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# CROWDSOURCING GLOBAL SECURITY

## FIGHTING PANDEMIC DISEASE IN THE INFORMATION AGE

Efrat Rosenzweig

*The Project on International Peace and Security*
The College of William and Mary

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Amy Oakes, Director
Dennis A. Smith, Director

The Project on International Peace and Security
The Institute for Theory and Practice of International Relations
Department of Government
The College of William and Mary
P.O. Box 8795
Williamsburg, VA 23187-8795
757.221.5086
pips@wm.edu

## Abstract

Pandemic disease constitutes a threat for which we are nationally and globally unprepared. Left unchecked, pandemic disease can lead to millions of deaths, shifts in the balance of power, resource wars, mass migration, and state failure.[1] The ability to prevent pandemics hinges on early detection. Epidemiological surveillance in areas where novel viruses are likely to emerge, however, is rudimentary, allowing most diseases to spread undetected.[2] Reliance on inadequate reporting is a dangerous oversight that potentially compromises national and global stability.

This brief proposes an alternative method of preventative surveillance that uses crowdsourcing technology to provide states with real-time data on potential epidemiological threats. Based on reporting by health professionals, this system will create a map on which clusters of similar cases indicating a possible epidemic could be observed. Ultimately, information sharing between states in the field of public health will provide a basis for increased cooperation to combat other transnational security threats, including organized crime and terror.


## Dangers of Pandemic Disease

Between 50 and 100 million people were killed by the Spanish influenza epidemic of 1918, a virus believed to be a strain of avian flu.[3] Other viruses, like the measles and polio, are more infectious than influenza and could be more fatal.[4] While high casualties alone are a threat to human security, pandemics affect traditional security issues as well.

- Pandemics can precipitate violent conflicts and determine their outcome.[5] A state affected by an epidemic may experience a decline in military capability, resulting in destabilizing shifts in regional balances of power.

    - For example, the Spanish flu of 1918 emerged in Austria-Hungary in 1917, a year before it reached Allied troops. Mortality rates were highest in Germany and Austria-Hungary and lowest in England and France. In particular, the pandemic dramatically reduced the number of troops available for the German offensive in the spring of 1918 which could have led to a victory for the Central Powers.[6] The difference in mortality contributed to the Allied victory in World War I.[7]

- States that lose the capacity to provide vital services to their citizens are more vulnerable to criminal and insurgent groups. Further, as an epidemic spreads, governments will be crippled by widespread police and military absenteeism.[8] As a result of this decreased capacity, states will be more likely to collapse.

- Epidemic disease can lead to a significant disruption of the adult workforce and damage international trade, causing an economic decline and contributing to domestic instability. States with high disease burdens are more prone to insurgencies and high crime rates.[9]

    - HIV/AIDS is expected to cause a 60% decline in South Africa's GDP by 2050.[10] The beginnings of this economic decline have contributed to riots in many of the poverty-stricken townships surrounding South Africa's cities and boycotting of elections in areas where the ANC enjoyed strong support before the AIDS pandemic began.[11]

- Vaccine development for a novel pathogen can take anywhere from two months to twenty years.[12] During an epidemic, countries with vaccine manufacturing capability would give priority to their own populations.[13] The supply of vaccines available to developing countries will be limited due to stockpiling by high income countries.[14] This will increase tensions between developing and developed countries and may also lead to interstate conflict as states compete for limited medical resources.

    - When H5N1 Avian flu emerged in Indonesia in 2005, Tamiflu was unavailable to Indonesian buyers, as the drug had been stockpiled by wealthy countries. Samples of the virus were sent by Indonesia to the WHO and then to an Australian pharmaceutical company for vaccine development. The manufacturer did not intend to sell a potential vaccine in Indonesia.[15] In February 2007, the Indonesian Health Ministry announced that they would cease virus sharing for testing and drug development unless new terms were negotiated by the WHO that would be more beneficial to developing countries.[16]

- Pandemics increase the probability of refugee crises as people flee affected countries, contributing to food and water shortages and exacerbating regional tensions.[17] If the crisis persists, mass migration can cause intrastate conflict.[18]

    - Since 2008, over three million people have fled Zimbabwe to South Africa. In addition to the political instability in Zimbabwe, many are fleeing cholera and the AIDS epidemics; others are disease victims seeking treatment that is unavailable in Zimbabwe's collapsed health system. South Africa has labeled refugees as "voluntary economic migrants," which denies them legal status and government protection. Tensions have steadily increased as the refugee population has grown and, in May 2008, these tensions erupted in violence against the refugees that killed 60 and further displaced over 25,000.[19]

International security analysts have traditionally categorized pandemic disease as a global health or humanitarian issue.[20] Since the SARS and H1N1 scares and with the threat of avian flu

looming, it has become increasingly clear that pandemic disease has real security implications that cannot be ignored. As with any threat, the first line of defense is accurate intelligence.

## Status of Epidemiological Surveillance

While most developed countries have highly effective epidemiological surveillance systems, the majority of developing countries do not.[21] This lack of surveillance is dangerous, as agrarian communities without proper sanitation provide an ideal breeding ground for novel viruses.[22]

### Surveillance in the U.S.: A Problematic Model for Developing Countries

The U.S. uses a population-based model, in which doctors record diseases classified by the World Health Organization as "reportable," such as cholera and H5N1 influenza.[23] The U.S. Centers for Disease Control and Prevention (CDC) responds to these reports through several programs:

- The Office of Surveillance, Epidemiology, and Laboratory Services (OSELS) examines birth, death, and medical records in order to compile statistics on the frequency of reportable diseases.[24]

- The National Center for Emerging and Zoonotic Infectious Diseases (NCEZID) coordinates the government's response to outbreaks.[25]

- The Office of Public Health Preparedness and Response (PHPR) monitors reporting systems and maintains the strategic national stockpile of medical supplies.[26]

Most developing countries use the U.S. method as a model for their own surveillance systems. Among these countries, low reporting rates and inadequate data analysis are pervasive.[27] This is primarily because:

- Low income countries have a severe shortage of health professionals, most of whom have neither the time nor the inclination to complete the requisite paperwork.[28]

- The U.S. spends close to $2 billion per year on infectious disease prevention.[29] Low income countries cannot afford such a costly surveillance system.

Surveillance in Developing Countries

Most developing countries have modified the U.S. model in an attempt to decrease costs. These adaptations make surveillance systems less effective and are inadequate.

- Due to the cost of a population-based model, most countries use sampling, which gathers information on only 10-20% of patients.[30] The vast majority of patients and illnesses go unreported.

- Sentinel sites–major hospitals with staff willing to report regularly–conduct sampling.[31] In many developing countries, only the wealthy can afford to seek care at these hospitals.[32] Low-income patients, who are most likely to be infected with zoonotic- or animal borne- diseases, do not have access to these sites.

- Most states have no enforcement mechanism to ensure reporting. The forms are lengthy and compliance is low.[33] The average reporting rate in developing countries is 7-8%.[34]

These factors produce a highly inefficient system that can allow pathogens to spread unchecked through a population and across borders.

**Current Initiatives to Improve Global Epidemiological Surveillance**

Humanitarian projects to improve reporting fit broadly into two categories: those that seek to improve the ability of developing nations to conduct their own epidemiological surveillance and those that seek to bypass governments and gather information independently.

Capacity-Building Programs

Programs to improve the ability of developing countries to obtain accurate statistics on infectious diseases are appealing because they are, theoretically, a one-time cost with continuing returns. The most significant of these programs are:

- The CDC's Global Disease Detection Program, which aims to establish 16 centers worldwide that will serve as laboratory and information-gathering systems on global infectious diseases.

*Weakness*: Only six of these centers have been built due to budget shortages.[35] Those that exist only analyze samples of reportable diseases. Many doctors are reluctant to cooperate with CDC labs due their affiliation with the United States.

- The Field Epidemiology Training Program (FETP), which seeks to train local epidemiologists in the developing world.[36]

  *Weakness*: The primary job of FETP graduates is to trace outbreaks back to patient zero after they occur. This has little preventative value.

- WHO-Afro's Integrated Disease Surveillance and Response Program, which assesses surveillance systems and recommends improvements.

  *Weakness*: Only 4 of 46 participating countries have undergone analysis, as the WHO does not fund improvements to existing systems.[37]

These issues weaken the ability of capacity-building programs to improve surveillance. Most programs never reach the rural agrarian communities that are most at risk for emerging diseases.

Independent Monitoring Programs

Rather than improving government capacity to reach poverty-stricken rural populations, some organizations have developed programs to gather information independently of governments. These include:

- WHO's Program for Monitoring Emerging Diseases (ProMED), which reports on outbreaks of zoonotic diseases in member states [38] Information comes from government reports and independent sources, including media reports, local observers, and online sources.[39]

  *Weakness*: While it does include non-government sources, ProMED still relies on secondary information, rather than direct reporting by health professionals.

- The Peruvian Navy's AlertaDISAMAR, which is a local effort to use crowdsourcing technology to improve reporting from naval hospitals. The internet-based system allows doctors to use cell phones to submit information on reportable diseases.[40]

*Weakness*: Limited resources and lack of cooperation from other segments of government have resulted in the system being limited to naval hospitals. Population-wide surveillance is not possible.

While government programs do not make full use of innovations in information technology, independent programs generally take advantage of the internet to gather large quantities of information quickly. This coincides with a general trend in the global health community of using information technology to improve health in the developing world. Existing projects, however, have failed to significantly improve surveillance. New technologies are now available that will make it possible to gather accurate, real-time data on diseases.

## The Promise of Crowdsourcing

The newest innovation in information-gathering technology is crowdsourcing.[41] Users can post to an application with any internet-capable device, and their post appears as a pinpoint on a map.

The first application of crowdsourcing to disease monitoring came in 2010 with OutbreakMD, a smart phone application that uses this technology to allow doctors to post information on reportable diseases to HealthMap.[42] Using crowdsourcing for disease monitoring is a vital innovation that will provide the basis for new epidemiological surveillance systems.

### OutbreakMD: Crowdsourcing in Global Health

During a pilot program in Port-au-Prince, Haiti, the program was embraced by the general public but generated a very low reporting rate amongst health professionals: only 117 reports were made by doctors over three months.[43] HealthMap itself receives no reports from most of Africa, Asia, and South America.[44] The low reporting rate can be attributed to a number of weaknesses in the program:

- Any person with internet access can post to OutbreakMD, which generates too much "noise", or inaccurate data, and is easily tampered with. OutbreakMD is a traditional crowdsourcing application; it is based on the premise that a large number of reports from all people with internet access will generate patterns faster than expert reporting. However, disease diagnosis requires medical training, and amateur diagnoses are typically incorrect.[45]

- The form is only available in English and has no place to enter patient age range, gender, or ethnicity.[46]

- The form relies entirely on the GPS function. It does not have a field for patient address, and the application is not programmed to extrapolate map data from that address. In many developing countries, patients travel large distances to seek care, meaning that a disease is not always located in the place where it is reported.[47]

- The lack of built-in analysis puts a heavy burden on health provision services.

- HealthMap does not send region-specific reports to health professionals automatically. Doctors must access HealthMap to see the map. Given the shortage of doctors in most developing countries, many do not have time to check HealthMap regularly.[48]

- Information is made public through HealthMap, limiting the willingness of countries to allow their doctors to participate.[49] Governments are reluctant to publicize potential internal weaknesses.

If the issues listed above were remedied, OutbreakMD would be a useful tool for providing vital statistics on endemic, reportable diseases to local governments. It would not, however, be useful for tracking emerging pathogens or potential pandemics because:

- The OutbreakMD form can only be submitted on reportable diseases, as defined by the WHO.[50] This limits its effectiveness in detecting emerging diseases.

- The raw data obtained by OutbreakMD are not analyzed for patterns associated with epidemics.

While OutbreakMD represents the most promising innovation in epidemiological surveillance, there is room for significant improvement. In order to be useful for pandemic prevention, a similar application must be able to cope with the volume of incoming data and, more importantly, it must overcome the political and economic issues preventing health professionals from using OutbreakMD. This brief proposes such an application.

## *Nafasi*: A Social Network for Disease Detection

Building off of the innovations made by the Harvard-HealthMap team, this brief proposes a new application—*Nafasi*—that will use crowdsourcing to gather information but will overcome the limitations of the OutbreakMD system. *Nafasi* will:

- Require each doctor to have a registration code to ensure that all reports are reliable and will color code posts to differentiate between those coming from doctors, other health professionals, and independent reporters.

- Integrate with Google Translate, allowing forms to be filled out in 63 languages.

- Use a fill-in form containing fields for patient age range, gender, ethnicity, symptoms, treatment, and prognosis, rather than checkboxes of already reportable diseases.

- Include an optional section in the form for patient address if the patient is being seen by a doctor outside of their place of residence.

- Inform health professionals about potential threats in their areas. This puts doctors on the alert for specific symptoms and will increase compliance by underscoring that contributing information is important to a wider community of health workers.

These modifications will make the application more accessible to public health professionals and make it more difficult to tamper with data input. In addition, there are logistical, financial, and political realities that must be addressed in order to ensure widespread use of *Nafasi*.

Logistical Considerations

- Posting reports to *Nafasi* relies on internet access in rural areas of low-income countries. 11.4% of Africans, 23.8% of Asians, and 36.2% of Latin Americans have internet access.[51]

  *Solution*: Internet access has grown 480% in the past 10 years, and 2527.4% in Africa. While many areas are still unconnected, this is changing rapidly—even without any additional intervention.[52] During an outbreak, the government could further improve access by constructing additional cellular phone towers—the fastest and cheapest way to increase wireless access—in isolated affected areas.

- A major hurdle in implementing any new program is spreading awareness. Since crowdsourcing is particularly dependent on mass participation, implementation of *Nafasi* must include a mechanism for education and training.

  *Solution*: Countries can spread *Nafasi* by requiring schools to educate future health professionals in the use of *Nafasi* during their training, teaching caregivers about the importance of accurate reporting. For health professionals who have completed their

education, additional training programs could be held. In addition to training doctors, the implementation of *Nafasi* should begin with a pilot program at the district or province level, which would then spread to other provinces, eventually creating an integrated nationwide system.[53]

Financial Considerations

*Nafasi* will generate an enormous amount of raw data that must be analyzed.

- Individual countries often cannot afford the high cost of manual analysis, and the WHO does not have the budget or the workforce to integrate and analyze all countries' data.[54]

  *Solution*: The application uses a standard GETIS-ORD algorithm, which is open source and can be programmed into the application to analyze data. This algorithm looks for hot-spots, defined as areas containing a certain number or proportion of cases. When it detects a cluster of multiple hotspots in the same area, it will trigger an alert.

- Smart phones are expensive. Even if internet access reaches into all areas of developing countries, not all health professionals will be able to access *Nafasi*.

  *Solution*: Several NGO's are already beginning to distribute smart phones to villagers in remote areas.[55] Elsewhere, purchasing a single internet-capable device per village is an inexpensive commitment for participating countries to make.

The major obstacle for current epidemiological surveillance systems is that information gathering and analysis are prohibitively expensive. By improving internet access and using GIS-pattern recognition rather than manual analysis to handle raw data, the cost of implementing *Nafasi* will be significantly lower than current systems.

Political Considerations

Crowdsourcing systems have generally faced little political opposition, as they are operated by citizens and not states. But since health professionals in many developing countries are government employees, the cooperation of governments is crucial to the success of *Nafasi*. State participation faces several barriers:

- Any system tied to a U.S.-based actor will be perceived as interference by Washington in a country's domestic affairs, if not outright imperialism. This would severely curtail the willingness of states to participate in the program.

- If information is publicly available, as with traditional crowdsourcing applications, many countries will limit what their public health community is allowed to report, in order to prevent hostile states from taking advantage of internal weaknesses or for fear that news of an outbreak will affect international trade and tourism.

- States may refuse to participate due to a historical unwillingness to share information. For example, the failure to report the SARS outbreak in China indicates a reluctance to cooperate with the international community on such matters or admit to their inability to control the outbreak.[56]

Achieving large-scale cooperation and information sharing among countries is a difficult undertaking that cannot be solved solely by technology. The key to garnering state support for *Nafasi* is a program of implementation that moves gradually from domestic implementation to global partnerships.

## Implementation of *Nafasi*: Overcoming Political Barriers Through Gradual Centralization

In order to overcome opposition to information sharing, this brief proposes a three-phase rollout of *Nafasi*.

### Phase One: Individual States Adopt *Nafasi*

The lack of accurate information in global epidemiological surveillance stems from two separate problems: (1) the lack of local surveillance within each country, and (2) hesitation on the part of individual states to report sensitive information to the international community. Phase One will address the first of these problems. During Phase One:

- *Nafasi* will be provided to countries for free with regular updates being made available online, similar to Mozilla's products. It will be available as a website or as an application for Apple products or those with an Android operating system.

- Countries that adopt *Nafasi* will have access only to their own raw data and a *Nafasi*-produced map.

- Each country will be responsible for encouraging the use of *Nafasi* throughout its health system and reacting to any outbreaks detected by the system.

- No information sharing will be required or expected.

Countries will adopt *Nafasi* because it provides a cheap, efficient, and effective means of meeting the demand for improved epidemiological surveillance, and is also in line with the general trend in the global health community of using information technology to improve health.[57] Most developing nations have budgets for improving surveillance using the WHO's health systems building blocks—Zimbabwe spent $75 million on AIDS surveillance in 2010 alone—but have not seen the hoped-for successes.[58]

A country will have completed Phase One when at least 75% of health professionals in rural areas use *Nafasi* regularly to submit information on reportable diseases or suspicious symptoms.

Phase Two: Bilateral Information Sharing

Phase Two will address the fact that epidemics cross borders, and that information sharing by neighbors is necessary to obtain a complete picture of potential outbreaks. There is already a precedent for states to cooperate in the case of an outbreak, so this form of information sharing will occur naturally. In Phase Two:

- States will first sign bilateral information-sharing agreements, followed by multilateral or regional agreements.

- Individual national maps will be combined into a single regional map to which all partners will have access.
- The regional map will be analyzed by GIS algorithms as a whole, rather than by country, and all partners will receive notification of all potential outbreaks within cooperating states.

During outbreaks, even hostile states routinely cooperate on detection and prevention. This precedent is most notably apparent in MECIDS, the longstanding partnership between Israel, the Palestinian Authority, and Jordan to detect and prevent food-borne illnesses. In 2005 and 2009, this infrastructure was used to track and prevent avian and swine flu outbreaks, respectively. The partnership involves a documented plan for each country's responsibilities in the event of a pandemic and has included efforts by Israel to improve lab testing and treatment services for influenza in both the Palestinian Authority and Jordan. [59]

Bilateral agreements have the potential to encourage countries to provide aid to neighbors should an outbreak strike, in the interest of preventing the disease from spreading into their own territory. Over time, it may also increase interdependence between states, giving each partner a vested interest in maintaining the stability of cooperating states.

Phase Three: Centralization

Phase Three will occur in conjunction with Phase Two and will centralize the data gathered by each country's *Nafasi* at the WHO in order to create a global database of information on potential outbreaks. While the WHO is currently undergoing major cutbacks due to loss of funding, managing a global *Nafasi* system would not require additional funds, and could be accomplished by reallocating resources from other information gathering programs made obsolete by *Nafasi*.[60] During Phase Three:

- The WHO will provide incentives for countries to share individual *Nafasi* maps with the WHO, in keeping with their stated commitment to encourage improved epidemiological surveillance.[61] These incentives will include:
    - Aid in the case of an outbreak. This can be done by reallocating the $816 million currently in the 2012-2013 WHO budget for improving surveillance and outbreak response.[62]
    - Improvements on public health infrastructures, such as clinics, laboratory facilities for diagnosis, and health education programs.
    - Pressure from other WHO member states during regular meetings. This is the primary means of persuading states to share information currently used by the WHO.[63]
- A global map will be constructed from participating countries' *Nafasi* maps and GIS-analyzed by the WHO.
- Individual countries will *not* have access to the *Nafasi* maps of all countries sharing information with the WHO but will continue to have access to any bilateral or regional maps formed in Phase Two.

- The WHO will not notify individual countries of an outbreak in another country unless there is an information sharing agreement already in place or the WHO deems it impossible to control the outbreak before it crosses international borders.

- WHO representatives and the affected country will both receive a notification in the case of an outbreak.

Phase Three will allow the WHO to ensure that an outbreak has not spread beyond its country of origin and to provide early warning to potentially threatened countries if it appears that a state is unwilling or unable to isolate the outbreak within its borders. Early warning will allow states to take preventative measures, such as closing borders, to protect their populations from disease and their national interests from the instability and conflict that can accompany pandemic disease.

## Conclusion

Infectious agents are evolving more rapidly than they have at any point in history, threatening all states with the potential for a global pandemic. Even a moderately infectious disease could kill millions, cause economic collapse as the workforce is decimated, create domestic instability as governments lose the capacity to function, and trigger interstate conflicts as regional balances of power are disrupted by outbreaks in the military. A pandemic cannot be stopped once it has spread across international borders, but it can be prevented at its source. By replacing inefficient, inaccurate epidemiological surveillance systems with a more advanced, cheaper, global network based on cutting edge crowdsourcing technology, outbreaks can be isolated and resources devoted to their control.

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[7] Andrew T. Price-Smith, "The Pandemic Influenza of 1918: Implications for Modern Health Governance and International Security" (paper presented to Finnish Institute of International Affairs, Helsinki, May 10, 2011).
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[9] Internal stability would be caused by labor shortages and low productivity. High mortality rates- particularly in adults- and dramatically lower income create a generation of poverty-stricken, homeless, uneducated orphans who are significantly more likely to be tempted by violent crime or the promises of radicalism

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[11] U.S. Library of Congress. Congressional Research Service. *South Africa: Current Issues and U.S. Relations* by Lauren Ploch. Washington: The Service, 2011.

[12] Vaccine development for a new strain of influenza- the best case scenario, as a protocol for vaccine creation already exists- would take 3-6 months, and producing enough vaccines for the entire global population would take 2-3 years, with all factories working at full capacity (Lee and Fidler, 2007).

[13] The fourteen largest vaccine production factories produce 90% of the supply; these factories are all in OECD high income countries (European Vaccine Manufacturers, Worldwide Major Vaccine Manufacturers in Figures, 2004, p.1, from EVM Website, http://www.evm-vaccines.org/pdfs/mfrs_in_figures.pdf, Accessed January 16, 2012.)

[14] Edward Hammond. "Indonesia fights to change WHO rules on flu vaccines." *Seedling*, April 18, 2009, 24-32.

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[28] *Ibid*.

[29]The budget for OSELS in FY2011 was $237,747,000. The budget for the NCEZID was $304,193,000, and the budget for PHPR was $1,415,416,000. Centers for Disease Control and Prevention, *Fiscal Year 2011 Operating Plan Table* (Washington, D.C., 2011), 1.

[30] Frerichs, "Epidemiological Surveillance in Developing Countries," pp. 257-90.

[31] *Ibid.*

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