devoted to this purpose. In a first step, OECD and WHO have started to map the type of services included in the functional classification in the SHA framework with generic activities of the 19 Technical Areas of the Joint External Evaluation (JEE) Tool.

As part of this mapping exercise three possible scenarios could be identified:

- Some of the SHA sub-functions, particularly in preventive care, can be fully, or almost fully, linked to the JEE health security indicators. These include "immunisation programmes", "epidemiological surveillance and risk and disease control programmes" and "preparing for disaster and emergency response programmes".
- For a number of SHA sub-functions, a small share of its spending should be allocated to different JEE health security indicators. For example, a small proportion of the cost for "health system administration and financing" refers to activities under JEE Technical Area "National legislation, policy and financing". The situation is similar for the Technical Area "Antimicrobial resistance" where the implementation costs of national action plans within health facility would be included in spending on curative care.
- Some activities of JEE Technical Areas are completely outside of the scope of SHA. This refers, for example, to all activities related to animal health covered in the Technical Area "Zoonotic disease".

A next step would look into the implementation of this theoretical cross-walk. This would require an analysis of possible data sources to identify the costs associated with JEE activities within the different health spending sub-categories and an identification of new data sources for JEE activities outside of the health sector. Based on this assessment, guidelines for data compilers would need to be produced and the feasibility to derive spending on health security and prevention preparedness and response from SHA data would need to be piloted at a country level. In the long-run, the possibility to include spending on health security as part of the annual routine data collection should be explored with national health accounts experts.

This text box is based on a contribution from OECD.

International financing for domestic spending on PPR is significant, but well short of needs

The analysis of international financing also has limitations due to the lack of agreement on what should be considered core PPR (vs. disease specific program or broader health system strengthening). Existing analyses have been based on different sources, all of which are imperfect.[5] Issues that arise in tracking international financing for PPR include a lack of consistent coding of PPR financing, different level of comprehensiveness of databases, and lags in reporting. As a result of both boundary and data issues, estimates of financing can vary quite considerably. Nonetheless, it is possible to draw some broad conclusions that can help guide discussions of future financing.[6]

Overall Development Assistance for Health (DAH) has been estimated at around $40bn per year in the period prior to COVID. Although DAH is substantial, only a small share, estimated at around 1-2.5% (approx. US$0.5-1 billion) is directed at supporting core PPR functions at global and country level, with the remainder going to disease specific programs (nearly 75%) and broader health system strengthening.[7] Of this total, only a share is directed towards PPR needs at country level. Estimates of PPR financing would be somewhat higher if we also consider "PPR adjacent" financing, which would include disease-specific investments related to surveillance, laboratory capacity and other areas.

Financing gaps at country level are large, but there is a way forward

For several reasons highlighted above, there are uncertainties around both the costs of strengthened PPR at country level and current levels of international financing.

To estimate the need for international financing for national needs, our proposal takes the following two assumptions: i) national governments invest between 1% and 3% of their healthcare spending into PPR ii) level of international financing support decreases with

---

[5] Key sources include the OECD Creditor Reporting System, the Global Health Security Tracking (https://tracking.ghscosting.org/), IHME financing data (https://www.healthdata.org/data-visualization/financing-global-health), and G-Finder database for R&D (https://gfinder.policycuresresearch.org/). Details on the Creditor Reporting system and directions for better tracking of PPR financing can be found in Annex B.

[6] This section draws on analysis by McKinsey (Pandemic Preparedness and Response: Baselining PPR funding and capabilities, 2021) as well as two publications: Kraus, Jessica, et al. "Measuring development assistance for health systems strengthening and health security: an analysis using the Creditor Reporting System database." F1000Research 9, no. 584 (2020): 584 and Micah, Angela E., et al. "Tracking development assistance for health and for COVID-19: a review of development assistance, government, out-of-pocket, and other private spending on health for 204 countries and territories, 1990–2050." The Lancet 398.10308 (2021): 1317-1343.

[7] This is significantly lower than estimates by McKinsey of international financing of core PPR of around $3bn and as much as $9 billion if "PPR adjacent" financing is included. However, these estimates include large volumes of private financing for R&D so are not directly comparable. Overall, key funders for PPR in the pre-COVID period include bilaterals (US government, USAID, Canada, UK and Germany), multilaterals and international organization (WHO, World Bank/IDA, UNICEF, GFATM). In the context of COVID-19, the landscape shifted, with some bilaterals (in particular US) significantly stepping up funding for R&D and IFIs playing an increased role in providing non-R&D financing.

income per capita – based on this logic LICs should be supported at 100% of their needs, while LMICs would be supported up to 60%, and UMICs up to 20%[8].

Leveraging these assumptions, gaps are calculated in two steps: first, total gap is assessed as a difference between need outlined earlier and 1% or 3% of healthcare spending invested in PPR, second, the self-financing capacity is factored in to determine how much of the total gap needs to be financed by the international community. The result of this calculation is shown in table 5.. This initial estimation will need to be further refined as teams at the World Bank and the World Health Organization continue their work supporting the Health and Finance track of the G20.

Table 5: High level preliminary estimation of international financing gap for national needs assuming 1-3% spend on PPR and differentiated support by income group

	PPR framework subsystems	National level priority needs	Minimum priority gaps assuming 1% spend on PPR	Minimum priority gaps assuming 3% spend on PPR
1)	Surveillance, collaborative intelligence and early warning	$ 10.4 billion	$ 3.8 billion	$ 2.7 billion
2)	Prioritized research and equitable access to medical countermeasures and essential supplies	$ 2.0 billion	$ 0.7 billion	$ 0.5 billion
3)	Public health and social measures and engaged, resilient communities	$ 6.5 billion	$ 2.3 billion	$ 1.7 billion
4)	Lifesaving, safe and scalable health interventions and resilient health systems	$ 5.4 billion	$ 1.9 billion	$ 1.4 billion
5)	PPR strategy, coordination & emergency operations	$ 2.0 billion	$ 0.7 billion	$ 0.5 billion
	TOTAL	**$ 26.4 billion**	**$ 9.3 billion**	**$ 7.0 billion**

PPR capacity gaps exist across the income spectrum, and continued efforts to increase transparency around the status of PPR capacity and PPR financing will be critical for global health security, while also underpinning arrangements for collective accountability.

From the perspective of international financing, it is clear that strengthening PPR capacity in LICs and LMICs should be a key priority, along with financing global public goods in the area of PPR. The analysis highlights the need to both increase international financing for core PPR functions to address gaps highlighted above, and to leverage funding for health system strengthening and disease programs to strengthen PPR. Such leveraging is in fact already

[8] Consistent with approach for Financing Framework of the ACT-Accelerator endorsed by Facilitation Council Financial Working Group including representatives of Canada, France, Germany, Indonesia, Italy, Norway, South Africa, UK, USA

happening to some extent – for example, GFATM has provided significant support to surveillance and laboratory capacity, with funding targeting malaria / HIV / TB programs.

C2. Regional and global level needs and gaps

PPR at the regional and global level

COVID-19 showed that new approaches are required at global and regional levels to harness information from strengthened and networked national surveillance systems. Ad hoc and time-limited global initiatives were put in place to meet the urgent need highlighted by COVID-19 for mechanisms to prioritize and incentivize research and development, rapidly scale the manufacturing of countermeasures and procure them at scale to ensure equitable access. And the COVID-19 pandemic has once again underlined the value of a globally networked corps of professionalized health emergency responders as part of a global health emergency workforce.

Many of these capacities will be needed in the future and fit-for-purpose institutional arrangements will need to be found. In this regard, COVID-19 also brought important advances. Not only did "traditional" actors step up, coordinate and stretch their mandates to provide needed support; we also saw the emergence of new, pooled procurement mechanisms, like COVAX and the African Vaccine Acquisition Task Team (AVATT) and Trust (AVAT) for vaccines, as well as regional platforms for the procurement of other medical countermeasures, such as the Africa Medical Supplies Platform (AMSP) launched by Africa CDC, AU, UNECA, Afrexim bank and the COVID-19 Action Fund for Africa.

In this landscape of institutional change and innovation, and of multiple ongoing or planned fundraising efforts, any effort to address financing gaps is fraught with challenges. Nonetheless, this section makes the case that there are critical unmet funding needs, but that needs will be dynamic and it will be vital to establish robust platforms for coordinating investments on an ongoing basis to ensure best value and avoid the duplication of efforts to strengthen global PPR.

What are the PPR financing gaps at global and regional level?

The HLIP report estimated that $8bn of financing per year was needed at global level. Since the HLIP report was prepared, there have been many significant developments and fundraising efforts. New global surveillance initiatives have been launched, including the new "WHO Global Hub for Pandemic and Epidemic Intelligence", supported by Germany and the "Global Pandemic Radar", supported by the UK and Wellcome Trust. There have been important advances in regional surveillance and genomics at a regional level in Africa. CEPI published its new replenishment with a US$ 3.5 billion target to support research on immunization for major public health concerns. And there have been important developments in distributed manufacturing of vaccines, with significant financing being mobilized, including US$ 4 billion under the IFC's Global Health Platform. The ACT-Accelerator has been running for the last 18 months and launched its most recent fundraising campaign in February 2022.

At the same time, the COVID-19 pandemic has demonstrated the important role that regional institutions can play in areas such as surveillance, reporting and information sharing on disease outbreaks, sharing of key public health assets such as high complexity laboratories, regulatory harmonization, and procurement of counter measures and medical supplies. Plugging capacity gaps in existing regional institutions and building dedicated PPR entities, such as the one proposed by the African Union in October 2021, modeled on the European Health Emergency preparedness and Response Authority, HERA, can go a long way in preparing the world for the next pandemic. Institutions such as these, in Africa and other developing regions, will require significant funding support.

In order to estimate the global need our proposal follows the same approach as in the case of national needs, leveraging the existing studies as outlined in Annex A on PPR financing to prioritize essential components of PPR at global level. These prioritized needs sum up to preliminary high-level estimate of US$ 4.7 billion.

To find the global gap for international financing one assumption was taken: existing institutions and funding avenues have the capacity to contribute approximately 25%[9] of the need, leaving a potential international funding gap estimated at US$ 3.5 billion. This estimation is to be further refined as part of the working group.

Table 6: High level preliminary estimation of global needs and international funding gaps assuming 25% contribution from existing institutions and funding mechanisms

	PPR framework buckets	Global level priority needs	Minimum global level priority gaps
1)	Surveillance, collaborative intelligence and early warning	$ 0.9 billion	$ 0.7 billion
2)	Prioritized research and equitable access to medical countermeasures and essential supplies	$ 1.7 billion	$ 1.3 billion
3)	Public health and social measures and engaged, resilient communities	$ 0.9 billion	$ 0.7 billion
4)	Lifesaving, safe and scalable health interventions and resilient health systems	$ 0.6 billion	$ 0.5 billion
5)	PPR strategy, coordination & emergency operations	$ 0.4 billion	$ 0.3 billion
	TOTAL	**$ 4.7 billion**	**$ 3.5 billion**

[9] Conservative estimate based on annual reports from CEPI, FIND, GAVI, The Global Fund, UNICEF, WHO

C3. Summary of overall PPR needs and international financing gaps

This first evaluation of the financing needs and international financing gaps builds upon an important corpus trying to evaluate the total cost for PPR. However, the estimates in the literature vary widely – a more accurate estimation of needs and gaps, as well as by subsystems, will continue to evolve as priorities and investments in PPR are made.

Figure 6: Comparison of HLIP and current proposal funding needs in US$ billions

These estimates are in line with the values outlines in the G20 HLIP. However, the breakdown between national and global costs is significantly different, this is consistent with the fact that pandemics start and end in communities and strong national systems are critical for effective preparedness and response.

At this stage an overall high-level preliminary evaluation of the needs and gaps is given in Table 7.

Table 7: High level preliminary estimation of overall PPR needs and gaps

PPR framework buckets	PPR financing needs	Minimum priority PPR financing gaps[10]
1) Surveillance, collaborative intelligence and early warning	$ 11.4 billion	$ 3.5 billion
2) Prioritized research and equitable access to medical countermeasures and essential supplies	$ 3.7 billion	$ 1.8 billion
3) Public health and social measures and engaged, resilient communities	$ 7.5 billion	$ 2.4 billion
4) Lifesaving, safe and scalable health interventions and resilient health systems	$ 6.1 billion	$ 1.9 billion
5) PPR strategy, coordination & emergency operations	$ 2.5 billion	$ 0.8 billion
TOTAL	**$ 31.1 billion**	**$ 10.5 billion**

[10] Overall PPR gap shown assumes 3% of domestic healthcare spend invested in PPR

D. PRINCIPLES AND PRIORITIES FOR INTERNATIONAL PPR FINANCING

Three key options identified to strengthen PPR and address financing gaps

The analysis above points to significant structural PPR financing gaps that need to be filled across the five critical sub-systems at all levels (country, regional, global), alongside improvements in coordination. In a resource-constrained environment, it is vital for scarce donor funding to be channeled optimally to achieve the greatest impact. Several options in this regard were considered.

To address the above-outlined US$ 10.5 billion financing gap for PPR, three high-level options have been identified:

1) Selectively augment resources of existing institutions to support PPR investments
2) Establish a new, dedicated stream of additional, catalytic international financing for PPR, that can be channeled through existing institutions (e.g., 'fund of funds')
3) Consolidate the PPR functions of existing agencies, funds & programs

1) Selectively augment resources of existing institutions to support PPR investments

The existing PPR financing gap could be addressed by increasing investments in priority areas through selectively augmenting funding for selected existing institutions. This would enable existing institutions to further strengthen their individual PPR footprints and collectively address a substantial share of the PPR needs. This, however, does not represent a major shift from current practices.

2) Establish a new, dedicated stream of additional, catalytic international financing for PPR, that can be channeled through existing institutions (e.g., 'fund of funds')

A new "fund of funds" would provide a dedicated stream of funding for critical PPR interventions, while offering the flexibility to work through a variety of existing implementing partner institutions, drawing on their comparative advantages, and in a manner that brings added value to contributors and recipients. Further, it would allow non-ODA resources to be mobilized. Key principles underpinning the mechanism could include i) complementarity with existing international financing and fundraising efforts, ii) helping to improve coordination of support, iii) leveraging existing implementing partners; iv) ensuring early and extensive involvement of recipient countries and regional institutions, including to define fit-for-purpose institutional arrangements for addressing PPR gaps at country, regional and global levels. It could invest in both the country-specific and global public goods aspects of PPR.

3) Consolidate existing PPR funds & programs from various agencies

Over the longer term, consolidating the PPR functions of various existing, dedicated global health financing institutions into a single entity could be considered. This would imply a far-reaching restructuring of the global health financing architecture and would present practical implementation challenges. For example, in many organizations, PPR support is integrated in broader health systems strengthening or disease-specific programs. Further, it would still leave open the question of coordination between any new consolidated entity, existing institutions, and the MDBs, some of which play a significant role in financing PPR.

Direction from G20 countries required to further define strategic options

These options map out at a high level the range of possible strategic directions to strengthen PPR globally and unlock adequate financial resources. With the guidance and direction of G20 members, one or more of these options can be further elaborated. Given the supply constrained financing environment, options need to be assessed against impact and feasibility considerations and, in particular, their i) ability to leverage financing from other sources (e.g., MDBs, private sector), ii) catalytic role for critical investments, iii) complementarity to existing instruments, iv) systemic impact, and v) ability to strengthen coordination.

Annex A | Pandemic preparedness response subsystems and gaps

A1. Surveillance, collaborative intelligence and early warning

Public health decision-making at local, national, and regional/global levels must be based on real-time, accurate disease surveillance data and analysis. Put simply, effective response is dependent on dynamic knowledge of what to respond to, where, and at what scale. The COVID-19 pandemic exposed and continues to expose marked weaknesses in multiple aspects of disease surveillance in nearly all countries. Furthermore, COVID-19 highlighted the need connect surveillance and alert systems into a regional and global network to detect zoonotic transmission events, raise the alarm early to enable a swift public health response, and accelerate the development of medical countermeasures. Deficiencies in surveillance affected every phase of detection and response:

- Initial detection and investigation efforts were compromised by a global failure to anchor surveillance within the principle of One Health – with inadequate vigilance at the intersection of human, animal and environmental health and a clear need to extend active surveillance into wild and domestic animal populations as part of broader measures to reduce zoonotic transmission.
- Containment and control efforts have often been compromised by inadequate diagnostic capacity, insufficient contact tracing, fragmented data systems, and an often slow and incomplete analysis of data to inform a dynamic calibration of public health and social measures.
- Mitigation efforts have too often been undermined by weak surveillance of cases and insufficient national capacity to adjust public health measures on the basis of timely data.

National disease surveillance is the foundation on which global pandemic preparedness and response must be built. Transforming fragmented and often antiquated public health surveillance systems into a modern, integrated and effective system will require substantial long-term investments in laboratory capacities; digitization; standardization of data collection methods and appropriate access for the public, local and national health authorities, regional bodies, and WHO as set out under the International Health Regulations (2005); and an extension of disease surveillance beyond the intersection of human, animal and environmental health founded on the principle of One Health. Dedicated investments will also be needed to ensure that high-risk populations, especially in humanitarian contexts, are not excluded from improved surveillance systems.

At the regional and global levels, new approaches are required to harness information from strengthened and networked national surveillance systems, and combine it with diverse contextual data, including from many sources outside the traditional purview of epidemiology in order to yield new actionable insights into pandemic risk, and open new avenues for prevention, readiness and response. Achieving this will, at a minimum, require universal data collection standards along with standard procedures to rapidly share sequencing data and samples for pathogens (as has been already done for influenza). The WHO Biohub initiative, the WHO Hub for Pandemic and Epidemic Intelligence (the WHO Hub), and the Global Pandemic Radar supported by the UK and Wellcome Trust, are some of a number of initiatives that could form the foundations of this new approach to collaborative pandemic and epidemic intelligence.

Building such a global program requires sustainable investment at the interface of multiple sectors. For long-term financial sustainability, innovative financing strategies would need to be developed.

Table 8: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (USD Bn)
Discover unknown zoonotic viral threats (map global virome) Estimates based on The Global Virome Project's calculations: 1. $1.2B over 10 years would allow mapping of 71% of Zoonotic viral threats to humans 2. 2. $3.7B over 10 years would allow mapping of nearly all zoonotic viral threats to humans Average comes down to $2.4B over 10 years, or $245M per year.	$ 0.2
Population-representative surveillance foundation) CRVS: Top-down estimates for software, systems costs and cost per registration event from the World Bank CRVS report and CRVS Gateway. Expert interviews used to narrow in on wide range provided to $100M for HICs. Cost per registration used to derive per capita cost based on countries annual birth/death rate from the World Bank. Given other non-surveillance uses of a CRVS system, only 2/3 assumed to be for CRVS. HICs assumed to have 90% of target state CRVS systems. For CRVS, HIC assumes best-in-class CRVS for incremental funding needed SRS: Used total costs for the COMSA program in Mozambique to estimate a per capita spend for a SRS for L/MICs – L/MICs assumed to have 20% of target state SRS systems. L/MICs assume target state SRS Mortality: Cost per activity (cause of death verification, verbal autopsy, autopsy) from CRVS Gateway, Sierra Leone MITS program, benchmark of published data, and expert interviews. • % undergoing autopsy/equivalent: 1% (target based on ideal MITS program) and 2% for best in class (based on WHO data for European countries of 10% current autopsy rate, of which 20% cost attributed to surveillance) •% cause of death attributed target: 80-99%; 50% of verification cost attributed to surveillance L/MICs assumed to have 10% of target state mortaility surveillance systems, HICs assumed to have 90% For incremental spending for mortality assumes average of target and best-in-class	$ 1.9

Function	Estimated need (USD Bn)
Pathogen surveillance including sequencing Lab costs: Set-up cost of up to $40M per lab from APHL estimate for HIC, $20M for L/MIC, with 1 lab per 6M population in target and per 3M in best-in-class. Ongoing labor costs of 40 people per lab. 15% of total public health lab cost assumed to be for surveillance per ECDC analysis L/MICs assumed to have 30% of target lab systems, HICs assumed to have 80%. Incremental spending estimate assumes mid-point average between target and best-in-class spending Pathogen Genomic Sequencing: assuming sequencing platforms to be added to existing public health labs • Capacity: Weekly sequencing capacity needed is most uncertain input given recency of PGS technology. Yearly capacity (as % of total population) 0.5% for target and 2.5% for best-in-class. That roughly translates to ~2% of weekly COVID-19 peak number of positive cases for target and ~10% for best-in-class, or (though COVID-19 cases and peak varies significantly by country) • Fixed costs: For a capacity of ~500k sequenced samples per year, labor and platform capital costs estimated as a blended average of different high throughput lab network set-ups – totalling ~$2.5M in HIC and ~$5M in L/MICs, with an ongoing labor cost of ~$600k/year and $200k/year respectively • Variable costs: Sample prep, logistics and sequencing cost of reagents and consumables calculated to be ~$60/sample. Total variable cost calculated based on capacity multiplied expected utilization of 50% L/MICs assumed to have 20% of target PGS systems, HICs assumed to have 50% For PGS, given recency of technology use, with lower existing baseline, therefore assume less progress towards best-inclass (only 25% of best-in-class) Sewer and septic: Sample sites assumed to cover population of 50-100k population, with enough sites to cover 50-80% of the population, per expert interviews and ongoing Malawi waste water surveillance effort. Frequency of sample collection per site ranges from twice a month once a week L/MICs assumed to have 15% of target sewer and septic surveillance systems, HICs assumed to have 25%. Incremental spending estimate assumes mid-point average between target and best-in-class spending	$ 4.8
Specialized surveillance programs Main costs are program management costs of a couple of FTE per program and sample collection and analysis Costs per sample collected and analyzed multiplied by the number of samples taken as part of study or survey Total cost of ~$0.5M per study in HIC. Assuming 1-8 sero-surveillance studies per year and 1-3 vaccine effectiveness studies per year L/MICs assumed to have 10% of specialized surveillance programs, HICs assumed to have 40% Incremental spending estimate assumes mid-point average between target and best-in-class spending for all components *Note:* *Doubled original amount to account for specialized surveillance in conflict areas*	$ 0.8

Function	Estimated need (USD Bn)
Notifiable disease and IDSR-like surveillance Community based surveillance: L/MIC: using network of CHW receiving modest incentive and salaried supervisors. No. of volunteer CHW estimated from study showing 33% sensitivity with 1000 pop per CHW. Number of volunteers increased linearly for higher sensitivity (50% for target, 80% for best-in-class). No. of surveillance managers per volunteers assumed to be 1:25, and data managers ssumed to be 1:75 HIC: assumed cost of an ongoing health awareness campaign to direct population towards health system or national phone hotline L/MICs assumed to have 30% of target state indicator based surveillance systems, HICs assumed to have 60% Indicator based surveillance: Main cost (~80% of total) comes from FTEs related to data collection and data entry of data from health facilities and labs. Assuming ~2 FTEs per 500k population from expert interviews L/MICs assumed to have 20% of target state mortaility surveillance systems, HICs assumed to have 90% Response: estimated rapid response team FTEs needed (a team of 5 per 200k of population for target and 100k for bestin-class) per expert interview and IHR's Joint External Evaluation L/MICs assumed to have 30% of target response teams, HICs assumed to have 60% Incremental spending estimate assumes mid-point average between target and best-in-class pending for all components *Note:* *Assumed to also include costs of globally coordinating surveillance*	$ 1.9

Table 9: Examples of how the needs are distributed across the Detect/Respond phase

	Investigate	Contain	Control	Mitigate/respond
Surveillance, collaborative intelligence and early warning	$ 1.8	$ 1.7	$ 0.2	< $0.01

A2) Prioritized research and equitable access to medical countermeasures and essential supplies

The speed with which the world came together to develop safe and effective COVID-19 vaccines, diagnostics, and therapeutics remains one of the most impressive achievements of the pandemic. This collective success, however, stands in stark contrast to what amounts to our collective failure to ensure that the fruits of research are shared equitably and effectively.

A strengthened pandemic preparedness and response architecture should build on the lessons learned through the experiences of the ACT accelerator and other regional and national initiatives to solve the problems of how to:

Prioritize and incentivize research and development for both long-term upstream research into emerging and potential infectious diseases integrated with strengthened surveillance, and downstream preclinical and clinical research, for prevention tools and response countermeasures, and surge research and development for response tools. Research into many pathogens with epidemic potential continues to be ignored and underfunded and the market devotes socially suboptimal levels of investment into research and development for diseases that primarily affect low-income countries. Many countries and regions are therefore seeking to strengthen their research and development capabilities, including for product development of vaccines as well as other medical countermeasures. However, few countries have end-to-end capacity to translate basic research into products within their own borders, and low-income countries typically lack both the technical capabilities and the financial resources to advance R&D-related agendas. Strengthened coordination and collaboration in R&D is needed to avoid duplication and to enable the necessary benefit for all that an effective global system requires.

Rapidly scale manufacturing. The deep inequities that COVID-19 has highlighted in access to vaccines, testing and other medical countermeasures between rich and poor countries highlights the need to invest much more in globally distributed manufacturing capacity for products that can be easily adapted and adjusted to new needs as they emerge, build resilient supply chains, and ensure that procurement mechanisms that can be activated in times of crisis are well prepared, in advance, through efforts in inter-pandemic years.

Procure at scale to ensure equitable access. Traditionally, procurement is vertically organized, with UN organizations and international NGOs leading procurement in emergency response. Other agencies are organized around specific commodities. COVID-19 demonstrated that there were insufficient stockpiles of essential countermeasures and inadequate emergency supply chain planning, and that health supply chains in low-income countries were underdeveloped.

Ensure countries have the regulatory, technical and operational capacity to rapidly translate access to new products into effective public response measures.

Key gaps at present include:

- A well-resourced global research and development roadmap building on the WHO R&D Blueprint.
- An entity at global/regional level with both an overview of manufacturing and distribution supply chains for essential pandemic public goods, and the mandate and capability to intervene effectively to prevent or address shortages.
- Flexible global manufacturing capacity, technology platforms, and technology transfer agreements for key products such as vaccines.
- Stronger global ownership for product lifecycle funding for key products – vaccines, therapeutics, and diagnostics – is also required.

- Pooled procurement mechanisms for medical countermeasures can potentially offer many benefits but require i) assured financing to place orders early; ii) diversified order portfolios; iii) the ability to provide predictability to recipients; and iv) country ownership and effective coordination with recipients are critical.
- A global entity with a clear mandate to catalyse product development in the area of therapeutics.
- A sustainable mechanism to underwrite the risk of development and large-scale manufacture of new products to both address urgent needs and ensure equitable access in the event of a pandemic.
- Operational and implementation research on preparedness and response interventions (incl. therapeutics and diagnostic, and research on how to increase community engagement, effective leaderships according to country or community contexts)

Table 10: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (USD Bn)
Close known existing vaccine and therapeutic gaps Estimate includes the cost of closing the existing vaccine gap and closing the therapeutics gap. 1. Closing the existing vaccine gap uses Gouglas et al.'s estimates that the cost of progressing at least 1 Vx through end of phase 2a for each disease in portfolio of 11 priority epidemic infectious diseases (Chikungunya, Zika, Rift Valley Fever, MERS, Marbug, Lassa, CCHF, Nipah, SARS, SFTs, Ebola) is ~$3.25B. This is then multiplied by 2 to take into account that at least 2 vaccines would need to be progressed (one mRNA and one protein sub-unit, which assumes two different players are needed). 2. Closing the existing therapeutics gap assumes 6 virus families will progress 2 therapeutics through phase 3. Six virus families include: Corona, Orthomyxo, Paramyxo, Arena, Flavi, and Filo. 3. Progressing universal influenza vaccine calculated using average cost of bringing two candidates of the 11 priority epidemic infectious diseases through Phase II, and applying a 2.5x multiple to account for complexity.	$ 1.4
Scale vaccine manufacturing capacity Used current COVID vaccine supply curve to estimate time needed to produce sufficient vaccine for global population at current capacity level. Assumed target months to produce a new vaccine should be half the time of current response, thereby requiring a doubling of manufacturing capabilities. Assuming each facility can produce 400M doses per year, and that the target is for 14.7B doses to be produced, that would require 37 new facilities to be built at a cost of $500M each (based on WHO and NCBI estimates). Ramp up of building these new facilities was spread across 3 years. WHO estimates maintenance of facilities to be 250M each, though costs were reduced for interpandemic years. DP maintenance, assumed to account for 50% of costs, was eliminated. DS maintenance, assumed to account for the other 50% of costs, was discounted by 25%. *Note:*	$ 0.2

Function	Estimated need (USD Bn)
Based on agencies' asks as per ACT-A 2020 & 2021 budget. Incl. 50M for Vx, 123M for Tx, and 18M for Dx	
Supply chain prep (global stockpile) Baseline stockpile per person calculated through proposed US SNS budget for FY 2022 of $905M divided by US population. Global population then split into HIC and LIC/MIC using World Bank's population estimates and economic classifications. Gap in stockpiling identified in LIC/MIC was triangulated through two sources. PLOS Journal identified PPE deficiencies from SPAs assessments in Nepal, DRC, Haiti, Tanzania, and Afghanistan to be 62%. QuartzAfrica cited South Africa planned to produce an additional 10k ventilators to supplement their 6k on hand in April 2020, implying a gap of 63% Gap in HIC identified based on US's SNS FY 2022 budget proposal increase to $905M (28% increase). Rationale was cited as "to maintain replenishment of critical medical supplies and restructuring efforts initiated during the COVID-19 pandemic" Maintenance calculated by using US's annual stockpile budget / total value of stockpile as a proxy for share of stockpile gap cost needed for annual maintenance *Note:* *Stockpiling during prepare phase. Value taken from ACT-A budget, required to build supplies for 7 days*	$ 0.6

Table 11: Examples of how the needs are distributed across the Detect/Respond phase

	Investigate	Contain	Control	Mitigate/respond
Prioritized research and equitable access to medical countermeasures and essential supplies	$ 0.7	$ 0.7	$ 0.2	< $0.01

A3) Public health and social measures and engaged, resilient communities

Outbreaks, epidemics and pandemics begin in communities, spreading via the social and economic links between us all. Ultimately, all outbreaks also end in communities, through the successful implementation of public health and social measures by and in concert with affected communities. The difficulties that many countries have faced in implementing public health and social measures during COVID-19 points to the need for new approaches to risk communication, community engagement, and methods of fostering community resilience. Priorities include:

- Strengthening of the global, regional and national capacity to manage the infodemic during acute crises. Key aspects of infodemic management include fostering a dynamic understanding of public attitudes, understanding and conversations about infectious pathogens and public health and response measures; the ability to ensure accurate, evidence-based and appropriate information is available and prominent in public discourse at the expense of misinformation and disinformation with the potential to erode public understanding and trust in public health messages and undermine the effectiveness of public health and social measures.
- Addressing the need for long-term investment in a culture of social connectedness and investment in civic mindedness, and the promotion of participatory decision-making and partnerships between governments and communities to ensure that preparedness, response and recovery efforts address community needs. Communities, community health workers, and civil society organizations should be early partners in the design, planning, implementation, and assessment of pandemic preparedness and response efforts.
- Clear structures and sustained funding for bi-directional community engagement at national level, in addition to technical support from regional and global levels, to foster durable trust in authorities in times of crisis, vulnerability and uncertainty. Earning and maintaining trust is a continuous process.
- Sustained investment in public health information campaigns and community engagement to promote long-term pandemic preparedness goals including reducing the risk of zoonotic transmission

Table 12: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (USD Bn)
Limit human / wildlife interactions, specific activities Estimates include reducing spillover from livestock, reducing wild meat trade in China, and regulating wildlife trade. These estimates are based on analysis by Andrew Dobson, Stuart L Pimm and team - published on Sciencemag. 1. Spillover from Livestock: Methodology calculates the annual cost of implementing enhanced biosecurity for zoonoses around farming systems for 139 low and middle income countries to be $1.9B for low disease prevalence and $3.4B for high disease prevalence (based on World Bank One World One Health). 31 out of these 139 countries have high risk of wildlife viral spillover, therefore, taking into account 31/139 countries the range becomes $424M to $758M in 2012 dollars, which equates to $476M to $842M 2020 dollars. 2. Reducing wild meat trade – China estimate based on a study by the Chinese cademy of Engineering, which concluded that wildlife consumed as food has annual value of $19.4B 2020 dollars, or $14 / capita. Extrapolated to all LIC/MICs by population, the global wild meat market is $89B. Reducing the market by 25% over 10 years equates to $2.2B per year. Wildlife farming for food employs 6.3 Million people, whole wildlife farming sector employs 14 million people in China 3. Regulating wildlife trade - OIE has $34M/yr annual operating budget to assess disease risk in livestock trade without conducting testing. Method then assumes	$ 3.4

Function	Estimated need (USD Bn)
similar budget to assess disease risk in wildlife trade ($30M/year). From there it adds cost of disease surveillance (USAID PREDICT budgets for disease monitoring in 20 countries = $20M/yr) and scale 10-fold (USAID PREDICT built capacity for 100k wildlife specimens in 20 countries. 10-fold increase to accout for high volume of shipments that would need to be tested). $30M + $20M = $50M x 10-fold scale = $500M *Note:* *Assumed to account for costs required to support communities in adherence to guidance on human/wildlife interactions*	
Communication and messaging Estimates calculated using South Africa, Thailand, and Benin IHR costing results. Total annual and startup costs from each country were divided by their respective GDP. Average cost/GDP ratios were then multiplied by total Global GDP for LIC and MIC to extrapolate total start-up and annual costs required. Each cost was further extrapolated for each line-item in IHR costing tool. Baseline HIC estimates extrapolated from LIC/MIC using population ratios. Gap for LICs uses eSPAR assessment for African continent. Gap for HICs calculated using WHO eSPAR assessment for Italy and South Korea as proxies. Each cost was further extrapolated for each line-item in IHR costing tool. Communication initiative includes: 1. "risk communication systems" 2. "internal and partner communication and coordination" 3. "public coordination" 4. "communication engagement with affected communities" 5. "dynamic listening and rumor management" Gaps identified based on WHO e-SPAR results	$ 0.4
Border Health - "Routine capacities are established at POE", and "effective public health response at POE" Estimates calculated using South Africa, Thailand, and Benin IHR costing results. Total annual and startup costs from each country were divided by their respective GDP. Average cost/GDP ratios were then multiplied by total Global GDP for LIC and MIC to extrapolate total start-up and annual costs required. Each cost was further extrapolated for each line-item in IHR costing tool. Baseline HIC estimates extrapolated from LIC/MIC using population ratios. Gap for LICs uses eSPAR assessment for African continent. Gap for HICs calculated using WHO eSPAR assessment for Italy and South Korea as proxies. Each cost was further extrapolated for each line-item in IHR costing tool. Border Health initiative includes:	$ 1.3

Function	Estimated need (USD Bn)
1. "Routine capacities are established at POE", and 2. "effective public health response at POE" Gaps identified based on WHO e-SPAR results	

Table 13: Examples of how the needs are distributed across the Detect/Respond phase

	Investigate	Contain	Control	Mitigate/respond
Public health and social measures and engaged, resilient communities	$ 0.2	$ 0.2	$ 0.1	< $0.01

A4) Lifesaving, safe and scalable health interventions and resilient health systems

Resilience in the context of health systems and pandemic preparedness and response is most usefully defined as the ability to prepare for, manage, and adapt to shocks. COVID-19 has affected every health system in the world, and exposed marked differences amongst them in terms of their resilience. The inability of many health systems to manage and adapt to COVID-19 has often been one of the primary drivers of the indirect human and economic costs of the pandemic. Drawing lessons from those systems that showed greatest resilience, we can highlight a number of the key qualities to prioritise in national health systems that will yield a resilience dividend, with benefits that accrue far beyond pandemic preparedness and response.

- The ability to increase capacity to cope with a sudden surge in demand is a prerequisite of resilience, with embedded surge capacity (human resources, infrastructure, and material) enabling an effective response to any rapid increase in demand.
- At the global level, countries will require support from international mechanisms, including elements of a global health emergency workforce such as emergency medical teams, in the event of large-scale crises in which demand for critical care facilities and key resources exceed national supply.
- Complementing surveillance information systems, health information systems with the ability to delivery accurate real time data about health system capacity and utilization are vital tools for decision-making but are often antiquated and inadequate.

  A robust, flexible and well-motivated workforce is a critical element of pandemic preparedness. Well-motivated and supported staff are better able to adapt extra burdens during periods of acute demand. Training and long-term planning for health workforce development is crucial preparation for scenarios in which health workers must be redeployed to meet a surge in demand.

Table 14: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (USD Bn)
National Public Health Institutes Assuming regional hub teams responsible for local populations of ~3m each, with 1 single centralized national-level setup per country Assuming a team of ~15 dedicated FTEs (e.g., data encoders, program officers, managers, epidemiologists) per every 3M population per expert interviews L/MICs assumed to have 30% of central NPHI capacity, HICs assumed to have 80% Incremental spending estimate assumes mid-point average between target and best-in-class spending	$ 0.3
Pandemic and health security specific health system strengthening Extrapolated gap in strengthening health systems based on Kenya's HHFA results (one of pilot countries for HHFA in 2018/2019). Codified 500+ line items of services and equipment in HHFA results as either related to pandemic preparedness or general. From there, calculated deficiency (difference between Kenya result vs. target) for each line item, then took the average (assumes that each line item holds same weight) which yielded an average total deficiency of 53%. Calculated percentage of deficiencies related to pandemic preparedness to be 18% by taking the sum of deficiencies related to pandemic preparedness divided by sum of total deficiencies. Took Kenya's annual spend on Healthcare per capita ($88) and increased it by 53% to reflect the total annual spend needed in Kenya per capita ($134). Took the difference to find the gap of $46 per person (which is close to the LIC/LMIC global gap identified by Moses et. al in an article published on The Lancet in December 2018). Multiplied the gap of $46 per person by the percentage of deficiencies related to pandemic preparedness to get $9 per capita. Multiplied the $9 by total LMIC / LIC population to get to $30.2B. Assumed ramp up would take two years to address that gap ($15B per year) and that maintenance cost would be 10% per year ($3.0B)	$ 5.4

Table 15: Examples of how the needs are distributed across the Detect/Respond phase

	Investigate	Contain	Control	Mitigate/respond
Lifesaving, safe and scalable health interventions and resilient health systems	$ 0.2	$ 0.2	$ 0.1	< $0.01

A5) PPR strategy, coordination & emergency operations

The goal of coordination is to systematically marshal and deploy the appropriate resources (knowledge and data, financial, material, and operational) to prepare for, prevent, detect, and respond rapidly to any pandemic threat, and guide the recovery of society and the evolution of the preparedness and response system in the period following a pandemic interlude. At all levels of organization, coordination must be underpinned by effective, accountable leadership. At the national, regional and global level COVID-19 exposed deficiencies in our collective ability to coordinate pandemic preparedness and response. Priorities for strengthening include:

- At the global level a strengthened and accountable WHO with a clear mandate for establishing the norms and standards at the centre of pandemic preparedness and response policy. At global, regional, and country level, WHO harnesses expertise in order to translate evidence into actionable guidance for every aspect of infectious hazard management, and support the stress testing of infectious hazard management response plans and IHR core capacities at national level. Monitoring and accountability for the application and adaptation of that guidance as public health policy before, during, and after pandemics must be strengthened.

- At national level, the development of evidence-based strategic preparedness and response plans, the financing of those plans, and the rapid mobilization of human and material resources across the whole of government and whole of society, as appropriate, should be the responsibility of a standing, professionalized health emergency corps. Such a corps should be coordinated from Emergency Operations Centres (EOCs) based on the Polio Response model.
- A multidisciplinary global health emergency workforce is required to address the specific problems of insufficient specialized, integrated health emergency response teams at national and subnational levels; fragmentation and lack of coordination between countries during their response to health emergencies; and a lack of trained, accredited and resourced response teams able to deploy across international borders rapidly and at short notice to supplement national capacities under national authorities and/or as part of an international response. At present, a lack of integration and coordination between different capacity strengthening initiatives across the health emergency cycle has given rise to a fragmented and siloed health emergency workforce that is less than the sum of its parts.

Table 16: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (USD Bn)
Data integration For a country of 30M people, necessary cloud infrastructure costing $300k/year, with software licenses costing $100k/year (and an additional $300k in the first year) Team of 5 dedicated FTEs during set-up to lobby and push for health centers and for each surveillance program to share data and to have interoperable data with common meta-data – 2 dedicated FTEs ongoing Build team of nearly 40 FTEs ($1.5M for LIC/MIC and $3M for HIC) to set up system. Ongoing support from 20 data scientists and 10 data and IT support staff ($1.5M for LIC/MIC and $3M for HIC) L/MICs assumed to have 30% of data integration capacity, HICs assumed to have 80% Incremental spending estimate assumes mid-point average between target and best-in-class spending	$ 0.4

Function	Estimated need (USD Bn)
Emergency operations and Emergency Financial Funds Estimates include filling gaps in emergency operations and emergency financial funds 1. Emergency operations: US spend per capita based on CDC's PHEP program's "State and Local Preparedness and Response capability" budget of $675M for FY 2020 was used as proxy for standard operations. WHO estimates a 37% gap, which was used to calculated weighted average gaps between HIC and LIC/MIC economies to obtain $854M to $1,230M. Estimate also triangulated through IHR estimated gaps in Benin, Thailand, and South Africa, which were used to extrapolate global gap 2. Emergency Financial Funds: Sums average funding required for Pandemic Emergency Financing Facility, WHO's Contingency Fund for Emergencies, and WHO's CHEPR *Note:* *Fully aligned on Emergency Operations Centers. Need to be built out both on National levels as well as a Global level. Emergency Financial Funds excluded, financing gap question, not need question*	$ 0.2
Conduct regular simulations and other cross-sectoral exercises Estimate uses FEMA's Category 3 hurricane simulation as a proxy to calculate spend per capita. This is then applied to global population to yield global spending needed of $12M/year *Note:* *Replaced with bottom-up calculation based on expert input.*	$ 0.3
Conduct relevant assessments to highlight gaps in healthcare systems Estimates assuming HHFA (Harmonized Health Facility Assessment is the assessment conducted). HHFA does not have specific details in costing, but builds off of SARA, SDI, and SPA. Therefore, given that it is lengthier and more comprehensive that previous assessments, assumed a 30% cost increase to SARA. SARA cost was estimated using the SARA reference manual, which provides estimates for conducting assessment in small, medium, large countries for different options of the assessment. Size of country is defined by number of hospitals in SARA, therefore used OECD data on number of hospitals by coutry to identify the number of countries in each category determined by SARA's cutoffs. There are five options on how to conduct SARA assessment. Option 1: "National Estimates" is the most common form of assessment (based on reference manual), so model assumes 80% of assessments follow that cost guideline. Remaining 20% assumed to follow "District sample" option. All large countries follow District sample since "National Estimates"	$ 0.1

Function	Estimated need (USD Bn)
option does not provide cost estimates for large countries. The proportion of assessments that are National vs. District are used to estimate the total cost of SARA for small, medium, and large countries ($44.66M). The assumed 30% higher cost is then applied to yield $58M for HHFA.	

Table 17: Examples of how the needs are distributed across the Detect/Respond phase

	Investigate	Contain	Control	Mitigate/respond
PPR strategy, coordination & emergency operations	$ 0.7	$ 0.7	$ 0.1	< $0.01

Annex B | Tracking international PPR financing

This annex is based on a contribution from OECD.

International statistics on development finance and support to the SDGs

The OECD Creditor Reporting System (CRS) database provides internationally comparable statistics on concessional and non-concessional development finance, i.e. Official Development Assistance (ODA) and other official flows (OOF), provided by DAC members, non-DAC and multilateral donors as well as philanthropic foundations. In addition to the CRS, the recently developed Total Official Support for Sustainable Development (TOSSD) measure managed by the International TOSSD Task Force aims to capture the financing of the Sustainable Development Goals (SDGs), through cross-border flows to developing countries (pillar I) and regional and global support to international public goods and global challenges (pillar II). Its tracking goes beyond official development finance captured in the CRS, in particular by capturing (i) south-south co-operation not tracked in the CRS, and (ii) support to international public goods and global challenges.

Tracking support to pandemic preparedness and response (PPR)

Currently the CRS and TOSSD databases do not track, in a precise manner, the financing of pandemic preparedness and response (PPR). However, the CRS and TOSSD sector codes enable the tracking of support for health and for its sub-categories that can be used as proxies for pandemic preparedness and response (i.e. infectious disease control). Concessional and non-concessional flows from all providers for health reached USD 27 billion in 2019, out of which USD 12 billion targeted infectious disease control (including malaria, tuberculosis, STD and HIV/AIDS and other infectious diseases). This includes USD 3.9 billion of expenditures by private philanthropic foundations, including USD 1.9 billion on infectious disease control. TOSSD for health amounted to USD 25 billion in 2019, including USD 21.5 billion through cross-border flows to developing countries and USD 3.5 billion through global and regional support to international public goods and global challenges. TOSSD for infectious disease control amounted to USD 10.7 billion, with USD 9.8 billion in the form of cross-border flows to developing countries and USD 930 million in the form global and regional expenditures. It should be noted that because TOSSD is a new statistical measure, its data coverage has not yet reached its full potential but will improve over the next few years. In addition, the CRS and TOSSD databases also track support for animal health, although these data are not included in the figures stated above.

In light of current and future global health security risks, there is increasing demand to improve the tracking of financial contributions for pandemic preparedness and response, especially given the push for scaled up investments in this area. The TOSSD Task Force has already started to discuss more targeted tracking methods for PPR, for example through the use of a cross-sectoral keyword. In parallel, the OECD is also looking to advance discussions on tracking PPR flows in the context of the CRS. Noting the challenges in defining PPR, these efforts would involve further consultations with relevant global bodies, in particular the Global Preparedness Monitoring Board (GPMB).

ANNEX C | Three broad pathways to address financing gaps

1) Selectively augment resources of existing institutions to support PPR investments

Description:
The existing PPR financing gap could be addressed by increasing investments in priority areas through selectively augmenting funding for existing institutions. This would enable existing institutions to further strengthen their individual PPR footprints and collectively address a substantial share of the PPR needs.

Effectiveness:
This option neither structurally addresses critical gaps in today's PPR financing landscape nor does it offer the opportunity to leverage non-ODA resources or incentivize additional global public good investments. Furthermore, it creates incentives for each institution to launch its own (competing) fundraising campaign, doing little to address the coordination challenges in the PPR space. Consequently, this option leaves the risk that urgent PPR priorities remain under- or too slowly funded, as exposed during the COVID-19 pandemic.

Feasibility:
Since this option does not represent a shift from current practices, it would not entail implementation challenges.

2) Establish a new, dedicated stream of additional, catalytic international financing for PPR, that can be channeled through existing institutions (e.g., 'fund of funds')

Description:
A new "fund of funds" would provide a dedicated stream of funding for PPR interventions, while offering the flexibility to work through a variety of existing implementing partner institutions, drawing on their comparative advantages. Further, it would allow non-ODA resources to be mobilized. Key principles would include: i) complementarity with existing international financing and fundraising efforts, ii) helping to improve coordination of support, iii) leveraging existing implementing partners; iv) ensuring early and extensive involvement of recipient countries and regional institutions, including to define fit-for-purpose institutional arrangements for addressing PPR gaps at country, regional and global levels. It could support both the country-specific and global public goods aspects of PPR.

Effectiveness:
This approach would offer a comprehensive and agile solution to addressing the identified PPR financing gap. Through a 'fund of funds', gaps in today's PPR financing landscape can be filled and catalytic investments of various kinds can be supported to more flexibly address PPR priorities. Further, it would enable a swifter response to urgent needs without requiring additional fundraising or newly arranged partnership models each time a new crisis strikes.

Feasibility:
Implementing this option requires establishing a new financing mechanism but this can be done quickly and cost-effectively by leveraging existing know-how and expertise.

3) Consolidate existing agencies, funds & programs

Description:
A consolidation of the PPR functions of various existing, dedicated global health financing institutions into a single entity.

Effectiveness:
This could enable simplified management and coordination of international investments in PPR, enabling the continuous monitoring of progress and flexible (re-)prioritization of funds.

Feasibility:
Establishing a new institution of this scope and size introduces substantial transaction costs and complexity. This would imply a far-reaching restructuring of the global health financing architecture as in many organizations PPR support is currently integrated in broader health systems strengthening or disease-specific programs. Such large change in operating model would present practical implementation challenges. Further, it would still leave open the question of coordination between any new consolidated entity, existing institutions, and the MDBs, some of which play a significant role in PPR financing.