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

Prepared for the G20 Joint Finance & Health Task Force

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Key messages:

1. A global **Pandemic Preparedness and Response (PPR) architecture consists of five sub-systems** that are interlinked and must be deployed at national, regional and global level:
    - Surveillance, collaborative intelligence, and early warning
    - Prioritized research and equitable access to 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 case for investing in PPR is clear. The **frequency and impact** of pandemic-prone **pathogens are increasing**. **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. Such investments will also help address long-standing challenges that are key drivers of mortality today, including HIV/AIDS, tuberculosis, malaria and anti-microbial resistance.

3. The total annual financing need for the future PPR system is **estimated at US$ 31.1 billion**, 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 to fund a fit-for-purpose PPR architecture.
    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 annual financing needs are estimated to be in the order of US$ 16.2 billion per year, with a gap of at least **US$ 7.0 billion** to be covered by international financing.
    b. Meeting the annual financing gap for the global and regional components of the PPR architecture is estimated to require in the order of **US$ 3.5 billion per year**.

4. The COVID-19 crisis has shown **the need to invest more in PPR. Further, the world currently lacks the capacity to coordinate the magnitude of funds required to fill critical gaps in PPR. Three high-level approaches, which are not mutually exclusive,** provide possible solutions:
    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 strengthen PPR in a way that brings the most added value for both contributors and recipients (e.g., a pooled fund);
    c. Establish a new agency to consolidate the necessary fiduciary capacity and legal, administrative, and technical expertise (limited feasibility in the short to medium term).

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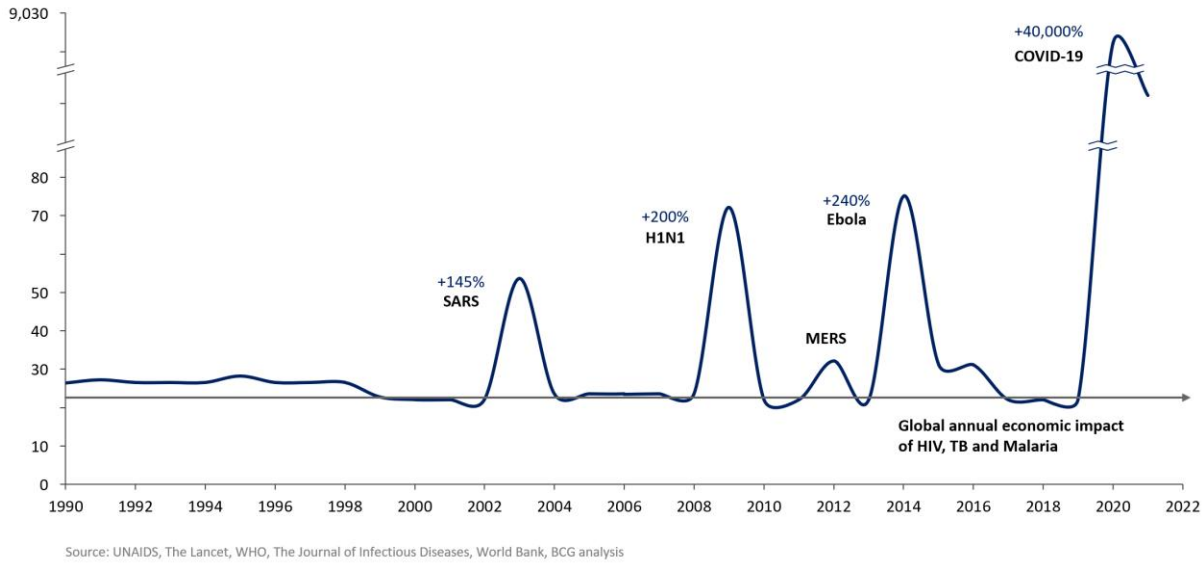
A | Context and scope

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 to 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).

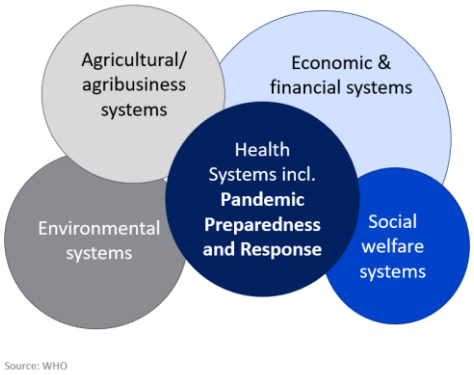
Figure 1. Economic impact of selected outbreaks over past 30 years (in US$ billion)



Source: UNAIDS, The Lancet, WHO, The Journal of Infectious Diseases, World Bank, BCG analysis

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 yielded more than 200 individual recommendations[1]. In broad terms these recommendations can be mapped to the three pillars of the global architecture of pandemic preparedness and response: systems, financing, and governance. The experience of COVID-19 has shown that each of these three pillars must be built on the foundational principles of equity, inclusion 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.

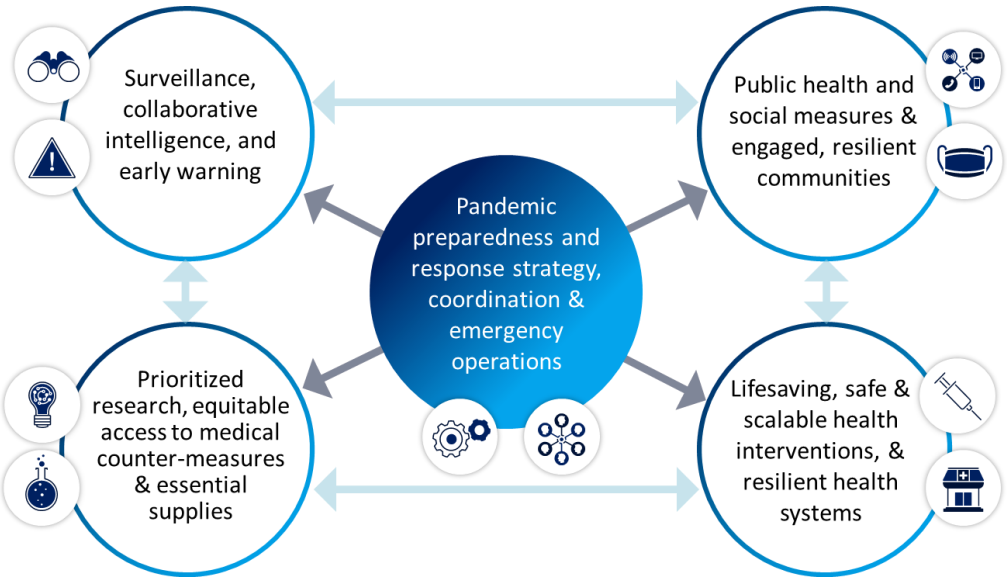
B | Pandemic preparedness and response: systems and architecture

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**, and **emergency operations**

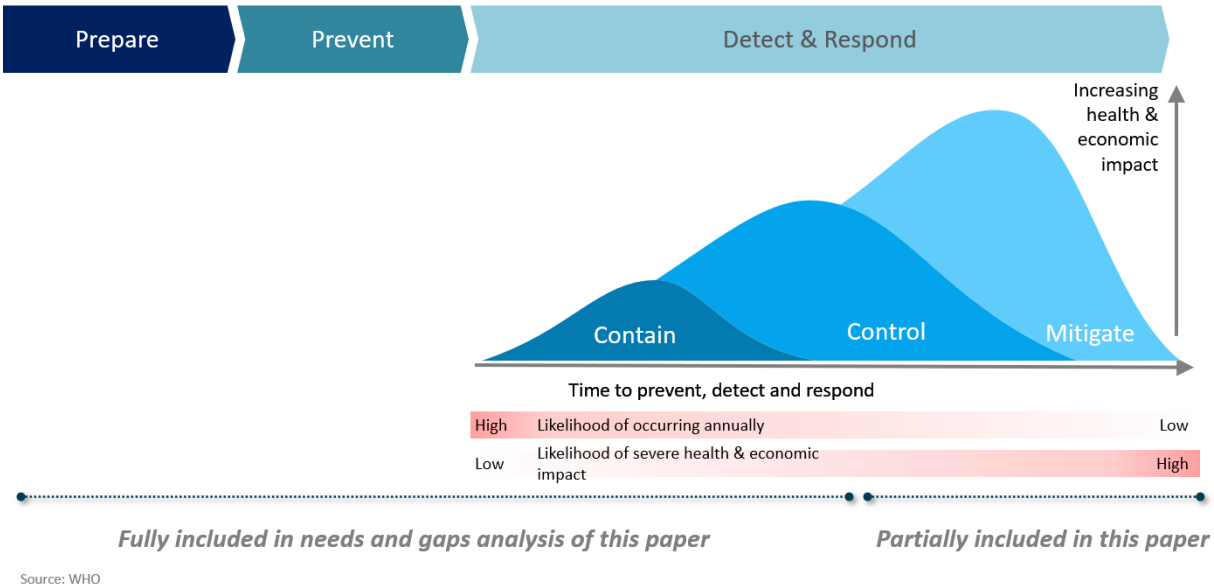
[1] For example see the WHO's dashboard for recommendations. It aggregates data from official reports by Member States, documents placed in the public domain by intergovernmental bodies, non-papers submitted by Member States, as well as other reports or papers published by recognized independent expert parties

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



Source: WHO

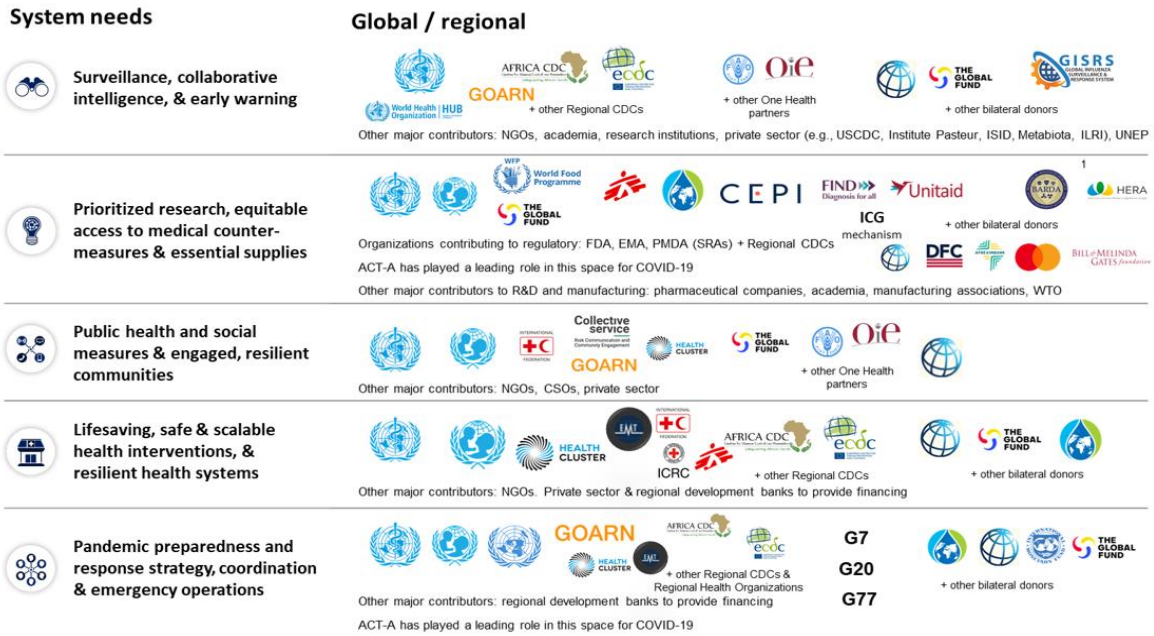
There is also a temporal dimension: the constituent parts of each core element take on different roles and functions at each step of the health emergency continuum from preparedness, through prevention, readiness, detection, and response. Response may be further subdivided into several phases depending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

containment to control and mitigation (Figure 4). All five subsystems and the connections between them are essential to PPR. Broadly speaking, however, it is true to say that effective surveillance, coordination, and equitable access to effective countermeasures are not only the core fundamentals of an effective national response, but also yield the greatest ancillary benefits to regional and global pandemic preparedness and response.

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 have produced a pandemic preparedness and response architecture that has failed to realize its potential. COVID-19 also exposed the absence of essential systemic elements (such as the absence of a global institute with oversight of the development of therapeutics for pandemic preparedness and response) 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.

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 5 shows a mapping of the key global institutions with a remit in each of these pandemic preparedness and response subsystems.

Figure 5. Mapping of the pandemic preparedness and response ecosystem (non-exhaustive)



C | PPR financing needs and gaps

COVID-19 has demonstrated 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, at what scale, and with what tools, and it is predicated on long-term investments in prevention and preparedness. The COVID-19 pandemic exposed weaknesses in many aspects of disease surveillance in almost all countries, in the ability of countries to coordinate and implement public health and social measures at scale, in the resilience of health systems, and in the world's ability to equitably distribute effective countermeasures and other essential commodities. In all cases, dedicated investments will be needed to ensure that high-risk populations, especially in fragile contexts, are not excluded from improved pandemic preparedness and response.

In this section we estimate the total amount of funding the future pandemic architecture would require at the national, regional and global level (the financing needs), and we estimate how much of this need would have to be financed by the international community (the financing gaps).

C1. Local and national level needs and gaps

The five-subsystems framework of WHO builds on 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[2]. These benchmarks – and in some cases other related standards – form the basis for assessing both technical gaps in national capacities and associated financing gaps. To reflect on the learnings of the last 17 years of outbreaks and pandemics, WHO has built on the concepts of IHR to outline an overarching PPR architecture built on five essential subsystems (figure 3; more detail on the IHR benchmarks and the five subsystems can be found at the end of Annex A).

[2] 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.

Assessing country financing needs from the bottom up

One approach to assessing financing needs is to build on country-level PPR assessments (voluntary Joint External Evaluations (JEEs) and IHR State Party Self-Assessment Annual Reports (SPAR)), and the associated processes to cost investments and activities required to address critical gaps. National Action Plans for Health Security (NAPHS), 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 how recurrent needs 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	Kenya	Nigeria	Cameroon
Cost of achieving core PPR capacities, including expanded workforce	0.02	0.07	0.19	4.35	2.95	3.01

Source: Compiled by the World Bank based on publicly available data from National Action Plans for Health Security framework of WHO.

From country assessments to aggregate 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 analyses differ in scope, methods, and assumptions, and hence offer a range of estimates. However, based on a recent systematic review of ten key studies of the financial needs for improving PPR, several important conclusions emerge.[3] In particular:

- The estimated needs per capita per year to achieve benchmark levels ranges 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 needs are higher in LICs and LMICs than higher-income countries given lower baseline capacities and associated needs for frontloaded capital investments.
- Most needs estimates are based on a One Health approach but vary in scope. AMR is often excluded entirely, and the scope of zoonotic prevention and detection activities is inconsistent.

[3] 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 the review by Clarke et al and prior costing analyses, 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",[4] published in June 2021, as well as the McKinsey & Company publication "Not the last pandemic: Investing now to reimagine public-health systems"[5] from May 2021, to provide estimates of needs and gaps 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 items were removed, introducing a first level of prioritization. A breakdown of the five subsystems and what is included in cost estimates 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 above-mentioned adjustments to the selected papers, the revised country-level PPR financing needs are estimated at US$ 26.4 billion per year (see Table 2 below). These estimates are in line with the values outlined in the G20 HLIP and within the range of needs that emerge from the review of a broader set of studies and NAPHSs.

Table 2: National level financing requirements of the PPR architecture by income group (in US$ billion)

PPR framework subsystems	Estimated national-level priority needs (US$ billion)			
	LIC	LMIC	UMIC	Total
1) *Surveillance, collaborative intelligence and early warning*	1.3	6.2	4.7	12.2
2) *Prioritized research and equitable access to medical countermeasures and essential supplies*	0.2	1.0	0.8	2.0
3) *Public health and social measures and engaged, resilient communities*	0.5	2.5	1.8	4.8
4) *Lifesaving, safe and scalable health interventions and resilient health systems*	0.5	2.8	2.1	5.4
5) *PPR strategy, coordination and emergency operations*	0.2	1.0	0.8	2.0
Total	**2.7**	**13.5**	**10.2**	**26.4**

The biggest drivers of these needs are "surveillance, collaborative intelligence, and early warning" (US$ 12.2 billion); "public health and social measures and engaged, resilient communities" (US$ 4.8 billion); and "lifesaving, safe and scalable health interventions and resilient health systems" (US$ 5.4 billion). Smaller annual investments of US$ 2.0 billion each are needed for "equitable access to specialist medical supplies and countermeasures" and

[4] G20 High-Level Independent Panel report "Financing the Global Commons for PPR" available at https://pandemic-financing.org/report/foreword/

[5] McKinsey & Company publication "Not the last pandemic: Investing now to reimagine public-health systems" available at https://www.mckinsey.com/industries/public-and-social-sector/our-insights/not-the-last-pandemic-investing-now-to-reimagine-public-health-systems

"PPR strategy, coordination, and emergency operations". The US$ 26.4 billion need is unevenly distributed across income groups (see Table 2).

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

As with the estimation of PPR needs, data limitations make the estimation of PPR financing at national level challenging. In the case of domestic financing, National Health Accounts currently do not identify PPR spending as part of broader health spending and are 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 an 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 (see Table 3), which suggests a range of 1–3%.[6]

Table 3: National health and PPR spending estimates

Income group	Dom. govt. exp. on health (US$ per capita)	Domestic PPR spending per capita in US$	
		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.

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 national budgets, significant gaps will remain over the medium term, in particular in the current fiscal context.

[6] Outliers at 5% of healthcare spend into PPR also exist. The paper used the 1-3% range as this is consistent with a review by McKinsey & Company. For example, 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.

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 the Organisation for Economic Co-operation and Development .

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

To estimate the degree of international financing required for national needs, we make the following two assumptions: i) national governments invest between 1% and 3% of their healthcare spending on PPR; ii) there is currently a substantial amount of international financial support going towards national level PPR, with the amount decreasing with increasing income per capita. In our model LICs are currently supported by international

financing at 100% of their needs, while LMICs are supported for up to 60%, and UMICs up to 20% of their needs[7].

Leveraging these assumptions, gaps are calculated in two steps: first, the total international and domestic financing required per country income group is assessed (as per assumption ii above); second, current domestic funding (based on assumption i) is taken into account. If the country group already spends more than the domestic financing required as calculated in the first step, the international funding gap is reduced by the excess amount; if the country income group spends more than the cumulative international and domestic funding requirement, the gap is considered nil. The result of this calculation is shown in Table 4[8].

Table 4: International financing gap for national needs assuming 1% or 3% domestic spend on PPR and differentiated support by income group

PPR framework subsystems	Estimated national-level priority needs (US$ billion)	Minimum priority gaps assuming 1% spend on PPR[9] (US$ billion)	Minimum priority gaps assuming 3% spend on PPR[8] (US$ billion)
1) *Surveillance, collaborative intelligence and early warning*	12.2	4.3	3.2
2) *Prioritized research and equitable access to medical countermeasures and essential supplies*	2.0	0.7	0.5
3) *Public health and social measures and engaged, resilient communities*	4.8	1.7	1.2
4) *Lifesaving, safe and scalable health interventions and resilient health systems*	5.4	1.9	1.4
5) *PPR strategy, coordination and emergency operations*	2.0	0.7	0.5
Total	**26.4**	**9.3**	**7.0**

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. Our analysis highlights the need to both increase international financing for core PPR

[7] Consistent with approach for The Global Fund as well as with the 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

[8] Detailed breakdown of funding flows is available in Section D

[9] Assumes the international community will finance LICs up to a 100%, and LMICs up to 60%. UMICs have the capacity to self-finance their complete need, and as such are not shown on the table as having to rely on international financing for national needs.

functions to address the gaps highlighted above, and to leverage funding for health systems strengthening and disease control programs to strengthen PPR. Such leveraging is already happening to some extent – for example, the Global Fund has provided significant support to surveillance and laboratory capacity, with its funding that targets malaria, HIV, and tuberculosis programmes.

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 strengthen national surveillance systems, link the systems across all 3 levels, prioritize research and enable equitable access to countermeasures and essential supplies, support public health and social measures with engaged communities, deploy lifesaving safe and scalable health interventions within resilient health systems, develop and coordinate PPR strategy, and run global emergency operations.

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 in keeping with 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. The global health architecture also needs to be empowered and enabled to set global standards on risk assessment and vulnerability mapping.

Ad hoc and time-limited global initiatives were put in place to meet the urgent needs of COVID-19 for mechanisms to prioritize and incentivize research and development, rapidly scale the manufacturing of countermeasures, and procure these tools at scale to ensure equitable access. The COVID-19 pandemic has also once again underlined the value of a globally networked corps of professional 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 established. 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, these was also the emergence of new, pooled procurement mechanisms such as COVAX and the African Vaccine Acquisition Trust (AVAT) for vaccines, as well as regional platforms for the procurement of other medical countermeasures, such as the Africa Medical Supplies Platform (AMSP).

In this landscape of institutional change and innovation, and of multiple ongoing or planned fundraising efforts, estimating and addressing financing gaps is fraught with challenges.

Nonetheless, there are critical unmet funding needs, these needs are 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 US$ 8bn of financing per year is needed for PPR at global level. Since the HLIP report was prepared, there have been many significant developments and fundraising efforts in this area. 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 United Kingdom and Wellcome Trust. There have been important advances in regional surveillance and genomics in Africa. CEPI published its new replenishment target of US$ 3.5 billion 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 International Finance Corporation's (IFC) Global Health Platform. The ACT-Accelerator was established in April 2020 and launched its most recent fundraising campaign in February 2022.

At the same time, the COVID-19 pandemic has demonstrated the important role 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. Addressing 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 towards preparing the world for the next pandemic. Institutions such as these will require significant funding support.

Mechanisms to fund global PPR needs exist, but need further strengthening

To estimate this global need, our analysis followed the same approach as for the estimation of national needs, leveraging existing studies on PPR financing as outlined in Annex A to prioritize essential components of PPR at global level. To enable an easier overview, regional level needs are not shown separately, but are included in global numbers (e.g. regional manufacturing hubs are accounted for as part of global need). Our high-level estimate of these prioritized needs amounts to an annual investment of US$ 4.7 billion (Table 5).

To estimate the global gap for international financing we assumed that existing institutions and funding mechanisms have the capacity to contribute approximately 25%[10] of the need based on current trends, leaving an estimated potential annual international funding gap of US$ 3.5 billion.

[10] Conservative estimate based on pre-pandemic PPR spend as outlined in annual reports of CEPI, FIND, GAVI, The Global Fund, UNICEF, WHO

Table 5: Global needs and international funding gaps assuming 25% contribution from existing institutions and funding mechanisms based on current trends

PPR framework buckets	Estimated global level priority needs (US$ billion)	Minimum global level priority gaps (US$ billion)
1) Surveillance, collaborative intelligence and early warning	1.2	0.9
2) Prioritized research and equitable access to medical countermeasures and essential supplies	1.8	1.3
3) Public health and social measures and engaged, resilient communities	0.7	0.5
4) Lifesaving, safe and scalable health interventions and resilient health systems	0.6	0.5
5) PPR strategy, coordination & emergency operations	0.4	0.3
Total	**4.7**	**3.5**

C3. Summary of overall PPR needs and international financing gaps

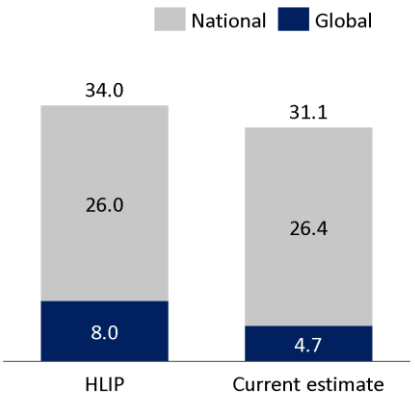
A high-level estimate of overall PPR needs and gaps is given in Table 6.

Table 6: Overall PPR needs and gaps

PPR framework buckets	Estimated PPR financing needs (US$ billion)	Minimum priority PPR financing gaps[11] (US$ billion)
1) Surveillance, collaborative intelligence and early warning	13.3	4.1
2) Prioritized research and equitable access to medical countermeasures and essential supplies	3.7	1.8
3) Public health and social measures and engaged, resilient communities	5.5	1.8
4) Lifesaving, safe and scalable health interventions and resilient health systems	6.1	1.9
5) PPR strategy, coordination and emergency operations	2.5	0.9
Total	**31.1**	**10.5**

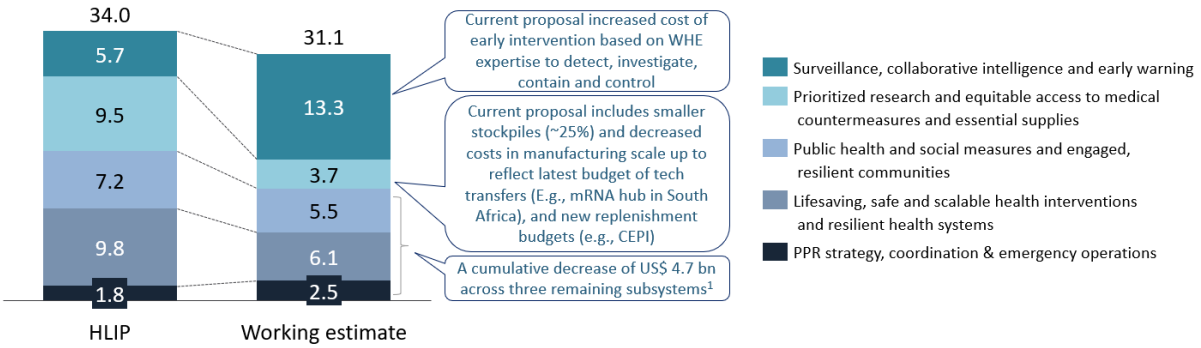
[11] Overall PPR gap shown assumes 3% of domestic healthcare spend invested in PPR

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



These estimates are in line with the values outlined in the G20 HLIP report (Figure 6). A comparison of the two analyses, broken down by subsystem, is shown in Figure 7. As the breakdown shows, there are two areas where there are substantial differences in the estimated needs: surveillance and early intervention, and prioritized research and development and equitable access to countermeasures. This analysis estimates these greater needs for surveillance based on an analysis of WHO's World Health Emergencies Programme. The current analysis also estimates substantially lower needs for research and countermeasures than did the G20 HLIP, with the difference largely driven by a smaller estimated need for countermeasure stockpiles and decreased costs for manufacturing scale-up based on the experience of the ACT Accelerator. Of note, the original HLIP data are split across three cost categories rather than the five subsystems of the PPR architecture. HLIP data were mapped to the five subsystems architecture through a line-by-line cost item analysis with the help of the team that worked on the HLIP.

Figure 7: Detailed cross walk between HLIP and current analysis in US$ billion



1. For PHSM and Communities: decrease of US$ 1.7 billion due to some activities being reassigned to surveillance based on WHO/WHE expertise; Health interventions and resilient health systems: decrease of US$ 3.7 billion as the working estimate employs more targeted initiatives during response phase as per WHO/WHE expertise; PPR strategy, coordination & emergency operations: increase of US$ 0.7 billion due to an increased focus on coordination in response phase based on WHO/WHE expertise

This analysis of the financing needs and international financing gaps builds on a body of work that has attempted to evaluate the total cost for PPR. A more precise estimation of needs and gaps, as well as by subsystems, will continue to evolve as priorities change and investments in PPR are made.

C4. The case for addressing these financing gaps is clear

The intensification of, and interaction between, factors such as ecological degradation, climate change, conflict and resource competition, mass population movement and displacement, urbanization, global travel and trade, and changes in agricultural practices continue to multiply the risks of emergence and re-emergence of epidemic and pandemic threats. Outbreaks of high-impact pathogens arise not only as a result of contact between

people, but increasingly as a result of the complex web of interactions between people, wild animals, domesticated animals, and the environment. Modeling suggests that the probability of a zoonotic event in which a pathogen with a pandemic potential similar to SARS-CoV2 jumps from another species into humans is between 2.5% and 3.3% annually, putting the chances of a similar outbreak between 47% and 57% within the next 25 years.[12]

It is a certainty that new pandemic threats will emerge with the potential to exact a cost even greater than that due to COVID-19. Calculating the potential return on investment in a PPR architecture capable of preventing and effectively responding to such pandemic threats is complex, but a team from Imperial College London has built a scenario model based on epidemiological and economic data to project the deaths and short-term GDP loss associated with future pandemics. To account for the fact that future threats might look and act differently from SARS-CoV-2, their scenarios included three other potential respiratory pathogens: Spanish flu-like, SARS-like, and Swine flu-like. They then modelled various outbreak mitigation strategies (unmitigated, full lockdown, and reactive closures) for each type of pathogen across four G20 countries (USA, UK, China, India). The Imperial team concluded that PPR is a highly cost-effective investment for protecting both health and economic well-being. Depending on country level baseline health spending and mitigation strategies, deaths averted average between 40 and 124 per 100 000 population. In financial terms, taking the US as an example, the model estimates that for every US$ invested in PPR, countries can expect a health gain to the value of US$ 1703 and an expected economic gain to the value of US$ 1102[13]. This is a return several orders of magnitude greater than traditional population-level health interventions such as seasonal influenza vaccination or lead paint control. Across all traditional measures every US$ 1 invested yields a median of US$ 14, based on a systematic review of relevant studies[14].

D| Financing sources, flows and mechanisms

D1. Methodology and quantification

To estimate the amount of funding flowing into PPR by source or mechanism, we took the following steps:

- First, funding sources were identified
- Second, a custom analysis, described below, was developed for each funding source
- Third, based on the custom analysis, flows from each source were calculated.

[12] Based on "What's Next? Predicting The Frequency and Scale of Future Pandemics" presentation by Metabiota held in July 2021 moderated by the Center for Global Development, available at https://cgdev.org/event/whats-next-predicting-frequency-and-scale-future-pandemics

[13] Based on "What is the Return on Investment of Pandemic Preparedness" presentation by Jameel Institute at Imperial College London held in October 2021 moderated by the Center for Global Development, available at https://www.cgdev.org/event/what-return-investment-pandemic-preparedness

[14] Rebecca Masters, Elspeth Anwar, Brendan Collins, Richard Cookson, and Simon Capewell "Return on investment of public health interventions: a systematic review" https://jech.bmj.com/content/71/8/827

For all financing sources and flows the approach only considered activities which constituted core PPR work and excluded those which were only 'PPR adjacent'. A summary of all estimates follows in section D2.

For the purposes of our analysis, we used the following definitions: "financing sources" are where the money originates from; "financing flows" are the vectors of money capturing magnitude and direction; "financing mechanisms" are the institutions that can oversee these flows.

Domestic resources and multilateral development bank (MDB) financing

For the purposes of this analysis, we defined domestic resources as all national spending that goes into PPR. To estimate domestic resources, our analysis assumes that 3% of healthcare spend goes into PPR (as outlined in section C1). While MDBs are not a domestic financing mechanism, potential MDB funding that is made available to countries to help fund PPR is reflected together with domestic financing in this analysis for simplicity of presentation and because projects funded by MDBs[15] rely on plans jointly developed by the respective country and the supporting development bank (regardless of whether the project had been initially proposed by the country government or MDB) with MDB funding disbursed only once the investment had been evaluated and jointly appraised. Combined, this translates into US$ 14.1 billion of existing domestic and MDB flows.

Bilateral aid

For the purposes of this analysis, we defined bilateral aid to be funding flowing directly from one country to another. To quantify the amount of bilateral aid invested for core PPR funding, the proposal relied on two different data points: first, a bottom-up estimation of core PPR funding being 5-10% of the total US$ 22.4 billion in bilateral ODA for Health pre-COVID-19, based on OECD data. Second, a World Bank estimate that 1-2.5% of total US$ 40 billion Development Aid for Health (DAH) is being directed at PPR activities. The former yields US$ 0.8-1.6 billion, the latter US$ 1 billion, so a conservative estimate of US$ 1 billion was taken[16].

Multilateral aid

For the purposes of this analysis, we defined multilateral aid as funding that flows through multilateral financing mechanisms, which in the context of PPR primarily refers to health agencies. We estimated PPR-related flows based on a review of agency strategies and their respective annual funding. A share of annual agency funding was taken as core PPR flow in proportion to the share of objectives that were relevant for core PPR. This translates into multilateral aid of US$ 0.6 billion[17].

Targeted pooled mechanisms (with a specific epidemic/pandemic focus)

For the purposes of this analysis, we defined pooled mechanisms as funds and health agencies that focus on specific epidemics and pandemic response. To quantify the investments made

[15] MDB funded projects may include both policy lending and investment lending
[16] This is based on averaged data for 2018-2019 and assuming no major pandemic event
[17] Examples for health agencies included: UNICEF, GAVI, FIND, Unitaid and others. The estimate is based on averaged data for 2014-2019 and assuming no major pandemic event

by these mechanisms towards PPR, two methods were used: first, when available, public data on pledges and contributions made to these funds and agencies for PPR was leveraged. This informed our understanding of the magnitude of resources in FIFs and trust funds that is focused on PPR (e.g. the Pandemic Emergency Financing Facility (PEF)[18], the Health Emergency Preparedness Trust Fund (HEPRTF)) and others which include some elements of PPR in their mandate (e.g. Catastrophe Containment and Relief Trust Fund (CCRT) and the International Finance Facility for Immunization (IFFIm)). Secondly, and similar to our approach to multilateral aid, we estimated PPR-related flows based on a review of fund or agency strategies and their respective annual funding; a share of the annual funding was taken as a PPR-related flow in proportion to the share of objectives that were relevant for core PPR. This translated into US$ 1.4 billion of targeted pooled mechanisms[19].

Private sector

For the purposes of this analysis, we defined private sector funds to be private contributions pledged in the context of fundraising for PPR. Recent private sector support to PPR R&D is considered as one-off and driven by COVID-19, and therefore is excluded. Support provided through pooled mechanisms (e.g. FiFs) is also excluded. To quantify this flow, we analyzed health agency and fund donation sources. For those with available data, the portion of their yearly funding from private sources[20] was identified. The median share of private contributions was 11%. This was then applied to current existing PPR funding flows (including both global and national) to derive private sector flows. This yields US$ 1.6 billion of private sector flows directed towards PPR[21].

Philanthropy and other sources

For the purposes of this analysis, we defined funds from philanthropy and other sources to be flows from foundations or other charitable organizations/individuals that are spontaneous donations in support of PPR. Public declarations of the largest foundations were analyzed to understand their extraordinary contribution to PPR, meaning donations that were not part of their regular funding of existing work that agencies/funds were already doing or fundraising for. This translated into US$ 0.2 billion in spending from philanthropy[22].

D2. Summary of results

A high-level breakdown of sources and flows that support national and global PPR is shown in Figures 8 and 9, respectively. These figures summarize the results explained in section D1. Existing financing flows are in blue; flows that are not yet funded (i.e. gaps) are in yellow.

[18] PEFF closed as of mid-2021. It was used to develop our understanding of the magnitude of resources that FIFs and trust funds contributing to PPR have had historically

[19] Examples beyond those mentioned in the main text: CEPI, Global Fund. Estimate is based on averaged data for 2014-2019 for all actors except CEPI (note: CEPI has published a new 2022-26 strategy detailing PPR spending) and assuming no major pandemic event

[20] For instance: “La Caixa” Foundation, ELMA Vaccines and Immunization Foundation, Mastercard, Toyota, Tiktok, Spotify

[21] This is based on data ranging from 2016 to 2021 and assuming no major pandemic event

[22] This is based on data published so far in 2022 (incl. BMGF, Rockefeller Foundation)

Please note that flows, both funded and unfunded, to individual subsystems are based on the pro-rata share of that subsystem of the total PPR architecture.

Figure 8[23]: National PPR needs and gaps breakdown by funding avenues in US$ billions

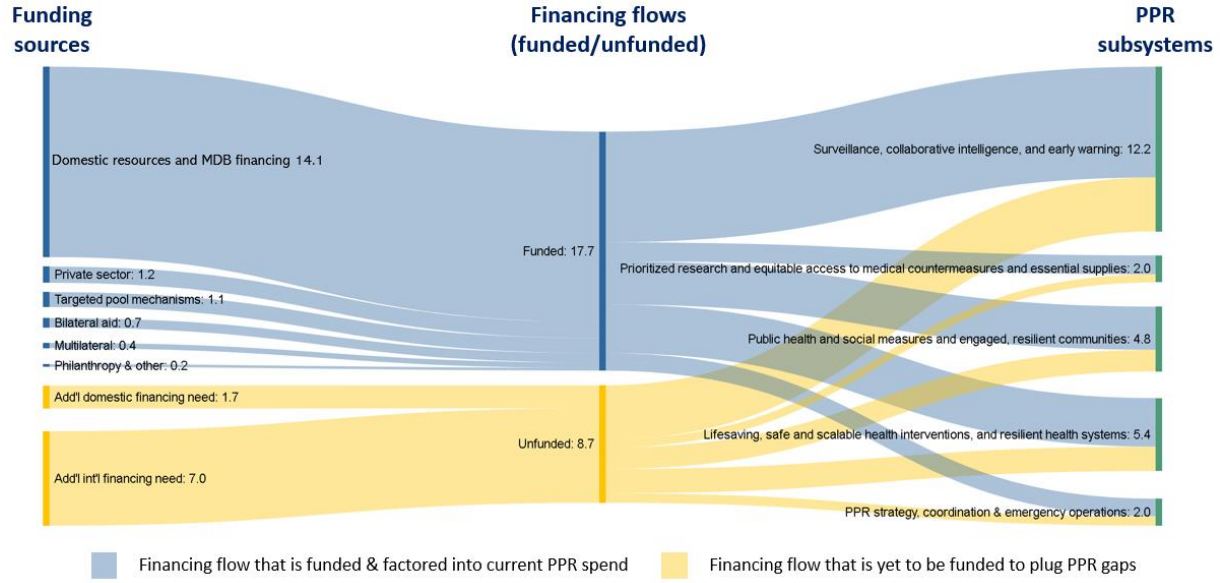
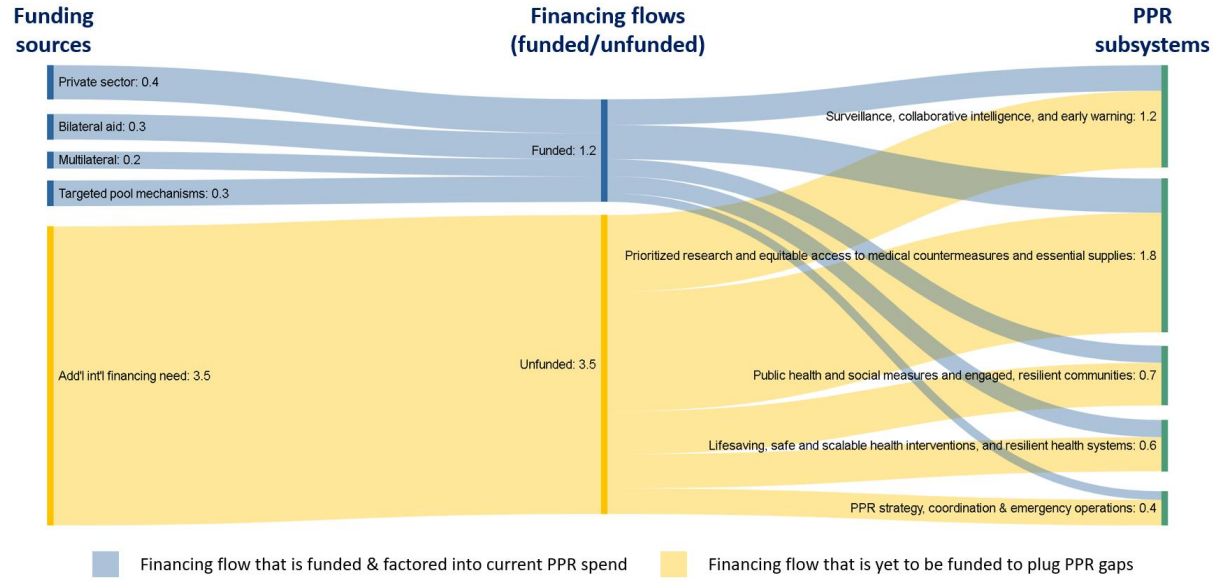


Figure 9: Global PPR needs and gaps breakdown by funding avenues in US$ billions



Several limitations to any analysis of international financing sources and flows should be noted. There is a lack of agreement on what should be considered spending on core PPR, as opposed to disease-specific programs or broader health system strengthening. Issues also

[23] Note: The international funding gap for national needs is US$ 7 billion. The unfunded flows shown in the figure also include US$ 1.7 billion in additional domestic financing, as LMICs are expected to be financed at up to only 60% of their needs by the international community.. For more detail please refer to the sections on national level needs and gaps,

arise in tracking international financing for PPR, including a lack of consistent coding of PPR financing, inconsistencies of inclusion in key databases, and lags in reporting. As a result of both scope and data issues, estimates of financing flows can vary quite considerably.[24] The estimates shown are in line with ranges presented in other research.

D3. Assessment of selected mechanisms that could be used to address gaps in PPR financing

The Global Health financing landscape is populated with many different actors, both public and private. Here we only outline international mechanisms with direct relevance for closing the PPR gaps outlined in section C of this document – three broad categories, though non-exhaustive, provide an accurate overview of the main options for PPR financing. As other sources shown in D1. and D2. would not be able to address the identified gap sustainably and systematically and at scale, they are not included in this section.

Multilateral Development Banks (MDBs)

MDBs provide grants as well as low-interest or concessional loans to countries, in the context of specific development programs. Eligibility for these programs varies, but it is generally dependent on a set of criteria, including relative poverty, and a lack of creditworthiness to borrow on market terms resulting in a need for concessional resources to finance development programs. Though national and regional development banks (e.g. African Development Bank, Asian Development Bank) can play a role in financing PPR initiatives, the field is dominated by the World Bank. A specific characteristic of MDB financing mechanisms is the country 'demand-driven' allocation of funding to governments. MDBs today are an important mechanism to help with financing of PPR needs identified and prioritized at country-level.

While the core funding mechanisms of development banks are best suited to support country or regional level investments, MDBs also host pooled mechanisms that can support public goods at the global level. For example, the World Bank hosts Financial Intermediary Funds (FIFs) and Multi-donor Trust Funds that can support country, regional and global level investments in public goods (see below). The private sector arms of MDBs, like the IFC, are designed to support market creation through investments in the private sector.

Pooled Funds

Pooled funds act as intermediaries between donating and receiving parties, raising and allocating money towards specific activities. They are generally financed through cyclical replenishments (annual or multi-year) or through innovative financing instruments (e.g. state-guaranteed bonds). Funds usually do not implement the programs they help finance, and

[24] Sections D1. and D2. draw on analysis by McKinsey ("Not the last pandemic: Investing now to reimagine public-health systems") 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.

have limited oversight powers after transactions have been completed. To be approved for funding, countries and implementing partners must apply to specific programs and demonstrate eligibility. This process can be time consuming, which is a crucial flaw when trying to respond to health emergencies. While there are several small to middle-sized funds (e.g. CCRT, PEF, IFFIm), as well as a few larger, centralized actors (e.g. Global Fund, GAVI, CEPI) with mandates that partially address PPR financing priorities, there is no single fund that could comprehensively and systematically address the broad range of PPR financing needs. As a result, countries and implementing partners need to navigate a complex, often fragmented web of funds to unlock financing for individual PPR priorities.

Health Agencies

Health agencies are defined as specialized actors who focus either fully or in part on the Global Health agenda. Based on this definition various health agencies allocate substantial financial resources on issues that help address critical PPR priorities. As a fundamental player in and coordinator of the Global Health agenda, WHO plays a critical role in PPR. WHO's work is supported by other UN agencies, such as UNICEF, civil society and other organizations. Nevertheless, at this stage no health agency, including WHO, comprehensively addresses the full spectrum of PPR activities and priorities. Insufficient strategic and operational PPR coordination results both in structural gaps in certain areas and in duplication of efforts in others[25].

In summary, today's PPR financing landscape relies on a broad range of mechanisms that contribute to addressing critical PPR priorities. At the same time, the above-mentioned shortcomings of these financing mechanisms means that there is not a fit for purpose mechanism to support PPR strengthening in a coordinated and flexible way. The high degree of fragmentation among different actors creates operational and bureaucratic complexities, while preventing a systematic, comprehensive approach to PPR. To sustainably strengthen global PPR, shortcomings need to be addressed across all entities, including existing actors and any new ones that are created as the Global Health Architecture for Health and Pandemic Emergencies is strengthened.

[25] This section includes UN agencies such as WHO, UNICEF, UNFPA, UNAIDS as well as UNITAID (Secretariat hosted at WHO). Based on the definition in the main text health agencies can also include bilateral agencies such as USAID, or national/regional agencies such Centers for Disease Control and Prevention (e.g., US CDC, EU CDC). Civil society organizations involved in the Global Health agenda include for instance Doctors Without Borders (Medecines Sans Frontieres, MSF), and the International Red Cross and Red Crescent Movement. Note, based on their activity, large sized centralized pooled fund actors such as the Global Fund, CEPI and GAVI can also be considered health agencies.

E | Options for strengthening PPR and closing the priority financing gaps

Three potential approaches to strengthen PPR and address financing gaps

The analysis above points to significant structural challenges of PPR that need to be addressed across the five critical subsystems at all levels (national, regional, global), alongside systemic improvements in financing. In a resource-constrained environment, it is vital for scarce donor funding to be channeled optimally to achieve the greatest impact.

Addressing the above-outlined US$ 10.5 billion priority financing gap for PPR will require efforts across multiple fronts. Three high-level options have been identified, which are not mutually exclusive:

1) Selectively augment the resources of existing institutions/mechanisms to support PPR
2) Establish a new, dedicated stream of additional, catalytic international financing for PPR, that can be channeled through existing institutions (e.g., a pooled fund)
3) Establish a new PPR financing agency with the necessary fiduciary capacity and legal, administrative, and technical expertise

1) Selectively augment the resources of existing institutions/mechanisms to support PPR

Description:

The existing PPR financing gap could be addressed, at least in part, by selectively augmenting funding for existing institutions that directly or indirectly address PPR needs. For instance, this could entail increased funding for WHO, the Global Fund, CEPI, GAVI, UNICEF, FIND and related organizations; increased funding for multipurpose institutions such as the UN's Central Emergency Response Fund (CERF), so that it could provide more financing for response; increased funding for existing PPR-focused trust funds, like the World Bank's HEPRTF to support low-income and low PRR capability countries. This would enable these institutions/mechanisms to strengthen their individual PPR footprints and collectively address a substantial share of the PPR needs. Some of these institutions (e.g. Global Fund, CEPI) are already in the process of replenishment and, if adequately resourced, can play an important role in strengthening some aspects of PPR. The recently negotiated IDA20 replenishment package also includes ambitious commitments to support countries to strengthen PPR. Other MDBs are also engaged in the PPR space.

The IMF's Resilience & Sustainability Trust (RST) seeks to channel SDRs from higher income countries to LICs and MICs having a strong external position, with a focus on longer term issues including investments to tackle climate change and pandemic preparedness.[26] However, funding from the RST would not be earmarked for specific investments but would be provided as balance of payments or budgetary support conditional upon policy/legislative reforms.

[26] IMF Blog on "A New Trust to Help Countries Build Resilience and Sustainability" available at https://blogs.imf.org/2022/01/20/a-new-trust-to-help-countries-build-resilience-and-sustainability/

Assessment:

The existing set of institutions involved in financing global health – including WHO; MDBs pooled international financing mechanisms like the Global Fund, GAVI/IFFIm, CEPI; bilateral institutions; philanthropies, private sector - must continue to be leveraged to increase financing for PPR. However, this approach would not offer an assured, dedicated, long-term stream of funding for PPR or the opportunity to strengthen coordination and rapidly address critical. Consequently, there is the risk that urgent PPR priorities remain under-funded or too slowly funded, as exposed during the COVID-19 pandemic.

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

Description:

A new pooled fund could provide a dedicated stream of funding for critical PPR interventions. Such a fund could invest in both the global public goods and county-specific aspects of PPR. If well-structured it could a) mobilize additional resources for PPR from multiple sources, including non-ODA resources; b) offer flexibility to work through a variety of existing institutions/agencies, drawing on their capabilities and comparative advantages; c) have flexibility to make adjustments over time as needs and the institutional landscape evolves; d) create incentives for domestic investments for PPR and catalyze private investments; e) promote strategic coordination among the various PPR players; f) be anchored in the PPR priorities and gaps identified at national and international levels through the International Health Regulations (e.g. State Party self-assessment Annual Reporting, Joint External Evaluations, , Universal Health and Preparedness Reviews, National Action Plans for Health Security).

Key principles underpinning such a fund would include avoiding duplication and ensuring complementarity with existing financing efforts and institutions; flexibility in the mobilization and channeling of resources; simplicity in governance; streamlined operating arrangements; and a small, agile secretariat. Early and extensive involvement of recipient countries and implementing entities would be important to ensuring a fit-for-purpose design. Given the already crowded global health financing architecture, a key consideration would be to avoid creating a standalone institution or new legal entity, but rather build on exiting institutional capacities (e.g. of the World Bank and WHO). In addition, the new fund would need to work with and complement existing institutions and mechanisms (e.g. Global Fund, FIND, GAVI) by providing catalytic investments in areas of PPR that are underserved. To enable the dedicated fund to identify and prioritize these strategic investment gaps, the future PPR financing landscape would need to operate in a more coordinated and transparent way; targeted investments of this kind are only possible if it is known what money flows where.

Multiple reports released during the COVID-19 pandemic proposed a new pooled fund as a solution to addressing gaps in the PPR financing architecture. For example, WHO's Independent Panel for Pandemic Preparedness and Response (IPPPR)[27] proposed the

[27] Independent Panel on Pandemic Preparedness and Response (IPPPR), COVID-19: Make it the Last Pandemic, available at https://theindependentpanel.org/mainreport

establishment of an International Pandemic Financing Facility (IPFF) and the G20 HLIP suggested the creation of a new Global Health Threats Fund. Such funds create particular value when a key set of factors come together in a global call for collective action for a global public good requiring (a) large-scale additional pooled funds that are expected to be available over the medium/long term; (b) closely coordinated decision making; and (c) implementation across a significant number of multilateral organizations (i.e. MDBs and UN agencies)[28]. These conditions are all clearly met in the context of strengthening the global PPR architecture.

While the exact modalities of a new fund remain to be defined, there are examples that could be swiftly customized. The World Bank hosts Financial Intermediary Funds (FIFs) which are highly flexible and could be leveraged, and the UN hosts Multi-Partner Trust Funds (MPTFs) which could be used similarly[29].

Assessment:
This approach would offer an agile solution that could help address the identified PPR financing gap. Through a pooled fund, gaps in today's PPR financing landscape could be filled and various kinds of catalytic investments could be channeled to more flexibly address PPR priorities. Such a fund could also enable a swifter response to urgent needs without requiring new partnership arrangements and fundraising each time a new crisis strikes. A new fund must, however, be seen as part of the solution and complementary to what existing institutions are doing and could do with additional financing. The details and modalities of how a fund of this magnitude could be administered by existing institutions would need to defined.

3) Establish a new entity to consolidate the necessary fiduciary capacity and legal, administrative, and technical expertise

Description:
As no existing entity has the full scope of functions needed, one option could entail the establishment of a new entity to consolidate the financial (e.g. fiduciary), operational (e.g. legal and administrative) and technical (e.g. scientific and PPR expertise) capacities needed to create an overarching institution dedicated to supporting PPR. Such an entity could even consolidate functions of existing agencies, funds, and programmes that work on and finance PPR. This would, however, imply a far-reaching restructuring of the global health financing and possibly implementing architecture to capture synergies across the existing funds, which would present several practical challenges.

Assessment:
Such an approach would cover every aspect of PPR through one institution, providing both the depth and the breadth required to support the future architecture. This could potentially

[28] World Bank FIF Management Framework June 4, 2019
[29] More detail about UN MPTF available at https://mptf.undp.org/overview/office

allow for increased levels of coordination across international investments in PPR, enhance continuity between all steps of the process, and, ideally, minimize inefficiencies. Such an entity could also facilitate assessments of the PPR financing needs and gaps at any given time, enable continuous monitoring of progress, and facilitate flexible (re-)prioritization of funds.

Establishing a new institution of this scope and size introduces substantial implementation complexity and transaction costs. First, reaching agreement between stakeholders to launch a new entity of this scale would be very difficult. Second, it is unclear how a new entity would consensually consolidate areas of work of existing, successful actors in PPR (risking a duplication of efforts if consolidation fails even partially) or how it would cooperate with other players in the Global Health ecosystem (endangering the synergies and positive spillovers that currently exist between PPR and other health programmes). Furthermore, a dedicated PPR entity would reduce the ability to leverage the non-PPR expertise of the respective institutions.

Overall assessment and next steps

The three options outlined above map out at a high level the range of possibilities for strengthening the PPR financing architecture globally and unlocking additional financial resources. These options are not necessarily mutually exclusive; in fact, a combination of options 1 and 2 will most likely be required to ensure that most key PPR capacities are financed on an ongoing basis and that critical gaps are rapidly addressed.

While increasing the aggregate funding available for PPR is crucial, there is also a need to shape the overall PPR financing setup for future in a more transparent way and to provide investments that are better aligned to solving the most critical gaps. To optimize the impact of these initiatives, the Health and Finance communities might also consider establishing arrangements for working together on an ongoing basis to refine assessments of critical gaps in PPR, identify which can be filled through domestic financing and where international financing should be prioritized, monitor how these investments are performing, and track what progress is being made in filling gaps and strengthening PPR.

Annex A | Deep-dive into PPR 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 prevention and 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 prevention, 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 7: Examples of the key functions and needs at global/regional and national/local levels in this subsystem.

Function	Estimated need (US$ billion)
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 (US$ billion)
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 *Original (kept to facilitate HLIP comparison):* 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 (adjustment):*	0.8

Function	Estimated need (US$ billion)
Doubled original amount to account for specialized surveillance in conflict areas	
Notifiable disease and IDSR-like surveillance *Original (kept to facilitate HLIP comparison):* Community based surveillance: L/MIC: using network of CHW and 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 (adjustment):* *Assumed to also include costs of globally coordinating surveillance*	1.9

Table 8: Examples of how the needs are distributed across the Detect/Respond phase

in USD billion	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 9: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (US$ billion)
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 *Original (kept to facilitate HLIP comparison):* 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%.	0.2

Function	Estimated need (US$ billion)
Note (adjustment): *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) *Original (kept to facilitate HLIP comparison):* 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 (adjustment):* *Stockpiling during prepare phase. Value taken from ACT-A budget, required to build supplies for 7 days*	0.6

Table 10: Examples of how the needs are distributed across the Detect/Respond phase

in US$ billion	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 (essential to prevent as many spillover events as possible)

Table 11: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (USD$ billion)
Limit human / wildlife interactions, specific activities *Original (kept to facilitate HLIP comparison):* 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	3.4

Function	Estimated need (USD$ billion)
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 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 36ountry for high volume of shipments that would need to be tested). $30M + $20M = $50M x 10-fold scale = $500M *Note (adjustment):* *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	1.3

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

Table 12: Examples of how the needs are distributed across the Detect/Respond phase

in US$ billion	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 13: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (US$ billion)
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 14: Examples of how the needs are distributed across the Detect/Respond phase

in USD$ billion	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 15: Examples of the key functions and needs at global/regional and national/local levels in this subsystem

Function	Estimated need (US$ billion)
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 (US$ billion)
Emergency operations and Emergency Financial Funds *Original (kept to facilitate HLIP comparison):* 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 (adjustment):* *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 *Original (kept to facilitate HLIP comparison):* 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 (adjustment):* *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 40ountry 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	0.1

Function	Estimated need (US$ billion)
20% assumed to follow “District sample” option. All large countries follow District sample since “National Estimates” 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 16: Examples of how the needs are distributed across the Detect/Respond phase

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

A6) IHR and the five-subsystem framework

Table 17: IHR benchmark categories matched with the five-subsystems framework (Please note, a 1:1 matching would not be unique, as there are several benchmark categories that could fit multiple sub-systems. As the future PPR subsystems get further defined, this mapping will also evolve)

IHR benchmark category	Brief description based on IHR	Which of the five-subsystems it belongs to
1) National legislation, policy, and financing	-Establishing legal framework -Provision of adequate funding for IHR implemtation -Measures can be implemented across all sectors noth just health -Monitoring and evaluation	*PPR strategy, coordination & emergency operations*
2) Coordination and NFP communications	-Ensure effective coordination, communication and partnerships to prevent, detect, assess and respond to any public health events	*PPR strategy, coordination & emergency operations*
3) Antimicrobial resistance (AMR)	-Prevent and combat antimicrobial resistance (AMR) with a One Health approach	*Lifesaving, safe and scalable health interventions and resilient health systems*
4) Zoonotic disease	-Multisectoral, multidisciplinary mechanisms, policies, systems and practices are in place to minimize the transmission and spread of zoonotic diseases between animals and humans.	*Public health and social measures and engaged, resilient communities*
5) Food safety	-A functional system is in place for surveillance and response capacity of States Parties for foodborne disease and food contamination risks or events with effective communication and collaboration among the sectors responsible for food safety	*Public health and social measures and engaged, resilient communities*
6) Immunization	-A vaccine delivery system is in place – with nationwide reach, effective distribution, easy access for marginalized populations, adequate cold chain and ongoing quality control – to respond to existing and new disease threats.	*Public health and social measures and engaged, resilient communities*
7) National laboratory system	-Surveillance with a national laboratory system, including all relevant sectors, particularly in human and animal (domestic animals and wildlife) health, and effective modern point-of-care and laboratory-based diagnostics is in place.	*Surveillance, collaborative intelligence and early warning*
8) Biosafety and biosecurity	-Whole-of-government multisectoral national biosafety and biosecurity system with dangerous pathogens identified, held, secured and monitored in a minimal number of facilities according to best practices	*Surveillance, collaborative intelligence and early warning*
9) Surveillance	-Strengthened surveillance systems are able to detect events of significance for public health and health security	*Surveillance, collaborative intelligence and early warning*

10) Human resources	-Well-motivated health personnel for sustainable and functional public health surveillance and response are available at all levels of the health system. Include nurses and midwives, physicians, epidemiologists and other public health and environmental specialists, social scientists, communications personnel, occupational health personnel, laboratory scientists/technicians, biostatisticians, information technology (IT) specialists and biomedical technicians	*PPR strategy, coordination & emergency operations*
11) Emergency preparedness	-Combination of planning, allocation of resources, training, exercising and organizing to build, sustain and improve operational capabilities at national, intermediate and local or primary response levels based on strategic risk assessments	*PPR strategy, coordination & emergency operations*
12) Emergency response operations	-Coordination mechanism, incident management systems, exercise management programmes and public health emergency operation centres (EOCs) functioning according to minimum common standards	*PPR strategy, coordination & emergency operations*
13) Linking public health and security authorities	-Rapid, multisectoral response for any event of suspected or confirmed deliberate origin, including the capacity to link public health and law enforcement, and to provide timely international assistance	*Public health and social measures and engaged, resilient communities*
14) Medical countermeasures and personnel deployment	-Framework for transferring (sending and receiving) medical countermeasures, public health and medical personnel from unaffected regions (rapid response teams/national emergency medical teams), and international partners during public health emergencies; and procedures for case management of events due to IHR relevant hazards	*Prioritized research and equitable access to medical countermeasures and essential supplies*
15) Risk communication	-Ensure timely and effective two-way communication between concerned authorities and the population at risk	*Public health and social measures and engaged, resilient communities*
16) Points of entry	-At airports and ports implement public health measures required to prevent, detect and manage a variety of public health risks in a multisectoral approach	*Public health and social measures and engaged, resilient communities*
17) Chemical events	-Have in place surveillance and response capacity for chemical risks or events	*Surveillance, collaborative intelligence and early warning*
18) Radiation emergencies	-Have surveillance and response capacity for radiological emergencies and nuclear incidents	*Surveillance, collaborative intelligence and early warning*

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.

Considering 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 using 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).