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Designing Trigger Mechanisms for Epidemic and Pandemic Financing and Response

 Nita K. Madhav, Ben Oppenheim, and Cristina Stefan

Abstract

Nearly every consequential choice in epidemic and pandemic response requires a trigger of some kind: a set of criteria—often, but not always, quantitative—that determines whether alerts or public health declarations are issued, financing for outbreak containment and response is released, whether personnel and medical countermeasure deployment are surged, and so on. Triggers are sometimes implicit or internally facing, nested within expert guidance and decision-support processes, but are increasingly public-facing, to help the stakeholders and citizens make sense of public health guidelines and decisions. Consequently, triggers are both increasingly utilized and increasingly visible, and are the subject of continuous innovation and debate. However, there are no established frameworks or standards guiding the development and integration of triggers into public health decision-making generally, or epidemic and pandemic financing and response specifically. This chapter presents a framework for high-quality trigger design with specific application to pandemic financing and response, with the goals of improving trigger effectiveness, reliability, and communication of their attributes and intended performance to stakeholders, including the public. It also includes a brief case study on the World Bank's Pandemic Emergency Financing Facility (PEF).

KEYWORDS

Triggers, alerts,
public health
declarations,
financing, response

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Designing Trigger Mechanisms for Epidemic and Pandemic Financing and Response

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Introduction

Nearly every consequential choice in epidemic and pandemic response requires a trigger of some kind: a set of criteria—often, but not always, quantitative—that determines whether alerts or public health declarations are issued, financing for outbreak containment and response is released, whether personnel and medical countermeasure deployment are surged, and so on. This chapter focuses mainly on the design and development of triggers for pre-arranged financing mechanisms. Additional applications for triggers in epidemic and pandemic preparedness and response are also briefly discussed. The primary focus of this chapter is to explore the trigger design process and propose criteria that can be used to assess the quality of trigger designs, with the goal of supporting technical improvements to trigger designs in public health, especially for financing response activities. This chapter is not an argument to incorporate quantitative triggers into all financing mechanisms or decision processes; the suitability and feasibility of triggers (and of specific trigger designs) varies with different objectives, applications, scenarios and risks.

A trigger is a pre-arranged mechanism or set of conditions that determines when a financial or operational response is activated as a result of an event occurring or being predicted to occur.

Triggers are perhaps best known for their use in insurance contracts, both private-market contracts as well as sovereign disaster risk financing mechanisms that provide capital (typically from multilateral organizations or specialized capital pools) to governments. In the context of insurance, triggers comprise a critical element of a contract that binds one party to release capital to another under pre-agreed conditions; of note, the trigger criteria are designed to correlate with the economic loss that the beneficiary of the financing would incur. The process of trigger design that we describe in this chapter is designed to identify, address and propose options to reduce information asymmetries that present a fundamental barrier to the quantification (including pricing) of risk and successful contracting to transfer it. However, triggers also have broad application to non-contractual settings, including in the design and implementation of decision processes. In the context of supporting decision-making, triggers can provide a structure to guide policymakers in making difficult choices (for example, whether and when to implement and relax public health restrictions).

Triggers have varying degrees of complexity. For example, a simple trigger could be designed to activate upon an emergency declaration by a ministry of health. A more complex trigger could incorporate multiple parameters that need to meet specific joint thresholds to activate.

The term “parametric trigger” comes from the use of a parameter or combination of parameters—quantitative in nature—that prompts the release of funds; each parameter has a threshold or required value that, if reached (or, in the case of multi-parameter designs, collectively reached), triggers the release of funds. A parametric trigger can also be in the form of an index, which involves the combination or calculation of a value or values based on measured parameters; data sources can

vary greatly, from reported epidemiological data, to meteorological data, to remote sensing/satellite data. Triggers can also be based on modeled results, which would be simulated by a model taking the estimated parameter values as inputs.

Trigger design is currently the focus of technical and creative energy for a broad range of use cases, ranging from the insurance industry, risk modeling, climate science, to humanitarian and development applications. Designing triggers that work well, however, is challenging.

There are numerous examples of trigger mechanisms—especially parametric trigger mechanisms—in disaster risk financing. This is especially so for natural hazards such as tropical cyclones, earthquakes, floods, and droughts (Cissé, 2021). Despite standing to benefit substantially from pre-agreed funding mechanisms, the health sector has arguably been slow to consider and adopt these types of constructs.

Triggers for epidemic risk financing

In the late 2010s and early 2020s, parametric triggers started to be incorporated into financing mechanisms designed to mitigate risk from epidemics and pandemics (see Table 1 for selected examples). In these financing mechanisms, a parametric trigger defines the necessary quantitative criteria for the release of capital during or following the occurrence of an epidemic. In the case of epidemics, the total loss includes the impacted number of lives and livelihoods, along with budgetary expenses incurred during epidemic response activities such as contact tracing, vaccination, and clinical case management.

Parametric triggers can be used to develop coverage through parametric insurance, which disburses funding without waiting for a claim assessment on the ground to determine the exact loss suffered by each insured party. This is in contrast with indemnity insurance, which is defined by post-facto reimbursement of actual losses incurred, and typically requires evidence of “proof of loss”, such as (in the case of epidemics) evidence of fiscal outlays for containment and response activities. This same logic applies to non-insurance financing mechanisms: formal incorporation of a parametric trigger can release funding rapidly, without the need for expert assessments or ex-post humanitarian appeals and response-cost estimates from governments impacted by disasters. Financing mechanisms may also use a “hybrid trigger” that combines both parametric and indemnity-based trigger criteria, though hybrid triggers are typically less common due to their complexity. Trigger mechanisms are often progressive or scaled, with additional triggers releasing more funding as an event progresses and more losses and operational costs are incurred.

The main rationale for using a parametric trigger is the predictability and speed at which a payout can be released. Because the payout can occur as soon as the trigger is reached, funds can be disbursed far more rapidly than in the case of an indemnity trigger, which typically requires a

lengthy process: waiting until the damage occurs, proof of loss is submitted, the loss is independently assessed, an insurance adjustment is performed, and payment is eventually released. Financing mechanisms based on parametric triggers can pay out in days or weeks, whereas those incorporating indemnity-based triggers would more typically pay out in months or even years after an event has occurred. There have even been parametric trigger-based financing mechanisms that release funds in advance of an event—for example, a novel African Risk Capacity drought insurance instrument (Maslo, 2022).

There is a growing body of evidence confirming the significant welfare benefits of early response to catastrophes (Pople et al., 2021). This is true for a wide variety of crises, but especially for infectious disease events. Rapid financing can significantly reduce the financial and health impacts caused by epidemics. For epidemics, rapid access to capital can enable more timely and effective reduction and potential containment of disease transmission—for example, by supporting contact tracing, public education and risk-reduction campaigns, and diagnostic, drug and vaccine distribution. Rapid containment can, in turn, reduce the severity and duration of an epidemic, leading to significant reductions in human and economic losses. Early, rapid containment has the potential to mitigate infectious disease spread, preventing events from reaching their full potential magnitude. The effects of early mitigation can be especially significant for epidemics and pandemics, because (unlike other acute natural hazards, such as earthquakes or hurricanes) some infectious disease events may last years (e.g., the 1918 influenza pandemic, COVID-19) while others (such as the HIV/AIDS pandemic) may last decades.

The timeliness and predictability of funding can also provide incentives for all actors involved in outbreak detection and epidemic response: to detect and report potential threats to public health quickly, and to develop and maintain operational plans that will guide response activities. Pre-arranged, predictable financing can provide greater confidence that funding will be available, allowing agencies and leaders to focus on managing response activities rather than fundraising.

While we have focused our discussion here primarily on disaster risk financing mechanisms for rapid response and mitigation of biological hazards, it is important to note that mechanisms for epidemic and pandemic financing can serve other functions—for example, containment to reduce the risk of disease spread beyond the initially-affected country. Optimal trigger design depends entirely upon the problem that the financing instrument is designed to solve. We discuss this issue further below.

TABLE 1. Trigger design examples from selected epidemic and pandemic financing instruments (non-exhaustive)

Instrument	Objective	Covered Perils	Covered Geographies	Trigger Elements	Potential Design Challenge(s)
Pandemic Emergency Financing Facility (PEF) (International Bank for Reconstruction and Development, 2017)	To provide financing for multi-country epidemics and pandemics (rather than single-country outbreaks)	• Pandemic Influenza • Novel coronaviruses • Filoviruses • Lassa Fever • Rift Valley Fever • Crimean Congo Hemorrhagic fever	• IDA countries (World Bank, 2021b)	Triggers were specific to bond class and pathogen group, and included: • Cumulative cases • Eligible event period day • Total confirmed deaths • Geographic spread • Growth rate • Confirmation ratio for certain pathogens	• Received criticisms due to complex trigger design and timing of payouts for COVID-19 • Did not pay out during Ebola epidemics from the insurance window, but did pay from the cash (contingency) window
African Risk Capacity Outbreaks & Epidemics policy (Böhm, 2023)	To provide rapid financing in the earliest stages of an epidemic	• Filoviruses • Meningitis	• Senegal	• Total laboratory-confirmed cases (filoviruses) • Districts in alert and epidemic phase (meningitis)	• Uncertainty about case counts very early in an outbreak
Pathogen Rx (Asian Development Bank, 2022)*	To provide liquidity for private sector firms facing cash flow and/or operational disruption during an epidemic	• “Infectious disease outbreaks”	• Worldwide and regional	• Confirmed outbreak • Infections • Deaths • Sentiment Index (Oppenheim et al., 2019) • Proof of loss	• Coverage limited depending on geographic characteristics of the event • Hybrid trigger, including indemnity component: proof of loss required (Wright & Lacovara, 2020)
Munich Re Epidemic Risk Transfer Solutions (Munich Reinsurance, 2024)*	To efficiently reallocate epidemic and pandemic risk across various stakeholders	• “Viral epidemic and pandemic outbreaks”	• Worldwide and regional	• PHEIC • Civil Authority Restriction • Proof of loss	• Reliance on subjective triggers • Proof of loss required from the insured (long time to assess the claim)
Gavi First Response Fund (Gavi, 2024)	To secure early access to vaccines and to protect existing immunization programmes	• Pathogens with PHEIC potential • Pathogens qualified as Grade 2 or 3 by WHO	• Gavi-eligible countries	• Pandemic or PHEIC declaration	• Reliance on subjective triggers • Lack of predictability and transparency

*Note: Private sector insurance structures

Beyond financing: Triggers for decision-making

Triggers have a wide range of applications beyond financing mechanisms, including providing quantitative, objective criteria for implementing, altering, or ending (for example) containment policies, programs, or public declarations of health emergencies. A key virtue of triggers is that they support the rapid implementation of decisions that have effectively been made in advance, and therefore provide both speed and insulation from political pressures that may quickly build up once a crisis occurs. Not all decisions require or necessarily benefit from being implemented via a trigger mechanism. However, a surprisingly wide range of decision processes are suitable, and many if not all policy and decision processes can benefit from the logical process of working through how they *might* be implemented using a trigger-like mechanism.

Below we discuss a selection of illustrative, non-exhaustive examples for situations and decision points where having a trigger mechanism in place could be beneficial during an epidemic or pandemic.

Health notifications, alerts, and emergency declarations

One important category of decision-making during an outbreak or epidemic is whether to issue health notifications, alerts, or emergency declarations. Notable examples include the issuance of a notification by a health authority (e.g., WHO's Disease Outbreak News (DON) (World Health Organization, 2025a)), the dissemination of an alert (e.g., CDC's Health Alert Network Health Advisory (CDC, 2025)), the declaration of a public health emergency (e.g., declaration by the WHO of a Public Health Emergency of International Concern (PHEIC) (World Health Organization, 2019)), and the WHO's declaration of meningitis districts in alert or epidemic based on different disease thresholds (World Health Organization, 2014). The process for determining whether to issue a PHEIC has, in particular, been criticized for being complex and non-transparent; an empirical analysis of emergency committee deliberations found that criteria for determining whether to issue a PHEIC declaration have not been consistently applied (Mullen et al., 2020; Fan et al., 2023).

Public health emergency declaration processes often provide for substantial decision-making flexibility: this is a virtue, as there may be substantial uncertainty about the characteristics and severity of the potential threat, the speed of its development, and its potential impacts. The virtue of flexibility is that it can allow for scientific judgement to address these points of uncertainty; a vice is that it also allows for political factors—electoral costs, reputational risks, fears of economic damages—to cloud judgment. Here, incorporation of quantitative triggers can help provide both expert guidance and political insulation, as some potentially “costly” aspects of the emergency declaration process can be addressed through pre-agreed mechanisms.

Rapid response and containment

Early in an outbreak, it may be possible to limit spread and contain the event while it is still relatively small and manageable. A key challenge is that data are often sparse and incomplete at this early stage, so there is substantial uncertainty which can raise the political cost and risk associated with taking potentially costly steps to contain transmission. Data sparsity and uncertainty can also make it difficult to design an appropriate trigger to activate rapid response and containment measures; especially in this early stage of an outbreak, quantitative information may not yet be available or even known, and modeled estimates may have high levels of uncertainty. Therefore, binary parametric triggers or qualitative triggers may play a more important role than during other stages of an epidemic or pandemic. For example, a rapid risk assessment of a new respiratory virus may consider the presence or absence of sustained human-to-human transmission, among other relevant factors (Ferguson et al., 2005; Longini et al., 2005; World Health Organization, 2025b), as this is potentially indicative of elevated epidemic or pandemic risk. A critical priority during this early stage of an outbreak is to obtain as much relevant data as possible—which is much easier to do when persistent pathogen monitoring systems are already in place prior to an event.

Medical countermeasures

Authorities—including national governments as well as international and multilateral agencies—also make critical decisions regarding the use of medical countermeasures. For example, these may include:

- Release of a government stockpile—for example of diagnostics, treatments, vaccines, or personal protective equipment (PPE) (BARDA, 2025).
- Initiating a “100-day” countdown for vaccine development (Pandemic Preparedness Partnership, 2021).
- Government interventions to encourage or compel manufacturing of critical materials (such as masks, ventilators, vaccines, etc.), such as the US Defense Production Act (Hart, 2024) and Operation Warp Speed during the COVID-19 pandemic (Lopez, 2020).
- Rapidly expanding clinical capacity, such as the activation of “surge” clinical facilities, emergency conversion of non-medical facilities to provide care—for example, the Fangcang shelter hospitals built in China during the COVID-19 pandemic (Chen et al., 2020)—or construction of new hospital facilities

Targeted and population-wide interventions

- Implementation (and ending) of population-wide measures to reduce transmission, such as social distancing and mask mandates (Oshitani, 2025)
- Implementation (and ending) of targeted measures to reduce disease transmission (Chen et al., 2025), such as school closures (Bundy et al., 2025). For example, a school might be closed in response to an outbreak or sharp increase in incidence in neighboring schools

(Cauchemez et al., 2009). Alternatively, a pooled testing strategy in schools could be used for decision-making based on positivity trends in schools (McKnight & Sureka, 2024).

- Implementation of politically-sensitive policy measures, such as travel restrictions, border closures, or trade restrictions. Having a pre-defined trigger in place could reduce the potential for a “knee-jerk” and effectively punitive reaction to a country’s early detection and reporting of an outbreak, when this is the precise surveillance capability and behavior that should be incentivized. For example, South Africa suffered adverse consequences during the COVID-19 pandemic by being the first to detect and report the SARS-CoV-2 omicron variant (Gudina & Gidi, 2025).

Framework for high-quality trigger design

An effective trigger must possess several qualities to be accepted by the involved parties in a financing transaction (e.g., the insured, insurer, reinsurer, donors, multilateral agencies, etc.) or policy process. A high-quality trigger must be:

1. **Simple:** complicated triggers make it difficult to have an intuitive sense about whether and under what conditions a policy will trigger, potentially leading to misaligned expectations between counterparties (such as insurers and the insured). If a payout does not occur, does not occur rapidly enough, or does not occur at sufficient scale, this can lead to mistrust and a perception that the trigger and the underlying financial contract has been poorly designed, or even worse, made deliberately complicated to avoid making a payout.
2. **Transparent:** all the involved parties in the transaction or the decision process must have access to the same underlying data used for calculation, as well as to the trigger calculations themselves. This is so anyone assessing whether the trigger threshold has been met would have all the necessary information to perform the required calculations.
3. **Objective:** based on factors that can be reliably and consistently measured.
4. **Verifiable:** it must be possible to independently and objectively corroborate that trigger conditions have been met (or not).
5. **Pre-agreed:** in order to meet all the prior qualities outlined above and to avoid confusion and delays during the assessment if trigger criteria have been met.

Appropriate trigger design is critical to ensure funds are disbursed rapidly, and to minimize the likelihood of inordinate and unpredictable payouts. Effective triggers can be developed by first establishing clear criteria for the context (when, for what) in which activation should occur. Crafting good triggers involves balancing the preferences and demands of the stakeholders, technical feasibility, and practical considerations (such as calculation processes, sources of data for the trigger and their reliability over time, failsafe procedures, etc.).

The trigger design process (which is part of a larger “structuring” process) is generally a complex process involving the iterative exploration, development, testing and calibration of various trigger concepts, in an effort to balance multiple design criteria and ensure that stakeholders are aware and aligned on what the instrument is designed to do (and what it is not designed to do). A thorough design process identifies requirements regarding the needs of responders at that specific moment in time, examines technical possibilities, and addresses potential failure points in advance. For whatever purpose the trigger is being designed, it behooves the developers of the trigger mechanism to follow an analytically-sound design process, which is transparent and inclusive of all stakeholder viewpoints. Ideally, a collaborative process of trigger design can help build trust and confidence between all the key stakeholders.

Below, we discuss key elements and considerations of the trigger design process.

Event definition

The foundational element of a trigger is an **event definition**, which clearly defines the types of adverse shocks to which the trigger applies. In the case of epidemic risk, a financing instrument may provide funding only for specific pathogens (e.g., viral hemorrhagic fevers such as Ebola, Marburg, or Nipah viruses, which are capable of rapid, sustained transmission and have the potential to cause substantial societal and economic disruption), or only epidemics of a magnitude that cannot be managed through routine health system functions and health budgets.

Event definitions for epidemics and pandemics may rely on an event being declared by a health authority, such as a ministry of health or multilateral body (e.g., Africa Centers for Disease Control or the World Health Organization (WHO)). An event may be defined by the authority based on pathogen-specific criteria linked to the epidemiology of the disease and historical patterns in outbreak control. For example, an Ebola Virus Disease (EVD) outbreak is declared once there is a single confirmed case based on laboratory testing (World Health Organization, 2024). Likewise, there may be specific criteria for declaring the end of the outbreak. For EVD, this is typically the end of 42-days with no new, epidemiologically-linked cases (Djaafara et al., 2021). However, for other types of diseases, especially more routine occurrences such as meningitis, events may be defined based on how far incidence has spiked above an established baseline of historical disease levels.

An event definition can also define whether a series of losses are considered a single event, or multiple occurrences. For example, substantial litigation took place over whether the two plane impacts on the World Trade Center in the 9/11 terrorist attacks were considered separate events or a single attack, with substantial sums of money at stake (Johnson, 2010). Similarly, an event definition for an epidemic or pandemic trigger could define whether a mutation—for example, the emergence of a new variant or strain capable of more efficient transmission or immune evasion—is considered part of an ongoing outbreak, or is a distinct event that could trigger a financing mechanism or policy response.

In addition to defining which events are covered, it is also important to define which events are not covered (i.e., exclusions). Familiar insurance exclusions include “acts of God”, terrorism, and war. In this case of epidemics, exclusions may include ongoing or foreseen events, such as epidemics that are already underway, as well as infectious disease hazards whose characteristics have not been accounted for in trigger design or pricing. For example, pandemic influenza is sometimes excluded due to its potential to be a “systemic risk”, leading to correlated, catastrophic losses across far-flung geographical locations. Also sometimes excluded are biowarfare and bioterrorism, as they would fall more broadly under war or terrorism exclusions, and the accidental release of human-made or manipulated infectious agents (sometimes referred to as “bio-error”) (Williams et al., 2025).

Another aspect of the coverage definition includes the covered geographic area—that is, the area within the geographic scope of the financing mechanism. It can be defined by country or territorial boundaries, or even could be defined by a polygon (e.g., “Cat in a Box”) (Franco et al., 2024). For epidemic or pandemic applications, such a polygon could be applied to a “spark risk map” and could be used as the basis for triggers following the progressive geographic spread of an epidemic beyond known hot spots.

As a general principle, the event definition should be developed drawing upon knowledge from all parties involved in epidemic preparedness and response—not just the health and finance sectors. This should include scientists and technical experts, community-based organizations, civil society, government officials from the wide range of ministries whose missions and constituents are impacted by epidemics (such as the education, labor, and security sectors). This allows for local context and local knowledge to be incorporated at the most fundamental level of design, ensuring that the trigger solves for real-world scenarios and problems.

Quantitative triggers

Quantitative triggers rely on measurable data and parameters. Several factors should be considered in determining which data and parameters to include. First and foremost, it must be determined which parameters are correlated to the outcome of interest, such as the loss to the insured. Second, the parameters should be easily measured. Third, the parameter values should be transparent, meaning they should be reported by an official, unbiased source, so that everyone has equal access to the information. Fourth, the source data should be reliable and updated in a timely fashion. Fifth, to ensure appropriate trigger calibration, there should be sufficient historical information to establish baseline levels or “normal” levels of risk. Fifth, if, for the purpose of designing a trigger, input data are transformed, the transformation methods should be well documented, including any relevant formulas and source code to perform the calculation. Sixth, any methods used to fill data gaps (such as imputation), or reliance on alternative data sources, should be transparently described and well-documented.

In the case of epidemics and pandemics, quantitative triggers can be based on a number of parameter values, including reported measures of event severity (e.g., laboratory-confirmed deaths or reduction in foot traffic) or reported government policy responses and actions for containment (such as closing borders, limiting social contact, curfew, etc.) that can be measured categorically or measured via an index (Hale et al., 2021).

A range of data types and sources may be considered for incorporation into a trigger. The first is one based on reported data. This is typically considered the most objective, as it is based on a third party (usually “official”) reporting source which would be supplying the information independent of any financing considerations; though this can be challenging for sovereign covers when a country is reporting the information, such as numbers of cases. A second type of data used to underpin a quantitative (and specifically parametric) trigger is an index, which is based on a calculated formula from reported data. For example, the Vita series of mortality bonds (Klein, 2006) includes a mortality index that weights general population reported mortality to an insurance portfolio, thus building the correlation between the reported data on mortality rates and the estimated losses. Relatedly, a trigger can also incorporate parameters that are estimated from empirical data: for example R_0 can be calculated from reported epidemiological data, and could (in theory) serve as a parameter in a trigger design. A third potential type of data used for a trigger is model output, which is often from a mechanistic model. In this kind of trigger, certain measured or reported parameter values are inputted into a model and generate a modeled outcome—whether it is a loss estimate or index value, which ultimately will be compared against a trigger criterion.

Amongst these different types of trigger formulations, it is also important to consider the sources of error and uncertainty that may be present in the selected data and parameters (Mari & Giordani, 2015). For example, confirmatory testing in a laboratory will be subject to measurement errors related to the sensitivity and specificity of the test; therefore, in some cases, a secondary test may be required to corroborate the findings of an initial test. Measurement error for empirical data can be highly variable across events, and variable within events both over space (for example, due to different countries having varying capacity or willingness to report accurate epidemiological data), and over time (for example due to intensification of surveillance during the course of an epidemic, the development and deployment of new diagnostic tests, or the failure of existing tests, etc.) For calculated parameters, these errors may have a complex interplay. For example, the case-fatality ratio (a measure of deaths divided by cases), could have ascertainment errors and biases in both the numerator and denominator (Lipsitch et al., 2015). However, this could be partially mitigated for larger datasets of modeled or calculated parameter values, which could include point estimates and metrics of the uncertainty, such as a 95% confidence interval.

Counts of confirmed or probable infections and deaths are frequently considered in the trigger design (Table 1). However, verifying these parameters may prove to be challenging during an epidemic. For example, case counts are often subject to under-reporting (Meadows et al., 2022), or may not meet the condition of being verifiable, unless there is a laboratory confirmation. In a cruel

irony, capacity for lab confirmation (and thus to meet trigger criteria) may be limited in those very settings, such as low-income and fragile states, which may benefit substantially from a disaster-risk financing mechanism to cover response costs and economic losses. Stakeholder needs must also be taken into account. For example, it may be difficult to get buy-in from public health stakeholders for a trigger based solely on counts of deaths—which are undesirable metrics from a public health standpoint and potentially present the risk of adverse media coverage (e.g., McVeigh, 2020)—while for financial stakeholders, this may not be an obvious concern.

Emerging infectious disease surveillance approaches such as environmental monitoring can potentially unlock novel approaches to trigger design by generating data that could overcome some of the challenges of verifiability and underreporting described above. For example, wastewater testing for pathogens of interest could allow for triggers based on the detection of an emerging pathogen with epidemic potential (such as Nipah or Marburg viruses) in municipal sanitation (Kilaru et al., 2023; Grassly et al., 2024). However, more sophisticated trigger concepts, such as triggering based on a spike in concentration well in excess of typical levels, would require more established analytical methods for estimating epidemiological metrics of interest (such as cases, infection rates, etc.) from wastewater epidemiology metrics, along with a sufficiently long time series of data which would allow the establishment of baselines.

In deciding which parameters to include in the trigger design, there are methods employed to evaluate the importance of different components in the trigger calculation. For example, sensitivity testing is often an important step, used to understand which components of the trigger calculation are most influential. Additionally, it is critical to consider the correlation of the parameters and variables with the actual loss; this comparison is often achieved using historical data.

Qualitative triggers

Qualitative triggers—those based on subjective criteria—such as declarations of a Public Health Emergency of International Concern (PHEIC), the issuance of Disease Outbreak News (DON) reports, or an emergency declaration by state actors, have been previously incorporated into trigger designs, including in the Gavi First Response Fund (Box 1). As we noted above, qualitative triggers must be designed with great care as they can be problematic, because such declarations are based upon expert judgment, political and economic considerations, and other subjective criteria. The arbitrary nature of these factors suggests that triggers based on such criteria would not meet the qualities of being transparent and objective (Fan et al., 2023).

Moreover, subjectivity presents challenges for modeling, which is often used to inform trigger design in a financing mechanism. Subjectivity in trigger design makes it difficult to use modeling to estimate whether a trigger structure will pay out under the right conditions, and whether the risk has been appropriately estimated and priced, leading to potentially higher than necessary risk premiums that incorporate an extra buffer for underestimated activation probability. It could also potentially

bias the declaration process itself, if decision makers become more (or less) likely to declare an emergency if such a declaration will trigger a payout. This bias—or political risk from the potential *perception* of bias—becomes even more problematic if the agency making the declaration is also the recipient of funding from the financial instrument.

BOX 1. Applying qualitative triggers to vaccine procurement for epidemic response

Qualitative triggers figure prominently in the Gavi First Response Fund. In June 2024, Gavi launched the first “day zero” financing mechanism of “US\$ 500 million designed to secure early access to vaccines and to protect existing immunization programmes within days of a pandemic or a public health emergency of international concern being declared (Gavi, 2024).” The trigger is made such that 80% of funding will be disbursed for at-risk procurement of vaccines for pathogens with PHEIC potential where GAVI has no existing vaccine or outbreak response program. The rest of 20% of funds can be deployed for pathogens qualified as Grade 2 or 3 by WHO, but for which a vaccination response is needed or in case routine immunization is at risk given the outbreak (as was the case in the 10th DRC Ebola outbreak, when measles routine immunizations dropped significantly during the outbreak). The final decision is made by a committee at Gavi using input from technical partners and WHO. What is unclear is whether a formal request from a given country is necessary to activate the discussions of the committee or if this committee is meeting regardless as long as the WHO classifications are communicated.

This trigger framework is unusual in that it relies on pre-agreed, albeit, “soft” qualitative triggers that include WHO assessments and PHEIC declaration as well as information gathering from other partners for a committee to launch the decision process. While it is a quite flexible and all-encompassing mechanism—does not apply to a single pathogen, is not restricting disbursements to any country—it also has no participation cost from countries and so it retains significant discretion in how the funds are being spent. The potential risk is that flexibility may create ambiguity, such that countries may not be able to easily anticipate which events will qualify, and which will not, as well as the potential for such a mechanism to be perceived as arbitrary. These potential risks can be best mitigated through transparency, and active communication to countries and other stakeholders that might rely on the mechanism. Without such efforts, such a flexible mechanism might fall short of ensuring the much needed predictability of funding and transparency that would empower countries to make the right decisions during the next epidemic or pandemic.

Trigger timing

The timing of the trigger, with respect to the epidemic curve—and pandemic financing cycle (Fan et al., 2024)—is a crucial consideration. Early in an outbreak, while an outbreak is still small, the implementation of disease control and response measures have a much greater chance for outbreak

containment (Chen et al., 2025). As a result, financing provided at this stage is likely to be highly cost effective. However, at this early stage there is also greater uncertainty about the number of cases or the presence of sustained human-to-human transmission, due to limited information and sometimes incomplete and fragmentary surveillance data, which can make it difficult to establish the expected trajectory of an outbreak. The ARC structure is a notable example of a mechanism designed to trigger very early in an outbreak (Table 1).

However, some triggers may require data stability and a higher level of certainty about the magnitude of outbreak before activation. By the time these necessary criteria are met, several weeks or months might have passed and full containment may not be possible at that point, but the financing could support public health and social measures to “flatten the curve”—including active case identification, case isolation, and contact tracing—and reduce the burden on the health system and overall impact of the event (Oshitani, 2025). This is probably most similar to the financing mechanism incorporated into the World Bank’s PEF (Table 1).

A third potential timepoint around which to build a trigger that is not often implemented is before an outbreak even reaches a country. For example, if an event affects one country, then a neighboring country could be the beneficiary of seed financing that would help support surveillance and containment measures designed to prevent introduction of the pathogen and spread of the epidemic. A potential design for such a concept was discussed previously in an Asian Development Bank report (Asian Development Bank, 2022). While an anticipatory/containment design of this kind could be potentially be effective and worth exploring, a key challenge is that it may be politically difficult to justify allocating response funds to a country that is not (yet) directly impacted by a health emergency, especially if funds are limited and response activities in the directly-impacted country are under-financed. While an anticipatory/containment design of this kind could be potentially be effective and worth exploring, a key challenge is that it may be politically difficult to justify allocating response funds to a country that is not (yet) directly impacted by a health emergency, especially if funds are limited and response activities in the directly-impacted country are under-financed.

Avoiding recency bias

A common pitfall in trigger design is to build a trigger for the event that occurred most recently—a behavior analogous to preparing to fight the last war. In the context of epidemic risk, this could, for example, entail limiting the event definition to only those pathogens that have recently caused epidemics, or setting parameter combinations and thresholds based solely on observed data from recent outbreaks rather than modeled risk estimates that consider broader probability distributions (Madhav et al., 2023). Some mechanisms—notably the World Bank’s PEF insurance window—have incorporated emerging pathogens (such as Rift Valley Fever virus) that have known epidemic and potentially pandemic potential, but have not caused large-scale public health emergencies to date. Incorporating wholly novel pathogens into a trigger structure is also possible, but introduces challenges to risk modeling due to data sparsity.

Future epidemic and pandemic scenarios may look very different from the most recent events. As such, it is critical to consider the widest relevant range of scenarios that could occur and fit within the conceptual and policy objectives of the financing mechanism or policy process. Scenario planning processes as well as the use of simulation-derived event catalogs can provide structured ways to address and mitigate recency bias (Madhav et al., 2021; Schwartz, 1997).

Flexibility

Flexibility in trigger design, such as incorporating technical and operational experts into consultation processes, can be advantageous, allowing for local context and local stakeholders knowledge to be factored in, to “correct” mismatches between a predefined trigger and the reality on the ground. In this sense, a level of flexibility (as opposed to full discretion over the activation of funds for response) can sometimes enhance a mechanism’s overall effectiveness.

Trigger mechanisms, especially for non-financial applications, could be built into a playbook or tiered response system that would allow some flexibility and adaptability during a crisis. An overly rigid system may be difficult to adhere to during a crisis—and the next crisis may look very different from previous crises upon which the trigger criteria may have been designed. It is important to think beyond previous events, and to avoid recency bias, that is, over indexing on the most recent event to have occurred. An example of this is how some financing mechanisms have a contingency fund component, which may relax some of the more rigid criteria and design principles that would underpin triggers for insurance-backed financing mechanisms that can come in later, at higher levels of severity of the outbreak.

Adding an element of flexibility can also diminish basis risk (i.e., chance of a false positive or false negative) and ensures that there is ownership given to decision makers. To date, notable structures for epidemic risk financing have included asymmetric mechanisms to address basis risk, including cash windows that can (with some parameters and rules) release financing for events that would not otherwise qualify. We are not aware of mechanisms to address false positives, though these are theoretically possible. The risk is that stakeholders who are unhappy with a specific decision may view “flexibility” as “arbitrariness”; this risk should be mitigated to the greatest extent possible with transparency, broad involvement of stakeholder groups in the development of decision-making rules and guidelines, and active communication once a potentially qualifying event has occurred.

Testing, refinement, and calibration

During the process of designing the trigger, an important step is to test whether or not it performs as anticipated and desired: for example, whether it correctly activates under scenarios that the financing mechanism (or other policy intervention) is being designed to respond to. This requires clarity and alignment regarding the types of scenarios that the mechanism is meant to address.

Trigger designers should, in close conversation with stakeholders, define the types and severities of events that should trigger the mechanism; it is likely critical that they clearly define the types of scenarios that should not trigger. To test this, the draft trigger concept would be calculated against historical epidemic events to determine which events would have set off the trigger and which ones would have not. If the results do not lead to the desired outcomes, then it is determined which parameters and thresholds led to the failure and the trigger will be reformulated to ameliorate the issue, and tested again. This is an iterative process, typically entailing multiple rounds of testing, and refinement—with care given to understand the implications of design changes, and ensure that a change to address one apparent failure does not cause other problems (such as causing the mechanism to trigger under undesirable circumstances; see Trigger Failure, below.)

If the occurrence being tested against is a rare event, the trigger is also often tested against modeled or hypothetical scenarios, again to see under which scenarios the trigger conditions are met. When a full range of hypothetical, plausible scenarios is available, such as in a stochastic catalog (Madhav et al., 2023), then additional statistics may be calculated, such as the overall probability of the trigger conditions being met.

Upon completion of the iterative process, there should be agreement by all involved parties that the trigger is measurable, that the payout occurs with appropriate timing and predictability, and that stakeholder incentives and expectations are aligned—keeping in mind that for triggers incorporated into disaster risk financing instruments, the stakeholders involved often span public and private sectors (Schanz, 2021).

Case study: The World Bank Pandemic Emergency Financing Facility (PEF)

The PEF, the first sovereign insurance mechanism for epidemic and pandemic risk, was issued in 2017, in reaction to the slow and initially inadequate donor financing response to the 2014 West Africa Ebola epidemic. It was designed to provide financing for several types of infectious disease risks and was organized into two classes. Class A was configured to release funding in the event of a large, multi-country outbreak of a respiratory pathogen (i.e., an influenza virus or a novel coronavirus), which could develop into a pandemic. Class B was designed to provide funding to contain a multi-country epidemic, similar to the 2014 West Africa Ebola epidemic, and caused by pathogens including filoviruses, novel coronaviruses, Lassa virus, Rift Valley fever phlebovirus, or Nairovirus (the causative agent of Crimean-Congo Hemorrhagic fever).

The PEF was explicitly designed to provide financing for multi-country epidemics, rather than sustained epidemics within a single country. This design criterion would later lead to substantial criticism during the North Kivu Ebola epidemic (also known as the 10th Ebola outbreak in the DRC), which lasted from 2018 to 2020, remained almost entirely contained within the Democratic

Republic of the Congo, and for which no payout from the insurance window was released (Jonas, 2019).¹ However, the PEF also included a “cash window”, a funding pool that could be flexibly deployed to support response activities for events that did not meet trigger criteria for either class. The cash window did ultimately release funds to support the response to the North Kivu epidemic (World Bank, 2019).

The PEF had several other notable design characteristics. First, the IDA countries² that were potential recipients of PEF funds did not have to pay for coverage. The World Bank financed the development and implementation of the PEF disaster risk financing mechanism with IDA funds; international donor funding paid the entirety of the premium. The use of IDA funds to finance the PEF generated debate, particularly since IDA money flowed to private insurance companies in the form of premium payments (Jonas, 2019). That critique relates to the source of funds, rather than the trigger design, but may have amplified later concern over the complexity of the triggers themselves.

Second, the triggers were complex, leading to criticisms about the lack of transparency or verifiability of the triggers. Especially controversial was the growth rate trigger criterion, which was complex and did not have easily accessible methodological documentation and data, such that it could be quickly replicated. Trigger complexity, including the growth rate trigger criterion, was likely the result of the interplay between competing stakeholder demands versus budget constraints in the design of the trigger. The design of the trigger encapsulates the push-and-pull between the desire on the part of the beneficiaries to receive the funding as much and as soon as possible and often with minimal criteria, while the capital providers (especially if they include insurers and investment professionals) may demand indisputable confirmation of an event and evidence that the funds are needed. In the case of PEF, the growth rate trigger criterion may have arisen as a way to provide evidence that an eligible epidemic event was continuing to worsen, and thus the funds would still be necessary by the time they would be disbursed. Other relevant factors in the trigger design were likely misaligned incentives and an attempt to limit the perception of inordinate payout risk on the part of capital market participants who would be more skeptical about a novel financing mechanism.

The COVID-19 pandemic met the trigger criteria for the PEF on April 17, 2020, about five weeks after the WHO PHEIC declaration on March 11, 2020. This resulted in a full payout from Class A of over \$195 million, which by September 30, 2020, had been distributed to beneficiary countries. PEF funds were used to support varying response activities, specific to the needs of each beneficiary country. Funding uses included, for example, procurement of diagnostics and personal protective equipment (PPE), increasing diagnostic testing capacity in national labs, expansion of hospital bed capacity, investments in oxygen generation and distribution, and funding to mobilize skilled medical personnel (Juma, 2021; Kostallari, 2020; World Bank, 2021a). This six month lag from the

1 Apart from 4 deaths in Uganda, which occurred when a family crossed the border from DRC into Uganda to seek treatment.

2 Countries eligible for grants and concessional loans from the International Development Association, which provides support to countries that cannot borrow funds at the market rate.

trigger criteria being met to the completion of fund disbursement should ideally be shortened in future financing mechanisms for infectious disease risks to ensure that the payout amount remains relevant for the stage of the outbreak. For PEF, detractors primarily criticized the payment amount as “too little, too late” for a pandemic of such magnitude—though arguably, no financing mechanism in existence at that time could have covered the entire cost of the COVID-19 pandemic, and so a more appropriate bar would be to assess if the PEF financing was accretive to the other financing available at the time.

As we note above, it is critical to clearly articulate the problem that the financing instrument is designed to solve, and which scenarios would lead to a payout, and which would not. Another aspect to be improved in future iterations of such global disaster risk products is the transparency about the rules of distributing the funds between beneficiaries when the event occurs.

The lessons from PEF are numerous. As discussed above, an effective trigger should be simple, transparent, objective, verifiable, and pre-agreed. Of these characteristics PEF arguably fell short mainly in the areas of having a simple, transparent, and easily verifiable trigger (Meenan, 2020). The first lesson from the PEF experience pointed to the challenges that arise with a complex trigger, which can make it difficult to verify, and potentially lead to a lack of trust in the financing instrument as a whole. A second major lesson is around transparency, pointing to the need for very early, frequent, and informative communication to all the stakeholders (including the public), so that there is a high degree of comfort and understanding of the trigger design, the scenarios in which it is expected to trigger (and not trigger), what technical choices were made in the trigger design process, and why. As we note above, the PEF did not trigger a payout from its insurance mechanism for the North Kivu Ebola epidemic of 2018–2020, leading to substantial criticism of its complex trigger structure (see Table 1) (Brim & Wenham, 2019). While there are important lessons to be learned from the practical implementation of the trigger, the PEF was fundamentally designed to respond to multi-country epidemics, rather than sustained events that remained (largely) contained within a single country. As a result, debate about the North Kivu non-trigger should have focused on the fundamental design and covered event definition, rather than narrowly on the trigger design. This is why careful concept-testing and discussion regarding the event definition among all stakeholders—beneficiaries, trigger designers, donors, governments—is so critical.

A third lesson, going beyond the trigger, is that PEF’s cash window was an effective way to maintain flexibility for situations where an epidemic might require rapid financing, but trigger criteria are not met for the insurance window. Maintaining this level of flexibility, both in the circumstances under which funds can be disbursed, along with what they can be used for, is critical to ensure that funds can go towards unanticipated needs that arise.

A fourth lesson that emerged was the need to closely engage beneficiary countries to build awareness and tie the financing mechanism with the creation of incentives towards actions that can

prepare for and reduce overall epidemic risk, such as investing in diagnostic capacity and pathogen monitoring programs.

Arguably the final lesson from the PEF—one already gained from hard experience in other risk financing domains, such as climate and natural catastrophe risk—is that designing financing mechanisms for challenges where both the risk (Meadows et al., 2023) and the fundamental science are rapidly evolving, is difficult and requires a commitment to ongoing learning and dialogue.

Ultimately, a proper independent evaluation will provide the most thorough assessment of the successes, challenges, and lessons learned from the PEF.

Trigger failure

Parametric triggers can fail in many ways, which often fall in one of two main categories: false positives and false negatives. A false positive in the context of a financing instrument is an event that meets the criteria for release of funds, but the actual losses incurred are zero or less than the payout amount. In this case, the providers of the capital “suffer” from a loss of their capital. This also potentially sends the a signal that there is inadequate science or design rigor behind the trigger, thus the financing mechanism could be perceived as a “lottery.” A false negative occurs when the trigger criteria are not met, even though substantial losses are incurred. In this case, the beneficiary or insured suffers, since they are impacted by real losses and expenses which they expected to have covered by the financing mechanism. The goal during the trigger design and calibration phase of the structuring process is to minimize the probability of both types of errors, (also described by practitioners as “basis risk”). During this process, and to minimize basis risk, the trigger criteria will be tested and configured based on historical data and model estimates so as to maximize correlation to actual loss.

There are also ambiguous situations. Consider, for example, a scenario in which a trigger is designed to support early response and containment of Nipah virus disease epidemics in South Asia, and is configured to pay out when 20 deaths caused by Nipah virus occur. An outbreak subsequently occurs in Bangladesh: 40 people are infected, 20 people recover, 19 people die within the first 3 weeks; the final infected person remains in the clinic for a week, then dies. The policy pays out, but the outbreak is over. This may be viewed by capital providers as a false positive, since the outbreak is no longer active. However, the policy could still be effective, as it could provide financing to the country for response and containment activities initiated earlier in the outbreak, and prospectively for any ongoing surveillance to ensure that any additional cases are rapidly detected. Capital providers and the recipient countries may have honestly diverging points of view over whether the financing mechanism and trigger structure were successfully designed. The converse problem could occur under a more complex trigger structure, for example one that includes infections, deaths, and the growth rate (that is, trajectory of the epidemiological curve). In such a circumstance, case or death

trigger criteria could be met slowly enough that the growth trigger is not reached; this could lead to complaints—as it was the case for the PEF—that the policy should nevertheless have triggered.

Triggers could potentially be manipulated, “gamed”, or the presence of a financing mechanism may create perverse incentive structures that alter the probability of a payout. First, having a financing mechanism in place may—in theory—create a “moral hazard”: an incentive to take riskier actions or forego risk-reducing actions (Rowell & Connelly, 2012). In the context of epidemics, moral hazard—i.e., misaligned incentives—could conceivably include relaxing disease control measures until the trigger is met (a risk which could become more substantial as the proximity of breaching the trigger point increases). A perhaps more plausible version of this risk could be that a country applies tentative or inadequate population-wide measures to reduce disease transmission, knowing that such measures may be economically damaging, and that additional financing support is more likely to be triggered if the partial measures are unsuccessful.

A more plausible—and indeed, a positive externality—incentive created by a financing structure may be to intensify surveillance and case-detection efforts. From the perspective of the insurer or capital provider, however, this may be problematic, as trigger design or pricing efforts would not have taken more intensive surveillance (and presumably, case identification) into account. These dynamics may vary by disease. For example, for endemic diseases with incomplete surveillance—such as Lassa fever in portions of West Africa—the presence of a sufficiently large financing mechanism could lead to investments in surveillance that increase the probability of detecting baseline levels of endemic transmission, and therefore triggering a payout. In contrast, the “investment case” for a country to recoup surveillance expenses by detecting less frequent occurrences, such as a spillover of Nipah virus in Malaysia, may be more limited.

It should be noted that the “risk” of surveillance improvements leading to unanticipated increases in the likelihood of financing mechanism to trigger depends entirely on the size (and perceived probability) of the payout relative to the cost of surveillance, including potential negative consequences and disincentives for outbreak reporting, including for example international trade restrictions. In our view, this is unlikely given the cost of sustained, high-quality surveillance relative to the typical, relatively modest payouts built into disaster risk financing mechanisms for epidemic risk.

The risk associated with false positive payout can be mitigated by (for example) limiting the use of funds to pre-agreed uses that will not apply if an epidemic response is not warranted, to design a policy that reimburses for already incurred expenses or to require that the beneficiary provide proof of loss before the funds are released. However, these limitations turn a relatively simple parametric mechanism into a more complicated, indemnity-like mechanism, potentially preserving the speed with which financing can be released, but adding complexity and auditing requirements to the post-disaster recovery phase. Because false positives have effectively been “priced into” the mechanism design, another approach can be to roll unspent funds from false positives into a cash

window, to be expended on other crisis response activities, including payment for false negatives. While theoretically feasible, such mechanisms would be operationally and politically challenging, and potentially increase the scope for miscommunication and misaligned expectations between stakeholders.

Mitigating the risk from false negatives—payouts that should occur, but do not—is perhaps more challenging. One option that has been previously tested in disaster risk financing instruments is to include a “cash window” or “contingency window”: a pool of capital that can be flexibly deployed for a variety of purposes, including supporting response costs for an event that meets the stated intent of the financing mechanism but due to some unforeseen complexity or challenges, does not meet the trigger criteria (World Bank, 2021b). To build trust and predictability for the beneficiary, cash windows must also have a detailed operations playbook explaining what they are intended for and who makes the payout decision using either a set of criteria or parametric logic to channel and delimit the use of funds: for example a cash window could require at least *N* reported, laboratory-confirmed deaths caused by a viral pathogen.

Conclusions

Well-defined triggers can provide clarity and speed to complex decision-making processes that often take place, unrehearsed, in the midst of an active crisis. Parametric triggers have been most frequently employed in insurance and natural hazards risk financing instruments. That said, many decision processes and financing mechanisms in the health sector resemble these instruments, in the sense that they formally incorporate variables, transparent, measurable thresholds, and other objective criteria to guide or even bind complex decision-making processes based on pre-agreed terms.

This chapter is not a call to blindly adopt triggers—parametric or otherwise—in epidemic financing and policy processes.³ Rather, we urge readers to use and learn from sound design principles in the development of triggers, whether they are qualitative, quantitative, or a mixture of both. The most fundamental design principle is to design with care and incorporate diverse knowledge—especially practical, operational knowledge—about the risk context. This means designing with broad participation, as well as transparency, to ensure that the purpose of the trigger is clear, understood, and accepted by all involved. All other design principles are, in an important sense, technical, and can be addressed through careful, iterative analysis, testing, and refinement.

In this chapter, we have focused primarily on the design of triggers for financing mechanisms. Here, it is important to note that no single ‘comprehensive crisis financing structure’ (Centre for Disaster Protection, 2021) will be applicable for all future threats, including biological threats. Instead,

³ That is to say, we do not propose a hegemonic parametric agenda, but rather, thoughtful application of parametric approaches where appropriate.

triggers should be designed to address specific, well-defined problems and risks, using a clear event definition and appropriate technical design. Triggers can also be designed to support policy decisions once an epidemic or pandemic has occurred, notably whether and how intensely to apply population-wide disease control measures, and when to relax or end such measures. A primary virtue of triggers is that they can be built into a range of “playbooks” tailored to specific scenarios and risks, helping guide policymakers where decision frameworks are sound, and perhaps alerting them to scenarios where prior guidance—and the factors and thresholds that it is rooted in—may not be fit for purpose.

Finally, we note that triggers are (if designed with care) an efficient, objective, and predictable way to mobilize money to contain crises and save lives and livelihoods. Ultimately what is needed is strong, credible, and consistent commitment from funders to provide adequate pre-arranged financing for epidemic preparedness and response in a predictable and timely way. Without this, effective containment and response to epidemics and pandemics will remain impossible to achieve. With it, a more secure future is possible.

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