
Costing Framework for International Health Regulations (2005)

Rebecca Katz, Vibhuti Haté, Sarah Kornblet, and Julie E. Fischer

The revised International Health Regulations (IHR [2005]) conferred new responsibilities on member states of the World Health Organization, requiring them to develop core capacities to detect, assess, report, and respond to public health emergencies. Many countries have not yet developed these capacities, and poor understanding of the associated costs have created a barrier to effectively marshaling assistance. To help national and international decision makers understand the inputs and associated costs of implementing the IHR (2005), we developed an IHR implementation strategy to serve as a framework for making preliminary estimates of fixed and operating costs associated with developing and sustaining IHR core capacities across an entire public health system. This tool lays the groundwork for modeling the costs of strengthening public health systems from the central to the peripheral level of an integrated health system, a key step in helping national health authorities define necessary actions and investments required for IHR compliance.

In 2005, the member states of the World Health Organization (WHO) recognized the need to overhaul international public health cooperation, and they revised the International Health Regulations (IHR). The IHR (2005) focus on strengthening capabilities for confronting all potential public health emergencies of international concern when and where they occur. The 194 states parties made a commitment to develop core capacities to detect, assess, report, and respond to any public health event that might have international effects, regardless of type or origin of the event. The IHR (2005) also conferred

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new responsibilities on WHO and the global health community to share resources, information, and expertise to help nations prepare for and respond to public health events (1).

The WHO checklist and indicators for monitoring progress in the development of IHR core capacities by states parties, also known as the IHR Monitoring Framework, details 8 core capacities plus activities at points of entry that must be developed to fully implement the IHR (Table 1) (2). The IHR Monitoring Framework, first published in 2010, also defines country-level indicators within each core capacity. The regulations and the framework describe the core capacities needed for functional implementation of the IHR (2005) but leave flexibility for nations to determine how best to structure and develop these capacities (3).

The IHR also direct countries to strengthen and integrate existing systems for public health surveillance and response, rather than to create new, vertical programs. Various national approaches to IHR implementation have emerged, depending on factors such as the sophistication of preexisting systems and infrastructure, past and present objectives of health ministries and their external partners, availability of resources, architecture of health systems, and strength of regional commitments to health cooperation and coordination. Examples of the latter are the Integrated Disease Surveillance and Response strategy previously adopted by the WHO Regional Committee for Africa and shared standards developed through a Latin American subregional trade alliance (4–7). Two WHO regional offices, Southeast Asia Regional Office (SEARO) and Western Pacific Regional Office (WPRO), collaboratively developed the Asia Pacific Strategy for Emerging Diseases, providing a framework for coordinated approaches to rapid disease detection and public health emergency responses across sectors, countries, and regions (8).

RESEARCH

Table 1. Summary of 2010 World Health Organization IHR Monitoring Framework*

Core capacity	Component	Country-level indicator
National legislation, policy, and financing	National legislation and policy	Laws, regulations, administrative requirements, policies, or other government instruments in place are sufficient for implementation of obligations under IHR.
	Financing	Funding is available and accessible for implementing IHR (including developing core capacities).
Coordination and NFP communications	IHR coordination, communication, and advocacy	A mechanism is established for the coordination of relevant sectors in the implementation of IHR. IHR National Focal Point functions and operations are in place as defined by the IHR (2005).
Surveillance	Indicator-based, or routine, surveillance (also referred to as structured surveillance, routine surveillance, and surveillance for defined conditions)	Indicator-based, routine, surveillance includes the early warning function for the early detection of public health events.
	Event based surveillance established Surveillance overview of information on IHR-related hazards (situation awareness)	Event-based surveillance is established. A coordinated mechanism is in place for collecting and integrating information from sectors relevant to IHR
Response	Rapid response capacity	Public health emergency response mechanisms are established.
	Case management	Case management procedures are established for IHR-relevant hazards.
	Infection control	Infection prevention and control is established at national and hospital levels.
Preparedness	Disinfection, decontamination, and vector control	A program for disinfection, decontamination, and vector control is established.
	Public health emergency preparedness and response Risk and resource management for IHR preparedness	Multihazard national public health emergency preparedness and response plan is developed. Public health risks and resources are mapped.
Risk Communication	Policy and procedures for public communications	Mechanisms for effective risk communication during a public health emergency are established.
Human Resources	Human resource capacity	Human resources are available to implement IHR core capacity requirements.
Laboratories	Laboratory diagnostic and confirmation capacity	Laboratory services are available and accessible to test for priority health threats.
	Specimen collection and transport	Influenza surveillance is established. System for collection, packaging, and transport of clinical specimens is established.
	Laboratory biosafety and biosecurity Laboratory-based surveillance	Laboratory biosafety/biosecurity practices are in place. Laboratory data management and reporting is established.
Points of Entry	Surveillance at points of entry	Effective surveillance is established at points of entry.
	Response at points of entry	Effective response at points of entry established.

*IHR, International Health Regulations; NFP, National Focal Point. Data from (2).

Even with regional support, achieving the IHR core competencies is challenging for many nations at high risk for epidemic-prone or emerging infectious disease outbreaks and other public health crises. Member states initially agreed to implement IHR (2005) by June 2012, but a substantial proportion will clearly need at least one 2-year extension. Under Article 44 of the IHR, nations agreed to collaborate on developing and maintaining the public health capacities for IHR implementation by providing technical, logistical, and financial assistance to developing nations. The flexibility of the IHR framework, which enables national leaders to interpret the IHR requirements through mechanisms that are sensitive to local and regional contexts, makes it challenging to marshal such assistance effectively. The decision to measure IHR core capacity development in terms of functional outcomes rather than specific activities means that there could be 194 distinct but equally valid

national approaches to fulfilling IHR (2005) obligations. Consequently, many nations that could use help with IHR implementation are still in the process of identifying opportunities for cooperative capacity building with external partners, often without information on how much it will cost to implement their national IHR action plans.

We describe steps for estimating the costs of achieving IHR (2005) implementation in countries with different economic climates by first identifying essential inputs. We identified functional pathways for implementing the 8 core capacities and actions at points of entry identified in the WHO 2010 IHR Monitoring Framework, on the basis of current and planned actions in 6 Southeast Asian case-study countries at different levels of economic and health systems development. We used this to develop a representative IHR implementation strategy to serve as a framework for a preliminary estimate of fixed and operating

costs associated with developing and sustaining IHR core capacities across an entire public health system.

Methods

Case-Study Countries

To develop an initial costing framework for IHR implementation, we sought case-study countries that could provide examples of field-tested strategies and practices in the 8 IHR core capacities and at points of entry, along with associated costs. On the basis of geographic proximity, recent responses to emerging infectious diseases of public health significance, economic development levels, and accessibility of financial and policy information, we identified 6 case-study countries in Southeast Asia: 1 low-income (Cambodia), 3 lower-middle income (Lao People's Democratic Republic, Vietnam, and Timor-Leste), and 2 upper-middle income (Malaysia and Thailand) (9). These 6 countries fall into the SEARO and WPRO areas, which share the Asia Pacific Strategy for Emerging Diseases capacity-building strategy (8).

Core Capacities Matrix

The 2010 WHO IHR Monitoring Framework identified 20 country-level indicators that states parties could use to assess IHR core capacity development (Table 1). The framework described levels of capability that could be used to evaluate progress toward each indicator, categorizing capabilities as prerequisites/foundational (level <1), inputs and processes (level 1), outputs and outcomes (level 2), and additional (level 3). Framework guidance specified that for all indicators to meet IHR requirements, countries must successfully demonstrate the attributes at levels 1 and 2.

For each country-level indicator, we identified specific activities and resources that could operationally achieve levels 1 and 2 attributes. Identification involved a 2-step process: 1) determining whether a technical standard exists for achieving each country-level indicator and 2) mapping activities and strategies among the case-study countries to the IHR Monitoring Framework.

To identify standards for building and sustaining the 8 core capacities, we reviewed guidance published by WHO and its regional offices, accrediting and professional organizations, and the US Centers for Disease Control and Prevention; consensus recommendations developed by expert working groups; and peer-reviewed publications, supplemented by additional input from subject matter experts in relevant disciplines.

To describe capabilities, activities, tools, and processes identified by decision makers in each case-study country as relevant to IHR core capacities, we reviewed published and unpublished government documents (e.g., legislation; regulations; national strategies; operational

and programmatic guidance; training materials; self-assessments; proposed and enacted budgets; and plans for developing, strengthening, or maintaining IHR core capacities, pandemic preparedness, public health or emergency medical preparedness, indicator- and event-based surveillance, and laboratory systems) and materials prepared with or for development partners, technical partners, and nongovernmental stakeholders in each country. We supplemented the literature review through interviews with governmental and nongovernmental stakeholders in case-study countries. To determine requirements for diagnostic testing capabilities, we derived a priority disease list comprised of the endemic, epidemic-prone, and emerging infectious diseases specifically cited as always notifiable by the IHR (2005) Annex 2 reporting algorithm plus those appearing on ≥ 3 case-study country priority disease lists.

We mapped the activities and strategies identified through the reviews of technical guidance and case-study country activities to specific country-level indicators in the IHR Monitoring Framework, creating an operating core capacities matrix. To identify the practices and attributes common to some or all case-study countries for each core capacity, we compared these activities and strategies, distilling the strategies and practices into a representative Southeast Asian country, hereafter referred to as Country X, that has achieved levels 1 and 2 under each country-level indicator. Where no clear consensus emerged on strategies or practices, we selected the national approach that most closely resembled international or regional technical standards.

Costing Framework

For each activity or capability mapped to a specific country-level indicator in the Country X core capacities matrix, we extrapolated requirements for physical infrastructure (facilities, equipment, utilities), human capabilities (workforce, training, skills, and knowledge), and tools and processes (e.g., diagnostic platforms, materials, reagents, quality control and assurance, reporting systems), building on the foundations of existing public health surveillance costing platforms, such as the Integrated Disease Surveillance and Response SurvCost tool (10). Because of the integrated nature of the IHR core capacities, some physical infrastructure, human resources, and tools and processes might contribute to multiple core capacities. We sought to prevent overlap by including such elements only 1 time, under the most immediately relevant indicator.

To develop a preliminary cost estimate for developing and sustaining such infrastructure, human capabilities, and tools and process, we used the following: 1) costs calculated by case-study country government actors for procurement

or national budgets; 2) estimates derived with or for international partners; 3) the WHO CHOICE (CHOosing Interventions that are Cost Effective) database as a source of average salaries, per diem and travel compensation, physical infrastructure, and tradables specific to the subregions of SEARO B and WPRO B, into which the case-study countries fall; and 4) commercial price lists and supply schedules. Because the WHO CHOICE dataset expresses average costs in 2005 international dollars (defined as equivalent to \$US in 2005 purchasing power parity), we likewise included or adjusted all costs in 2005 \$US. We did not attempt to distinguish between the contributions of public, private, or international actors in mapping the surveillance, response, and laboratory systems for Country X. We thus assumed that the total costs of developing and sustaining each activity or capacity would be the same regardless of the payer. We did not attempt to calculate tariffs or other additional fees specific to each country.

Assumptions and Limitations

The Country X template represents a composite of demographic, political, and geographic attributes of 6 low- to middle-income case-study countries in 2 WHO sub-regions (SEARO B and WPRO B). All estimates for Country X assume a population of 60 million persons; 64 provinces with 600 functional districts; and 6 designated points of entry with a Ministry of Health responsible for public health surveillance, response, and laboratory capabilities at the national, provincial, district, and community levels (Figure 1).

Among the case-study countries, national strategies for public health surveillance depend heavily on facility-based surveillance. The reliability and timeliness of facilities-based reporting depend on population access to basic health services with trained health workers at peripheral, intermediate, and central levels. Such services are an absolute prerequisite to IHR implementation but are not explicitly included in the IHR (2005) or associated guidance. Any estimates for costs of public health surveillance and response developed through the framework described here should therefore be considered additional to the costs of developing and sustaining adequate essential health services.

Results

When we identified practices and strategies in 6 case-study Southeast Asian countries, referenced against regional/global technical standards, that could achieve the functional outcomes specified by each country-level indicator in the IHR Monitoring Framework, the resulting core capacities matrix created a detailed template for fully implementing IHR (2005) in a model Southeast

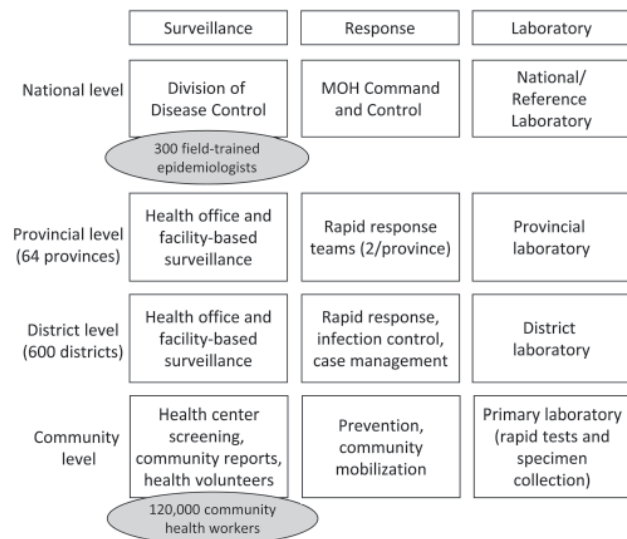


Figure 1. Overview of national public health system for model Southeast Asian country with a population of 60 million. MOH, Ministry of Health.

Asian country. We present this matrix as a framework for determining the inputs—physical infrastructure, human capabilities, and tools and processes—required to achieve each core capacity at the peripheral, intermediate, and central levels of the Country X template and for estimating the costs associated with these inputs (Table 2).

Core Capacity 1: National Legislation, Policy, and Financing

Country-level indicators focus on adoption of budgetary and regulatory frameworks to support IHR implementation. We identified only 1 input with cost implications—support for legal expertise (domestic or external consultants) to review and, as needed, revise national public health laws, estimated at \$75,000 (in 2005 \$US)—which was based on past consulting costs for revising national regulations with regard to avian and human influenza.

Core Capacity 2: Coordination and National Focal Point Communications

IHR coordination, communications, and advocacy require designation of an IHR National Focal Point and mechanisms to identify, convene, and coordinate stakeholders in public health surveillance and response across sectors. Inputs include information and communications technologies equipment and services as well as office infrastructure, transportation, and salary support for the individual or office serving as National Focal Points (online Technical Appendix Table 1, wwwnc.cdc.gov/EID/pdfs/12-0191-Techapp.pdf).

Table 2. Summary of costs for all 8 International Health Regulations core capacities and ports of entry in Country X

Core capacity	Fixed costs, \$US	Operating costs, \$US
National legislation, policy, and financing	75,000	0
Coordination and National Focal Point communications	823,102	347,959–88,868
Surveillance	5,261,764	26,238,293–69,606,113
Response	20,480,332	3,981,294–5,215,857
Preparedness	2,889,166	103,726,507–103,786,408
Risk communications	4,389	1,868,869–2,141,939
Human resources	4,389	620,649–653,009
Laboratories	49,619,443	13,742,692–20,057,218
Points of entry	153,062	838,851–1,435,767
Total	79,310,647	151,365,114–203,485,179
Total cost, fixed + operating	Not applicable	230,675,761–282,795,826

Core Capacity 3: Surveillance

The IHR Monitoring Framework specifies that this core capacity encompasses indicator-based surveillance (the routine reporting of diseases or syndromes that meet specific case definitions) and event-based surveillance (the rapid detection and reporting of unusual or unexpected disease patterns, deaths, and exposure risks) (Figure 2; online Technical Appendix Table 2). All case-study countries conduct national indicator-based surveillance for priority diseases and have developed strategies for combining routine surveillance data with reports from other sources to provide early warning of emerging public health events. The resources for detecting, reporting, and managing cases of priority diseases and unusual events overlap substantially in the Country X template, particularly at the community level.

For Country X, we developed a template for surveillance staffing structure based on a combination of health systems structure and population. We did not attempt to prorate the share of office space, utilities, transportation, etc., dedicated to surveillance for epidemic-prone or emerging infections versus other goals (such as tracking noncommunicable conditions or high-risk behavior).

Indicator-based Surveillance

The template for surveillance core capacities in Country X includes activities to support indicator-based surveillance at the central, intermediate, and peripheral levels of the national health system and includes additional capabilities for collecting and analyzing urgent reports for event-based surveillance. Figure 2 provides an overview of Country X inputs; online Technical Appendix Table 2 provides a more detailed examination of the infrastructure, human capabilities, and tools and resources for supporting these inputs, including estimates intended to illustrate the approximate costs of implementing IHR core capacities according to this template.

The template uses the proposed minimum standard endorsed by the US Centers for Disease Control and Prevention: 1 field-trained epidemiologist per 200,000 population (11). To identify the full operating costs,

the template assumes that Country X has achieved this population-based target (300 epidemiologists).

For Country X, numerous provinces with populations of ≈ 1 million persons serve as the hub for surveillance activities at the intermediate level, and districts (with catchment populations of $\approx 100,000$) serve as the central hubs for surveillance activities at the peripheral level. The template for Core Capacity 3 includes dedicated personnel at the intermediate and peripheral levels to compile and report data on priority diseases and unusual events, to use and disseminate data and guidance issued from the national level, and to train local stakeholders. The template assumes that these functions are housed within existing health offices and health care facilities at the provincial and district levels. We developed the staffing model at each level on the basis of case-study country practices considered by interviewed experts to adequately serve case load.

According to experiences in the case-study countries, some mechanism is needed to extend government disease prevention and control programs to the community level. The inputs for the surveillance template include on-site training of community health center staff and for information and communications technologies equipment and services to facilitate the exchange of information between district health offices, basic health facilities, and communities. The template also includes monthly allowances for training, travel, and communications for 1 village or community health worker per 500 population (the approximate median among the case-study countries with established community health worker networks) to extend disease surveillance and prevention efforts to the household level.

Event-based Surveillance

We assume that the infrastructure, capabilities, systems, and processes developed for routine or indicator-based surveillance will also serve as the backbone for event-based surveillance, particularly at the community level where community health volunteers are likely to play a role in collecting reports of unusual disease clusters. The Country X template includes inputs for a center open 24

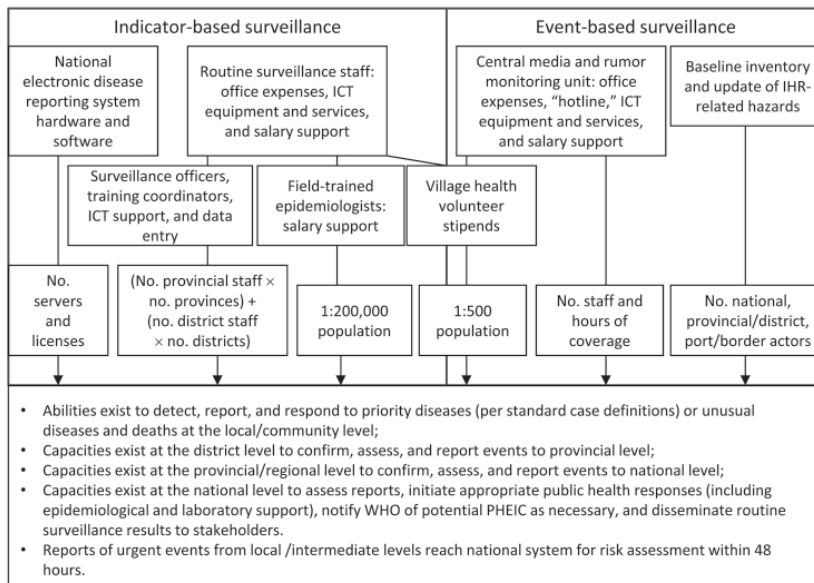


Figure 2. Inputs for Core Capacity 3 (Surveillance). IHR, International Health Regulations; ICT, information and communications technologies; WHO, World Health Organization; PoE, points of entry; PHEIC, public health emergency of international concern.

hours per day, 7 days per week, 365 days per year that would monitor and respond to urgent inquiries from health workers and the public and would collect and analyze structured and unstructured reports. To maximize the use of limited resources, the Country X event monitoring center shares physical infrastructure, information and communications technology resources, and other utilities with the Command and Control Center described in Core Capacity 4.

Hazards Mapping

The Country X template includes inputs to develop a baseline inventory of community and national health risks. It applies across all sectors through consultative workshops and field assessments.

Core Capacity 4: Response

Country X template inputs for response include a functional, dedicated command and control center with room and information and communications technology equipment and services to accommodate up to 40 personnel during an event (online Technical Appendix Table 3). Other inputs include materials, supplementary compensation, training, and travel allowances for 2 trained, 5-member multidisciplinary rapid response teams per province, plus 2 central rapid response teams, to investigate and respond to at least 1 public health event per year, with logistical and risk communications support from the provincial level. Inputs also include development and dissemination of guidance for infection control and case management, related training, and systems for isolating and transporting potentially infectious patients.

Core Capacity 5: Preparedness

The inputs for the Country X preparedness template encompass development, planning, and testing of a national public health emergency response plan (online Technical Appendix Table 4). This template is based on a comprehensive national risk assessment and on establishment of a national stockpile of materials to respond to priority events.

Core Capacity 6: Risk Communications

Inputs for risk communication include the development, printing, and dissemination of a national risk communications plan (online Technical Appendix Table 5). These activities are supported by annual training workshops and purchase of broadcast and print media at the peripheral, intermediate, and central levels.

Core Capacity 7: Human Resources

The inputs for human resources in Country X include resources for developing a coordinated national strategy for public health workforce development (online Technical Appendix Table 6). The inputs also include resources for fully supporting field epidemiology training (including travel support for field investigations) for as many as 16 trainees per year.

Core Capacity 8: Laboratories

For diagnostic testing capabilities, we identified the testing platforms, materials and reagents, and specimen collection and referral systems necessary to support detection and confirmatory testing of the Country X priority diseases as appropriate at each level of a tiered, integrated health system. Online Technical Appendix

Table 7 represents costs only of infrastructure and human capabilities associated with laboratory capacity.

Points of Entry

The inputs for the Country X template include a health office at each designated point of entry (online Technical Appendix Table 8). Each office is staffed by 4-person multidisciplinary public health response teams trained and equipped to respond to medical emergencies.

Discussion

This study was designed to help decision makers understand the demands of implementing IHR (2005) and to build the business case for strengthening global capacities to detect, assess, report, and respond to public health emergencies. The lack of standards in many areas of public health capacity-building and the many options at almost every step of investment allow for dozens of variations in each category of core capacity, with concomitant variations in costs. However, the framework described in this article illustrates the scope of IHR implementation demands and is intended to help national and international decision makers understand the inputs and associated costs of implementing the IHR (2005).

The framework includes all inputs and associated costs of building capacity for IHR-relevant public health surveillance and response rather than the marginal costs of adding new features to existing surveillance capabilities. Many countries will build the necessary capacities incrementally, and most already have capacities in place. This framework presents a way to estimate one-time capital costs, plus recurrent costs calculated on an annual basis, assuming that the total costs of national implementation depend on variables such as population, existing infrastructure, and health status. For most countries, the first step in developing a national IHR action plan is assessing the gap between current status and their ultimate strategies for implementing IHR core capacities fully.

We believe that this framework serves as a first step in helping national health authorities define to their own governments the actions and investments required to meet their IHR obligations, to protect their populations during public health emergencies, and to build a business case for potential donors. Articulating the elements of IHR core capacity-building can also help the global health community better comprehend a complex obligation that, if implemented fully, will strengthen the public health diagnostic, analytical, and information-sharing capacities

that underpin effective decision making across health systems.

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Technical Appendix

Technical Appendix Table 1. Coordination and NFP Communications – Summary of Inputs

Functional capabilities	Inputs	Variables
Protocols and bodies to coordinate stakeholders across sectors are established and tested	Printing and disseminating national IHR action plan and protocols; Convening annual multi-sectoral workshop on IHR implementation	Number of stakeholders; costs of printing, venues, and travel allowances
The designated IHR NFP communicates with WHO and national stakeholders	Office expenses, ICT equipment and access, transportation, and salary support for NFP staff	Number of senior and support staff assigned to NFP functions; salary and communications costs

Technical Appendix Table 2. Summary of Inputs and Costs for Core Capacity 3, Surveillance in Model Southeast Asian Country

IHR Component	Level	Inputs	Description of functions and capacities	Costs in \$US 2005
Indicator based, or routine, surveillance	Physical Infrastructure			
	Peripheral: District (600)	Start-up: ICT and office equipment	Per District Health Office plus District Medical Center: - office equipment - communications (fax/phones) - 2 computer stations with UPS	\$6414/district \$3,848,430 total
		Operating (annual): ICT services, office supplies	Telephone and internet services, mobile phone handsets and usage,	\$8357/district \$5,014,200 total
	Intermediate: Provincial (64)	Start-up: ICT and office equipment	Per Provincial Health Office plus Provincial Medical Center: - office equipment - communications (fax/phones) - 7 computer stations with UPS	\$19,337/province \$1,237,579 total
		Operating (annual): Office supplies, ICT, and travel (4 oversight trips to each district)	Telephone and internet services, mobile phone handsets and usage, vehicle fuel/maintenance	\$9315/province \$596,129 total
	National	Start-up: Hardware for national electronic disease reporting system	Data server, controller and operating system, storage, UPS	\$13,005
		Operating (annual): Software licenses/upgrades	Analytical and visualization software	\$9,688
	Human Capabilities			
	Peripheral: Sub-district	Operating (annual): Community mobilization and community-based surveillance	Monthly allowance for travel, communications, training for 1 village or community health volunteer per 500 population	\$2,880,000– \$28,800,000 ¹
	Peripheral: District (600)	Operating (annual): Salary support for surveillance staff at district health office and district hospital	Per district: 1 surveillance officer (public health assistant equivalent) 2 data entry clerks	\$10,943,400– \$21,777,600 ²
	Intermediate: Provincial (64)	Operating (annual): Salary support for surveillance staff at provincial health office and provincial hospital	Per province: 3 surveillance officers (public health assistant equivalent) 1 nurse/trainer 1 IT manager 2 data entry clerks	\$3,024,064– \$6,017,536 ²
	National	Operating (annual): Salary support for 300 field-trained epidemiologists assigned to posts nationwide	1 field-trained epidemiologist (public health specialist equivalent) per 200,000 population	\$3,522,900– \$7,010,400 ²

IHR Component	Level	Inputs	Description of functions and capacities	Costs in \$US 2005
Tools and Processes				
	National	Start-up: Adapt and install national electronic disease reporting system over 12 months	1 full time IT consultant to install and troubleshoot software, integrate maps, standardize databases, train staff	\$139,500
		Operating (annual): Update and maintain national electronic disease reporting system	Routine upgrading and maintenance of system hardware and software by IT professional	\$18,838
	National	Operating (annual): Travel allowances for one training/oversight visit at each level (national to provincial, provincial to district, district to average of 10 community health centers)	Annual "train-the-trainer" events to review notifiable diseases, case definitions, reporting protocols, strategies	\$90,136
Human Capabilities				
Event-based surveillance	National	Operating (annual): Salary support for 4-person teams to monitor and respond to urgent reports (national hotlines and other sources) on a 24/7/365 basis	Per team (x 4): 1 public health specialist 3 public health assistants	\$134,008– \$266,656 ²
Human Capabilities				
Surveillance overview of information on IHR related hazards (situation awareness)	National	Start-up: Assessment of public health risks across all sectors nationwide	One short-term consultant to coordinate data collection and develop database	\$23,250
	Tools and Processes			
	National	Operating (annual): Review and update data on all health hazards with public and private sector stakeholders	Annual consultative workshop on IHR-relevant risks	\$4,920

¹ Village/community health worker stipends vary from \$20/year to \$20/month among case study countries, reflected here as a range of national-level costs.

² Range reflects variation in average salaries for equivalent positions between WPRO B and SEARO B sub-regions in WHO CHOICE dataset.

Technical Appendix Table 3. Summary of Inputs and Costs for Core Capacity 4, Response in Model Southeast Asian Country

IHR Component	Level	Inputs	Description of functions and capacities	Costs in \$US 2005
Physical Infrastructure				
Rapid response capacity	Intermediate: Provincial (64)	Start-up: Dedicated transport for Rapid Response Teams	One vehicle for each Rapid Response Team (RRT) (2 per province plus 2 central)	\$2,591,550
		Operating (annual): Consumables for community-level outbreak investigation	2 outbreak investigation kits (specimen collection, packaging, record-keeping and PPE), per WHO checklist, plus vehicle fuel and maintenance	\$1,253,492
	National	Start-up: Dedicated Command and Control Center – facility plus ICT equipment and services for up to 40 personnel during a crisis	Construction (400 m ²) plus ICT equipment (including satellite phones, radios, videoconferencing) and standby generator	\$967,782
		Operating (annual): ICT services	Routine use by full-time (call and event monitoring staff) plus surge capacity	\$23,820
Human Capabilities				
	Intermediate: Provincial (64)	Operating (annual): Supplementary compensation for RRT members and full-time salary support for financial, logistical, risk communications, and training staff	Per RRT -- bonuses (equivalent to 1 week's annual salary) for: 1 Epidemiologist 1 Laboratory Specialist 1 Medical Officer 1 Public Health Specialist 1 Animal and/or Environmental Health Specialist; and Full salary support for one finance officer, one administration officer, and one risk communications officer per province	\$1,247,013– \$2,481,576 ²

IHR Component	Level	Inputs	Description of functions and capacities	Costs in \$US 2005
		Tools and Processes		
	National	Operating (annual): Travel allowances for all RRTs plus for field investigations	Annual national training conference for all Rapid Response Team members and travel allowances for outbreak investigations (1 week per team member per year)	\$443,230
Case management		Physical infrastructure		
	Intermediate: Provincial (64)	Start-up: Patient transport system and equipment	Ambulances for patient transport (average of 2.5 per province nationwide)	\$8,000,000
		Operating (annual): Annual vehicle maintenance costs	Maintenance for 2.5 ambulances per province	\$775,000
Infection prevention and control		Physical Infrastructure		
	Intermediate: Provincial (64) and District (600)	Start-up: 2 airborne infection isolation (negative pressure) rooms per province and 1 respiratory isolation unit (multi-bed) per district	Construction/renovation costs for 2 isolation rooms per province and conversion costs for one room per district	\$8,921,000
		Operating (annual): Consumables for isolation units	Annual HEPA filter changers per isolation room	\$130,405
		Human Capabilities		
	National	Operating (annual): National Infection Prevention and Control program and training coordinator	Salary support and travel allowances for one program coordinator and one trainer	\$28,398
		Tools and Processes		
	National	Operating (annual): Training and oversight for Infection Prevention and Control at facility levels	Printing and dissemination of protocols and annual oversight visits at the provincial level	\$41,936

¹ Village/community health worker stipends vary from \$20/year to \$20/month among case study countries, reflected here as a range of national-level costs.

² Range reflects variation in average salaries for equivalent positions between WPRO B and SEARO B sub-regions in WHO CHOICE dataset.

Technical Appendix Table 4. Summary of inputs and costs for Core Capacity 5 (Preparedness) in Model Southeast Asian Country

IHR Component	Level	Inputs	Description of functions and capacities	Costs in \$US 2005
		Physical Infrastructure		
Risk and resource management	National	Start-up: Climate controlled stockpile storage facility and management	1000 m2 warehouse (new construction) with air conditioning and generator; 2 delivery vehicles; inventory management software and computer	\$2,814,166
		Operating (annual): Medical equipment, personal protective equipment, and consumable supplies	Scenario-based estimates for surge capacity to accommodate 100 patients of severe/moderate acuity for 14 days plus equipment and supplies for 25 patients with novel influenza per province	\$1.6 M/province \$103.5M total
		Human Capabilities		
	National	Operating (annual): Salary support for 3-person stockpile management staff plus 24/7/365 security coverage	Manager Finance officer Transport driver/porter Security guard (4 shifts)	\$33,811–\$67,729
Public health emergency preparedness and response plan		Human Capabilities		
	National	Operating (annual): Salary support for national emergency exercise staff	1 program manager 2 nurse/trainers	\$26,249–\$52,232
		Tools and Processes		
	National	Operating (annual): Planning, implementation, and oversight for 1-day annual table-top exercise at the national, provincial, and district levels:	Supervisory visits to support planning, execution, and reporting of exercises - National to provincial (2 trainers x 3 days) - Provincial to district (1 trainer x 2 days) Printing and dissemination of exercise materials and after action reports for participants Travel and meeting expenses (100 participants each at the national and provincial levels and 20 participants at each district level)	\$95,948

Technical Appendix Table 5. Summary of inputs and costs for Core Capacity 6, Risk Communication in Model Southeast Asian Country

IHR Component	Level	Inputs	Description of functions and capacities	Cost in \$US 2005
Policy and procedures for risk communications	Human Capabilities			
	National	Start-up: Salary support a public health specialist to oversee development of national risk communication plan	Full-time salary equivalent for one public health specialist for 3 months	\$4,389
	Tools and Processes			
	National	Operating (annual): Consultative annual meeting for stakeholders to develop community-based national risk communication plan.	Per diem allowance for 50 stakeholders, and printing and dissemination of plan	\$4,367
	National	Operating (annual): Annual national workshop for risk communication stakeholders	Per diem and travel allowances for stakeholders at provincial and district level, and printing of training materials	\$87,258
National	Operating (annual): Broadcast and print media budget	Television, radio, and newspaper announcements for contingency messages, and posters/flyers for routine messages.	\$1,777,244–2,050,314	

Technical Appendix Table 6. Summary of inputs and costs for Core Capacity 7 (Human Resources) in Model Southeast Asian Country

IHR Component	Level	Inputs	Description of functions and capacities	Costs in \$US 2005
Policy and training for workforce development	Human Capabilities			
	National	Start-up: Salary support for staff to oversee development of public health workforce plan (part-time)	1 public health specialist (equivalent to 3 months' effort)	\$2,936–\$5,842
	Tools and Processes			
	National	Operating (annual): Review, revise, and disseminate public health workforce plan as needed	Two 1-day consultative meetings of 25 national stakeholders to review workforce development plan; printing and dissemination of plan	\$8,389
		Operating (annual): Field Epidemiology Training Program (FETP) administrative costs plus stipends and travel allowance for 16 fellows total each year	Salary support for FETP program manager Administrative/logistical staff Training stipends for 8 fellows (2 cohorts per year at the salary equivalent of public health specialist (total of 16 fellow in two-year program) Per-fellow allowance for travel, supplies, and equipment, assuming at least 1 field investigation/year	\$612,260–\$644,620

Technical Appendix Table 7. Summary of Inputs and Costs for Core Capacity 8, Laboratory in Model Southeast Asian Country

IHR Component	Level	Inputs	Description of functions and capacities	Cost in \$US 2005
Laboratory diagnostic testing	Physical Infrastructure			
	National	Start-up: Construction of laboratories plus data management office	7 work spaces: specimen processing, clean prep, BSL2 and BSL3 virology, BSL2 and BSL3 microbiology, electrophoresis and visualization	\$865,961
		Operating (annual): Utilities for national laboratories	Costs of water and energy services; laboratory equipment inventory and condition	\$57,288
	Provincial	Start-up: Laboratory construction	64 provincial labs at an average of \$615,545 per site. No BSL3 work spaces; specimen processing, clean prep, BSL2 virology, BSL2 microbiology, electrophoresis and visualization	\$39,394,880
	National, provincial, and district	Start-up: Voltage stabilizers and air conditioners plus standby generators	Equipment for labs at all , except generators which will be required only at national and provincial levels. National labs, 64 provincial labs, and 600 district labs.	\$892,472

IHR Component	Level	Inputs	Description of functions and capacities	Cost in \$US 2005
	Provincial and district	Operating (annual): Utilities for provincial and district laboratories	Costs of water and energy services; equipment inventory and condition; # of labs	\$5,000,000
	Human Capabilities			
	National	Operating (annual): Salary support for laboratory staff in national laboratories	Each virology and microbiology laboratory will include 1 senior program manager, 2 laboratory specialists, 2 laboratory technologists, and 2 laboratory assistants each, plus administrative and maintenance support	\$169,374–\$337,038
		Operating (annual): Salary support for national quality resource center staff	Annual salaries for national quality resource center director and trainers and procurement director	\$37,992–\$75,600
	Provincial	Operating (annual): Salaries for virology and microbiology laboratory staffs in 64 provincial laboratories	Virology and microbiology laboratory team will contain 1 manager, 1 specialist, 2 assistants each, plus administrative and maintenance support	\$5,579,072–\$11,101,568
	District	Operating (annual): Salary support for laboratory staff in 600 district labs	Each district lab will have 1 laboratory technologist and 1 assistant per lab	\$18,996–\$37,800
	Tools and Processes			
	National	Operating (annual): Guidance and training on national surveillance, laboratory, and specimen referral strategies	Travel allowance for staff at provincial and district level and costs of printing materials and printing costs; # of staff at sub-national level	\$41,874
		Operating (annual): National EQAS documentation, guidance, and oversight visits	Visits to sub-national labs subject to oversight	\$16,054
	Specimen collection and transport	Physical Infrastructure		
Provincial		Operating (annual): Specimen transport	2 dedicated vehicles per province for 64 provinces with cold boxes	\$2,686,976
Human Capabilities				
Provincial		Operating (annual): Salary support for administrative staff	2 transport drivers per province for 64 provinces	\$539,264–\$1,073,024
Tools and Processes				
National		Operating (annual): shipment of infectious agents	10 expedited international shipments at the national level and 10 expedited domestic shipments at the provincial level (10 per province) with complete packaging	\$125,345
National and provincial	Operating (annual): Training and documentation in shipment of infectious agents for laboratory staff	Strengthening and maintaining domestic diagnostic confirmation capabilities, accessibility of courier services, and specimen referral protocols	\$35,770	
Laboratory biosafety	Physical Infrastructure			
	National, provincial, and district	Start-up: Laboratory equipment	Biosafety cabinets (class II) and large autoclaves at national and provincial levels, and mid-sized autoclaves at each district site	\$4,897,561
		Operating (annual): Maintenance and certification of laboratory equipment	Annual maintenance and certification of biosafety cabinets at national and provincial levels	\$35,770
	National	Start-up: National biosafety training facility	Central training facility	\$139,682
	Human Capabilities			
	National	Operating (annual): Salary support for staff	Salaries for biosafety officers and trainers	\$35,229–\$70,104
	Tools and Processes			
	National	Operating (annual): Annual training of stakeholders	Biosafety training, guidance and documentation	\$60,780
National, provincial, and district	Operating (annual): Supplies and equipment for biosafety laboratories	Sharps containers, biohazard bags, and personal protective equipment for laboratories at all levels	\$1,537,911	
Laboratory-based surveillance	Physical Infrastructure			
	National, provincial and district	Start-up: ICT equipment for management and administration of daily activities	ICT: phone, fax, computers, printers, GPS	\$602,228

IHR Component	Level	Inputs	Description of functions and capacities	Cost in \$US 2005
	National, provincial and district	Operating (annual): ICT access for surveillance and data management	Phone, mobile, and internet access and management	\$441,721
	Human Capabilities			
	National	Operating (annual): Salary support for administrative staff	Salary for one data entry clerk	\$8213–\$9572
	Tools and Processes			
	District	Operating (annual): Reporting system	Paper-based weekly reporting forms for district labs	\$2,040

Technical Appendix Table 8. Summary of inputs and costs for Points of Entry in Model Southeast Asian Country

IHR Component	Level	Inputs	Description of functions and capacities	Costs in \$US 2005
Emergency response units at Points of Entry	Physical Infrastructure			
	National	Start-up: Transportation for ill passengers from plane or health unit to nearest appropriate healthcare facility (plus annual maintenance) for six points of entry sites	One vehicle per Point of Entry site to supplement existing ambulance capacity	\$148,673
		Operating (annual): Health units at Points of Entry for six points of entry sites	Real property rental, information and communications technology, office supplies, office equipment and supplies	\$115,200
	Human Capabilities			
	National	Start -up: Salary support for staff to develop national contingency plan	1 public health consultant for 3 months	\$4,389
		Operating (annual): Salary support for Points of Entry Response Teams with 24/7/365 coverage at six sites and two annual oversight visits per site	1 medical officer 1 nurse 1 public health assistant 1 administrative assistant/IT officer Expenses for 12 oversight visits annually	\$604,015–\$1,200,931
	Tools and Processes			
	National	Operating (annual): One-day workshop of stakeholders from relevant ministries and provincial/regional health facilitates to review the national public health emergency response plan , and Outbreak investigation/response kits for six sites	Printing and dissemination of plan Per diem for stakeholders 2 response kits per site (total of 12) PPE Decontamination material Diagnostic/treatment supplies	\$119,676