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# Global Health and Security

## Threats and Opportunities

Imagine a bioterrorism attack in which a genetically engineered pathogen is unleashed to pandemic proportions. Public health institutions would face a rapid and large influx of patients—both the sick and those who worry that they might be. Scientists would scramble to identify the unknown disease. Flows of people and goods would be disrupted. Political leaders would be faced with the job of containing both the pathogen and the mis- and disinformation that would proliferate as mortality rates increased. The social, economic, and political consequences could be catastrophic.

The spread of infectious disease can be deadlier than world wars. Compare World War I—one of the deadliest conflicts in human history, with 20 million military and civilian deaths combined—with the 1918 Spanish flu, which killed as many as 50 million people (Johnson and Mueller, 2002). The staggering death toll was trailed by economic, political, and social consequences that continue to be felt 100 years later. Today, rapid urbanization and greater connectivity make us all the more

vulnerable to infectious disease threats that transcend national borders (CSIS and CBACI, 2000).

Now, consider that the present threats to public health are also less overt and more insidious than a deadly pandemic. A major security breach of identifiable health data by an adversary looks all too likely. The burden of mental and behavioral health issues is growing, and depression is now the largest cause of disability worldwide (WHO, 2017). The absence of treatment options for mental health issues, particularly in low- and middle-income countries, is a violation of basic human rights (Patel and Prince, 2010). As we near 2020, the opioid crisis rages on with no easy solutions for its underlying social, economic, behavioral, and structural causes (Dasgupta, Beletsky, and Ciccarone, 2018).

The challenges are complex and interrelated, and require dynamic solutions. Measles outbreaks in 2019 at two universities in Los Angeles, California (“Over 1,000 People Impacted by Measles Quarantines at Los Angeles Universities,” 2019; “UCLA, Cal State LA Quarantine

Students Who Cannot Prove They Had Measles Vaccination,” 2019; Brice-Saddler, 2019) are stark reminders not only of how vulnerable populations are to threats that were once a distant memory, but also of the effects of a mistrust of medicine and science, as well as government, among some in society, as evidenced by the anti-vaxxer movement (Benecke and DeYoung, 2019). Antimicrobial resistance (AMR) is increasing, with few new treatment prospects. If those in a position to act—both governmental and nongovernmental leaders—fail to do so, by 2050, deaths attributed to AMR could outstrip those attributed to all other major causes, including cancer (Review on Antimicrobial Resistance, 2014; Taylor et al., 2014). Climate change affects the landscape of vector-borne diseases and has sizable effects on noncommunicable diseases (Kjellstrom et al., 2010), but predicting exactly how these changes will occur has remained difficult. Most emerging diseases, including animal influenza, anthrax, salmonellosis, and plague, have an animal origin and therefore can be transmitted between humans and animals (EFSA and ECDC, 2018; King, 2004). There is much we still do not know about the transmission pathways, making treatment and prevention difficult.

Indeed, decisionmakers increasingly acknowledge the systemic interdependencies among human health, animal health, and the environment, but how they are related, and how to measure and track them, are both poorly understood. In addition, the pace of globalization and urbanization and the increasing movement of people and animals are exacerbating existing vulnerabilities in the relationship among humans, animals, the food system, and the natural environment (Hinchliffe and Bingham, 2008). As a result, the risk of epidemics and the interplay among human,

### Abbreviations

AMR	antimicrobial resistance
CBACI	Chemical and Biological Arms Control Institute
CSIS	Center for Strategic and International Studies
DRC	Democratic Republic of the Congo
ECDC	European Centre for Disease Prevention and Control
EFSA	European Food Safety Authority
GHSA	Global Health Security Agenda
HIV/AIDS	human immunodeficiency virus/acquired immunodeficiency syndrome
IHR	International Health Regulations
SARS	severe acute respiratory syndrome
WHO	World Health Organization

animal, and environmental health on our planetary security and well-being is consistently underestimated.

We explore these issues through the lens of *global health security*—a concept that has evolved considerably over the past 30 years but that, at its core, focuses on averting bioterrorism and containing risks from infectious disease and acknowledges that collective action is required to address these problems (Aldis, 2008; Cullison and Morrison, 2019; Rushton, 2011; WHO, 2007). Recent examples include the 2014–2016 and 2018–2019 Ebola crises and the Zika virus pandemic in 2015. Global health security also encompasses more-explicit national security threats, such as those from the intentional release of chemical, biological, radiological, and nuclear weapons. The 2001 anthrax attacks in the United States exemplify escalated efforts to control health threats to national security. More recently, global health security has encompassed complex issues, such as AMR, that are integral to infectious disease control. Overall, however, the field of global health security has not kept pace with the expansion of threats to global risk and security.

The concept of global health security comprises three complex and fluid terms: *global*, *health*, and *security*. *Security* in its broadest form is the absence of threats and danger, and a continuous state of readiness to detect and address threats. The definition of *health* is narrowly conceived as the absence of disease; however, the holistic World Health Organization (WHO) definition from the Constitution of the WHO, signed in 1946, describes health as a state of “complete physical, mental and social well-being” (WHO, 2002). The WHO definition further states that the health of all peoples is “fundamental to their attainment of peace and security” (WHO, 2002). *Global*

in the context of health security recognizes how health is shaped by constant flows and connections of people and goods, the social and environmental consequences of the global economic order, and the sheer fact that infectious diseases do not stop at international borders.

To adequately plan for the future, we propose the need to reimagine the concepts, language, and practice of global health security. This would involve policymakers and decisionmakers more explicitly recognizing health security as a pillar of *national security*—that is, the protection of citizens and social, economic, food, and health systems from man-made and natural threats. The momentum in this direction is growing, specifically with the widening of the Global Health Security Agenda (GHSA) 2024 Framework, which spans topics from the prevention of AMR to workforce development (GHSA, 2018a; GHSA, 2018b). Still, a broader definition of global health security should be considered, one that would extend well beyond the threats of pandemics and bioweapons of mass destruction. In addition, global health security requires greater systematic focus on the complex interlinkages among human physical and mental health, animal health, and the environment.

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Our aims in this Perspective are threefold: First, we review the current scope and operation of global health security; second, we identify new threats that are emerging; and, finally, we assess how adequately current visions of global health security account for the growing landscape of threats, and whether a change in perspective and approach is needed as a result. Our overall objective is to draw out the inherent trade-offs and tensions arising from global health security frameworks and approaches in the context of emerging issues and complex interdependencies that we are only beginning to understand. These include implications for policy and practice, such as balancing agility and rapid decisionmaking during times of crisis with a holistic scope that encompasses both imminent and future threats. Another challenge is in leveraging the benefits of innovation while managing the risks from malicious use of novel

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technologies. We explore how global health security could be reconceived to garner more support as part of a robust domestic defense strategy while also supporting humanitarian efforts, and we propose that both of these objectives are likely to be essential to preparedness and long-term global stability.

To illuminate these trade-offs and tensions, we used an exploratory approach that included a literature review as well as in-depth interviews and a gaming workshop with subject-matter experts. First, we reviewed the literature to identify how global health security has been conceptualized, both by academics and policymakers, with a focus on the past five years. We then interviewed 14 subject-matter experts in the United States and the United Kingdom, to further identify core themes in the framing of global health security as well as emerging threats and challenges on the horizon that are not yet captured by global health security framings. We drew together the insights from the literature review and the interviews to develop a scenario illustrating the potential global health security landscape in the year 2050. The scenario formed the basis of a gaming workshop held in October 2018, which convened 18 U.S.-based researchers, practitioners, academics, and other stakeholders from government health security posts, the biotechnology industry, the defense industry, and academia. We focused on both the theoretical and the practical implications of different global health security definitions, and the workshop invited participants to situate themselves as decisionmakers in the world represented by the 2050 scenario. Participants were asked to then discuss and debate the threats posed in the scenario, as well as interlinkages with other issues, aspects that were poorly understood, and

potential mitigation strategies. Details of this approach are described in the appendix.

We specifically asked both interviewees and workshop participants to elaborate on the utility, feasibility, and trade-offs involved in expanding conventional definitions of global health security (i.e., definitions that center on the prevention of infectious disease pandemics and bioterrorism attacks). Their ideas for expanding the definition included incorporating nontraditional issues, such as the burgeoning burden of mental and behavioral health disorders, and taking more-expansive views of complex systemic issues, such as AMR. We pushed the boundaries of global health security by asking what dangers and opportunities lie just over the horizon and how policy- and decision-makers can put these concepts into action. We begin this Perspective by briefly depicting key concepts, debates, and agendas within global health security.

## **The Development and Expansion of Global Health Security**

Highly systematized public health control efforts have been in place since the 1850s, spurred by the necessity to control cholera and, later, smallpox epidemics (Gostin, 2004). However, the idea that infectious disease control should not only be a priority of national public health systems but also be coordinated through multilateral institutions is a 20th-century phenomenon (Fidler, 2005; WHO, 2007). This phenomenon is exemplified by the creation of the WHO in 1946. The WHO was characterized by a “concert of power” among member states, and solidified and supplied system-level solutions to internationally recognized health problems (Hoffman, 2010). The WHO adopted the

International Health Regulations (IHR) in 1951, which were revamped in 1969 to coordinate efforts to battle the most dangerous infectious diseases of that time, such as yellow fever, plague, and cholera (Gostin, 2004). At their core, the IHR outlined the requirements that each member state report any disease outbreaks to the WHO and adopt sanitary and hygiene measures at points of entry into a country; in addition, the IHR offered nations the ability to enforce vaccination requirements and other countermeasures for travelers entering a country (Gostin, 2004).

The following decades brought about a sea change in the ways public health practitioners understood the effects of globalization, global inequality, and inequities in access to health services on the global spread of disease (Brown et al., 2006). The human immunodeficiency virus/acquired immunodeficiency syndrome (HIV/AIDS) epidemic became a watershed moment that made global interconnectedness impossible to deny (Harman, 2012). This, in turn, shed light on the narrow focus of the IHR on a limited number of infectious diseases (cholera, plague, and yellow fever), leading to expansive revisions in the scope of the IHR in the mid to late 1990s (Gostin, 2004). The revised IHR also encapsulated a radical vision for the integrated governance of global public health that encompassed norms and principles of trade, human rights, environmental protection, and security (Fidler, 2005). At its core, global health security became a marker for an idea that is now accepted as common sense: that infectious diseases present risks that cannot be addressed by any one country acting alone, and solutions must encompass more than enforcing the use of medical countermeasures and cross-border reporting.

These revisions to the IHR corresponded with a growing awareness of the need for more strategic consideration of public health issues as national security concerns (Gostin, 2004). For example, in a 2000 speech to the United Nations Security Council, then–U.S. Vice President Al Gore advocated for a definition of security that included emerging and reemerging infectious diseases (Peterson, 2002). The following year, then–U.S. Secretary of State Colin Powell stressed that the HIV/AIDS crisis in Africa was a national security concern (Peterson, 2002). Concurrently, the U.S. National Intelligence Council warned that infectious diseases will “complicate US and global security” by endangering U.S. citizens and armed forces and by inducing instability in foreign settings (U.S. National Intelligence Council, 2000). This had the effect of raising the profile of infectious diseases—as opposed to other major drivers of morbidity and mortality, including the burgeoning burden of chronic and noncommunicable diseases—as national security concerns (Feldbaum et al., 2006). It also signaled a shift from viewing global health initiatives as humanitarian endeavors to viewing these initiatives as integral facets of national security.

In 2003, the rapid spread of severe acute respiratory syndrome (SARS) highlighted the need not only to extend the scope of the IHR but also to take a more future-oriented approach of preparedness for the *unknown* (indeed, for multiple unknowns, and inevitably *unknown unknowns*, i.e., issues we do not know that we do not know). This framing encompassed themes of anticipation, constant vigilance, and high alert; a focus on emergence and reemergence; and the ability to act swiftly when crises occur. Operationally, this meant crafting greatly revised, expanded, and legally binding IHR that expanded the types

of events that are reported to WHO and that strengthened communication pathways in order to more efficiently report public health emergencies (Katz, 2009). Importantly, the revised IHR moved beyond disease-specific efforts to take on a collaborative, global commitment to surveillance and stability of international trade routes (Katz, 2009). The revised IHR were more forward-looking, focusing on as yet unknown threats in addition to those already well recognized. With this revision, the IHR incorporated a much larger number of infectious diseases and extended beyond infectious diseases to address threats from other sources, including industrial accidents, natural disasters, and conflict (WHO, 2007). In 2005, this revised agenda was ratified by all 196 WHO member states.

Global health law experts note that the IHR enabled countries to negotiate and adopt normative rules for the surveillance, diagnosis, and reporting of public health emergencies, thereby achieving an important objective of global health governance (Gostin and Sridhar, 2014). Yet significant gaps remain in translating the increased emphasis on global health security into action. Funding remains a barrier to sustaining the IHR. The regulations also have no enforcement provisions “beyond peer pressure” (Cullison and Morrison, 2019). They thus “lack teeth,” as demonstrated by Indonesia’s refusal to share samples of the H5N1 virus during the 2007 outbreak (Fidler and Gostin, 2011; Hoffman, 2010). A 2012 report found that only 15 percent of countries worldwide actually met the IHR standards (Cullison and Morrison, 2019; GHSA, undated).

In an effort to address the shortcomings of the IHR, in 2014, the Group of Seven (G7) (Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States) endorsed the GHSA, a partnership and plan of action

among nearly 50 countries, nongovernmental agencies, and international organizations. The GHSA, in conjunction with the IHR, requires countries to report certain disease outbreaks and public health events to the WHO. Although the GHSA has not rectified a lack of commitment to funding for global health security, it has given cross-sector global health practitioners a common framework and metrics to assess a country's adherence to the IHR (Armstrong-Mensah and Ndiaye, 2018; Katz et al., 2014). In this respect, the GHSA's concept of global health security is closely tied to compliance with the IHR.

Several experts whom we interviewed noted that it ultimately took the Ebola crisis of 2014–2016—a narrowly missed global pandemic—to solidify support for the GHSA. Ebola exposed underlying issues that still persist, including tepid political will to enforce global health security (Heymann et al., 2015; Wolicki et al., 2016). It also reinforced a longstanding call from public health officials to standardize health security measures and improve inter-agency communication during a time of crisis (Asch et al., 2005). For all of the scholarship, media, and political attention devoted to the crises, however, actual investments in terms of policy, infrastructure, and resources have not seen noteworthy gains since 2016. In other words, attention and support for bolstering global health appears to have waned, at least in the public's imagination. Well into 2019, Ebola continues to afflict populations in the Democratic Republic of the Congo (DRC) and neighboring countries, and presents the potential for another international public health emergency (Gostin, Phelan, et al., 2019). Interviewees noted that, to complicate matters, social media amplified the spread of mis- and disinformation in the DRC, induced

paranoia and chaos, and deeply complicated recovery efforts.

Nevertheless, since its endorsement of the GHSA, the United States has invested \$1 billion to support the GHSA (Nuzzo and Inglesby, 2018). Other countries have committed funds to align with their specific geographic and topical priority areas. In 2017, Australia pledged \$240 million through 2022 to establish the Indo-Pacific Health Security Initiative (GHSA, 2018a). Within the same time frame, South Korea committed \$100 million to develop global immunization, laboratory, and workforce capacity (GHSA, 2018a). Multiple countries (e.g., Finland, Germany, and the Kingdom of Saudi Arabia), along with the Bill and Melinda Gates Foundation, are helping support the WHO's Joint External Evaluation to support greater compliance with the IHR (GHSA, 2018a). Indeed, there have been notable commitments; however, several experts we interviewed who are closely involved with the GHSA cautioned that the commitment to funding is episodic—ebbing and flowing with the rise of acute threats, such as the Ebola outbreaks—and is not sufficient to adequately prepare for future outbreaks.

Nearly two decades after Gore's proclamation on global health security before the United Nations Security Council, numerous scholars, civil servants, security officials, and public health practitioners, including at the WHO and through the GHSA, are still heralding the importance of linking global health with national and international security. These stakeholders are upholding support for the IHR and the GHSA and striving to garner the necessary political will and commitment to solidify these links. Furthermore, major efforts, such as the GHSA and the United Nations Sustainable Development Goals, demonstrate an awareness of interconnectedness, the

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advantages of strategic collaboration, and the need for a “long-run” view on funding and resources to fully respond to the calls for action. But although national governments, bilateral initiatives, multilateral agencies, not-for-profits, and corporations all claim to be chipping away at preparedness for global health security emergencies, their most cohesive framework remains the IHR. Calls to take a forward-thinking, anticipatory approach to the future of global health security are not receiving attention commensurate with the possible risks at hand.

The concept of global health security has evolved considerably since its first incarnation and now encompasses many elements that extend well beyond its original definition. Indeed, since the revisions to the IHR issued in the late 1990s, the actors, initiatives, threats, and solutions encompassed within health policy documents and the scientific literature have expanded greatly. Hence, the issue of framing known and unknown risks remains a challenge to

securing robust support for global health security. As one interviewee pointed out, global health security has largely been conceived as a form of defense against pandemic threats (more than security *per se*)—for example, through stockpiling of treatments. Extending this line of thinking, *defense* typically refers to a known enemy and to situations in which an approach can be identified to deal with specific issues in a given instance. To practice good defense is to employ multimodal approaches to prepare for any realistic threats of the present day and the near future (Finlayson et al., 2019). Infectious diseases (including drug-resistant infectious diseases) and bioterror are appropriate targets for a defensive position because they can be considered continuous trends (Hoehn et al., 2018) in global health security, are almost guaranteed to persist over the next 25 years, and have a set of identifiable strategies to address them.

By contrast, *security* is a more nebulous term and in its execution requires a continual state of readiness. In this respect, security is difficult to frame in absolute terms because, in contrast to defense, security extends the time frame into the long-term future and entails an ongoing set of projects without a clear target. Although the two terms are operationally enmeshed, defense assumes a target—for example, known pathogens—whereas security focuses on a system and is therefore equipped to take on the likelihood that new diseases will emerge. Security, so conceived, emphasizes emergence and rapid change, and so must also form the backbone of a global health security framework given the inherent risks, interlinkages, and complexities that we face in this domain.

One central challenge is building a system in which powerful sovereign states transform their thinking and

action from the protection of their individual populations from threats emerging in vulnerable states to a system that fully appreciates and accounts for the health of a *global* population (Frenk, Gómez-Dantés, and Moon, 2014; emphasis added). Existing threats to global health security will not be tackled unilaterally or bilaterally. The convergence of multiple threats to global security (not just those that fit squarely into global health security) are likely to test these somewhat tenuous foundations unless there is greater accountability and enforcement of action.

## Exploring Emerging Issues in Global Health Security

The idea of achieving a continual state of readiness—a foundational component of security *writ large*—invites the question of whether current efforts of global health security are both ready and continuous, but also requires investigating whether that continual state of readiness is even possible (or necessary). There have been major gains, particularly through the GHSA, but issues remain in relation to funding, compliance, and competing demands. The emergence of potential novel threats might test the bearings of current framings of global health security. In the interviews and the workshop, we asked global health security and biotechnology experts to offer their perceptions of underrecognized threats and of the extent to which current framings of global health security are equipped to manage these threats. Both prompts invited reflection on what needs to be built into our practices to ensure greater global resilience in the near- and long-term future.

As noted, global health security efforts have expanded considerably. In addition, support for global health security

has surged in response to “close calls,” such as the anthrax bioterrorist attacks and the Ebola epidemic, and to widespread crises, such as the HIV/AIDS epidemic (WHO, 2007). Full analyses of the contexts in which these close calls occurred, of how full catastrophes were averted, and of which policies are most likely to reduce the risk that another event could occur—or worse, could occur but not end as favorably—are obvious opportunities to strengthen global health security (Nuzzo and Ingelsby, 2018). One challenge is preventing historical amnesia, i.e., the forgetting of how close the world came to a pandemic. Another challenge is grasping emerging threats in light of the existing formidable challenges. In our exploratory interviews and our workshop, two broad categories of threats came to the fore (although we do not assert that these categories are exhaustive or comprehensive). First, there are risks from *slow-burn* problems—those that are recognized as issues, but whose long-term consequences are underestimated. These threats could receive insufficient attention until it is too late to act or reverse the damage. Second, new technologies might have novel, game-changing implications for how global health security challenges emerge and are addressed. In this section, we briefly look at each of these in turn.

Slow-burn challenges require generating and sustaining support for addressing risks that can be difficult to identify until very late in their evolution. These threats have received peripheral attention in global health security discourse. For example, in addition to being destabilized by infectious diseases and bioterrorism, societies can be destabilized by the increased prevalence of mental and behavioral health problems and chronic diseases. Here, it becomes difficult to appreciate the magnitude of the

problem—not just the psychological features, but the second-order social and economic implications. For example, in the United States alone, the incremental economic burden of major depressive disorders increased by more than 20 percent between 2005 and 2010, from \$173.2 billion in 2005 to \$210.5 billion in 2010 (Greenberg et al., 2015). Prescription opioid misuse (not including illicit opioids) in the United States translates to an estimated \$42 billion in lost workplace productivity (Florence et al., 2016). The psychosocial and mental health consequences of an increasingly automated workforce are felt not only in the immediate term through joblessness, but also through the burden of having to adapt to different workforce demands and seeking meaningful work in an age of automation.

AMR is a good example of a slow-burn issue, one that is becoming core to global health security framings but whose ultimate consequences are likely to be far greater than we have anticipated. AMR has a different temporality element from many traditional global health security concepts—one of “delayed destruction.” The problem is intergenerational, multifaceted, and has a distributed justice component in relation to access to therapeutics: Through the overuse and misuse of antibiotics today, the best lines of defense are rendered ineffective for future generations, and the arsenal of available treatments is depleted far faster than it can be replaced. For example, inconsistencies in access to and misuse of antibiotics fuel multidrug-resistant and extensively drug-resistant strains of tuberculosis. These forms of tuberculosis are resistant to the most-effective treatment options. They present a special risk for those with other conditions, such as HIV, that weaken the immune system. In this way, as one interviewee explained, AMR is fundamentally a different kind of crisis,

one that we need to bring from the future into the present, *making the present a future emergency*.

The temporal delay of slow-burn threats could mean that policymakers and global health leaders push them aside to prioritize more-immediate threats, such as a bioterrorism attack or infectious disease outbreaks, or, like the metaphorical frog in a boiling pot of water, become so habituated to these threats that they are ignored completely until it is too late. Worse, it can be difficult for policymakers and the public alike to conceive of the magnitude of these problems and the potential disasters that could arise if they go unaddressed. Overcoming this challenge requires trust in experts and civic institutions, precisely at a time when the lines between opinion and fact are continuously obscured (Kavanagh and Rich, 2018). In addition, rising populism is decidedly characterized by a reluctance to having longstanding beliefs and opinions be challenged by facts, and can suffer from the problem of focusing on the wrong slow-burn threats. Experts tackling slow-burn threats are Cassandras—harbingers of potentially disastrous consequences whose warnings are not heeded at best and disbelieved at worst. The delay inherent in long-term challenges means the costs of addressing them often appear to outweigh the benefits.

As a result, health security, if considered as a continual state of readiness, becomes a process that raises questions about the ultimate objective. How can slow-burn threats be elevated in the consciousness of both the public and policymakers? When is a society adequately healthy and secure? In the past, we might have viewed human health as an either/or state: A person was either healthy or ill. But today, health sits on a continuum, and security is much the same. In accordance with this way of thinking, an

interviewee proposed, we might need a version of health security that seeks equilibrium between states of healthiness and illness over the course of life and that more tightly responds to the bidirectional relationships among health outcomes, security, and prosperity. This view aligns with the notion of health as more than increased life expectancy and the “absence of disease or infirmity,” as declared in the WHO Constitution (WHO, 2002). It would be bold to embed well-being into the conceptual frameworks of health security. The goals of increasing healthy life years (as opposed to increasing life expectancy) and increasing protection against the spread of infectious diseases are not mutually exclusive.

Emerging technologies with biotechnological applications (e.g., artificial intelligence, additive manufacturing, precision medicine, unmanned vehicles, gene-editing technologies) present a second set of health-related threats, although these technologies also hold great potential for advancements in global health security. Notably, threats from emerging technologies did not feature prominently in our literature review of issues in global health security, yet virtually every sector will be affected by the disruption and pervasiveness of emerging technologies and, particularly, the implications of their *dual use*—that is, their use both for civilian purposes and for potential weaponization.

Such dual-use technologies are regularly cited for the benefits they are likely to confer on medicine and public health. Precision medicine and additive manufacturing (also known as three-dimensional printing) can accelerate the development of targeted medical countermeasures (Watson et al., 2018). Additive manufacturing can also improve the delivery of critical health care products, such as vaccines (Lee, 2016). Unmanned vehicles and

automated machines could revolutionize the safe distribution and administration of these products (Haidari et al., 2016), and autonomous cars could directly reduce the number of automotive-related deaths worldwide. By removing clinician subjectivity and using the identification of patterns, machine learning can greatly benefit diagnostics and decision support (Finlayson et al., 2019). In the context of infectious disease, machine learning can rapidly analyze genomic and geographic data, which can lead to more-precise and more-accurate infectious disease risk maps, hone in on appropriate countermeasures, and contain the spread of an infectious disease outbreak (Hay et al., 2013).

At the same time, there are trade-offs to the scaled-up deployment of these technologies (Bennett et al., 2009).

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## Virtually every form of machine learning is subject to the potential for adversarial attacks.

Virtually every form of machine learning is subject to the potential for adversarial attacks. A prime example is the manipulation of data inputs to deliberately distort the outcome of an algorithm, in turn leading an end user to make the wrong decision. Aside from issues of data manipulation, another threat could come in the form of health data security breaches, in which the ramifications would extend far beyond health outcomes. Workshop participants noted the challenges of protecting health and genetic data from reaching the hands of adversaries, especially given the fluidity in data exchanges. Participants also raised questions about the role of wearable technology, the Internet of Things, artificial intelligence and the big data interface, and implantable detectors for biothreats and the environment in global health governance and policy. Central to the discussion were existing infrastructural deficits in telehealth and regulatory challenges related to the integration of data and biomonitoring of populations—and the potentially wide-open opportunities for governments and international actors to exploit access to information and technologies. The more an adversary knows about where a society has health vulnerabilities, the more potent a bio-attack could prove to be. How to create both security

and agility in the use of machine learning remains a central challenge (Finlayson et al., 2019).

Emerging technologies also present risks by virtue of their pervasiveness and the relatively low cost of entry to their use. This phenomenon, in turn, complicates surveillance and control as the power of these technologies becomes more diffuse. This phenomenon was demonstrated by Chinese scientist He Jiankui, who claims to have used CRISPR gene-editing technology to manipulate the genome of twin babies (Greely, 2019), deliberately evading scientific norms and ethics and, in turn, signifying the power that individuals can wield with the growing accessibility of disruptive technologies.

Workshop participants discussed the need for a much greater emphasis on biosecurity, whereby the threat of malicious use of new technologies must be incorporated into our fundamental understanding of global health security. These issues are gaining awareness. The U.S. Assistant Secretary for Preparedness and Response in the Department of Health and Human Services continues to establish policies and guidelines to ensure biosafety in regard to the handling of synthetic biological materials and underscore the promises and perils of emerging biotechnologies (White House, 2018). The U.S. National Defense Strategy calls attention to the current “ease with which enemies may use bioengineering” (Cullison and Morrison, 2019). In addition, the GHSA Action Packages include efforts to reduce dual-use risks and deliberate malicious uses of biotechnology. This particular threat of dual-use biotechnologies indicates the need to reframe global health security as an international order in which more-concerted efforts are made to maximize the benefits of advancements in biology (including genetics, medicine, and agricultural

biology) among nations and to bolster defense to prevent or mitigate the nefarious use of emerging technologies. This issue again points to the dual functions of global health security: augmenting domestic defense against internal and international threats and bolstering the capacity of all nations to do the same.

In addition, the promises of emerging technologies should not be overestimated; that is, decisionmakers and the public alike should, based on the problem that needs to be solved, evaluate the implementation of these technologies and ask whether the function of a technology will rectify the problem at hand. In some cases, faster or more-precise technology will not be the antidote to the problem. Faster generation of a medical countermeasure will make little difference if disinformation and conspiracies surrounding it abound, as one workshop participant reported was the case with Ebola in the DRC in late 2018. Taking a reductionist perspective that fails to appreciate the importance and complexities of the interfaces between technology and human systems and that favors technological fixes for global health security issues that have social, political, economic, and behavioral determinants is shortsighted (Frenk, Gómez-Dantés, and Moon, 2014). Thus, technological advancements should be understood as opportunities, but not panaceas, within and alongside a suite of system-wide solutions.

Both the experts we interviewed and the workshop participants noted another key emerging trend related to the rise of novel biotechnologies: Power is accruing among those who control reliable data and information. Experts and participants viewed possession of health data, high-power computing required to decode and process these data, and superiority in gene-editing techniques as

political and economic advantages, although the precise mechanisms for this remain opaque. Moreover, possession of robust and reliable data will be critical to effective crisis response, particularly for infectious disease mapping and intervention. However, even the most reliable and robust data will be limited in utility if they are not adequately and appropriately used in policymaking (Moore et al., 2018).

These two broad categories of forthcoming threats—slow-burn problems and emerging technologies with biotechnological applications—are placing strain on existing modes of global health governance. Furthermore, these threats are concurrently emerging with a diffusion of power within global health governance whereby traditional actors—the WHO and the G7 member nations plus Russia—are giving way to nonstate actors, private philanthropists, nongovernmental organizations, and rising global powers, such as China (Szelák et al., 2010). Bringing slow-burn threats to the fore and being cautious about the potential perils of emerging technologies requires the kind of coordinated foresight and planning that breaks down the traditional siloed approaches taken to mitigate security and risk-related issues. It requires that decisionmakers and policymakers do not fall victim to

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The critical challenge is understanding the relationships between interrelated parts of a system or set of systems and being able to prepare for and address their effects over the short and long term.

desensitization of the urgency of these issues, even if they are slow-burn in nature. And it necessitates that decisionmakers and policymakers communicate the potential consequences in a balanced way to those to whom they are accountable. Understanding the links among existing and emerging threats and mapping the sequence of consequences that could arise from inaction, or, conversely, the advantages that could be conveyed from forward-thinking efforts, could bolster the health and security of the global population.

## Managing Interdependencies in Global Health Security

Slow-burn threats and the opportunities and challenges raised by the dual-use nature of new technologies point to a wider issue for the future shape of global health security frameworks and practices. The critical challenge is understanding the relationships between interrelated parts of a system or set of systems and being able to prepare for and address their effects over the short and long term.

This Perspective has outlined the pathways to modern global health security governance and the emerging threats that constantly call the adequacy of existing approaches into question. In this section, we highlight three sets of interdependencies that could have profound effects on global health security: first, the relationship between health and security; second, the interactions among human health, animal health, the environment, and our food systems; and third, the correspondence between cyclical or predictable events and unforeseen and potentially catastrophic events.

The concept of *security* fundamentally suggests an ongoing state of readiness and efforts that are never fully complete but rather are sufficient for generating a positive equilibrium. *Health* is much the same. Together, health and security represent a set of bidirectional relationships that are wedded to achieving stability. For example, economic crises are implicated in increasing mental and behavioral health issues (Gili et al., 2013; Margerison-Zilko et al., 2016) and infant mortality (Rajmil et al., 2014). These links are not always direct; a joint study by the Chemical and Biological Arms Control Institute and the Center for Strategic and International Studies outlined the negative

feedback loops whereby declining health and poor infrastructure contribute to the spread of infectious disease (CSIS and CBACI, 2000). This then fuels instability and creates economic downturns through absenteeism and labor shortages. The spread of disease also redirects funds that would otherwise be spent on critical infrastructure, increases individual health care costs, negatively affects trade and tourism, exacerbates capital flight, and decreases gross national product (CSIS and CBACI, 2000). In this vein, health and security are understood as interdependent on broader demographic shifts and migration, integrated economic systems, climate change, conflict, and technological change (Frenk, Gómez-Dantés, and Moon, 2014).

In postconflict societies, the interdependencies between health and security are even more pronounced. This was a notable concern among workshop participants, who argued that the perpetual and acute traumatization and subsequent severe mental health crises among those exposed to war and terrorism are creating a pressure cooker. Experts flagged the widespread presence of explosives—undetonated artillery left behind after a war—and a lack of safe havens, which keeps displaced people in unsafe, crowded conditions. The results of unmitigated conflict have been most recently apparent in Yemen. After four years of civil war, while the United Nations struggled to implement a ceasefire accord and the U.S. executive and legislative branches clashed over U.S. policy toward Yemen, famine worsened and the worst cholera outbreak in the epidemiological record emerged (Federspiel and Ali, 2018; Mohareb and Ivers, 2019). The interlocking humanitarian disasters in Yemen demonstrate the imperative of more closely integrating health and security approaches. The raging cholera epidemic (the initial driving force behind

coordinated public health efforts in the 19th century) is a stark reminder of the persistence of fundamental public health problems no matter how sophisticated our technologies become.

Workshop participants noted the growing push to see health security folded into economic stabilization operations, emphasizing that a nation cannot build labor opportunities without ensuring baseline health. Indeed, the importance of global health, conflict prevention, and stabilization practitioners working in close, systematic partnership should not be underemphasized. However, an integrated systems approach to health security as an essential element of security and stabilization operations remains elusive. Moreover, experts in conflict and stabilization efforts noted that U.S. policy has arguably *deprioritized* such multinational efforts.

Meanwhile, international development assistance for health has increased fivefold over the past 20 years, from \$5.6 billion in 1990 to \$28.1 billion in 2012 (Gostin and Sridhar, 2014; Institute for Health Metrics and Evaluation 2012). Private industry and charitable organizations are increasingly involved as well, changing the governance landscape for global health security at the same time (Gostin and Sridhar 2014; Hoffman 2010; Institute for Health Metrics and Evaluation, 2012). However, the level of funding and political will devoted to global health security threats is a matter of framing: If the prevention of an infectious disease outbreak is perceived solely as a health problem, the return on investment for policymakers could be seen as low vis-à-vis chronic, omnipresent health-related concerns. Indeed, U.S. spending on the prevention of infectious diseases is paltry (Sands, Mundaca-Shah, and Dzau, 2016). But if pandemic prevention is viewed by experts as

a security issue as well as a challenge to economic growth, pandemics represent a greater threat than both conventional and terrorist conflicts and natural disasters, and the return on investment would appear stronger. Hence, if health security is understood by policymakers and decisionmakers as a pillar of the well-being and prosperity of a population, nation, or region, it would likely command more attention in resource allocation debates.

A second set of interdependencies relates to the linkages between infectious disease, which has been the historic focus of global health security efforts, and other systemic challenges. This latter category includes non-communicable diseases and other serious public health burdens, such as obesity and drug dependence, that are increasingly defining population health. Decisionmakers and practitioners now recognize that health should be understood not as a stand-alone issue but as part of a system in which individual effects are difficult to depict and articulate. Mitigating potentially catastrophic threats requires more than simply improving population health and reducing poverty, crime, and other socioeconomic problems. Rather, through *vigilant protection* of critical and interconnected systems, governments can be better prepared for catastrophic events. This way of considering vulnerabilities within infrastructure, public services, economic systems, and political order—a *vital systems security*—has come to take shape alongside governance approaches that focus on more predictable and cyclical events (Collier and Lakoff, 2015). Balancing vital systems security with social welfare concerns will remain a challenging trade-off for policymakers. For example, preparedness for a potential pandemic might strengthen public services (e.g., hospitals), but it also might divert resources

away from persistent and omnipresent public health issues (Collier and Lakoff, 2015).

This approach takes into consideration the fact that social unrest is linked to resource insecurity, such as rising food prices (Bellemare, 2014) and water scarcity (Kreamer, 2012), among many other systemic issues. For example, water scarcity can breed conflict, which can drain health services, cause mass migration, and erode sanitation structures, in turn ripening conditions for infectious diseases (Bowles, Butler, and Morisetti, 2015). The aforementioned example of conflict and cholera in Yemen concretizes this point, and, as two experts noted in interviews, waning U.S. support for foreign humanitarian aid is a missed opportunity to curb the vicious cycle of conflict, famine, disease, and social unrest. The persistent challenge is how to incentivize multidisciplinary and multi-stakeholder engagement to address the complex interlinkages among health, environment, politics, the economy, and security and break down the walls that often separate these issue areas.

Complex interactions between human health and animal health, as well as the food chain and the wider environment, are increasingly recognized but not fully understood. However, a holistic approach to these disparate concerns that has gained increasing prominence over the past decade is the practice of *One Health* (Atlas, 2013; Frankson et al., 2016; Rubin et al., 2013). This concept captures the need for integrated responses to health issues, transcends the focus on responses to and treatment of infectious diseases, and accounts for the intersectional challenges that relate to the management of health. In this respect, the idea of One Health has been useful in raising awareness of the need for multifaceted responses to

interrelated problems, albeit largely rooted in the prevention and containment of zoonotic diseases, such as avian influenza.

During the workshop, participants argued that global health security continues to be understood primarily in relation to infectious disease and has remained stovepiped within public health institutions, and is therefore separate and distinct from national and international security bodies. Meanwhile, for some, One Health has become a catch-all phrase encompassing many issues but lacking sufficient coalescence around a set of core concerns. Hence, there is an inherent trade-off between taking a more expansive but abstract view and one that allows for more-direct, more-actionable goals. As a result, some of the experts at the workshop felt that One Health had yet to receive sufficient buy-in from all relevant stakeholder groups, complicating communication efforts between sectors and preventing One Health from being able to obtain sufficiently integrated funding strategies for the many important issues that it seeks to address.

The third set of interdependencies among issues might have large-scale implications that are hard to predict and difficult to prevent or treat. As this piece and previous research in the RAND Center for Global Risk and Security portfolio have maintained, for all of the promises of novel technologies, there are also deep concerns over their potential perilous applications (Geist and Lohn, 2018; Johnston, Smith, and Irwin, 2018). Discontinuous trends, or “black swans” (Hoehn et al., 2018; Taleb, 2007), will likely include the potential for the adversarial use of novel technologies, such as gene-editing techniques, artificial intelligence, and additive manufacturing.

Implicit in conceptualizing global health security through the lens of complex interdependence is the fact that “no single stakeholder—not even the most powerful government or corporation—is singlehandedly able to address all the health threats that affect it” (Frenk, Gómez-Dantés, and Moon, 2014), and this problem exists at multiple levels, from local to global. Nor are there any straightforward solutions. For example, closing borders in conflict-ridden zones to halt the spread of an infectious disease raises deeply troublesome human rights issues. The recognition of state interdependencies in acute crises and emergencies raised questions for workshop participants about responsibility and coordination to deal with health security challenges. Both nations and corporations tend to operate in information silos, with few joint communication systems apart from public social media. Workshop participants stressed the need for trust and collaboration among international leaders to coordinate and expedite responses

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to acute global health crises, facilitate preventative measures, share information, and coordinate global messaging to the public during health crises. This trust and collaboration are waning. Suggestions were put forth to invest in more data collection and computing technologies to track and control emerging threats. Information sharing is critical to consistent, coherent global public health messaging and supports the notion that global health security must encompass individuals, communities, nations, and international partnerships.

As mentioned, governance is being simultaneously shaped by the rise of populism, a lack of trust in multilateral institutions, and the illusion that closing borders or backing out of multilateral engagements will increase national health security. There is little appetite for taking the kind of long-term, collaborative approaches necessary to tackle complex, accelerated global health challenges, in part because complex issues require sustained commitment beyond short-term election cycles. Workshop participants and interviewees asserted that these trends, coupled with a lack of trust in the international community and in many areas of scientific research, impede the ability to mount coordinated international health responses and are creating voids for new players in global health security governance to fill. Suffice it to say, acknowledging interdependencies will usher in challenges related to scope, coordination, and accountability; but without a long-run view of interdependencies, critical vulnerabilities could emerge and go unaddressed.

## Looking Over the Horizon

One goal of RAND's Center for Global Risk and Security is to expand current thinking on the boundaries of risk and security. Many of today's global health security risks are unlikely to be solved within the next 25 years, and new challenges will undoubtedly arise. As a result, decision-makers will be faced with difficult trade-offs related to resource allocation and challenges with respect to the rapid spread of disruptive technologies, demographic shifts, cyber warfare, climate change, and the dislodging of global governance power structures. Yet there are many possible solutions, ranging from the prosaic to the high-tech. As this exploratory work emphasizes, global health security will raise important issues of technological regulation and control, governance, and values.

Emerging technologies will bring both promise and peril. Experts expect that data security, health technology, and health security will continue to converge. High-performance computing can track the DNA of infectious diseases to better identify vaccines and treatment options. It might even allow for greater sophistication in the identification of mental health threats. Additive manufacturing might drastically increase the speed and safety with which vaccines and treatments are deployed. But, as we have emphasized, these technologies will be double-edged swords, in that they have potential for malicious applications and likely will be more accessible and widespread (i.e., more difficult to monitor and control) than ever before.

The complexities of global health security now and in the near future necessitate a reevaluation of the common operationalization of the field—that is, a move beyond

a conception of global health security as the prevention of pandemics and bioterrorist attacks. This reevaluation introduces another vulnerability, however, wherein interdependencies challenge global health security efforts to the point of inaction because of the difficulties in operationalizing those efforts into discrete tasks. The central tension is how to balance agility—the ability to make decisions rapidly, particularly in times of crisis—with a holistic scope reflective of the broadened range of threats to human and environmental health. Against this challenge, policymakers, researchers, and practitioners alike will have to consider how like-minded actors (both state and nonstate) can collaborate, hold one another accountable, and commit to metrics that track progress. They must also be aware that power is becoming more diffuse in this highly complex, interdependent, and networked world, leaving voids for emerging actors to fill.

The future of global health security is one that inevitably requires vigilance against emerging and reemerging infectious disease, but is also made more complex as our understanding of the interactions between chronic and infectious diseases increase, our interest in well-being supplants the goal to extend life expectancy, and emerging technologies offer the potential for both enormous benefits and many risks. Looking over the horizon, we offer three core values that we see as constitutive of the future global health security landscape.

First, infectious disease must remain a priority—indeed, a pillar—of global health security. We have come far in the battle to identify, treat, and prevent many infectious diseases, but new threats are constantly arising. The rapid transportation of humans, animals, and goods and the overuse and misuse of medications have created

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drug-resistant and multidrug-resistant strains. It is entirely possible that human-engineered influenza strains could be weaponized if made different enough from the predicted seasonal influenza vaccine. Such a bioweapon could overwhelm hospitals, reduce economic productivity, spark the chaotic spread of misinformation, and, worse, create unnecessary suffering and mortality, especially among vulnerable populations.

Second, regardless of resource constraints, global health security—which includes monitoring and quarantining people—must not come at the expense of efforts to advance global public health, well-being, and human rights—including reducing poverty, improving nutrition, and expanding access to health care. These issues must

be addressed in tandem—in fact, it might behoove practitioners of global health security to see the two as inextricably linked and mutually beneficial.

Third, growing efforts to increase collaboration, align resources and aims, and break down the conceptual and operational barriers across security, global health, and global health security are promising and must be fostered. Emerging threats, increasing interdependencies, and diffusion of power across state and nonstate actors will limit global health security governance approaches if the status quo persists. The critical issue is whether policymakers and decisionmakers can be motivated to see healthy societies, broadly defined, as the foundation of national security, and whether key players can rethink collaborative governance in global health security. That orientation could prove finally effective in rallying the wide variety of stakeholders that come to bear on the future security of the health of our world.

## Appendix

### Methodology

The literature review included all articles published from 2013 through 2018 on PubMed using the search terms *global health security* and/or *health security*. The search yielded 312 articles and publicly available reports from leading global health organizations, particularly the WHO. We categorized all articles and reports based on the global health security issue addressed—i.e., whether it depicted prevention or mitigation strategies for global health security issues, what actors and organizations it involved, and whether it concerned a persistent issue or one that is novel or emerging. Our objective was to identify the main topics covered in the literature and to determine whether the literature directly addressed possible future concerns.

We also conducted 14 interviews with experts based in the United States and the United Kingdom, including policymakers and academics in the fields of global health, global health security, military and defense, agriculture, international development, public policy, biotechnology,

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and computing. Experts were identified after creating a list of national, multilateral, and independent global health and security institutions (e.g., U.S. Department of Homeland Security, UK Department of Health and Social Care). In addition, we reached out to academic and industry experts in global health security and biotechnology, respectively. We sought their perspectives on the definition and operationalization of global health security, historical gains and lessons learned, immediate challenges, and the potentially greatest threats over the coming 25 years. We recognize that this study is decidedly oriented to U.S. and UK perspectives. We hope that the insights from this exploratory study will serve as a prompt for others to investigate these issues from additional angles.

Drawing on what we learned from the literature review and expert interviews, we developed a series of future scenarios, culminating in the year 2040, an arbitrary date in the not-so-distant future. We tested the scenarios during a half-day gaming workshop held in Washington, D.C., in October 2018. Participants included 18 U.S.-based researchers, practitioners, academics, and other stakeholders from government, industry, defense, health security, and biotechnology who were invited to discuss the future of global health security. The workshop involved a 360° Game, pioneered at the RAND Center for Gaming (Henry, Berner, and Shlapak, 2018). The purpose of the 360° Game is to assist decisionmakers and program managers in

characterizing, analyzing, and responding to complex and multifaceted issues.

The 360° Game, more than other analytic games, is designed to foster an exploratory, cross-sectional analysis of a problem space and potential solutions without being prescriptive about ultimate decisionmaking. The intent is to reveal potential solutions and future approaches to complex, multifaceted issues. The aim of the workshop was for participants to reflect on what global health security in the next 25 years could look like by discussing future health security scenarios, which were presented in narrative and visual forms by a skilled moderator. The scenarios, which were based on discussions with colleagues, the expert interviews, and the literature review, were imaginative but plausible. They involved resurgence of pathogens following climate change events, unequal distribution of antidotes, austerity measures that contribute to the global mental health burden, and shifting demographics. The scenarios also posited advancements in the detection of emerging infectious disease outbreaks through big data analytics and a richer understanding of the links between the environment and health. The workshop also invited participants to discuss additional threats created by emerging health security concerns, potential mitigation strategies, linkages across the constellation of health security, and issues that remain poorly understood.

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## Funding

Funding for this venture was provided by the generous contributions of the RAND Center for Global Risk and Security (CGRS) Advisory Board.

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This work was conducted within the RAND Center for Global Risk and Security. CGRS works across the RAND Corporation to develop multi-disciplinary research and policy analysis dealing with systemic risks to

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## About This Perspective

In this Perspective, the authors review the current scope and operations of global health security, identify emerging threats, and assess how adequately current visions of global health security account for these threats. Two main issues within global health security are identified: *slow-burn* problems—whose long-term effects are underestimated, potentially causing them to receive insufficient attention until it is too late to reverse the damage—and emerging technologies that have beneficial uses but that also can be used as weapons. The authors of this Perspective propose that a broader definition of global health security should be considered—one that would extend well beyond the threats of pandemics and bioweapons of mass destruction. In addition, global health security requires greater systematic focus on the complex interlinkages among human physical and mental health, animal health, and the environment. Policymakers will face the challenge of balancing agility and rapid decisionmaking during times of crisis with a holistic scope that encompasses both imminent and future threats.

We would like to express great appreciation to the RAND Center for Global Risk and Security and to King Mallory, Robin Meili, and Charles P. Ries of RAND International Programs for their guidance and direction and for spearheading a venue for productive, forward-thinking research. Many thanks to Anita Chandra for her vision and guidance on the project and to Andrew Parasiliti for bringing the importance of the topic to the fore.

Fourteen subject matter experts offered their invaluable time and insights during in-depth interviews on the topic of health security. We also offer very special thanks to the many workshop participants and leaders in practice, research, and policy who generously donated their

time and expertise to exploring this challenging topic. We appreciate the many efforts of Jenny Oberholtzer, who contributed greatly to the facilitation of the workshop. In addition, we thank Adam Bertscher, who made excellent contributions to the literature review.

We wish to thank Stephen Hinchliffe and Christopher Nelson for their careful and thoughtful quality assurance reviews and constructive feedback on this Perspective. Finally, we would like to thank Sonni Efron, who offered helpful editorial reviews and many thought-provoking discussions that enhanced the work.

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