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Action-Based Costing for National Action Plans for Health Security: Accelerating Progress Toward the International Health Regulations (2005)

Christopher T. Lee, Rebecca Katz, Stephanie Eaneff, Michael Mahar, and Olubunmi Ojo

Multiple costing tools have been developed to understand the resources required to build and sustain implementation of the International Health Regulations (IHR), including a detailed costing tool developed by WHO ("WHO Costing Tool") and 2 action-based costing tools, Georgetown University's IHR Costing Tool and CDC's Priority Actions Costing Tool (PACT). The relative performance of these tools is unknown. Nigeria costed its National Action Plan for Health Security (NAPHS) using the WHO Costing Tool. We conducted a desktop review, using the other tools to compare the cost estimates generated using different costing approaches. Technical working groups developed activity plans and estimated component costs using the WHO Costing Tool during a weeklong workshop with approximately 60 participants from various ministries, departments, and federal agencies. We retrospectively applied the IHR Costing Tool and PACT to generate rapid cost estimates required to achieve a Joint External Evaluation (JEE) score of "demonstrated capacity" (level 4). The tools generated similar activities for implementation. Cost estimates varied based on the anticipated procurement and human resources requirements and by the level of implementation (eg, health facility–level versus local government area–level procurement). The desktop IHR Costing Tool and PACT tools required approximately 2 and 8 person-hours to complete, respectively. A strategic costing approach, wherein governments select from a menu of recommended and costed actions following the JEE to develop a NAPHS, could accelerate implementation of plans. Major cost drivers, including procurement and human resources, should be prioritized based on anticipated resource availability and countries' priorities.

Keywords: International Health Regulations (2005), Economic issues, Public health preparedness/response

Christopher T. Lee, MD, MSc, MPH, is Senior Technical Advisor—Prevent Epidemics, Resolve to Save Lives, an Initiative of Vital Strategies, New York, NY. Rebecca Katz, PhD, MPH, is Professor and Director, Center for Global Health Science and Security, Georgetown University, Washington, DC. Stephanie Eaneff, MSP, is Senior Researcher, Talus Analytics, Boulder, CO. Michael Mahar, PhD, is Public Health Advisor, Division of Global Health Protection, Center for Global Health, Centers for Disease Control and Prevention, Atlanta, GA. Olubunmi Ojo is with the Department of Surveillance and Epidemiology, Nigeria Centre for Disease Control, Abuja, Federal Capital Territory, Nigeria. The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention.

Health emergencies, including infectious disease outbreaks, have increased in frequency over time.[1] These events have the potential to cause deaths, fracture health systems, threaten global gross domestic product (GDP) and economic gains in developing countries, and cause disruptions in international travel and trade. For instance, the 2003 SARS epidemic and resulting economic shock was estimated to have cost the global economy between $30 billion and $50 billion, and it highlighted the lack of global capacity to detect and govern infectious disease outbreaks.[2] The SARS epidemic prompted the World Health Organization (WHO) and its member states to revise the International Health Regulations (IHR, 1969) to better address acute public health risks that threaten people worldwide. The IHR (2005), adopted by the World Health Assembly in May 2005, is a legally binding agreement, agreed to by 196 states parties, to develop and maintain capacity to prevent, detect, and respond to public health threats and report these events to WHO;[3] it came into force in June 2007.

Despite global commitments to improve capacity as evidenced by the IHR (2005), disparities in IHR implementation were highlighted by the 2014-2016 Ebola virus disease epidemic.[4] In addition to the loss of lives, an estimated $2.8 billion to $32.6 billion of GDP was projected to have been lost.[5-7] In addition to these economic impacts, an estimated additional $18.8 billion loss was attributed to deaths from non-Ebola causes as a result of health system disruption.[7]

WHO published the revised IHR Monitoring and Evaluation Framework (IHRMEF) in 2018 to measure progress on IHR (2005) implementation.[8] The IHRMEF includes a mandatory annual self-assessment of IHR (2005) capacities, the States Parties Annual Report (SPAR), in addition to 3 voluntary components: the Joint External Evaluation (JEE), after-action reviews, and simulation exercises. The JEEs provide the opportunity for a country to identify strengths and gaps by assigning a score from 1 to 5 (no capacity to sustainable capacity) to indicators that measure capacity levels for 19 technical areas.[9] In addition to providing a score that indicates the level of country capacity, the JEE report also provides "priority actions"—recommendations by the external evaluation team—to the host country to accelerate the development of capacity, which can form the basis for the prioritization and development of national strategies to increase capacities in 19 technical areas.[10-12]

National Action Planning for Health Security (NAPHS) is a process developed by WHO to create capacity-building plans based on recommendations from the IHRMEF, country risk assessments, and other assessments. The resulting NAPHS plan includes activities that are developed to address gaps identified by the IHRMEF, as well as activities from other national plans, including those for antimicrobial resistance and influenza pandemic preparedness.[13] The output of the NAPHS process includes a cost envelope of the actions required to increase preparedness for health emergencies, which can be used to develop specific annual implementation plans, allocate domestic budgets, and mobilize resources from bilateral and multilateral partners. Published NAPHS guidance recommends costing the national plan,[13] although there is a limited evidence base for countries to select and implement an appropriate costing strategy.[14]

The JEE provides a roadmap for NAPHS development, highlighting capacity gaps and providing priority actions for subsequent implementation. However, many countries have struggled with the prioritization, development, and costing of activities that cut across multiple sectors and technical areas. As of May 3, 2019, 95 JEEs have been conducted across all WHO regions and 54 NAPHS plans have been completed. Although a UN High-Level Panel called for costed action plans to be completed within 3 months of finishing a JEE,[15] the median delay from JEE to NAPHS completion is 364 days (interquartile range [IQR]: 266-497 days).[16]

To address the costing bottleneck, different costing approaches have been described.[10,11,17] WHO has developed an NAPHS costing tool to facilitate planning and costing of the NAPHS. The WHO NAPHS costing tool uses a detailed approach that aggregates the individual components of country-defined activities (eg, cost of workshop materials, meals, per diem, individual procurement items) to generate an overall cost estimate. This process has typically been conducted by holding a series of multisectoral workshops to prioritize and develop activities and cost their individual components.[10]

Other tools have been developed that estimate costs based on a set of predefined actions based on country capacity levels ("action-based"), using basic inputs and multipliers developed through country pilots and expert consultation. This approach assumes that there are common actions that need to be completed to increase JEE scores. Costs for these actions are populated automatically and can be further adjusted based on country-specific priorities and costs. This approach can be applied before creating a detailed plan of cost estimates based on activities that are commonly required to improve JEE scores.

Nigeria is the most populous nation in Africa, with a 2018 projected population of more than 190 million.[18] Nigeria undertook the JEE in June 2017[19] and launched the NAPHS in December 2018,[20] with high-level engagement from relevant ministries, departments, and agencies as well as bilateral and multilateral donors. During the preparatory workshop in February 2018, technical area groups identified activities that were already ongoing, areas that were critical for capacity development, which activities had known advocates, and which were "low hanging fruit." During the NAPHS costing workshop (July 2018), specific cost components for activity implementation were identified and initial costs were estimated. During the NAPHS finalization workshop (September 2018), the technical area groups pulled out specific activities for implementation in 2018-19, identified individual focal points for those activities, targeted

start and end dates, and set specific monitoring and evaluation indicators for each activity.

To better understand the performance of detailed versus action-based costing approaches, we conducted an analysis of the costing of Nigeria's NAPHS. We used the final Nigeria NAPHS, which was developed using a detailed costing approach, and compared it with desk review outputs from 2 action-based costing tools. We assessed each of the tools on the level of effort required, the activities defined, and the cost outputs to provide guidance and expectations for other countries' costing approaches.

Methods

We assessed the application of 3 different tools to cost the Nigeria NAPHS for the period 2018 to 2022. The WHO NAPHS Costing Tool was used for the NAPHS costing workshop and formed the basis of costs used in Nigeria's NAPHS. After the NAPHS was costed, we applied 2 action-based costing tools, developed by Georgetown University and the US CDC, which used the JEE scores and priority actions as inputs. A summary of the attributes of these tools is provided in Table 1. For this analysis, we excluded the cost of the immunization technical area, which was costed for a separate country planning process using a different tool, and combined the surveillance and reporting technical areas, as was done during the country NAPHS planning process.

Using the WHO NAPHS Costing Tool

During the weeklong NAPHS costing workshop, 60 participants from 25 ministries, departments, and agencies and 5 international facilitators worked in breakout sessions to develop the detailed cost components for all NAPHS activities. Basic assumptions for costing were populated by in-country procurement experts, which included the exchange rate, per diem for local and away participants, travel costs for international and local consultants, vehicle costs and per diem for field visits, and meeting costs, including the cost of hall rental, refreshments, meeting supplies, and facilitator costs.

Activities were grouped into 5 categories for costing: training sessions, workshops, and meetings; consultancies; supervision visits and field visits; human resources; and procurement. For training sessions, workshops and meetings, participants specified the duration and estimated the number of participants and facilitators attending locally or those that required additional travel costs. For consultancies, participants specified whether the consultant was national or international, the duration of the contract, and any required travel costs. For supervision and field visits, participants specified the number of supervisors, the duration of the visit, the number of vehicles and drivers, and any other related travel costs. For human resources, participants specified the positions required, the number and grade of those positions, and the duration of the contract. For procurement, participants specified the item and quantity, and a procurement specialist was present to facilitate cost estimates, although the costs of highly specialized equipment and reagents for antimicrobial susceptibility testing and chemical and radiological testing were difficult to obtain during the workshop.

IHR Costing Tool

The IHR Costing Tool, developed by Georgetown University, is publicly available online and allows users to load JEE scores from publicly reported JEEs (or to input JEE assessments manually), specify basic costing assumptions (eg, number of states or provinces, number of districts, number of health facilities, population, etc) and the desired increment of improvement in JEE indicator score (by 1 level, or to a level 4).[21] The IHR Costing Tool does not cost actions for indicators that are a level 4 or higher, as these indicators are already at the level of "demonstrated capacity." Rather than cost detailed activity components, the tool uses built-in functions to compute the quantity of inputs needed to implement recommended actions, using country-specific multipliers.[22] Back-end costing tables were developed by a review of IHR (2005) implementation in 14 countries and by building on user feedback and an earlier conceptual model piloted in 6 countries.[17,23] Users navigate the online tool by each JEE indicator; for each indicator, certain actions are recommended, and costs are populated by using transparent assumptions that can be revised by the user. The tool provides a summary of costs by year, technical area, and start-up and capital and recurrent costs. Users can download the output of the tool as an Excel file, which can be further modified by users to revise costing assumptions, or to add or remove specific items. For this comparison study, cost estimates were developed for all indicators to reach a target level of 4 (demonstrated capacity) during the 5-year implementation period. Costs to procure rapid diagnostic tests were excluded from subsequent analysis, as during the Nigeria NAPHS development process, substantial procurement of rapid diagnostic tests was intentionally deprioritized due to the high cost and lack of validated test kits.

Priority Actions Costing Tool

The Priority Actions Costing Tool (PACT), developed by US CDC, is designed to quickly generate cost estimates for the priority actions from the JEE report. Priority actions are 3 to 4 recommendations provided by the external assessment team, for each technical area, based on the strengths and weaknesses identified through the JEE process. The

Table 1. Comparison of Costing Tools

	Priority Actions Costing Tool (PACT)	*IHR Costing Tool*	*WHO NAPHS Costing Tool*
Costing Approach	Benchmark actions to address priority actions recommended from the JEE	Actions to increase JEE scores	Detailed activities; does not require a JEE
Overview	Excel-based tool that costs JEE priority actions by aligning them to sets of flexibly costed benchmarks	Web-based tool that calculates the cost of actions to increase JEE scores	Excel-based tool that calculates costs based on detailed activity inputs
Language	English	English and French	English
Linked to Which Assessment	JEE	JEE	JEE or International Health Regulations (2005) States Parties Annual Report
Inputs	Users enter the JEE priority actions and map them to benchmarks; country cost assumptions	JEE scores; users can choose whether the objective is to improve each indicator score by 1, or to increase all scores to 4; country cost assumptions	Detailed NAPHS activities with associated costing elements
Strengths	• Flexible • Usable immediately after the JEE • Breaks down priority actions for planning • Can be completed in ~1 day • Data visualization	• User friendly • Easy to access • Usable immediately after the JEE • Can be completed in ~1 hour • Exportable/modifiable tables • Data visualization • Available in English and French	• Flexible • Costing assumptions are easy to modify • Costs linked directly to activities • Does not require a JEE to be done • Links directly to NAPHS planning matrix • Creates buy-in and raises awareness across participating sectors
Weaknesses	• Less accurate if activities do not align to priority actions • Requires some technical expertise to refine costs • Selection of JEE priority actions can limit the overall cost envelope • Available only in English	• Order of magnitude cost estimates only • All actions required to reach level 4 capacity might not reflect countries' available resources or priorities • Secondary steps required for prioritizing and financing	• Labor intensive, can be completed in ~1 week • Requires a detailed NAPHS plan to be developed before tool can be used • Requires technical expertise to refine costs and deploy tool
Best Use Case	Immediately after JEE; provides a strategic estimate of the cost of implementation of recommended priority actions	Immediately after JEE; provides a strategic estimate of the cost of implementation of actions to advance JEE scores	Used during the NAPHS planning process to develop detailed cost estimates for specific activities that will be part of the NAPHS

Note. NAPHS = National Action Plan for Health Security; JEE = Joint External Evaluation.

tool is based on key actions needed to be taken to advance from one JEE score to the next. Each of these actions is "flexibly" costed, meaning that a generic cost is assigned to the action based on preassigned costs for salaries, travel, per diems, meeting space, building costs, and other costs associated with activities to build health security capacity. The user provides country-specific cost estimates that are used to recalculate the cost of each action. The user selects actions that need to be achieved to implement each priority action from the JEE. Based on these selections, the tool estimates the total cost to implement the priority actions. The tool also allows the user to view and edit the components that factor into the cost of each action. For this comparison study, all actions necessary to reach a score of 4 were selected. In indicators for which Nigeria had already reached a 4, actions that focused on sustaining those capacities were selected.

Table 2. Comparison of Costing Results by Technical Area[a]

	WHO NAPHS Costing Tool (USD)	*IHR Costing Tool (USD)*	*PACT (USD)*
National legislation, policy, financing	$1,331,587	$83,366	$855,344
IHR coordination	$2,371,960	$181,128	$564,639
Antimicrobial resistance	$3,961,156	$2,384,918	$2,755,995
Zoonotic disease	$2,181,927	$9,984,936	$2,538,329
Food safety	$2,620,240	$1,257,377	$1,193,309
Biosafety/biosecurity	$6,501,156	$9,605,374	$3,387,729
Laboratory	$35,275,396	$29,061,195[b]	$27,881,824
Surveillance and reporting (combined)	$29,226,725	$152,350,895	$8,387,488
Workforce	$37,226,226	$606,954	$3,400,623
Preparedness	$36,935,782	$391,396,732[c]	$762,698
Emergency response operations	$6,894,207	$3,248,590	$2,512,826
Linking public health and security	$571,044	$1,213,629	$542,340
Medical countermeasures, personnel deployment	$605,625	$175,382[c]	$1,973,372
Risk communications	$1,709,535	$2,614,782	$2,292,171
Points of entry	$4,272,949	$5,428,852	$4,084,418
Chemical events	$2,047,941	$2,086,869	$2,013,559
Radiation emergencies	$661,404	$696,406	$560,173
Total	$174,394,860	$612,377,385	$65,706,837

[a] Immunizations are excluded because costing was undertaken separately (done earlier by National Primary Health Care Development Agency), not using the NAPHS costing tool.
[b]Estimate excludes the cost of rapid diagnostic tests (US$1.9 billion) at points of care, which was a cost driver but not included in Nigeria NAPHS.
[c]The cost of procuring a strategic national stockpile is costed by default for Medical Countermeasures and Personnel Deployment in IHR costing tool; costs instead included here under Preparedness, as Nigeria NAPHS costed the stockpile as part of Preparedness.

Desktop Comparison

To complete the desktop review, we compared the cost estimate using the WHO NAPHS costing tool (based on detailed planning discussions in country) with the cost estimates we generated using the built-in assumptions of the 2 action-based rapid costing tools for the period 2018 to 2022. We then compared the activities and their costs that were generated by the tools, by technical area. We aligned the activities to compare the cost estimates for the same or similar activities. We identified nonaligned activities, which included those that were selected by the Nigeria country team during the costing workshop but not identified as activities for each of the action-based costing tools, and those activities recommended by the costing tools that were not selected for inclusion in the Nigeria NAPHS. For technical areas with substantial differences with cost estimates, we used the alignment of activities to identify whether discrepancies in costs resulted from differences in costing or differences in activity selection. We calculated the number of person-hours to complete the initial costing estimates for each tool. For currency conversions, we used the Central Bank of Nigeria exchange rate of 305 Nigerian naira (NGN) for 1 US dollar (USD). Unless otherwise specified, all costs are reported in US dollars.

Results

Comparison of Overall Cost Estimates

The 5-year cost estimates generated by the costing processes ranged from US$66 million to US$612 million (20–187 billion NGN) or approximately US$0.07 to US$0.61 per capita per year (Table 2). The highest cost estimate was generated by the IHR Costing Tool (US$612 million); however, this tool's major cost driver was a strategic national stockpile (SNS) for medical countermeasures (US$388 million), which was not comprehensively costed during the Nigerian NAPHS costing process or by the PACT tool. When this cost was excluded, the overall cost was approximately US$225 million ($0.22 per capita, per year), which was similar to the WHO Costing Tool estimate of US$174 million ($0.17 per capita, per year). The major cost drivers by technical area for the country's NAPHS were workforce development, preparedness, laboratory, and surveillance and reporting. The major cost drivers for the IHR Costing Tool were preparedness, surveillance and reporting, and laboratory.

The major cost drivers for the PACT tool were laboratory and surveillance and reporting, and the PACT tool generated the lowest overall cost estimate (US$66 million).

Costs and Activities for Selected Technical Areas

The IHR Costing Tool generated the highest estimates for surveillance and reporting (US$152 million) compared to the WHO Costing Tool (US$29 million) and PACT (US$8 million) (Table 3). The aligned activities all included training, procurement, and development of guidelines and standard operating procedures (SOPs), but the IHR Costing Tool estimate included additional costs for recurring supervisory field visits at health facilities, printing of job aids, and procurement of laptops, printers, and software licensing and training costs. Whereas the major cost driver for surveillance and reporting for the WHO Costing and PACT tools (US$14 million and US$4.5 million, respectively) was for training and supervisory visits, the major cost driver for the IHR Costing Tool was the provision of cell phones and cellular plans for staff at the healthcare facility level (US$86 million). Estimates generated by the PACT tool did not include internet and telecommunications costs but did include more specific activities for data analysis, data quality improvement, and exercises to test surveillance and reporting systems.

The aligned activities for the workforce development technical area included training and mentorship for the public health workforce, development of a national workforce strategy, and development of a database to track the public health workforce (Table 4). The largest cost difference between the tools was recruiting, enrolling, and training Field Epidemiology Training Program (FETP) trainees, specifically resulting from Nigeria's strategy to domesticate the FETP program within the Nigeria Center for Disease Control (NCDC) and establish an intermediate FETP program. The IHR Costing and PACT tools did not include the cost of establishing a new intermediate FETP program, because the country scored a level 4 on this JEE indicator; adding an intermediate FETP program would be an action to move from level 4 to level 5 on the JEE.

The WHO Costing and PACT tools generated similar cost estimates for aligned activities in the preparedness technical area (Table 5). The IHR Costing Tool estimates were substantially higher, resulting from additional human resources costs for training and resource mapping, additional planning activities at the local and intermediate levels, and additional costs associated with procurement of medical countermeasures. The largest cost discrepancy for the preparedness technical area is a result of procurement of the SNS of medical countermeasures, which was the highest cost activity action generated by the IHR Costing Tool (US$388 million). During the NAPHS planning process, the country generated a more limited inventory of medical countermeasures (US$26 million). The PACT estimates did not include procurement of SNS and medical countermeasures.

Costing Effort

The Nigeria NAPHS was generated over a series of meetings and workshops from February to September 2018. The costing workshop involved 84 people over 4 days (~2,700 person-hours), which included technical staff and facilitation by 5 international experts. The IHR Costing Tool was implemented by 1 international expert, using JEE scores as inputs, in 2 hours (2 person-hours). The PACT Tool was implemented by 1 international expert, using JEE scores and priority actions as inputs, in 8 hours (8 person-hours).

Discussion

This desktop costing exercise highlighted similarities and differences in the cost components for NAPHS development, using Nigeria as an example. Most high-level actions in the Nigeria NAPHS were similarly identified by the IHR Costing and PACT tools for implementation. Among these aligned actions, cost differences were primarily a result of a more comprehensive approach to procurement for the IHR Costing Tool at the health facility and local levels, and a narrower scope of actions resulting from specific priority actions recommended by JEE experts and a minimal set of pre-specified activities for the PACT Tool.

The IHR Costing Tool produced higher procurement estimates than the other 2 tools, notably for the procurement of a strategic national stockpile (SNS) (US$388 million). Omitting this cost resulted in a similar costing estimate as the WHO NAPHS Costing Tool. Other than the SNS, the single greatest cost driver in the Nigeria NAPHS was for FETP training, which was not costed substantially by the other tools because this indicator had achieved a level 4, indicating demonstrated capacity. PACT estimates, informed by the JEE priority actions and a minimal set of prespecified activities, were lower than the other 2 tools. The differences in cost estimates suggest that: (1) country priorities (eg, FETP training) might not be defined solely by JEE scores, and flexibility is needed for all tools to easily add or remove activities to meet country needs; (2) costing estimates generated by technical experts in a workshop setting might underestimate procurement and human resources requirements, reflecting either innate priority setting during the costing exercise or possible omission of major cost drivers during the costing process; and (3) JEE priority actions alone likely underestimate the planning needs and priorities of countries, and a more comprehensive library of recommended actions might aid countries during the planning process.

Table 3. Comparison of Costs: Surveillance and Reporting

	WHO NAPHS Costing Tool (USD)	*IHR Costing Tool (USD)*	*PACT Tool (USD)*	*Comments*
Aligned Activities				
Training and supervisory visits, including at the health facility/local levels	$13,705,132	$27,272,359	$4,565,513	IHR Costing Tool includes additional costs of supervisory visits at the healthcare facility level, plus printed job aids for healthcare facilities.
Procurement of vehicles, computers, and other capital expenses	$5,270,361	$13,999,466	$1,387,317	IHR Costing Tool includes additional costs of laptops, printers, and tablets, including at the local level.
Stakeholder meetings and workshops	$5,074,758	$294,230	—	WHO Costing Tool includes additional stakeholder meetings and workshops.
Develop and distribute strategies, guidelines, and SOPs	$3,339,368	$23,925,344	$212,674	Both IHR Costing and WHO tools assume distribution of guidelines at healthcare facility level, though IHR costing tool assumes additional printed materials (eg, job aids).
Internet and telecommunications costs	$562,786	$114,393	—	WHO Costing Tool costs 1,000 internet modems; IHR costing tool assumes cost of broadband internet access for national surveillance unit only.
Establish and maintain surveillance and reporting database	$24,885	$99,720	—	IHR Costing Tool includes recurring software licensing/training costs.
Total of Aligned Activities	$27,977,290	$65,705,512	$6,165,504	
Not-Aligned Activities				
Establish compartments or disease-free zones for 5 food animals	$481,164	—	—	WHO Costing Tool includes additional costs for establishing compartments or disease-free zones, including operational training events, certification processes, and periodic surveillance.
Cost sharing to support running costs for NCDC HQ	$395,902	—	—	WHO Costing Tool includes additional costs of logistics and utilities support for the Nigeria Centre for Disease Control.
Procurement of surveillance kits and materials	$327,869	—	—	WHO Costing Tool includes additional costs of animal surveillance kits, including sampling materials, disinfectants, gloves, and cool-boxes.
Influenza activities supported by US CDC	$44,500	—	—	WHO Costing Tool includes additional costs for activities specific to influenza surveillance and reporting, supported by US CDC.
Cell phones and cellular plans for staff at the healthcare facility level	—	$85,972,853	—	IHR Costing Tool assumes the additional costs of 2 mobile phones, with cellular plans, per healthcare facility participating in IHR-related activities.
Staff, salaried personnel, and stipends	—	$672,530	—	IHR Costing Tool assumes additional salaried workers, including epidemiologists, surveillance officers, and a specialist to develop materials and coordinate training.
Assessments and activities to continuously improve surveillance system	—	—	$1,177,318	
Data compilation, management, and analysis	—	—	$993,476	
Exercises to test surveillance and reporting	—	—	$51,190	
Total of Not-Aligned Activities	$1,249,435	$86,645,383	$2,221,984	
Grand Total	$29,226,725	$152,350,895	$8,387,488	

Table 4. Comparison of Costs: Workforce Development

	WHO NAPHS Costing Tool (USD)	*IHR Costing Tool (USD)*	*PACT Tool (USD)*	*Comments*
Aligned Activities				
Training and mentorship events for public health workforce	$242,164	$10,298	$46,973	IHR costing tool assumes fewer and less frequent training events than other tools.
Develop a national workforce strategy and associated plans	$132,202	$577,907	$203,082	IHR costing tool assumes the development of plans at the intermediate and local levels, in addition to at the national level.
Develop database to track public health workforce	$10,219	$18,749	$14,313	All tools include cost of database development and/or software licensing fees. IHR costing tool assumes additional cost of a part-time data entry clerk to help maintain database.
Total of Aligned Activities	$384,585	$606,954	$264,368	
Not-Aligned Activities				
Recruit, enroll, and train FETP trainees	$21,419,174	—	$3,136,255	As Nigeria received a score of 4 on the indicator D.4.2 (applied epidemiology training program), these costs are not included in estimates from IHR Costing Tool or PACT Tool.
Integrated Disease Surveillance and Response (IDSR) trainings for 774 people	$3,464,328	—	—	
Advocacy and resources for veterinarians	$6,817,106	—	—	WHO costing tool includes additional costs of animal health advocacy, programs, and research, beyond those activities costed in all 3 tools as part of the Zoonotic Disease technical area.
Development of animal health policy and programs	$5,141,033	—	—	
Total of Not-Aligned Activities	$36,841,641	—	$3,136,255	
Grand Total	$37,226,226	$606,954	$3,400,623	

Table 5. Comparison of Costs: Preparedness

	WHO Costing Tool (USD)	*IHR Costing Tool (USD)*	*PACT Tool (USD)*	*Comments*
Aligned Activities				
Develop inventory of IHR-related hazards and national risk assessment	$212,553	$1,245,948	$460,912	IHR Costing Tool is more broadly focused and includes a broad national risk assessment, while the WHO costing tool is focused specifically on zoonotic hazards. PACT includes subnational risk assessments and activities to update plans and procedures.
Resource mapping at national, intermediate, and local levels	$33,310	$758,078	$72,911	IHR Costing Tool assumes additional meetings and annual salaries for program managers.
Training, including training of personnel to serve as surge capacity	$222,926	$872,351	$139,616	IHR Costing Tool assumes salaried personnel and additional recurrent training.
Develop and distribute plans, guidelines, MOUs, and SOPs	$289,548	$758,690	$76,404	IHR Costing Tool assumes additional planning activities at the intermediate and local level, in addition to at the national level. PACT does not include cost of printing and distributing copies of plans.
Develop and maintain database to track public health resources	$12,393	$70,730	—	IHR Costing Tool assumes salaried personnel (eg, IT specialist), in addition to database and software licensing fees.
Total of Aligned Activities	$77,0730	$3,705,797	$749,843	
Not-Aligned Activities				
Procure and deploy medical countermeasures, including equipment, reagents, and medicines[a]	$26,229,508	$387,675,990	—	IHR Costing Tool includes a substantially broader inventory of materials, assuming cost of 1 stockpile kit per 1 million population (including portable x-rays, ventilators, respirators, gowns, gloves, and other supplies and drug products).
Pre-position health commodities, equipment, and medicines to strategic locations	$9,935,544	—	—	WHO Costing Tool assumes costs associated with activities to pre-position supplies to strategic locations consistent with vulnerability maps (eg, remote hard-to access areas).
Delivery truck for stockpile materials	—	$14,945	—	IHR Costing Tool assumes 1 delivery truck (or equivalent access by motorpool or rental) to transport stockpile materials to transit hub or local facility.
Activities related to legislative review and revision	—	—	$12,855	
Total of Not-Aligned Activities	$36,165,052	$387,690,935	$12,855	
Grand Total	$36,935,782	$391,396,732	$762,698	

[a]The cost of procuring a strategic national stockpile is costed by default for Medical Countermeasures/Personnel Deployment in IHR costing tool; costs instead included here under Preparedness, as Nigeria NAPHS costed the stockpile as part of Preparedness.

Costing is one step in the process, from assessing country needs to implementing and evaluating programs and impact, but multiple costing approaches[24] and the lack of global guidance have hindered the development of costed plans. Existing multisectoral costing tools, including the United Nations OneHealth tool, do not currently include a module for implementing IHR (2005) or JEE recommendations.[25,26] Costing should be coupled with strategic planning in order to forecast and plan budget allocations domestically, and to advocate for additional resources from bilateral and multilateral partners where appropriate.[27] Substantial progress has been made in conducting JEEs globally, which provide a strong basis for countries to develop multisectoral plans to develop IHR (2005) and health security capacities. From these assessments, and informed by country-specific risks, a strategic plan should be developed and costed. In most cases, action-based ("resource needs model" or "general activity") costing is the preferred approach to cost strategic plans and estimate longer-term resource needs.[28] From the strategic plans, shorter-term operational plans can be developed by sector, which can be costed using a detailed approach.

The development of the Nigeria NAPHS was a year-long, multisectoral process that reflected discussions about country priorities and the resources required to implement them, resulting in an intermediate cost estimate. However, the process entailed nearly a year of meetings and development and required an effort that was several orders of magnitude higher than the plans and costs generated by the rapid costing tools. NAPHS development has been a bottleneck for countries to mobilize resources and implement plans, resulting from a lack of detailed guidance for specific activities to achieve IHR (2005) compliance and the reliance on technical experts to cost activities with minimal training.

In an effort to help countries develop specific activities for implementation based on the JEE and IHR (2005) States Parties Annual Reporting Tool (SPAR), WHO has recently published *Benchmarks for International Health Regulations (IHR) Capacities.*[29] This tool is organized using the technical areas and capacities of the JEE and SPAR and provides recommendations to implement to incrementally increase a country's score, based on the current capacity level. The IHR Costing and PACT tools use a similar logic, although at the time they were developed, there was not yet a published expert consensus on which actions would best help countries to develop the NAPHS.

This study is subject to several limitations. First, because of the detailed outputs of the costing exercises, we are unable to provide detailed activity comparisons for all technical areas of the NAPHS. Second, there are actions that overlap between technical areas that might result in different categorization from one tool to the other, which would bias comparisons toward more discrepancy; for instance, workforce requirements were included in different components of all tools, including zoonotic diseases, surveillance, and workforce development. Last, although the built-in functions of the IHR Costing and PACT tools use experiences from a number of pilot countries and have the ability to be further modified for the in-country context, they might not reflect the specific costs for procurement in Nigeria. However, to demonstrate that these tools can be used to rapidly develop and cost strategic plans, no additional modifications were made to the base assumptions of these tools.

Rapid progress is needed for countries to prevent, detect, and respond to public health threats. After the exclusion of SNS, we found that the 3 tools produced costing estimates ranging from US$0.07 to US$0.22 per capita per year. These estimates are lower than the approximately US$0.50 to US$1.00 per capita per year estimate[30] because of the exclusion of costing of the immunizations technical area, the inclusion of which would result in a cost of US$0.50 per capita per year using the WHO NAPHS costing tool or US$0.84 per capita per year using the IHR costing tool and including the SNS.

Although there were differences in requirements for procurement and human resources, the 3 approaches resulted in similar NAPHS activities. Despite yielding similar estimates, the costing effort varied substantially. The detailed WHO NAPHS costing tool required considerably more person-hours to complete than either of the activity-based costing tools. WHO's *Benchmarks* provide an opportunity to develop a flexible and user-friendly tool that uses JEE inputs and country priorities to select from a list of standard, recommended actions and their estimated costs to produce an initial costed plan immediately following the completion of the JEE. The strategic plan can then be modified and finalized by stakeholders from all sectors so that budgeting can begin, and detailed operational plans can be developed and implemented. Costing the *Benchmarks* could also provide a global "price tag" for increasing IHR (2005) capacities, as has been done to estimate the projected resource needs for countries to make progress toward the health Sustainable Development Goals,[31] which could be useful for the efforts of the newly established Global Preparedness Monitoring Board[32] and to advocate at the highest levels for appropriate financing for health security.

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Address correspondence to:
Christopher T. Lee, MD, MSc, MPH
Senior Technical Advisor, Prevent Epidemics
Resolve to Save Lives
100 Broadway, 4th Floor
New York, NY 10005

Email: clee@rtsl.org