EMERGING DISEASE **INSIGHTS**

Research from the PREDICT Modeling & Analytics team

Global Costs of Emerging Infectious Diseases: an Economic Case for the Global Virome Project

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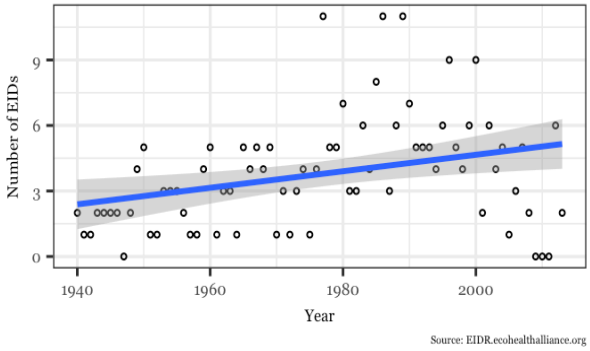
A single emerging infectious disease epidemic such as the SARS pandemic in 2003 can cost the global economy an estimated $30-50 billion, but investments in prevention and research are often insufficient. To make the economic case for investing in large-scale research, surveillance, and prevention programs, it is important to model and quantify the future economic impacts of Emerging Infectious Diseases (EIDs) and pandemics.

The Global Virome Project (GVP) is a proposed 10-year global effort to discover the majority of viruses with likely zoonotic potential residing in mammals and waterfowl. This project could reduce the burden of emerging infectious diseases by creating a viral sequence and metadata atlas that will support risk assessments, development of mitigation plans, and lower response times. The data generated by the GVP is also likely to speed technological advancements and provide a starting point for diagnostic and therapeutic discovery and development. Based on current projected lab and field costs, the GVP is estimated to be achievable for $1.2 billion or $120M annually over the next ten years. Given our estimations of EID frequency, mortality rates, and impacts on the global economy, we project the costs of all potential zoonotic emerging disease events over the next 30 years and calculate projected Return on Investment (ROI).

COSTS OF EMERGING INFECTIOUS DISEASES

The incidence of emerging infectious disease events is on the rise (1). A majority of these diseases, including SARS, MERS, Avian Influenza, and Ebola, are zoonoses caused by spillover from animal into human populations. To project future annual rates of zoonotic EID events, we calculate the average frequency and variance of EID events per year and the rate of change over time (2). We built a model to estimate the mortality, morbidity, and economic shocks per event, based on case fatality data from the Emerging Infectious Diseases Repository (EIDR).

Figure 1: Annual frequency of Emerging Infectious Diseases from 1940 to 2013.



ESTIMATING GLOBAL DAMAGES FROM EID EVENTS

Global damages, or economic costs, from emerging infectious diseases (EID) depend on the annual number of EID events and the average cost of each event. Damages of one event are the sum costs from mortality $M(t)$, morbidity $A(t)$, and economic shocks $G(t)$. To find the total present value of global damages $PVGD$, we use a standard five percent rate (δ=0.05) to discount future savings to their current value.

$$PVGD = \int_{t=0}^{t=30} (M(t) + A(t) + G(t))\, e^{-\delta t}$$

We use conventional methods to calculate the value of a statistical life and the value of one day

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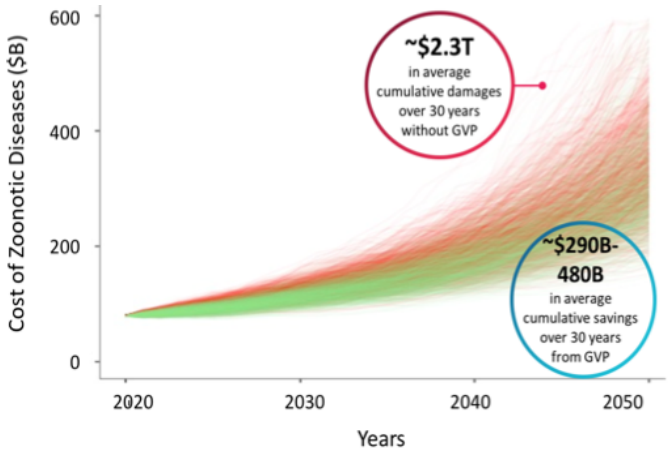
of work lost (3). In our model, economic shocks are proportional to the mortality of the event. We parameterized our model using the forecasted number of annual EID events, the historical global GDP growth rate of 2.4%, and the 2015 global GDP of $73.4 trillion. **Averaged over 5000 simulations, we find the discounted cost of emerging infectious diseases to be US$2.3 trillion over the next 30 years.**

COSTS AND ROI OF A GLOBAL VIROME PROJECT

To determine how much it would cost to discover all viral diversity in mammals, mark-recapture ecological techniques were used to estimate the sampling effort required to discover all viruses present in one species (4). We estimate that there are 1,669,106 (se 697,623 - 2,640,590) undiscovered viruses likely to reside in mammal and water bird hosts (2). However, only 32.2-45.0% (493,856-689,285) of these are likely to be zoonotic, and the ones that are more costly to find are less likely to spillover. Assuming that all mammal species would have equivalent lab and field costs, discovering 71% of all mammalian viruses and water bird influenzas would cost $1.2 billion, or an average of $120 million per year over 10 years.

Having a baseline of identified viral sequences would lead to earlier detection and quicker response times, lowering both epidemic frequency and impact. These improvements would not have an immediate impact, but benefits would accumulate throughout and beyond the lifespan of the GVP. For our calculations, we assume that these benefits collectively lead to an average of 10% in savings from damages in all events in the next 30 years ($290-480 billion). As such, a $1.2 billion Global Virome Project would return over $200 dollars in savings for each dollar invested.

Figure 2. Forecasted economic damages from EIDs over the next 30 years.



Red line shows damage growth under business-as-usual, green line shows reduced growth if the GVP causes a 10% reduction in damages.

Even if the GVP only reduces the likelihood and impact of EIDs by 10%, this project would generate large returns on investment due to the high and rising costs of pandemics. The premature loss of lives and economic shocks account for the largest proportion of economic damages from EID events. A $120 million annual budget for a 10-year Global Virome Project is an investment that could produce exceptionally high returns.

References

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