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# Cybersecurity and Health Regime (2015 to 2021): Security governance and global interconnectedness of actors and the involvement of technology in the surveillance of infectious diseases—perspectives from the Americas

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**Dedication | Dedicatoria**

This dissertation is dedicated to my dear parents, Rosa B. Ronquillo Castro and Santiago E. Sanclemente Jacome, who are my illuminating stars and who give me strength to succeed in life.

Without you I am nothing.
With you I am all.
The candles that light my path.
The cement holding the foundation,
with great strength and valor.
I grow. I learn. I see.
To be curious and to explore.
To have strength and perseverance.
I dedicate this work with love.

Esta tesis está dedicada a mis queridos padres, Rosa B. Ronquillo Castro y Santiago E. Sanclemente Jacome, que son mis estrellas iluminadoras y que me dan fuerza para el éxito en la vida.

Sin ustedes no soy nada.
Con ustedes soy todo.
Las velas que iluminan mi camino.
El cemento que sostiene la base,
con gran fuerza y valor.
Crezco. Aprendo. Veo.
De tener curiosidad y explorar.
De tener fuerza y perseverancia.
Les dedico este trabajo con mucho cariño.

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**List of Acronyms**

| | |
|---|---|
| ABR | Antibacterial Resistance |
| AGISAR | Technical Advisory Group on Integrated Surveillance of Antimicrobial Resistance |
| AMR | Antimicrobial Resistance |
| AI | Artificial Intelligence |
| ANT | Actor-Network Theory |
| ARDS | Acute Respiratory Distress Syndrome |
| CAESAR | Central Asian and European Surveillance of Antimicrobial Resistance |
| CDC | Centers for Disease Control and Prevention |
| CHINET | China Antimicrobial Surveillance Network |
| COVID-19 | Coronavirus Disease 2019 |
| DHS | Department of Homeland Security |
| EARS-Net | European Antimicrobial Resistance Surveillance Network |
| ECDC | European Centre for Disease Prevention and Control |
| FAO | Food and Agricultural Organization |
| FDA | Food and Drug Administration |
| GAP-AMR | Global Action Plan on Antimicrobial Resistance |
| GARDP | Global Antibiotic Research and Development Partnership |
| GDPR | General Data Protection Regulation |
| GGE | Group of Governmental Experts |
| GLASS | Global Antimicrobial Resistance Surveillance System |
| GHSA | Global Health Security Agenda |
| HHS | U.S. Department of Health and Human Services |
| HIV | Human Immunodeficiency Virus |
| IC | Intelligence Community |
| ICT | Information and Communication Technologies |
| IESS | Ecuadorian Social Security Institute |
| IHR | International Health Regulations |
| INR | Bureau of Intelligence and Research |
| INSPI | National Institute for Public Health Research (Instituto Nacional de Investigación en Salud Pública) |
| ISSPPOL | Social Security Institute of the National Police |
| IUTLD | International Union Against Tuberculosis and Lung Disease |
| MERS-CoV | Middle East respiratory syndrome coronavirus |
| MIC | Minimum Inhibitory Concentration |
| NBIS | National Defense Research Institute |
| NCC | National Coordinating Center |

| | |
|---|---|
| NFP | National Focal Point |
| NGO | Non-Governmental Organization |
| NRL | National Reference Laboratory |
| OECD | Organization for Economic Cooperation and Development |
| OIE | World Organization for Animal Health |
| OSINT | Open-Source Intelligence |
| PAHO | Pan American Health Organization |
| PACCARB | Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria |
| PEW | Pew Charitable Trusts |
| PHEIC | Public Health Emergency of International Concern |
| REDNARBEC | National Bacterial Resistance Surveillance Network of Ecuador (Red Nacional de Vigilancia de Resistencia Bacteriana del Ecuador) |
| ReLAVRA | Latin American Network for Antimicrobial Resistance Surveillance (Red Latinoamericana de Vigilancia de la Resistencia a los Antimicrobianos) |
| SARS | Severe Acute Respiratory Syndrome |
| SITREP | Situation Reports |
| SIVE | Integrated Epidemiological Surveillance System (Sistema Integrado de Vigilancia Epidemiológica) |
| SOSIG | Social Science Information Gateway |
| STAG-AMR | Strategic and Technical Advisory Group for Antimicrobial Resistance |
| UN | United Nations |
| USA | United States of America |
| USAID | United States Agency for International Development |
| WEKA | Waikato Environment for Knowledge Analysis |
| WHA | World Health Assembly |
| WHO | World Health Organization |
| WTO | World Trade Organization |

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Yo, Gaudys Laxury Sanclemente Ronquillo, autora de la tesis titulada "Cybersecurity and Health Regime (2015 to 2021): Security governance and global interconnectedness of actors and the involvement of technology in the surveillance of infectious diseases—perspectives from the Americas", declaro que la obra es de mi exclusiva autoridad, que la he elaborado para obtener el título de doctorado, concedido por la Facultad Latinoamericana de Ciencias Sociales, FLACSO Ecuador.

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**Abstract**

The promotion of a health regime stems from the security governance of infectious diseases through the interweaving structure and collaboration in information sharing of diverse actors such as nation-states and institutions. Global interconnection promotes a health regime that opens channels of nontraditional threats, such as infectious diseases. The technology database, Global Antimicrobial Resistance Surveillance System (GLASS), an open-source intelligence (OSINT) of publicly available information of the World Health Organization, requires working together and collaboration of different participating countries. Threat actors also benefit from access to open source, from planning biological attacks to cybercrimes. Certain intervening factors, such as manipulating algorithmic data could dissuade actors' dispositive nonhuman fact production mechanisms since not all data is neutral. First, the investigation opens the black box of a health regime, going beyond a mere description to study the open surveillance system's role in monitoring infectious diseases and explores the strength and weaknesses of inscription devices and different types of actors in the network. Second, the study analyzes how the emergence of an unconventional threat activates security governance, promoted by collaborative dynamics, *dispositifs*, and *boundary objects* connected to GLASS based on open data exchange to promote a health regime on the surveillance of human priority bacterial pathogens. Third, the research explains why security governance works to secure a health regime in the surveillance of infectious diseases through OSINT precisely because it identifies risks, vulnerabilities, and resources due to the complex ways multiple actors interconnect in the exchange of data. The theoretical framework explores the relational dimensions of three theories: liberal institutionalism, securitization, and actor-network grounded by complex interdependence, regimes, and security governance logic to understand the importance of the actor roles in the network securitizing dichotomy behind collaborative actions of referent objects. A specific case study details the dynamic between security governance and the emergence of a health regime. The methodology consists of a mixed-methods approach to map the network, analyze interconnectedness, and articulate cultural practice dynamics. This dissertation adds to the literature base by explaining the necessity of a new contemporary health regime to harmonize data sharing against nontraditional threats. It contributes to international studies, security studies, science and technology studies (STS), health sciences, and network science fields.

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Quito-Ecuador

## Introduction

I saw a large river meandering slowly along for miles,<br>
passing from one country to another.<br>
I saw huge forests, extending along several border.<br>
And I watched the extent of one ocean touch the shores of separate continents.<br>
Two words leaped to mind: commonality and interdependence.<br>
We are one world.<br>
—John-David Bartoe

### The Walls

When one realizes the importance of time and is faced with the task of writing a dissertation during a pandemic, their entire perspective on life is changed. Yet, they still press on. Similarly, civil society experienced a range of emotions as the walls of social distancing quickly arose, national borders closed, and countries went into lockdown, reaching global measures.

> Wall of dismissal.
> Wall of smugness.
> Wall of arrogance.
> Wall of confidence.
> Wall of aggression.
> Wall of denial.
> And then the wall starts crumbling down.

In the unforeseen year of 2020, unheralded new norms occurred brought upon by the coronavirus disease (COVID-19) as a public health crisis. The pandemic changed international and domestic relations. The pandemic increased tensile forces and caused the foundational crumbling of social, political, and economic structures. From enhanced technology to security challenges, the public and private sectors played crucial parts in providing crisis and emergency relief responses to the rapidly expanding virus. The coronavirus stirred tumultuous waves and storms across international borders. The COVID-19 virus forced security providers to go above and beyond their responsibilities to take on the blanket threat of infectious diseases and carry out tasks outside their security roles and norms.

Collaboration plays a critical role in ensuring security for civil society. Before the pandemic, security measures were typically implemented on a case-by-case basis within specific industry sectors. In the healthcare industry, the World Health Organization (WHO), with the aegis of participating countries, territories, and areas, collaborates on global health. Diverse actors interconnected through the support and collaboration of relevant players with a common interest. Meetings by nation-states, institutions, industry leaders, and the ministries of health were held between 2015 and 2021 to discuss strategies for combating antimicrobial resistance (AMR). However, with the rampant and unexpected global influx of COVID-19 across nations, emergency meetings were held by delegates and think tanks of different industries to tackle the new threat. As a result, two global threats forced actors to address and tackle the issues. In 2020, the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB) held a virtual meeting focused on the impact of COVID-19 and its effect on AMR. Who are the actors in the surveillance network of infectious diseases? Are nation-states the influential power players or institutions balancing the scales by maintaining a significant role in the international system?

Security governance of infectious diseases is crucial on a national and global scale to ensure crisis response accountability. For instance, during the pandemic, governments establish rules for the safe handling and management of the risk of infectious diseases, such as country lockdowns and advisories on wearing a mask. In context, many nation-states have taken fluctuating action to combat the threat. As a result, countries have been able to push forward security measures with minor push-back where there is a severe transnational threat.

However, the pandemic produces a soniferous system that reaches global measures. We already comprehend the avenues of disinformation on a worldwide and national scale. We already know there needs to be a change, and we keep asking these questions, going in circles. What is the solution? What do actors, as agents of continuity, need to do? Who are the actors that need to act to reduce this disinformation and uncertainty? It’s time to stop asking questions and take some action in a forward movement toward global health and security. The invariable cycle of unsureness brings divisions in many sectors. Still, collaboration and interconnection to battle infectious diseases remain at the forefront of promoting a health regime. Interconnectedness and transparency in data sharing are vital in tearing down the emotional walls of confusion and uncertainty.

**Objectives, Core Research Question, and Hypothesis**

As individuals reeled from a deadly pandemic, a mutual symbiosis per se arose, including the interconnection of actors that share resources to keep each other alive. Three objectives inspire this dissertation's research. The first objective opens the black box of a health regime by illustrating a surveillance system of OSINT that monitors infectious diseases and discusses strengths and weaknesses of instruments that produce *inscriptions*[1] to address nontraditional threats, for instance, infectious diseases, algorithms, biases, cybersecurity, and emerging technologies such as artificial intelligence (AI) and high-performance computing. The second objective analyzes how the emergence of an unconventional threat activates security governance, promoted by collaborative dynamics, *dispositifs*,[2] and *boundary objects*[3] (Bowker 2001; Star and Griesemer 1989; Latour 1987) based on open information exchange in the Global Antimicrobial Resistance Surveillance System (GLASS), which promotes a health regime on the surveillance of human priority bacterial pathogens. In particular, the study examines the role of international collaboration in establishing the surveillance instruments of production, data sharing, and monitoring of infectious diseases and antimicrobial resistance (AMR). The third objective explains why security governance works to secure a health regime in the surveillance of infectious diseases through OSINT precisely because it identifies risks, vulnerabilities, and resources due to the complex ways multiple actors mutually depend on each other to exchange data. This dissertation focuses on the core research question, why did security governance, through an OSINT technology database of the World Health Organization (WHO), promote the health regime on the surveillance of communicable diseases in the Americas from 2015 to 2021?

In this dissertation, I claim as a core hypothesis that a new contemporary health regime is built based on security governance to combat nonconventional threats. Security governance of

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[1] The term "inscription" means a visual display, not as an end goal, but as an intermediary used in the exchange between actors such as groups of researchers and scientists that cross purposes in their interest of the inscription; an instrument (or inscription device) produces an inscription (Latour 1987).

[2] The term "dispositif" refers to the apparatus such as discourses, institutions, regulatory decisions, laws, or scientific and philosophical statements (Foucault 1980).

[3] The term "boundary object" distinguishes differences while providing common points of reference and consists of scientific objects that inhabit intersections of the social world, information, organizational structure or arrangements, a negotiation process, the mediator between groups, or any concrete element that assists in drawing a boundary between data and policy (Orsini, Louafi, and Morin 2017; Star and Griesemer 1989; Gieryn 1983).

infectious diseases promotes the emergence of a health regime when countries collaborate through an open-source intelligence database that contributes to harmonizing data sharing in promoting global health. Security governance of infectious diseases fosters the emergence of a health regime when countries remove barriers, collaborate, and interconnect in information exchange transparency to promote global health.

This change is paramount to the progressive movement of change in international studies. Traditionally, how countries managed the national security threat was narrowly isolated to national boundaries and military security threats. However, infectious diseases do not care about borders. From 2015 to 2021, this study measures perceptions of nontraditional threats in the Americas, such as infectious diseases, in the emergence of a health regime when countries collaborate through an exchange of publicly available information and harmonize data sharing to promote global health.

Moreover, the WHO declared AMR a global public health problem and indicated its critical nature as a health threat through publicly available GLASS reports (World Health Organization 2020g, 2018a, 2017b). This dissertation proposes that as a process of intelligence collection and strategic opportunity, security governance promotes a health regime's emergence through information sharing from publicly available data. This collaborative process transforms the data into useful intelligence. Such collaborative interconnectedness gives real-time responses by agents of continuity, which includes policy-makers, military, hazardous teams, and medical emergency teams, to reduce strategic surprises because communicable diseases go beyond national borders and have an interconnected nature. This interweaving relationship, collaboration, and complex interdependence of countries and institutions occur because of strong net neutrality regulations versus proxy options for accessing data. Although open-source data in the surveillance of infectious diseases provide collateral material, it is a source for illicit activities and large cyber-criminal campaigns. Pathogens leading to global pandemics affect the economy and global citizens alike while opening the doors to provocative thought and analysis of the usefulness of information exchange in big data and collaborative actions.

I have organized this dissertation into five chapters. The study begins with an introduction to the research, the unit of analysis, and justification. It also describes the objectives, research question, core hypothesis, and dissertation structure. Testing the hypothesis requires an interconnected analysis of the data collection, dissemination, decision-making, and collaboration relations that link the units. Chapter 1 deals with the theoretical framework, where I conduct a deep dive into three theories grounded in three conceptual logics. I also pull insights from cross-disciplines such as health sociology, science and technology, and intelligence studies.

Chapter 2 discusses the study's methodology, and the chapter divides into three sections: the first section discusses the research design. The second section discusses the methodological limitations. The third section provides the data collection for phase one of the quantitative data structure and the qualitative data structure in phase two. Next, chapter 3 provides the case study divided into four sections. The first section discusses the data analysis and results of the study, which focuses on one single case study. The second section speaks to the various communicable diseases under investigation. The section provides an account of the GLASS technology database, discussing the eight human bacterial pathogens and the novel threat, COVID-19. The third section discusses measuring security governance to promote a health regime connected to the GLASS surveillance system of infectious diseases. This study creates the security governance metrics framework based on the information gathered from document analysis and semi-structured interviews. In the fourth section, I focus on the case study of GLASS and AMR on human bacterial pathogens. I also discuss the emergence of a new threat that came into existence in 2019 and emerged during the scope of my fieldwork studies: a severe global pandemic, COVID-19, as context research and reinforcement mechanism in connection to the study. In this chapter, I detail the alignment of data sharing in promoting a health regime by introducing five security governance dimensions.

Chapter 4 analyzes and discusses the objectives of the dissertation. First, to open the black box of a health regime; second, the activation of security governance based on the emergence of an unconventional threat to promote a health regime; and third, the alignment of managed big data sharing, which describes the different types of risks, vulnerabilities, and resources present in the use of surveillance systems such as GLASS to building a health regime. Lastly, chapter 5 provides the conclusions, which synthesize the chapters by tying all the parts together, establishing what was shown by my research, and substantiating how the research is relevant to my central research question and theme, global interconnectedness. Finally, the appendix section closes the dissertation with additional data tables, research instruments, and appropriate notes as references.

**Presentation of the Research and Justification**

Certain surveillance system databases contain intelligence collection and information sharing, such as data on AMR at a global level. Nevertheless, in what way does free information slow down or benefit actors who contribute information toward a common interest? For example, the WHO provides publicly available data through its GLASS technology database that contains health information on eight human-priority bacterial pathogens. The WHO declared AMR one of the top ten critical global public health threats (World Health Organization 2020b, 2017b). Promoting global health through collaborative efforts enhances countries' security, facilitates informed decision-making, and drives national, regional, and global actions.

Moreover, acute and chronic changes in health status, such as infectious diseases, influence national security. However, significant variations between countries are barriers to global collaborative health research efforts in big data sharing. How do security or privacy protection groups slow down the technological advancement of open-source information, transparency, and data sharing in healthcare surveillance systems that contain available information? The effect of security governance issues in international relations connects to states' behaviors. Whether actors collaborate raises security concerns against nontraditional threats such as infectious diseases, cybersecurity, and emerging technologies.

This dissertation measures perceptions of nontraditional threats in the Americas from 2015 to 2021, such as infectious diseases not restricted to national borders. In addition, the research focuses on the collective purpose of institutions, the process, and a system of rules or mechanisms that guides the international surveillance of infectious diseases and promotes the emergence of a health regime in response to security threats. The WHO developed the GLASS technology database to monitor infectious diseases during this timeframe. My research study analyzes GLASS data where countries collaborate in the surveillance network to promote global health and are motivated by common interests. The purpose of this investigation is not to conduct a controlled research study comparing nation-states since most countries provided incomplete information regarding the GLASS standards. Instead, I seek to analyze how GLASS, as a boundary object, links global countries through a security governance system in the surveillance of infectious diseases. Furthermore, I am interested in how GLASS acts as a supportive mechanism in building states' national surveillance systems and organizational responses to threats and how infectious diseases affect collaborative actor responses and heightened security measures in the interest of national security.

My research finds a gradual increase in country enrollment from 2015 to 2021 but a limited submission of AMR surveillance information by GLASS-enrolled countries from the southern subcontinent of the Americas during the scope of the investigation—Brazil, Argentina, and Peru. Section 3.1 provides a deep dive through data analysis of participating GLASS enrollments. One question that these data raise is: does the inclusion of additional global south countries in GLASS change the political landscape, hinder information exchange due to a lack of a technological mechanism or limit the input of information into a database due to a lack of collaborative knowledge production? Technological advancements and access to information in less developed countries also contribute to the need for knowledge production and data sharing as countries submit information early in the development stage.

Concerning academic scope and contribution to knowledge production, this dissertation has an identity and is investigatory. First, this study identifies the emergence of a health regime through a specific case study from the perspective of the Americas. The specific unit of analysis is a health regime. Building a security regime within a health regime materializes as my academic contribution. Second, the dissertation is investigative since, within international studies, the investigation will contribute scholarly information in security studies with a focus on cybersecurity and intelligence and lies crossing the intersection of science, technology, law, and policy.

Moreover, I chose this research topic for practical considerations. The dissertation develops more in-depth knowledge by providing information that facilitates informed decision-making, drives sustainability, and allows sharing of antimicrobial resistance surveillance information to drive global actions showcasing innovation. The topic is vital since the findings benefit the body of knowledge and its importance amongst multiple stakeholders. Likewise, the study raises awareness of global health of emerging resistance mechanisms spreading globally that threaten the ability to treat infectious diseases resulting in illness and death by showcasing collaborative efforts to enhance countries' security. Furthermore, my specific case study illustrates the interconnected actions of actors collaborating in the GLASS surveillance network toward a common cause, such as global health.

Although my primary analysis is the GLASS surveillance system of infectious diseases, the novel security threat, COVID-19, is a prime contemporary example of how diverse global actors take immediate action and collaborate in preventing a national security threat. However, context information illustrates data skewness and uncertainty when nation-states do not collaborate. Unfortunately, context plays a vital role in network and security governance and influences emergency actions and disaster responses. In addition, context information, such as China's potential resistance to providing information on the coronavirus outbreak, contributes to the reliability and uncertainty of data.

Furthermore, the pandemic disproportionately strikes diverse groups and industry sectors. Since each nation-state addresses security measures differently, governments must tackle the diseases and other variables thrown into the mix. Inadequacy of information sharing, and transparency affects the most vulnerable with limited access to testing capabilities, creates confusion, heightens civil division, and increases protests against the government for lack of accountability. An absence of ensuring citizen health, safety, and security stems from inadequate health and security measures early in combating the threat. Thus, how governments articulate security is paramount in fighting a pandemic—actor collaboration and interconnectedness are essential.

In 2019, the coronavirus's emergence as a nontraditional threat created an immediate response by the interconnection of actors. As a result, national security issues and information intelligence exchange arises in consideration of global health and open data sharing. My research findings contribute to the professional world, academic setting, the global north and south, and other parts where many actors collaborate and interconnect in sharing data of common interests and concerns. Thus, I include a brief analysis of COVID-19 as a research context to supplement and reinforce my core research topic.

**Innovations: Contributions to Knowledge Production**

What innovations does this research present? How is my investigation expanding the field of knowledge production? The innovations carried out by this study include collaborative innovation that makes use of publicly available information and data exchange through surveillance platforms such as GLASS to promote communication and health innovation and raise awareness of infectious diseases and AMR. Likewise, this study presents the value of technological innovation. Technology innovation commits to automating a high volume of data, streamlining low-value tasks, and allowing time and space to focus on higher-value threats, such as infectious diseases, through strategic security while harmonizing the global collaboration of AMR surveillance. In addition, this study disseminates the importance of innovative practices such as enhancing diverse ideas between actors and spreading awareness of the potential security risks in information control, controlling diseases, data sharing, and the use of open-source to a larger group of actors. Similarly, this research shows how openly available information is fundamental to nurturing curiosity, innovation, and learning. Thus, my work provides a new understanding of an emergent health regime that includes comprehending security concerns in the preparedness and response to infectious diseases through open data sharing to facilitate collaborative and technological innovations.

I aim to contribute to the research library as a scholar of thought-provoking ideas, avenues, and awareness. Understanding the interconnection between human and nonhuman actors over time in the monitoring, preparedness, and response to nontraditional threats requires researching how the collaborative environment affects data sharing and vice versa. This field of research is relatively new and is critical since it helps with informed decision-making, and the data drives global actions. The theme is also powerful because it intersects interdisciplinary fields such as science and technology, health, security, law, sociology, and policy, allowing us to connect information through diverse scales and exploration. I generate themes and ideas from several disciplines and branches of learning to redefine healthcare issues outside of normal boundaries and reach results based on a new understanding of complex matters. This research reveals the innovative value in not just one primary actor taking the lead but a combination of global actors such as nation-states, non-governmental organizations (NGO), the WHO, the United Nations system, research institutions, academies, subject matter experts, and so forth that form part of an international collaborative network by working together against infectious diseases.

**Synopsis of the Theoretical Framework**

Which theory aims to explain and provide a better comprehension of why security governance through an open-source intelligence technology database of the WHO promotes a health regime in the surveillance of infectious diseases? For this study, I strive to incorporate multiple theories to frame the research, for this study. I interweave theories and concepts to serve as interrelated propositions to articulate the dynamics of cultural practices that comprehensively analyze international studies. I review the relevant literature on three key theories: liberal institutionalism, securitization, and the actor-network. I also draw from the literature three complementary concepts: complex interdependence, regimes, and security governance. In addition, I draw from additional literature review to provide background information which includes a focus on the connections between the variables that pulls insights from sociology, the law of nations, and intelligence studies, which contribute to a collaborative network of relations in promoting a health regime on the surveillance of infectious diseases. I also interweave additional concepts: collaboration, boundary objects, *dispositifs*, and inscription devices to complement and act as anchors or bridges between the theories and concepts. The theories and concepts provide a more comprehensive approach to the importance of the actor roles in the network and explain the securitizing politics behind referent objects' collaborative actions.

A health regime cannot be black-boxed anymore. Time cannot be wasted debating "how many angels can dance on the point of a very fine needle?" (D'Israeli 1766-1848), which provides no practical value. As technology advances and security risks heighten, emerging issues placed on the back burner of the security agenda have now moved up in scale and masses as the threat increases. The scope of these knowledge-based theories and concepts gradually expands with the increase and frequency of resources as technology advances and threats emerge.

During the creation of the actor-network,[4] my fieldwork limited the scope of tracking information to the United States of America (USA) and other actor contexts of contribution, such as countries in the southern subcontinent of the Americas and their collaboration in the network towards surveillance of AMR and infectious diseases. Furthermore, another pathogen of astronomical proportion emerged during my USA fieldwork, COVID-19. This new virus brought reactions and responses from diverse actors, including policymakers, military, data scientists, researchers, academics, security, and intelligence experts, to combat the nonconventional threat. How does this case study reveal the importance of collaboration, data sharing, technology involvement, and interconnectedness to real-time responders?

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[4] The term actor-network in science and technology studies (STS) proposes that actors approach any system by viewing all parts as active and interconnected members, with each component, such as nature, technology, and humans, considered equal parts of the system (Latour 1988; Callon, Law, and Rip 1986; Law 1984).

As world complexities heighten, collaborative work evolves into the necessity of various actors partnering with each other. Where nation-states were once the primary actors in the international system, other contributory actors appear as technology and emerging threats advance. The collaboration and contribution of diverse actors, such as data scientists, engineers, and decision-makers, are critical to developing and improving change. Insights enrich the institutionalism approach from three different theoretical traditions that complement each other and help to answer the research question. Thus, the three theories—liberal institutionalism, securitization, and ANT—create discourse between the theories and the research.

The liberal institutionalism theory paves the way to include states and institutions in tackling world affairs. The securitization theory provides the analysis of security governance—as a causal complex or causal mechanism—to explain the status of securitization. However, limited literature exists to illustrate the causal connection between the behaviors of actors. Nevertheless, suppose participating countries do not gain a level of trust in the institution and the cause. In that case, there is a lack of contribution to the GLASS system by participating countries to monitor antimicrobial diseases. Securitization presents issues due to the inherent asymmetry of interest between nations on infectious diseases and cyberspace. Would this spatial area in the cyber world be subject to regulations and security measures? Thus, the securitization theory helps to explore the analysis further.

Furthermore, I incorporate contributions from the actor-network theory, which provides a better theoretical analysis explaining how networks suit a collaborative security governance mechanism. The flexibility of networks allows new actors to adapt to the collective interests and creates open communication channels enhanced in a complex interdependent world. This research incorporates contributions from ANT, such as translation, normalizing the black box, and network analysis. Likewise, ANT grants the ability to move beyond the black box and explore other nonhuman actors, such as the GLASS technology database and the IHR code of law. Thus, the liberal institutionalism theory focuses on states and institutional actors, the actor-network theory helps find the limits of a network, and the securitization theory interprets the social process between actors. Based on theoretical assumptions, the theories form the skeletal support structure of this dissertation. The theories collectively contribute to analyzing data and pathogens' security governance in promoting a health regime in the surveillance of infectious diseases.

Moreover, as new threats arise, various actions take place. On the one hand, actors establish new networks that are significantly affected. On the other hand, existing networks expand and raise the matter to a heightened security level. Concepts such as security governance, complex interdependence, and regimes lend a hand to critical thinking and international studies analysis. These concepts connect when governance links with the liberal institutionalism theory, which opens the door to nonstate actors in the network due to trust and legitimacy in the institution and a high degree of institutional capacity (Pierre and Peters 2005). As a conceptual reinforcement, security governance addresses global security practices, regimes provide rules of the game, and complex interdependence lends an ear to multiple-channel actor participation. However, interdependency in a complex system also means higher vulnerabilities and risks. While some scholars have agreed that security regimes are difficult to obtain because of fear of violations of interests by competitors, others have erred on the side of having a regime through the interdependence of actors. According to the UN high-level digital interdependence declaration on digital cooperation, "our aspirations and vulnerabilities are deeply interconnected and interdependent" (United Nations 2019a). It is difficult for global countries to cooperate on issues such as climate change and pollution because not all actors are significant contributors to a cooperative network. However, nation-states collaborate and interconnect due to the need for an increased global capacity to handle threats of infectious diseases. The drive to tackle a security threat is to create a collaborative framework to alert the world to a pandemic. The theories and concepts offer insights into the web of information exchange between diverse, interconnected actors. Therefore, interweaving them articulates the dynamics of boundary objects and cultural practice and assists in analyzing international studies.

Three additional areas of review—sociology of technology, international law and policy, and intelligence studies—reinforce the theoretical model and draw on diverse insights. Each of the areas creates a compendium of thought. The sociology of technology (codes, algorithms, and artificial intelligence) looks at nonhuman contributors as shaping the international system's network. Building collaboration, achieving institutional acceptance, gaining acceptance, defending change models, and accepting interconnectedness shape a complex interdependent world. Because, without them, there is no surveillance system network. Likewise, the jurisprudence lens also views codes as the code of law. International law and policies provide the rules, order, or regulations between actors in the quest to combat infectious diseases.

This study also extends the theories and concepts based on intelligence studies. How does intelligence do more to help the collaborative network of plans or operations in infectious disease control? Intelligence acts to reduce uncertainty, including the use of open-source data. Internet connectivity space transcends national boundaries. Electric impulses travel through the network when actors send AMR surveillance information to the GLASS platform or comment on the number of COVID-19 cases. Does this information in an open-source network create an avenue for security discourse and concerns in the digital ecosystem? Although cyberspace's securitization presents privacy concerns, it is a topic of discourse in high politics that eventually trickles down to low politics once there are stability and readiness. The global antimicrobial resistance surveillance system contains information in its publicly available technology database. It is a good source for intelligence analysts and the intelligence community (IC)[5] to reduce uncertainty about infectious diseases. However, who are the actors and players that benefit from the global AMR surveillance system technology database or similar surveillance networks?

In conclusion, interdisciplinary knowledge goes beyond the perspectives of disciplinary fields and creates a unity of intellectual, theoretical frameworks. A collaborative network's importance derives from various theories and concepts concerning diverse actors. Collaboration and interconnectedness contribute to the necessity of change. Likewise, as actors partner with other actors in the network in response to a threat such as infectious diseases, the health regime will not be black-boxed anymore. Nontraditional threats exist and may continue to live well into the future. No longer are issues tackled with only one centralized source. Still, actors of different dimensions—from nation-states to institutions to private industry—come together to address problems of common interest. However, to develop innovation and collaboration, a system of rules is paramount in response to security threats. This research does not make assumptions of completeness or terminal endings, as we assume some bias inadvertently affects the network analysis process. However, issues evolve and change every day. Thus, new pandemics spontaneously appear, affecting global relations and disrupting the network.

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[5] The term "intelligence community" used in this dissertation refers to the U.S. Intelligence Community, composed of 18 different organizations. See Office of the Director of National Intelligence at https://www.dni.gov/index.php/what-we-do/members-of-the-ic.

**Dissertation Structure**

Where a nontraditional threat is presented, such as infectious diseases, a higher likelihood of collaboration to combat the threat increases. This dissertation focuses on security governance, the global interconnectedness and collaboration of actors, and the involvement of technology in the surveillance of infectious diseases to promote a health regime. This research analyzes information from the GLASS technology database of the WHO. I use an explanatory sequential design model with mixed-methods (quantitative and qualitative) research. This study uses a macro-and meso-level inquiry of analysis and leaves ample space to explore the actors' different realms in the network. My study draws data from the USA, carefully drawn data analysis from the WHO's GLASS platform, and additional information from global south countries and actors relevant to the research in promoting a health regime.

Moreover, this research collects data from expert interviews connected to the research analysis unit. The dissertation references countries from the southern subcontinent of the Americas used as the context of contribution to the research throughout the chapters. Although I am not interested in a controlled study comparing the various participating countries in the database, my method is comparative. I am interested in seeing how more country participation and diverse actors increased or decreased between 2015 and 2020.

The research identifies the theories and methods relevant to the study discussed in detail in the following chapter. The dissertation identifies the data collected and discussed in the methodology chapter. The study identifies the independent variable as security governance of infectious diseases, the dependent variable as the perception of nonconventional threats in the emergence of a health regime, and the intervening variables, such as the potential manipulation of human bias, algorithms, restriction of information spread, and lack of timely information.

In the quantitative data structure, to statistically analyze the linkage between nodes and edges, this study creates four distinct collaborative network paths (CNPA, CNPB, CNPC, CNPD) for visualization purposes in Gephi using the Force Atlas algorithm layout (Bastian, Heymann, and Jacomy 2009). Likewise, in the qualitative data structure, the dissertation focuses on the triangulation between the interview data with the information obtained from other sources and the importance of the security threat topic through the lens of interconnected actors such as institutions and nation-states, both locally and internationally.

The data analysis and results in chapter 3 explain the interweaving link between various actors, from states and institutions to nonhuman actors, using the case study as the source. The case study includes network state actors tracked over time that come together for a common interest in combating a global threat, such as infectious diseases beyond national borders. The case study focuses on AMR in the surveillance of eight human bacterial pathogens and incorporates the novel COVID-19 coronavirus as context material.

The case study shows the IHR as the driving force of regulatory law linking nation-states and an institution to collaborate in the security governance of big data through open information that promotes a health regime on infectious surveillance diseases against nontraditional threats. This study establishes a causal relationship between security governance and the emergence of a health regime through its methodology, including reviewing the type of submissions the GLASS participating countries conduct and collaborate in from gaining access to GLASS in the surveillance network. How is the subject of AMR important in the USA ministry of health and participating GLASS member states? How many actors contribute to the GLASS system? Answering these questions through an analysis of the data collection helps to understand how much the actors commit to collaborative efforts to promote a health regime in the surveillance of infectious diseases.

During a pandemic, acts of centralization by nation-states appear from the top down to the bottom up. For instance, nation-states look to form a consensus with other actors, such as the WHO, which creates governmental decentralization. An agreement generates action during global health emergency threats, such as combating human bacterial pathogens. Other actors contributing to the interconnection lens are in between the analytical scales (meso-level). Actors such as private interest groups, NGOs, academics, researchers, scientists, intelligence, and security experts lay in the network sphere and contribute to global public health. The network actors collectively generate rules in response to threats to their health and security. By contrast, a lack of collaboration ensues in confusion, lack of legitimacy, disinformation, and loss of control in the happenstance. Thus, actors with shared interests in national security and civil society interconnect as an essential part of network collaboration.

Lastly, this study considers relations that do not directly exist between nodes but are part of the overall network structure. However, a pertinent part of network analysis includes identifying dissimilarities among actors. The study shows that these actors disrupted the collaborative network. However, these gap-creating actors also illustrate the importance of encouraging innovation and diversity of interconnection. Thus, network disruptions push for better actor collaboration and global interconnectedness.

Soundly, we have complex organizations dealing with dangerous situations. Nevertheless, are we so disconnected, or can actors (from countries to institutions) be linked and work on a common goal? What does recent experience reveal about organizational responses to threatening events? Are we prepared to face a pandemic of biblical proportions, or is AMR foreseen to be the next silent pandemic? By the time this dissertation transgresses and the audience reads, it will represent an outdated snapshot of reality since data increases and infectious diseases spread faster than the speed of light. More information grows as the world evolves. However, the security and stability of a country depend on citizen health. Actors do not just interact with other actors. Actors interrelate with everyone and everything. Actors interact with the space in which they find themselves. Global actors collaborate when there are common interests and purposes. Network analysis helps analyze complex formations within a diverse group of nodes (actors) that interconnect.

What is happening with interconnectedness? The interweaving link between human and nonhuman actors contributes to a cyclical fact production of data-sharing information as a sign to escalate the security issue on the agenda because diseases go beyond national borders. Through collaborative efforts of open data sharing, security governance of infectious diseases enhances the emergence of a health regime, security of countries, informed decision-making, and drives regional and global actions. However, time and experience transcend reflections on the complexity of interdependence. As an example, it is important to acknowledge that the international system may also involve actors who disrupt collaborative efforts as panic and uncertainty can spread more quickly than the virus itself. Therefore, it is crucial to have a clear understanding of each actor in the network, including those who withhold information, disseminate misinformation, or engage in disruptive cyber events. By doing so, it becomes possible to conduct a more thorough analysis of the network's limitations and gain a better understanding of the challenges that must be overcome. Nevertheless, pre-emptive measures to suppress a global pandemic require interconnection and collaboration from diverse entities, including state and non-state actors, because:

- Our economy largely interconnects.
- Our global health and well-being solidly interconnect.
- Our civil society conventionally interconnects.

Global pandemics do not respect national borders, exercise lessons of collective well-being, and present interconnectedness challenges in a complex interdependent world. An information ecosystem of resources right at our fingertips supercharges what to do with data. Our economic well-being is dependent on our collective health. Our health is dependent on security. Economics, health, and security are interdependent and mutually reliant on each other leading to the cycle of interconnection and the necessity of collaboration. This endless cycle of actors to combat nontraditional threats to national security immerses the promotion of a health regime tinged with security governance mechanisms. To address turbulence caused by nontraditional threats such as infectious diseases from AMR to COVID-19 requires collaboration and interconnection, the interweaving of actors, and understanding the dynamics of human and nonhuman actors—the natural and machine. Actors globally interconnect in a complex interdependent world.

This study looks at the network actors in generating the network, from decision-makers to policy instruments to institutions. This introductory chapter provided the premise for understanding the interconnection between actors in the collaborative environment to tackle global health and security issues such as infectious diseases. Likewise, it has set the stage for readers by presenting a brief overview of the research study, justification, objectives, theoretical framework, and dissertation structure. Moreover, seeking the quaesitum for the research question derives from in-depth quantitative and qualitative data analysis. Thus, the remainder of the chapters interconnect with each other and reinforce the grounds outlined in this introductory chapter.

# Chapter 1. Theoretical Framework

Sometimes all it takes, to crack a problem, is a new perspective.
—Adrian Tchaikovsky

## Introduction

Big data (which I have termed ingentis data) travels at the speed of light. Scholars define big data as large datasets that defy conventional computational storage and analysis (Halford and Savage 2017, 1133). However, the term encompasses a range of other qualities in the approaches to digital traces of habitual activities (Halford and Savage 2017, 1133). Therefore, the exponential growth of data coupled with global security threats, such as infectious diseases, increases privacy and security measures.

Actors exchange critical information to address diverse interests. Data sharing arises as a source for nonconventional threats by actors with access to open-source information. Publicly available infectious disease information opens the door as a target for biological attacks, cyberattacks, and emerging technologies. This chapter introduces an extensive literature review to contextualize the research findings, provide a foundation of knowledge, and identify prior scholarship. Through an OSINT database of the WHO, why did security governance promote the health regime on the surveillance of infectious diseases in the Americas from 2015 to 2021? This study chose the timeframe from 2015 to 2021 because important communicable disease-related events occurred during that period.

Which theoretical and conceptual strategy aligns with the research question? This dissertation closely matches a liberal approach, which rejects the realist perspective where nation-state actors are the only significant actors and adopts a blend of a liberal institutionalization viewpoint. The liberal approach emphasizes that, in addition to nation-states being primary actors, non-state actors, and institutional arrangements are essential to the international system due to a complex world of interdependence. The analytical framework introduces liberal institutionalism theory, securitization theory, and the actor-network theory grounded by complex interdependence, regimes, and security governance as concepts. Collectively, the theories and concepts provide the closest explanation of the phenomenon under study (emergence of a global health regime). Thus, this study morphs the theories and concepts during the analytical process, and their combination provides reinforcements to address three objectives:

- The first objective opens the black box of a health regime. The goal illustrates the existence of a surveillance system of open data collection to monitor infectious diseases by discussing the strengths and weaknesses of the policy instruments and the intelligence discipline in the interest of national security to tackle issues such as biological attacks of infectious diseases, cybersecurity, and emerging technologies.
- The second objective analyzes how an unconventional threat activates security governance, promoted by international collaboration, *dispositifs*, and *boundary objects* based on open data exchange in GLASS to promote a health regime on the surveillance of human-priority bacterial pathogens.
- The third objective explains why security governance works to secure a health regime in the surveillance of infectious diseases through OSINT. Security governance identifies risks, vulnerabilities, and resources due to the complex ways multiple actors interconnect during open data exchange.

This dissertation does not present theoretical reflections, such as analyzing historical processes through actors' path dependence. Instead, this study focuses on a deductive (logical) model of explanation drawing upon data from the United States and its interconnected actors to map the collaborative surveillance network of infectious diseases to learn about actor performance and interconnectedness. My contributions to the study of institutions, the operation of regulations, and the influence of technological advancements, networks, and interconnected actors' interactions are of interest to international studies, international relations, and science and technology scholars.

Moreover, I appreciate the creation and stabilization of early and mid-stage boundary objects (GLASS and IHR) through the different actors spanning divergent professional and scientific fields. Likewise, cross-disciplinary collaborators share similar goals yet face friction from differences in professional expertise, technical systems, and practices. As such, boundary objects such as GLASS, IHR, and even viewed in the abstract (infectious diseases) help span disciplinary divides. However, the same challenges can hinder initial boundary object development. Collectively, this research enriches the knowledge of these boundary objects to enable the global-local nature of addressing a security threat, and the empirical and theoretical application of the study enhances its development.

This study shows that the GLASS, a nonhuman actor, plays a vital role in this complex interdependence paradigm between actors. The IHR, an instrument of governance and policy, establishes the rules for the participating countries to understand the collaborative network process. Likewise, actor interactions include ideas, discussions, and preparedness to address microbes (Pestre 2012). Thus, the IHR, GLASS, and infectious diseases are boundary objects that link communities and allow different groups to interconnect.

Which theory addresses how social change works in the past and in international studies to address health, security, and interconnectedness? Three theoretical perspectives address the central research question. First, under the liberal institutionalism theory, the states do not serve as the only significant actor in the international system. Similarly, the ANT enhances the liberal institutionalism theory by finding the limits of the network and relational ties between human and nonhuman actors. Why are certain technologies part of the glue that holds actors together in this complex interdependent world? ANT provides social understanding. The literature also illustrates the securitization theory as a social process that interprets how groups construct something as a threat. However, the theory progresses as a causal mechanism with a multi-tasking lifetime career.

Likewise, which concepts emerge in international studies as an integral part of addressing the research question of health and security? This research examines three conceptual processes: the complex interdependence of actors at a global level in its variety, the establishment of a health regime (including regulatory and security measures), and the security governance of the disease and the data (including the management, control, and risk). The GLASS case study of international collaboration, the establishment of International Health Regulations, and the creation of a global surveillance database of infectious diseases illustrate these processes.

Traditionally, the state and military held a more dominant role in the international system. Now, complex interdependence allows multiple channels to connect global actors. Likewise, the dimension of complex interdependence allows more generous room for exploration. Regimes establish the rules of the game for actors to be interdependent. This study shows that the IHR, a boundary object masked as an instrument of governance, law, and policy, establishes the rules to promote a health regime. Similarly, security governance aims to manage the actor's existence in a web of response to their security threats and structure collaboration.

In addition, channels of interconnectedness exist through transportation and the internet, where collaborative interactions bring more opportunities for stability and preparedness. Actors follow regulations through collaboration to create order instead of chaos. In Knoke's felicitous notation, "Collaboration among actors who pool their power resources is generally more effective in realizing their common interests than are efforts by actors attempting influence and domination on their own" (Knoke 1993, 170). Along the same path, in the quest to address public health issues, actors are concerned over the management of global health created by statistics, sharpened by various incidents combined to build the problem of security, health security, and trade security (Quet 2022). Thus, to address global health issues, human actors, for instance, collaborate by imputing data into a publicly available surveillance technology database (nonhuman actors), and this interconnection drives the phases of security governance.

Multi-dimensions of regimes exist, such as cooperation and collaboration. The shared belief in cooperation furthers the development of regimes in the security sector. Decision-makers rely on competitive modes of behavior over suitable measures (Jervis 1982). In the 1980's, the notion of international collaboration became more prevalent as a new form of cooperation that supported the theory of mutual benefit over technical assistance (Gaillard and Arvanitis 2014). Thus, this dissertation focuses on collaboration. In concurrence with Holsti (1986), rejecting a state-centric view opens the intellectual door and opportunity to view international collaboration and international life. The active construction of a regime guides individual decision-making (Krasner 1982). Norms explain why states collaborate; rules explain what collaboration is about; and procedures explain how to collaborate (Haas 1980).

Moreover, due to increases in technologies' complexity, actors participate in science and technology through collaborative works (Arvanitis 2009). Nation-states collaborate in the interest of national security, and institutions collaborate in the interest of social parameters. Likewise, Gaillard and Arvanitis (2014) provided three levels of collaboration: 1) the policy environment and instruments that directly or indirectly affects the decision to collaborate based on instruments and tools, 2) the international level involving broader networks of collaborations including global issues (such as global health and tackling infectious diseases), and 3) the individual level and the choice of discipline, personal contacts, and career pattern. Thus, the focal point of collaboration aligns with the vision and essence of the dissertation theme.

Moreover, interconnection refers to the contacts or links between actors. The institution's ideas function when we have an excellent interconnection because each actor's contacts amplify towards meeting the goals. Furthermore, the connections appeal to the strong and weak ties in the network. For example, during a health crisis, interconnection problems involve a lack of explanation, disinformation, and access to healthcare, such as why nation-states have a high number of contagious cases correlating to a high percentage of deaths. While hospital institutions' infrastructure generates high rates of infectious cases and deaths, the interconnection exists between the groups held by decision-makers in selecting the instruments, such as production, data sharing, or monitoring. By contrast, a lack of clear rules slows negotiation and mediation in fulfilling the actors' objectives in the network. For example, during the COVID-19 pandemic, local and federal governments and institutions functioned differently, with a lack of precise coordination, destabilizing the network. In another circumstance, for instance, to tackle the big issue of risk evaluation and decision-making under uncertainty, actors discreetly organized collective reflection through the confines of diverse institutions where members ranged from various disciplines such as medicine, law, economics, and political science (Boudia 2014). As a result, the actors represented the path line to the creation of what would later be known as the Red Book of risk assessment and "defined priority domains such as health, air transport, and nuclear energy, in which research would serve to develop and improve methods of analysis" (Boudia 2014, 98). Therefore, when social control mechanisms and systems of rules exist between actors that form part of the collaborative network and the collective purpose, the transition toward fulfilling the objectives is less strenuous.

In a complex world, actors interweave in response to the challenges of nontraditional threats such as infectious diseases. In an objective sense, security measures the absence of threats to obtain value and calculates the absence of fear in the attacks of such values in a subjective sense (Saint-Pierre 2017). As the threat level increases, security issues rise higher in the health regime agenda in the interest of the state and civil society. Therefore, the theories intertwine to explain the phenomenon under study and are the skeleton of the chapter outlines. The concepts are the research's heart and brain and explain the actors' interconnectedness. Collectively, the theories and concepts interconnect, like muscles, to describe perceptions of nontraditional security threats in the emergence of a health regime.

### 1.1. The Evolution of Theories: Liberal Institutionalism Theory, Securitization Theory, and Actor-Network Theory

The theoretical framework builds on three theories: liberal institutionalism theory using a case study method, securitization theory using a context analysis method, and actor-network theory (ANT) using a network analysis method. The theories intertwine to explain the health regime phenomenon. How does open data through a surveillance system of infectious diseases pan out regarding security measures? Thoughts of battling other sources of nontraditional threats emerge, such as biological attacks, cybersecurity, and emerging technologies. The phenomenon exists independent of social actors guiding the researcher's ontological and epistemological position and choice of methods (Fontaine 2015; Grix 2002). This study takes a positivist approach, for science explains a reality independent of thinking. Likewise, it uses an objective ontology in the analytical process. Positivism advocates applying natural science methods to social reality study (Grix 2002). Other scholars deem international regimes a true phenomenon (Krasner 1982; Keohane and Nye 2012). Additional scholars note the importance of knowledge production, such as "institutions that set themselves the task of defining the norms and standards of the global world" (Pestre 2012, 430). There is a need to understand how actors articulate norms, who are the main actors in the transformation process, their interactions, and how it influences security. A fact production system includes nonhuman subjects. A system that contains ingentis data in the system entails its separate entity. Nevertheless, it cannot exist without human subjects and actors. Thus, the theories and ontological and epistemological positions provide a sound basis for analyzing validity and potential developments in promoting a health regime.

The theories help move beyond a health regime's complex black box (Latour 1987). The black box explores other interconnected and collaborating actors. For example, nonhuman actors, such as the IHR and GLASS, contribute to the security governance of infectious diseases beyond national borders. Thus, independent of social, network, and structural actors, the phenomenon also opens the door to analyzing risks and vulnerabilities.

#### 1.1.1. Liberal Institutionalism Theory: Enabler of Action in the Sea of Global Complexity

The shift in power between the military capacity to economic status in a particular niche (healthcare) creates the need for greater linkage and increased collaboration. Liberal institutionalism serves as the primary approach in international studies. It allows differing theories to converge due to common mechanisms in analyzing the international system. The development of technological advances, which once lurked in the shadows and challenged realist thinking, now gains momentum because of greater global interconnectedness.

Is it more prudent to separate the terminologies and analyze them in parts before delving into the actual theory? Liberalism (Kant 2006; Smith 2000; Locke 1980) speaks to the role of institutions, norms, the impact of state behavior, and the implications of interdependence. Liberalism examines state actions and directs its attention to other groups (Keohane and Nye 2012). Intergovernmental actors like the United Nations are essential in international relations (Abbott and Snidal 1998). International organizations "facilitate the diffusion of world culture" (Chorev 2012, 18). For example, in 2002, the international institution, the World Bank, delivered learning activities to over 48,000 participants in 150 countries through collaboration with more than 400 institutions to develop knowledge networks in the field of economic development (Goldman 2005). The liberal or Grotian tradition stresses the effect of complex interdependence, international society, and international institutions (Keohane and Nye 2012). Liberalism associates itself with a more liberal theory of regimes that help states realize common interests, and state actions depend on prevailing institutional arrangements (Keohane 1984). Thus, liberalists seek interdependence to analyze issues such as the transfer of technology (Viotti and Kauppi 2012) as an opportunity for building good relations between interdependent units due to how institutions affect global issues and relations of actors on the world stage.

In conjunction, institutionalism focuses on international organizations and believes that diverse actors participate directly in world politics. They play a crucial role in the co-production accounts of global making (Jasanoff 2004) and exist to legislate interests, conflicts, and values (Pestre 2012). Moreover, intergovernmental organizations help to manage interstate relations to address modern security threats, as the United Nations Security Council and the WHO do (Krahmann 2005; Abbott and Snidal 1998). International organizations play a global role due to the nature of their activities, independence, and centralization (Arvanitis 2009; Abbott and Snidal 1998). Norms reinforce the collaborative link between governments, which prescribe behavior towards common objectives such as global health (Keohane and Nye 2012; Viotti and Kauppi 2020).

Similarly, the collaboration between different players in advancing global health, the security of ingentis data, and combating nontraditional threats occurs under complex interdependence characteristics central to WHO's participation. International institutions' role increases in a complex world filled with many issues (Keohane and Nye 2012). Therefore, institutions play a vital role in global security due to increasing interdependence. Liberal institutionalism theory represents advancements in the interconnectedness between states and institutions. It provides an understanding of the dynamics of international cooperation amongst actors (Abbott and Snidal 1998; Keohane 1989, 1988). Under liberal institutionalism, the states maintain a primary role but are not the only significant international relations actors. The process of elaborating norms coincides with implementing new norms where "the state is no longer the monopolistic provider of the means of enforcement" (Brousseau, Marzouki, and Méadel 2012, 5). Other actors, such as international organizations, NGOs, and private interest groups (foundations and companies), also exist in an area traditionally reserved for the state. Some notable scholars emphasize institutional details through their increased role in peacebuilding (Cox and Jacobson 1973; Kirchner and Sperling 2007). At the same time, others analyze institutions through their transformational effect on decision-making (Fontaine 2015; Pierre and Peters 2005). Likewise, the theory emphasizes intergovernmental affairs, such that regimes help actors reach collaborative agreements (Abbott and Snidal 1998; Keohane 1984). This study shows that an institution creates a surveillance system database where various participating countries gain access and collaborate in monitoring human-priority bacterial pathogens and AMR. However, is data sharing getting into the wrong hands and generating unwelcome actions of nonconventional threats? Thus, a progressive theory of liberal institutionalism drives this investigation to unravel the question.

Indistinguishably, literature shows countering arguments between realists and liberal institutionalists. For instance, international organizations have unstructured internal management of international agencies and need help to solve external issues (Claude 1971). In addition, international organizations need more of a voice in their agenda to disseminate (Chorev 2012). Similarly, the WHO remains prone to international funding by philanthropic organizations and establishes policies managed by large NGOs. Grieco (1988) notes that states are the primary actors in global affairs and joint gains which produce potential foes in the future. Likewise, institutions exist not in high national security and defense politics but in low politics, such as health and communication (Mearsheimer 1994-5). Lakoff (2017) discusses how nation-states remain the site of authority.

Additionally, in the twenty-first century, the WHO acts as an administrative coordinator "to govern the actions of states in the name of a global space of public health security was highly constrained" (Lakoff 2017, 3). Hoffman (1995) questions the United Nations' capability during the Cold War. The author's stance on institutions during the Cold War indicates that international organizations paralyze the economic needs of liberal states when tackling security issues. Therefore, scholars argue that institutions have no weight when dealing with world affairs.

Nevertheless, nonstate actors, such as institutions, non-governmental organizations, and private interest groups (philanthropic and foundations), play a significant role in the network dichotomy. Here, the WHO developed a surveillance system against antimicrobial resistance. The GLASS system created a platform where participating countries voluntarily enroll and input information from their respective countries into this openly available database. As one of the power players in the collaborative network, the institution creates a system to link the actors. Therefore, due to increased interdependence, nontraditional actors play a significant role in global governance.

Likewise, a global health regime serves as an institution. Keohane (1988) indicates that an example of institutions includes the UN and the World Bank. Institutions refer to a general pattern of activity and a complex set of rules and norms identified by time and space (Stein 2008; Keohane 1988). General patterns of international society characterize institutions (Bull 1977) and varied behavior patterns (Keohane 1988; Young 1982). Coincidently, these definitions mirror regimes (Krasner 1982; Puchala and Hopkins 1982; Jervis 1982). For example, the WHO's pattern of activity enforces global health in the interest of civil society and the state. However, Lechanel (2013) illustrates that social actors need to emphasize the relationship between the prevention and cure of diseases to fit specific organizational needs due to their way of acting internationally. Through document analysis, this study shows questionable aspects of participating countries' collaboration. Various intermediate actors such as NGOs, private interest groups, and medical teams influence the international system of global health and collaborative network.

In 2014, the WHO published a report on the magnitude of antimicrobial resistance and global surveillance state (World Health Organization 2019a). Since 2015, the WHO has released reports connecting with collaborating centers and partnerships; and organized AMR-related events. These actions illustrate behavior patterns to support the action plan on AMR and promote global data sharing. However, how influential are institutional actions on global health and security when a push for global health investment exists and its framing has to consider citizens and the nation's security? Chorev (2012) notes that the WHO only generates revenue with resources and international funding from voluntary donors, participating countries, and philanthropic organizations. Examples of these organizations include the Rockefeller Foundation, the Bill & Melinda Gates Foundation, and Wellcome Trust. In 2017, large parts of the funding focused on the African region (21.7%) and south-east Asia region (57.1%), where most outbreaks and emergencies appear worldwide (World Health Organization 2016-2017). As of December 31, 2018, the WHO reported a total of US $723 million in available funds and US $38 million towards AMR (World Health Organization 2016-2017). However, the global south received the least amount of funding (US $20 million) compared to Africa (US $193 million) and south-east Asia (US $99 million) due to a high level of emergency, which illustrates an uneven distribution (World Health Organization 2016-2017). Thus, voluntary contributions influence the spending of funds.

In 2019, the WHO welcomed new funding commitments at the Global Fund's Sixth Replenishment Conference to finance the fight against infectious diseases (World Health Organization, 2019 #159, World Health Organization 2019c). In addition, in May 2019, Wellcome Trust provided funds for WHO's research and developed activities during epidemics. At the same time, Wellcome Trust tackles drug-resistant infections and advances global surveillance of communicable diseases (World Health Organization 2019c). However, would the actor's actions also influence and change the way institutions and countries consider a national security threat?

Institutions provide a "higher power in shaping situations" (Pestre 2012, 437). The advancements of technology to millennial changes bring new security threats. A complex reality that data rapidly grows at the speed of light, and diseases spread like the sea's tides, manifesting many global changes. Policies, laws, and diverse forces interconnect in tackling issues to meet new movements and expansion. The history of the Cold War sets a precedent for change. Prior experiences in international relations opened the doors to explore advocating norms and values in global movements. Future threats continue to exist, and tackling the issues will take an all-hands-on-deck approach. Thus, institutions and many other actors tackle new threats toward a more liberal institutional progressive form of network collaboration.

### 1.1.2. Securitization Theory: What is a Threat? In the Eyes of the Beholder or None

Security to one person is not a security threat to another. Similarly, nation-states have different values, practices, and considerations in defining a threat. How do actors translate security, and what instrument facilitates the process of translation? The securitization theory provides theoretical lenses to explain and understand what security for different actors entails. Constructivism originates from sociologizing security analysis. However, a more objectivist progressive approach uses securitization as a causal mechanism of a particular outcome. Scholars understand security through its performance, otherwise known as securitization. Securitization has multiple analytical dimensions and a lifetime career. Securitization acts as a framework of analysis, empirical theory, and conceptual move (Guzzini 2011; Kirchner and Sperling 2007). It opens the possibility of thinking about security on different issues. This research analytically draws towards a progressive viewpoint and designates referent objects. Likewise, securitization theory functions as a causal mechanism to explain the emergence of a health regime. It serves as an entry point into the rich empirical world to comprehend the extent to which states and institutions respond to health threats and technological advancements. Under the securitization theory, actors handle security issues urgently due to their heightened, menacing, and threatening level when labeled as dangerous political issues (Eroukhmanoff 2017; Kirchner and Sperling 2007). Thus, an existential threat presents an unprecedented response.

In addition, the securitization theory links liberal institutionalism and ANT theories by connecting external effects in the world. Traditionally, the safety of the state remained a priority for security. However, in showing more actor action-oriented mechanisms, a level of causality appears that turns the attention towards *referent objects* (Eroukhmanoff 2017; Kirchner and Sperling 2007) raised as security matters on the agenda. Referent objects of security include threats to cyberspace, the misuse of massive amounts of data, and citizens' health and wellness in combating infectious diseases.

According to the Copenhagen School (McSweeney 1996), the traditional meaning of securitization refers to security posing as an existential threat "understood as an essentially intersubjective process" (Buzan, Waever, and de Wild 1998, 30). The threat rises to a level of urgency when securitizing actors break from the normal agenda they would otherwise be bound by (Buzan, Waever, and de Wild 1998). This analytical knowledge level reinforces the state's causal theory, institutional behavior, and context for qualitative data analysis. Science studies examine issues based on considerations "in accordance with institutional situations, depending on where the knowledge is produced" (Pestre 2012, 427). By contrast, limitations stem from the asymmetric interests of varying countries in the securitization of infectious diseases (Jin and Karackattu 2011).

Nonetheless, securitizing actors look to extreme alert status to escalate the security issue on the agenda (Šulovic 2010). While securitization cannot be a forced idea, the audience of the security speech act decides on a successful securitization (Buzan, Waever, and de Wild 1998) which reinforces its existential threat. For Eroukhmanoff (2017, 104): a securitizing actor "has the social and institutional power to move the issue beyond politics." Securitization focuses more on referent objects (Eroukhmanoff 2017; Kirchner and Sperling 2007). A community looks to a matter as an existential threat to a referent object of such high risk that it rises to the level of urgency and needs exceptional measures to handle the threat (Guzzini 2011; Buzan and Waever 2003). Assessment tools (such as the cost-benefit of developing and participating in the GLASS database) make it conceivable to address risks which presents threats (Beck 1992; Pestre 2012). Likewise, securitization allows an assemblage of practices contextually mobilized by a securitizing actor to explain a referent object (Balzacq 2011). Thus, referent objects of security remain with citizens' health and wellness in combating infectious diseases, the misuse of big data, and threats to cyberspace information.

Distinguishably, Wolfers indicates that in an objective sense, security "measures the absence of threats to acquired values" (Wolfers 1962, 150). Likewise, Buzan, Waever, and de Wild express leniency towards an objectivist approach when the "threat is unambiguous and immediate" (Buzan, Waever, and de Wild 1998, 30). Nevertheless, the author maintains a stance on securitization as an intersubjective process. Thus, some authors express dissatisfaction with the Copenhagen school's limitation of securitization by not addressing causality. Some scholars indicate that the securitization process introduces a more progressive positivist stance and analyzes a causal mechanism (Oliveira 2017; Balzacq 2011; Guzzini 2011). Moreover, rationalists use a middle-ground approach to broaden securitization status and define it as a *causal complex* (Oliveira 2017). Other authors stress that the "task of a sociological theory of securitization…is to decipher the sequences of cause-and-effect" to stand "at the center of its explanatory architecture" (Balzacq 2015, 110). Securitization is both *explanandum* and *explanans*, seen as a process that triggers certain effects (Guzzini 2011). From Wolfers's (1962) objective security stance to Buzan's (1998) indicating an immediate and unambiguous threat as an objective approach, the doors of securitization open to including quantitative analysis. Therefore, securitization serves as a causal mechanism in the surveillance of infectious diseases and the emergence of a health regime.

Furthermore, the theory opens the window of discourse in understanding how political actors address the link between cyberspace and national security because the securitization process involves multiple settings and political functions (Balzacq and Cavelty 2016; Guzzini 2011). The rise of certain drugs' resistance influenced the Global Health Security Agenda (GHSA) launch in 2014. By 2015, the WHO developed the GLASS, asking participating countries to contribute and share their respective information on the surveillance of infectious diseases. Does contributing knowledge through open-source intelligence present a level of insecurity? Infectious diseases, big data, and advanced technologies come with repercussions. With computer networks exists a potential space for cybersecurity. The top ten countries that have the highest percentage of machine attacks and the greatest likelihood of new threats as of 2016 were: El Salvador (10.85%), Brazil (10.04%), Bangladesh (9.77%), Honduras (9.44%), Russia (8.96%), Venezuela (8.87%), Colombia (8.29%), Pakistan (8.17%), Mexico (7.99%) and Ecuador (7.67%) (PandaLabs 2017; Balzacq and Cavelty 2016). The United States presented the least infection rate, with less than two percent in 2016 (PandaLabs 2017). Regardless, countries risked cyberattacks, which occurred in data sharing and exchange of information.

Regarding infectious diseases, in 2016, the WHO estimated that one million people died from HIV-related illnesses, and 1.1 million people died of HIV-related diseases (World Health Organization 2018c, 2017f). In addition, the WHO estimated 36.7 million living with HIV, down from an estimated 2.1 million people in 2015 (World Health Organization 2018c, 2017f). In 2015, the WHO estimated 212 million malaria cases and approximately 429,000 malaria deaths, globally and by 2016, it reported approximately 216 million malaria cases occurred and 445,000 malaria deaths, globally (World Health Organization 2018c, 2017f). The prevalence of infectious diseases, "desperate health conditions of the poor and other vulnerable populations across the globe" (Chorev 2012, 3), the devastating HIV/AIDS epidemic, international concerns of the zika outbreak (Lakoff 2017), and cyberattacks influence modern-day nontraditional security threats. Once organizations establish protocols like the IHR, actors use the instrument repeatedly. The object functions appropriately as an inscription device, transforming facts into a regime (norms) (Jasanoff 2004; Latour 1987). However, if the context changes, does the protocol not change? How can the IHR work as *dispositifs* or devices which facilitate the transport of inscription between actors to define reality in a particular fashion?

The securitization theory assists in undertaking a systemic review of participating countries' diverse responses to the surveillance of infectious diseases. Peering through the causal lens of securitization helps analyze the interactions between state and non-state actors. Security governance involves a better understanding and explaining the interplay and dynamics between actors. A causal analysis of security governance in promoting a health regime includes aspects of social reality. For example, it prioritizes preventive and containment measures of communicable diseases and considers causal powers that interact with the causal complex affecting the world (Oliveira 2017). The four causal forces' complex interaction (formal, efficient, material, and final) explain change (Oliveira 2017). The forthcoming chapters of this dissertation conduct a causal analysis of securitization.

### 1.1.3. Actor-Network Theory: Imbroglios of Network Interactions from Heath to Security

As a system of rules, security governance reinforces cybersecurity practices, which leads to effective interventions and collaboration by diverse actors to promote a health regime and tackle secondary threats such as cyberattacks. The actor-network theory originates from science and technology studies and enables us to analyze the network's limitations and incorporates the junction of two worlds, human and nonhuman actors, into the hybrid space of analysis, organizational techniques, interactions, and calculations (Latour 2005). Scholars such as Latour suggest that we live in the reality of a hybrid world of "gods, people, stars, electrons, nuclear plants, and markets" that either turn into shambles or an ordered world (Latour 1999, 16). How would ANT inspire this research to comprehend the network process? The actor-networks five loops in policymaking unravel the mediations between political, legal, and collaborative networks. ANT describes the process of five loops or heterogeneous elements woven together for a realistic rendering of science as instruments, colleagues, allies, the public, and knots (Latour 1999). This study shows that the IHR provides the governing rules between actors in the network. It implements change in the exchange of open data sharing in the surveillance of infectious diseases. ANT reties and crisscrosses the knot to allow more in-depth insight by incorporating the collected data. The imbroglios weave our worlds together like an intricate and perplexing phenomenon that intertwines different political hemispheres (Latour 1993). Thus, the social and technical cannot float separately in an autonomous sphere but live collectively in an intertwined world.

An essential aspect of using ANT connects to the principle of radical symmetry, which includes the agency of human and nonhuman actors. Radical symmetry means that what is true of the object is true of the subject (Latour 1999). In other words, symmetry means "distributing qualities equally among all the actors—openness, accuracy, logic, rationality—and defects, such as closure, fuzziness, absurdity, irrationality" (Latour 1987, 205). Within actor-network compounds, an actor is also a network (Law 1992). Similarly, the traditional difference between the quietness of nonhuman denied desires and the openness of humans endowed with will is irrelevant and not enough to break the symmetry (Latour 1987; Callon, Law, and Rip 1986). ANT assists in understanding the symmetry between human and nonhuman actors, which claims that "social agents are never located in bodies and bodies alone, but rather that an actor is a patterned network of heterogeneous relations, or an effect produced by such a network" (Law 1992, 384). For example, the way we think, act, write, love, hate, produce, and reproduce are attributes of being human-generated in networks that pass within and beyond the body. Treating society and nature symmetrically rather than distinguishing between social and natural actors allows us to view the history of human and nonhuman actors. For instance, what are AMR, pathogens, and microbes? These actors cause illnesses and deaths or interrupt economic development. As we modify the actions, the actors' performance redefinition occurs.

Moreover, ANT inscribes practices into our technologies and reinvigorates the relationship between the material object (nonhuman) and cultural practice (human) to maintain consistency across cultures over time (Balzacq and Cavelty 2016; Latour 2005; Jasanoff 2004). No division exists between humans and nonhumans as it seeks to define the relational ties between such actors within a network with equal value (Balzacq and Cavelty 2016; Latour 2005; Star and Star and Ruhleder 1996). Network analysis emphasizes social relationships that create structures among actors and allows for socialization and diffusion in international relations (Hafner-Burton, Kahler, and Montgomery 2009). Thus, technology advancements affect the international system since incentives influence culture, and ANT gains momentum in international relations.

Likewise, ANT captures the apparatus (dispositif) that facilitates the inscription and translation process through hybrids or networks of human and nonhuman actors to break into the material and immaterial objects (Albornoz, Salamanca, and Becerra 2012; Callon, Law, and Rip 1986; Jasanoff 2004; Latour 2005). The dispositif refers to the apparatus or the nature of the connection between heterogeneous elements such as “discourses, institutions, architectural forms, regulatory decisions, laws, administrative measures, scientific statements, philosophical, moral and philanthropic propositions” (Foucault 1980, 194). Properties of institutions include a collective purpose and purposeful action (Latour 1999). Likewise, apparatuses are the properties of institutions (Foucault 1980). For example, the GLASS uses the WHONET database software to manage and analyze antimicrobial results, which allows the exporting to the GLASS data structure (World Health Organization 2017b). Therefore, the GLASS designs a global surveillance system to standardize the collection, analysis, and sharing of AMR data and uses the WHONET as a conditioning apparatus to transform data.

The WHO, through GLASS, its administrative mechanism or instrument (inscription device), produces inscriptions such as visual displays, layers, and associations (Latour 1999). For instance, the setup of visuals provides a final layer in scientific text. This study shows that the WHO institution and the GLASS system generate submission of AMR data directly from countries and established official AMR surveillance networks, specifically the Latin American Network for Antimicrobial Resistance Surveillance (*Rede Latinoamericana de Vigilancia de la Resistencia a Los Antimicrobianos, ReLAVRA*), European Antimicrobial Resistance Surveillance Network (EARS-Net), and Central Asian and European Surveillance of Antimicrobial Resistance (CAESAR) (World Health Organization 2021d, 2017b). The WHO institution and GLASS connect with microbiologists, epidemiologists, and scientists to gather data on pathogens and AMR. GLASS appears as an instrument of production and data sharing. It yields inscriptions that produce the GLASS reports, GLASS enrollment maps, and graphs of country AMR surveillance for bacterial species. From the WHO emerges the GLASS instrument such that member states and scientists (human actors) collect pathogenic data to create raw images (nonhuman actors) used in GLASS reports and the website. Thus, the interface results in the production of a hybrid mixture of human and nonhuman actors. Likewise, no matter how many participating member states enrolled and submitted AMR data to participate in the construction of the images or that it took from 2015 to 2019 (the early implementation phase) to harmonize global collaboration, the WHO-GLASS institution illustrates an instrument. Therefore, nonhuman actors, such as the IHR and GLASS, work as instruments to transmit meaning and production of data sharing, monitoring, governance, law, and policy.

Furthermore, another concept of science and technology studies (STS) is *boundary objects* (Star and Ruhleder 1996; Bowker and Star 1999; Star and Griesemer 1989), which does not derive from ANT but complements the ANT approach. Boundary objects stem from STS that distinguish differences and provide common reference points. They consist of objects such as the social world, negotiation processes, mediators between groups, information, organizational arrangements, or any concrete element that helps draw the boundary between data and policy (Orsini, Louafi, and Morin 2017; Star and Griesemer 1989; Gieryn 1983). A constructivist position notes boundary objects as synonymous with interpretive flexibility (Star 2010). While an objectivist ontological position looks at boundary objects as an organizational structure or arrangements, through the object's granularity scale, that help actors collaborate for a common interest (Bowker 2001). Other ANT scholars note that objects (Bowker 2006; Callon, Law, and Rip 1986; Law and Singleton 2005; Mol and Law 1994) come in diverse forms influencing the international system. To understand the importance of technical objects within networks, we have to constantly move between the social and technical and see the ability with which actants reshape the object (Akrich 1997). Once viewed from this perspective, the boundary between the inside and outside of an object is a consequence of the interaction rather than something that determines it (Akrich 1997). For instance, objects address modern security threats, monitor cheating, and ensure compliance with the regime (Krahmann 2005; Stein 1982). Likewise, biosecurity is a boundary object representing heterogeneous security dynamics and is a response to the issues of securing life in the state, scientific, and social contexts (Samimian-Darash, Henner-Shapira, and Daviko 2016). Thus, anything is considered a boundary object in the eyes of the beholder.

This research draws upon data from the GLASS architect, where participating countries collaborate to report AMR surveillance information. Therefore, collaboration requires information exchange, a mediator between groups, and GLASS represents a boundary object as a mediator, bridge, and information producer. Moreover, the GLASS network and its WHONET surveillance and data management software stand as a boundary object when they act as a mediator between groups and report on eight human bacterial pathogens. The objects push the boundaries of country collaboration and participation in the surveillance of infectious diseases. The information circulates within cyberspace and brings diverse groups of actors together, such as the national coordinating centers (NCC), national reference laboratories (NRL), surveillance and quality assessment collaborating centers, participating countries, decision-makers, scientists, and researchers. Cyberspace develops as a network of physical nodes of servers scattered worldwide (Carril 2020). It co-creates spaces because cyberspace includes *ingentis* data being exchanged and shared, raising cybersecurity issues. Thus, boundary objects allow a better understanding of the network's dimensions, which complements the ANT approach in human and nonhuman actor symmetry.

In conjunction, translation is a method where actors enroll others, which involves defining and distributing roles, the actor-world strategy with passage points, and the displacement other actors receive in following the itinerary (Callon, Law, and Rip 1986). Institutions help to build an actor world, and ANT incorporates the translation process to explain the legal and technical (Vinck 2010) and scientific with political sites (Balzacq and Cavelty 2016). The purification process establishes the limits between humans and nonhumans to translate the act of national security into truth (Latour 1993; Callon, Law, and Rip 1986). The purification process reveals the layers of a pathogenic global threat as an act of interest to national security. However, do boundary objects need to be more effective when the translation fails? This study shows that the WHO translates communicable diseases by generating awareness and support for the participating countries through its GLASS system, draws maps and an indeterminate number of translations (Star and Griesemer 1989). The IHR sets the game's rules and generates a compendium of boundary objects. The WHO-GLASS translates into a boundary object as a mediator between groups such as participating countries to share information. Thus, the WHO arises as a center of translation. The actor-network emphasizes the structure susceptible to change (Callon, Law, and Rip 1986). Therefore, ANT helps to find the limits of the network.

Moreover, network analysis provides theories and tools that generate puzzles about structures focusing on actor attributes (Arvanitis 2009; Hafner-Burton, Kahler, and Montgomery 2009).

Networks serve as sets of actors sharing common interests on a specific issue and links through relations that form structures and enable agents (Hafner-Burton, Kahler, and Montgomery 2009; Krahmann 2005). A network approach defines a structure through patterns of relations between agents (Hafner-Burton, Kahler, and Montgomery 2009; Krahmann 2005). A network analysis links the nodes or agents, such as institutions and states, and connects to the liberal approach, which rejects nation-states as the only significant actor. Due to increasing interdependence, the process depends on institutional arrangements where non-state actors are essential entities.

In conjunction, collaborative networks encourage all forms of communication, which relies on some form of sharing, which requires openness (Clark 2020), while policy networks serve as organized entities, consisting of relationships between various actors during a collective action of common interest for action and constraints (Sandström and Carlsson 2008). However, is it possible to set the limits of a network without limits? ANT assists in appreciating the complexity of reality. Understanding the network's limitations includes analyzing mediations by examining places, regulations, and code programs (Latour 1999; Barnes 1979). Some authors interpret regulation as the actions intended to define and transform the activity of an organization (Akrich and Meadel 2012). Regulation is also conceived as a "continuous collective learning process whose mechanism remain partly implicit" (Akrich and Meadel 2012, 235). Considering actors inside the network, for instance, the WHO member states, and actors outside the network, such as China, cyber threat actors, and COVID-19, helps to understand a network's construction. Furthermore, networks empirically expand the thought process of identifying risks, vulnerabilities, resources, and relationships between actors. Therefore, network analysis explains how the decision-making process works between actors and finds the network's limits.

### 1.2. Representative Reality of Surveillance Data: The Interplay between Complex Interdependence, Regimes, and Security Governance

Individuals use different theoretical perspectives to predict or explain the future (Viotti and Kauppi 2020). The theoretical framework gives meaning to using ingentis data in a network surveillance system of infectious diseases within the healthcare industry. This investigation uses three concepts to ground the theories: complex interdependence, regimes, and security governance. The conceptual framework links the investigative process elements with the researcher's thought pattern, literature, interest, and methods (Ravitch and Riggan 2012). These international studies concepts represent reality elements, open the black box (Latour 1987), and explain the challenges of public health in foreign policy. The concepts form the thematic focus of the research. Thus, the concepts serve as the chapter outlines' the heart and brain of the study detailed in the following sections.

### 1.2.1. Complex Interdependence in Pandemic Threats

In the last five decades, substantial development has existed in the politics of infectious disease control, cybersecurity, and technological advancements. How does health politics conform to elements of complex interdependence within international studies? Complex interdependence has three main attributes: (1) multiple channels of contact between societies, (2) the agenda consists of numerous issues not arranged in a consistent hierarchy, and (3) a reduced military role. The international system of complex interdependence exists where actions between society and states increase while military power decreases (Keohane and Nye 2012; Pierre and Peters 2005). By contrast, interdependence involves the link between actors and the system of actor interrelation (Coate, Griffin, and Elliott-Gover 2017). Interdependence distinguishes reciprocal effects among actors in different countries (Keohane and Nye 2012). Interdependence illustrates asymmetry through significant events and increased technological innovations in powerful states that influence other nations (Holsti 1978). Behavioral contingency (Coate, Griffin, and Elliott-Gover 2017), rather than using *autarkic policies* (Holsti 1978), leads to power imbalances and global indifference. Any pertinent changes of one actor influence other actors. Thus, complex interdependence expands interdependence.

This study shows that channels, such as transnational relationships, exist when participating countries contribute information on infectious disease surveillance. The WHO plays a vital role in the telecommunication between actors. The collaborative actor network includes international organizations, participating countries, governmental elites, representatives of the National Focal Points (NFP) surveillance centers, non-governmental organizations such as philanthropic organizations, private interest groups, foundations and companies, and the WHO's GLASS.

During the GLASS process, the research shows a reduction of hierarchical power because military security does not dominate the GLASS agenda on the surveillance of infectious diseases. Is the GLASS database key to the collaborative link between different actors? The technology database does not transpire as a standalone thing. Digital technologies influence governance by facilitating the “management of the innovative processes of elaborating norms and standard,” such as archives management (Brousseau, Marzouki, and Méadel 2012, 4). An organism has different meanings to those who use or identify it as a boundary object where many actors collaborate and interpret things differently (Star and Ruhleder 1996). Likewise, digital technologies also provide an easier means to implement norms. For instance, “the control of access and code makes it possible to monitor how information and virtual spaces are accessed and used” (Brousseau, Marzouki, and Méadel 2012, 4). Thus, complex relationships define the use of technology.

Nonetheless, if the participating countries adhere to the rules governed by the IHR, each state freely tracks and reports its surveillance of pathogenic threats. Similarly, governments participating in GLASS and adhering to the IHR strengthen their national antimicrobial resistance surveillance. In addition, participating countries generate quality global data sharing with an implied underlying non-use of military force against other network governments. These minor actions illustrate compliance with the IHR. Thus, a particular regulation enhances interests and combines resources for a specific *dispositif*.

The interweaving web of complex interdependence defines the GLASS system as a channel connecting societies. How does heterogeneity or diversity in character and collaboration coexist when there are many global power players in data-sharing security and management? Even though the GLASS database and IHR exist, they must manage infectious diseases adequately. What happens when a participating country needs more means (time, space, or manner) to track and monitor the data? The costly reciprocal effects reduce when the interconnectedness between actors does not have significant expensive effects (Coate, Griffin, and Elliott-Gover 2017; Keohane and Nye 2012). This research shows limited interaction between participating countries during information exchange on human bacterial pathogens and AMR agents. The countries submit data to their respective NFP centers that input pathogenic information to the GLASS network. Nevertheless, “microbes, objects, and techniques are a part of interactions” (Pestre 2012, 431). Therefore, infectious diseases transpire as a boundary object due to the common interest in monitoring the threats among the actors.

Actor collaboration and interconnectedness with common interests do not implement high costs or raise interdependence. However, how does necessity illustrate a progressive movement toward promoting a health regime in a complex interdependent world? Complex interdependence exists because multiple channels interact for a higher cause. Likewise, it occurs when states mutually depend on other states for their well-being (Keohane, 2012). A heightened security level exists due to the open data sharing placed in the wrong hands.

Nonetheless, direct cost accountability occurs in participating countries' responsibility to invest in surveillance tools and mechanisms to obtain the data. Any incurred costs vary between major and minor players and are a luxury that less developed countries cannot afford (Holsti 1978). Does the necessity of combating an infectious disease outweigh the cost of investment in surveillance tools? A complex interdependent world creates asymmetry. The collective action to prevent a global pathogenic threat outweighs the potential cost. However, participating countries may not have the means to implement and produce faster information than non-participating countries. Likewise, even between participating countries, the lack of funds or accessibility to invest in high-technology surveillance systems may skew the reports. Herein lies the *catch-22* of a complex interdependent world.

Other authors agree that complex interdependence includes "multiple transnational channels that connect societies" between elite governments (Viotti and Kauppi 2020, 399). States become dependent on transnational organizations that provide information (Nye and Keohane 1971). The state's agenda under complex interdependence consists of multiple problems not arranged precisely or in a constant hierarchy (Viotti and Kauppi 2020). Furthermore, new resources of power affect the agenda (Keohane and Nye 2012). Marked by both continuity and change (Keohane and Nye 2012), the world continually evolves. Every new threat opens the door for collaborative efforts to combat global issues. Groups that disrupt the network have their plan and strive for hegemonic dominance in technology or industrial capital.

The interconnection of actors develops or improves artificial intelligence applications, and, most likely, data scientists and engineers connect to enhance the AI applications. Big data is necessary for building AI models and promoting their acquisition. The technological revolution of artificial intelligence mechanisms and speed of *ingentis* data grows to explode volume as change occurs. Nonetheless, with change come potential risks. New nonconventional threats such as biological attacks, cybersecurity, and emerging technologies change the landscape's security and international agenda. Although under complex interdependence, the forefront of the agenda does not include national security (Coate, Griffin, and Elliott-Gover 2017), politicization raises the issue (Keohane and Nye 2012; Guzzini 2011; Ruggie 1975). For example, infectious diseases affect multiple countries, raising national security questions. Thus, global health is a heightened issue that persuades states to collaborate. Likewise, the emergence of nonconventional threats such as cyberattacks raises the issue on the political agenda. The dominant factor became an interest in national security. Therefore, a factor of importance and due diligence check in the political network equation includes national security.

Institutions provide enhanced telecommunications and information flow, reduce uncertainty, and provide avenues for agenda-setting and bargains (Coate, Griffin, and Elliott-Gover 2017; Holsti 1978). For example, the WHO raises global health issues on the agenda that otherwise would not be relevant. However, does the WHO have sufficient power to influence global actors when external demands, heightened security threats, and technological advances are high? The WHO relies on "member states' funds, votes, and recognition" (Chorev 2012, 226). If an institution depends on funding and outside sources, does it lessen its character as a power influencer in the complex interdependent world? Nonetheless, with global threats beyond the power of human existence, such as a pandemic, the dynamics of power play between states and institutions blurs. Governments will unlikely face traditional security as a principal issue (Keohane and Nye 2012). Security mechanisms cannot be swept under the rug with international data sharing, even with publicly available technology. Such open data leaves the door unlocked to potential outside threats.

Furthermore, the political agenda uncenters military security, and governments do not use military force against one another (Viotti and Kauppi 2020). However, new threats create more attention uncentered on military-security concerns (Keohane and Nye 2012). The information revolution influences the international system and alters the scope of complex interdependence. Keohane (1998) indicates three types of information as a power source: information commercially provided at a price; valuable contained strategic information unless placed in the wrong hands; and free information, which actors create without compensation. The information shifts the patterns of complex interdependence and increases communication lines amongst actors in the network (Keohane 1989). This study shows that communication increases when an institution develops a technology database and participating countries input information on the surveillance of infectious diseases.

Complex interdependence illustrates the ties between actors in collaborative efforts to tackle nontraditional threats. The level of the channels of communication increases when countries volunteer to participate in a collaborative network. For instance, an institution's or state's issue agenda consists of a global health problem that includes monitoring specific human bacterial pathogens and surveilling AMR, considered one of the top ten global critical health problems (World Health Organization 2020b, 2017b). Therefore, in such a matter, the military does not dominate the agenda, and complex interdependence allows more generous room for exploration outside of the traditional hierarchical norms.

Although complex interdependence comes closer to reality than realism (Keohane and Nye 2012), other scholars differ in their views of the concept. Haas (1975) notes an imbalance of complex interdependence leading to a decrease in interconnectedness. Likewise, Banks (1985) indicates that state power and military force are enduring forces incapable of change. In conjunction, Waltz (1979) contends that the international system provides an enduring anarchic character of global millennia. Holsti (1978) indicates that specific actions break the sequence of complex interdependence, for instance, Great Britain's inability to maintain unilateral regimes and the United States' failure to maintain global relationships with other hegemonies such as China.

Nonetheless, conditions to further develop complex interdependence sound promising. Established behavior patterns make it difficult to change regimes under an international organization model (Keohane and Nye 2012; Holsti 1978). Moreover, the international organization model assumes the need for changes in institutional collaborative networks. Complex interdependence promotes a health regime, collaborative actions, and interconnectedness in the actor network. Thus, the model guides the reality of promoting a more complex, mutually reliant world.

### 1.2.2. Regimes: A Complex Interdependent Dichotomy between Countries, Institutions, and Regulations through Instrument Compliance and Expectations of Open Data Sharing on the Surveillance of Infectious Diseases

A health regime's promotion stems from reporting on pathogenic threats to maintain health surveillance and response capabilities. Scholars provide diverse definitions for regimes. The most common words to describe regimes include a set of principles, norms, rules, and procedures

(Abbott and Snidal 1998; Haas 1980; Jervis 1982; Keohane 1984; Keohane and Nye 2012; Krasner 1982). How do scholars interpret regimes where institutions conduct certain types of activities regulated in the space of international studies? Ruggie (1975) defines regimes as generally agreed-upon rules through organizations' commitment. Haas (1980) adds that regimes serve as procedures to regulate issues. Meanwhile, other authors describe regimes as a legal framework (Keohane 1982) which establishes rules of the game (Bevir 2007) or patterns of behavior of actors (Blanton and Kegley 2017; Krasner 1982; Puchala and Hopkins 1982; Jervis 1982), or as forums where states have efficient interactions (Abbott and Snidal 1998) and govern arrangements (Keohane and Nye 2012).

The literature review reveals a link between complex interdependence and regimes. Authors explore regimes by focusing on the relationship between institutions and interdependence (Young 1982; Keohane and Nye 2012). Regimes serve as an interdependent arrangement between actors with mutual expectations that stem from rules and regulations (Ruggie 1975). Modifications in principles and norms transpire in changes in the regime itself (Krasner 1982). Numerous regimes develop, such as Plato's (n.d.) discussion of five regimes: aristocracy, timocracy, oligarchy, democracy, and tyranny, to more progressive regime types such as security, health, finance, and technology.

A perspective of a regime of knowledge production stems from the outputs of diverse players, for example, micro-level human agencies, meso-level organizations, and the drafting of standards and official negotiations (Pestre 2012). In addition, state and non-state actors implement contextual changes which lead to international regimes such as the *United Nations Agenda 21*, which deals with sustainable development (Fontaine 2015). Therefore, transnational networks address nontraditional security issues that present global challenges.

Regimes explain a heightened "complex, interdependent, and dangerous world" (Puchala and Hopkins 1982, 245; Krasner 1982). Monetary investment and formation reduce the conditions of complex interdependence. How does governance through the surveillance of infectious diseases and data control promote a health regime? A pivotal position in the network exists when the "position of some actors as gatekeepers makes them able to act as control points in the internet space or as governments' instruments of law" (Brousseau, Marzouki, and Méadel 2012, 16). Security governance promotes a health regime by considering the complexity of sharing data and the propensity of infectious diseases, including risks of AMR. The IHR, as an instrument of law, provides protocols for participating countries to follow in the aim of global health. The participating countries comply with rules to fight the spread of infectious diseases. Nation-states place their differences aside, accept reciprocity, and sacrifice short-term interests (Stein 2008; Krasner 1982). The actions of actors result in the expectation of global health and combating nonconventional threats for the future.

Moreover, potential threats implement a health regime because of a mutually shared interest in global health, and nonconventional threats raise security measures. Security regimes provide value and complexity because of fear that the other party violates common interests (Jervis 1982). Nonetheless, the goal of fighting nontraditional threats is more valuable since individualistic actions or national sovereignty deems more costly than dangerous (Krahmann 2005; Jervis 1982). Likewise, a security regime forms when actors desire a regulated environment without fear of retaliation. The actors believe that other nation-states share a value of mutual security, and such a regime creates assurance in need of security (Jervis 1982). This study shows that AMR's surveillance informs actors' policies to consider addressing health security challenges (World Health Organization 2019a). Surveillance assuages doubts that other network members receive information through open data sharing. Therefore, although interdependence influences the building of regimes more rigidly, complex interdependence allows flexibility between actors where a global regime exists.

Nevertheless, how have scholars differed about the existence of an international regime? First, only some international regimes exist for global communications (Krasner 1991). Regimes serve as state-centric mechanisms in comprehending world politics (Strange 1983). Moreover, states fear that competitors violate common interests hindering the difficulty of achieving security regimes (Jervis 1982). Thus, states act on their political agenda and do not collaborate for fear of a power struggle. The risk of contribution slants the balance of power. Finally, regimes are only a small step from each state's underlying capabilities of power (Waltz 1979; Jervis 1982). Therefore, while some authors oppose regimes, others favor regimes because succumbing to fear of risks brings unfavorable repercussions.

Science requires cooperation to create common comprehension (Star and Griesemer 1989). Nation-states perform together or *co-operate* towards a common goal, which produces boundary objects (Bowker and Star 1999; Star and Griesemer 1989). However, not all countries cooperate so readily due to political, socio-economic, or historical conflicts. Under cooperation, each participant changes their behavior contingent on changes in the other party's behavior (Keohane 1988). Changes illustrate an unstable form of cooperative relations. Powerful nuclei at the core harm society. Communicable diseases transcend national borders, and, more likely than not, nation-states *co-labor* on common goals. With growing awareness of epidemics, new information-sharing commences because "microbes move rapidly across national borders and between large bureaucracies at an unprecedented rate" (Bowker and Star 1999, 17).

That said, a metaphor helps reduce uncertainty in the dynamics between collaboration and cooperation. A typical symphony orchestra consists of musicians, the conductor, and the instruments. The orchestra follows a script agreed upon to create a musical masterpiece. Likewise, collaboration exists during the crescendo moment, with the sound ultimately heard. The individualized rhythm circle showcases the sound of cooperation. In this scenario, the musicians leave the process while the music remains. Thus, the collaboration presents a source of resolution to bring the musical notes to their highest peak, meeting the orchestra's interests.

Moreover, a tendency exists to evolve toward multiple-actor participation and a more decentralized process of diverse stakeholders, such as experts, professionals, and citizens, to elaborate norms (Brousseau, Marzouki, and Méadel 2012). Regimes establish regulations like the IHR that incite participating countries and other actors to collaborate (World Health Organization 2016a). Whether states choose to collaborate or not raises security issues higher on the spectrum of the agenda. Regimes include transnational government actors such as the WHO and the World Trade Organization (WTO). States, as co-participants, have a voice on the agenda. Institutions have a platform to organize summits and conferences (Fontaine 2015). This mutual contribution enhances all sides' interest— *quid pro quo*. The research shows that the WHO developed the GLASS system, allowing participating countries to participate and share their AMR reports. The health regime includes the collaboration of participating countries. The institution has enhanced overall global awareness through events such as the *Artificial Intelligence for Good Global Summit and the International Conference on Prevention and Infection Control*. Thus, it has engaged participating countries to collaborate and organize events to further its goal of eradicating infectious diseases.

### 1.2.3. Security Governance in the Control of Infectious Diseases and Data through Open-Source Intelligence Technology

As the world becomes more globalized with rapid advancements in transportation and communication, traditional security means evolve into another spectrum of thought. Advancements in technology stir maneuvering thoughts of a complex interdependent society. The emergence of new threats no longer lies rigidly in the dyads of states (Kirchner and Sperling 2007). Instead, new threats target multiple actors, such as society, individuals, and states. Scholars understand governance as "the reflexive self-organization of independent actors involved in complex relations of reciprocal interdependence" based on continued dialogue and resource-sharing to develop joint ideas that mutually benefit the other while managing the contradictions involved in the matters (Jessop 2003, 101; Brousseau, Marzouki, and Méadel 2012). This dissertation conceptualizes or measures security governance as a system of rules that actors conceive to manage their collective existence in response to threats (Breakspear 2013; Bevir 2007; Krahmann 2005; Webber et al. 2004). Security threats exist when there are potential negative ramifications for the welfare of the individual, society, or the state. Probability, specificity, scope, and seriousness define the security threat (Kirchner and Sperling 2007; Krahmann 2005). Thus, global recognition in security governance promotes a health regime.

Most people do not object to an analysis of opening the black box of a health regime but more to the surveillance itself (O'Neil 2016). Infectious diseases affect human survival. Mobilization of the economy does not exist without its citizens or a community. Moreover, new security threats exist, such as contagious diseases, which change the landscape of security and push the emergence of security governance due to the evolving nature of threats (Krahmann 2005; Bowker and Star 1999). Likewise, different governance types exist in the international system, such as democratic, centralized, traditional, and administrative power, and those acting in the state's name (Fontaine 2015; Kooiman 2002). Therefore, governance depends on the interaction and process of multiple players, such as state and nonstate actors, public workers, and socio-economic actors.

Scholars use common words to define governance as a system, set, form, mechanism, or regulation process in determining state affairs. Some note that governance acts as a system of rules accepted by the majority (Rosenau 1992) and regulates the situation due to immediate information and arrangements between actors for policy action (Fontaine 2015; Webber et al. 2004). Other authors determine that governance serves as a system of regulations to motivate public and private institutions and manage their everyday affairs (Bevir 2007; Webber et al. 2004). Others describe governance as a set of processes and institutions guiding international surveillance (Keohane and Nye 2012; Viotti and Kauppi 2020). Additional authors note that governance indicates a fragmented network that structures collaboration, mode of policymaking, and collective group activities to help society adapt to change and attain those goals (Breakspear 2013; Krahmann 2005; Pierre and Peters 2005). The governance structure enables an organization to anticipate change, open windows of opportunities, or avoid the harmful effects of threats (Fontaine 2015; Breakspear 2013).

Furthermore, recognizing a legitimate problem implies that actors place a particular hierarchy level on multiple existing issues and select the most urgent ones (Fontaine 2015; Pierre and Peters 2005). Moreover, other scholars define security governance as "a system of rule conceived by […] actors aiming at coordinating, managing, and regulating their collective existence in response to threats to their physical and ontological security" (Liao 2012; Adler and Greve 2009, 64; Kirchner and Sperling 2007). At the same time, other authors indicate that national elites strive for international security governance flexibility by eschewing war as a state-crafted instrument. Meanwhile, others accept that the benefit of security governance outweighs a declaration of war and respect the existing situation (Kirchner and Sperling 2007; Keohane 2002). Thus, international organizations such as the UN and the WHO incite decision-making and influence the subject's importance.

The literature further suggests that security governance works to secure a health regime because governance identifies vulnerabilities to understanding the structure of interdependence relationships and which actors set the rules of the game or *ceteris paribus* (Keohane and Nye 2012). In an increasingly complex world in matters of the organizations of governance, "technical capabilities are the source of new legitimacies and new capabilities, and, hence, new potentialities and needs" (Brousseau, Marzouki, and Méadel 2012, 7). Complex interdependence faithfully reflects how security governance promotes regimes on the surveillance of infectious diseases by understanding global relations between actors in a collaborative network. This research analyzed economic pressures, increased new security threats, and increased transnational contacts (Krahmann 2005, 2003). Furthermore, the focus of the study includes the development of security governance and its five features: heterarchy, the interaction of a large number of public and private actors (depending on the issue), formal and informal institutionalization, relations between actors, and collective purpose (Webber et al. 2004). Specifically, the concept of security governance involves the:

> Coordinated management and regulation of issues by multiple and separate authorities, the interventions of both private and public actors (depending upon the issue), formal and informal arrangements, in turn, structured by discourse and norms, and purposefully directed toward policy outcomes (Webber et al. 2004, 4).

Heterarchy characterizes governance and suggests various coordinated actions and the absence of central political power. It entails the presence of multiple positions of authority in a security space (Sperling and Webber 2014) and composed of more than just self-regulated actors and spaces (Brousseau, Marzouki, and Méadel 2012). The heterarchy complexity defines new interaction patterns through collaboration and interaction between actors. In the context of the second dimension, interactions, the focus of attention entails the involvement between many connected actors in a regional and sometimes global setting. The third dimension indicates the institutionalization of rules and norms that identify legitimate actors and set the boundaries of behaviors through committees, meetings, or institutional initiatives. The fourth dimension of security governance involves the ideational relationship between multiple actors that engage in common acts structured around addressing a particular issue (Sperling and Webber 2014; Webber 2004). Lastly, the fifth dimension maintains that security governance is about achieving a collective goal and the collective process by which actors obtain the goals (Sperling and Webber 2014; Rosenau 2000). Thus, while conducting the case study, these five valuable features assisted in analyzing collaboration in data sharing on the surveillance of infectious diseases.

This study shows that global health security recognizes infectious diseases as a threat. The theoretical perspectives serve as tools to analyze new forms of security threats appropriately and provide alternative ways to address the issues by collaborating with diverse actors (Liao 2012). Furthermore, the collaboration of states through the IHR, an international legal instrument, contributes to the security governance of massive amounts of data obtained through publicly available information in the surveillance of infectious diseases. At the same time, security governance keeps the traditional state-centered security structure. Thus, the conceptual analysis strengthens state functions when analyzing non-state actors' international relations.

The subsequent chapters measure the perception of nontraditional security threats, such as infectious diseases, and secondary threats, such as cyberattacks and emerging technologies. For example, nonconventional threats develop during the security governance process on the surveillance of infectious diseases to promote a health regime's emergence. Thus, an open-source intelligence database harmonizes data sharing to promote global health.

### 1.3. Additional Interdisciplinary Knowledge: Drawing Insights from the Sociology of Technology, Law of Nations, and Intelligence Studies to Gain Deeper Knowledge of Collaborative Networks

Analytical reflection stems from three fields of inquiry: sociology of technology, international law, and intelligence studies. This section examines these fields and draws diverse insights to address the research question: "Through an OSINT technology database of the WHO, why did security governance promote the health regime on the surveillance of infectious diseases in the Americas from 2015 to 2021?"

#### 1.3.1. Sociology of Technology: Codes, Algorithms, and Artificial Intelligence in the Actor Relational Space on the Surveillance of Infectious Diseases

What necessary collaborative norms address the international security dimension of tech innovation? How is technology an impetus for social transformation? At times, the idea of a panacea or a belief that one idea or a norm will solve all issues, a utopian ideology, is improbable. Thus, a dynamic process appears more probable. Analysis of the sociology of technology addresses the contributions of nonhuman actors, such as the code of international law (an instrument for social control), algorithms (a set of operational rules), or artificial intelligence (development of computer systems that requires tasks of human intelligence). The sociology of technology helps us understand how change occurs when introducing technologies as actors in the network. The actors build a network relationship. Multiple actors, both human and nonhuman, usher in a better future. As digital technology provides an accessible means to implement norms, the control of code and access "makes it possible to monitor how information and virtual spaces are accessed and used" (Brousseau, Marzouki, and Méadel 2012, 4). Analysis of codes, algorithms, and artificial intelligence contributes to the network, which allows a better understanding of the complex interdependence between actors. Thus, the sociology of technology literature review provides a deeper analytical explanation of the social interactions between actors and technological innovations.

The code of law and technology rapidly changes as society evolves into a complex and unpredictable world (Pierre and Peters 2005). In jurisprudence, the legislation serves as the code of law. In cyberspace, operations work with software assistance that consists of a code or program (Balzacq and Cavelty 2016). Both software programming codes and legal codes are nonhuman actors. Since codes have a purpose, nonhuman actors contribute to political relevancy, perception, and abstract concepts such as security governance, regimes, and complex interdependence. Technology does not drive history; instead, political and legal institutions remain the driving forces that shape an individual's way of life (Jasanoff 2004). Technology produces knowledge around interdependent technical objects: material, knowledge, and information, and humans such as engineers and scientists (Arvanitis 2009) and treat objects or "actants" equally (Pestre 2012).

Likewise, technical objects build diverse networks which bring together human and nonhuman actants (Akrich 1997). Boundary objects appertain to the negotiation process because each actor knows what the object means to itself in a shared infrastructure (Bowker 2000). Open-source information and transparency lead to a collaborative movement between nations. On one end, codes, rules, and regulations drive the urgency to keep up with actors' interdependence. On the other hand, technological changes necessitate conformity to a growing society. A new generation of individuals governs a contemporary culture of progress and contributes to the knowledge infrastructure. In social science, computer technology allows greater communication and interdependence, contributing to technological innovations. Advancements in technology increase interconnectedness, and "technological innovations increase the individual and collective well-being" (Beck 1992, 184). Both technical and legal codes affect the political and social realm, regulate space and behavior, and work in the norms of virtual space to analyze information on a large scale (Balzacq and Cavelty 2016; Lessig 2006). Thus, codes mediate the realm between law and technology.

Likewise, algorithms constitute part of the database that makes up the framework within the technology ecosystem (Webb 2019). Nevertheless, bias influences algorithms' shape and information infrastructure development. Who are the creators behind the algorithms inputted into the database? How are they interacting actors redefining the world? This study questions the GLASS object because algorithmic bias skews the security and intelligence analysis level by reshaping what actors consider as a threat in the interest of national security.

In addition, emerging technologies pose threats or comprise powerful enabling capabilities that operational end-users use (U.S. Department of Homeland Security 2020b). While the focus lies on global health and cyber issues, other emerging technologies, such as artificial intelligence, have entered the field. By 2026, the AI market expects an increase to approximately US$53.1 billion and a compound annual growth rate (CAGR) of 35.4 percent between 2019 and 2026 (Anzivino, Anfossi, and Saracino 2021). Thus, monitoring emerging technologies enhances analysis, increases prediction, and reactivates the capacity to acknowledge foreseeable threats.

Mechanisms of AI, such as machine learning, automate a vast amount of information that quickly and efficiently assesses data. In its most rudimentary comprehension, AI is the engineering of developing intelligent machines to understand human intelligence through biologically observable methods (McCarthy 2007). AI also refers to a "set of computer science disciplines aimed at the scientific understanding of the mechanisms underlying thought and intelligent behavior and the embodiment of these principles in machines" (Congress.gov 2016, 9), which deliver value to people and society. Similarly, the National Security Commission Artificial Intelligence Act of 2018 defines AI as "an artificial system designed to act rationally, including an intelligence software agent or embodied robot that achieves goals using perception, planning, reasoning, learning, communicating, decision making, and acting" (Congress.gov 2018b, 8). The diverse, interconnected group of actors in the network, coupled with new technologies from AI mechanisms to algorithms in the GLASS platform, influence change in combating the threat more than any other cohort.

As a subset of AI, machine learning depends on the researcher or scientist to judge and guide the process and assess intermediate results (Kitchin 2014). Machine learning helps recognize patterns, predict threats, identify big data and spam, and classify malware (Gibert, Mateu, and Planes 2020). Computer algorithms undertake a significant amount of data through machine learning or automated processes, spot patterns, and generate theories (Steadman 2013). Algorithms work on big data to discover associations between data without the guidance of a hypothesis (Kitchin 2014, 22). Therefore, big data is necessary to establish a surveillance system for infectious diseases.

Algorithmic bias exists when a data scientist introduces issues that train the machine learning system. By contrast, a person creates algorithms with unintended cognitive biases since "neither may a programmer whose program behaves differently from what he had intended look for the fault anywhere but in the game he has himself created" (Weizenbaum 1976, 112). Likewise, "considerable flaws and biases can exist in the algorithms that support AI systems, calling into question the accuracy of such systems and its potential for unequal treatment" (Congress.gov 2018a, 3). A potential method to identify algorithmic bias obtained from the intelligent machine includes hiring auditors to offer algorithmic scrutiny, which helps to mitigate how analysts conduct intelligence (Danks and London 2017; O'Neil 2016). Therefore, perceptions provide an avenue of added information to comprehend reality.

Nevertheless, what is the ideal modus operandi for governance to keep up with emerging technology? Emerging technologies pose security concerns when they shorten distances and create novel and extraordinarily effective means of destruction, which threaten humankind's security and survival when placed in the hands of nations that claim unrestricted freedom of action (Einstein 2011). However, excessive regulation stifles the growth of global health and digital services by over-regulating.

Have our ancestors lacked cognition in comparison to modern thinkers? Has cognitive bias grown over time? Advancements in technology do not mean we are any better than our ancestors since bias exists due to the natural tendency of the brain to seek world connections. Nonetheless, genetic engineering, a technology-driven field, "could result in major social disruptions worldwide during coming decades" (Clark 2020, 280). Therefore, although the increased pace of technology provides benefits, technology-driven systems create uncertainty in strategic planning and unintentional consequences.

Emerging technologies, such as AI, use their implements exponentially, which brings about new opportunities and challenges. AI "drives information enhancement, helps interpret information, provides answers at the speed of light" (Sanclemente 2021, 7). Raising awareness of the potential pitfalls of emerging technologies and other topic-relevant actors creates a better security process for IC analysis in the national security interest. Thus, the key to addressing questions, opportunities, and challenges includes a collection of diverse actors and approaches from the bottom-up to the top-down with mindfulness to obtain solutions cautiously.

AI influences a network and the speed of information shared between actors. Digital technologies and AI protect society from health emergencies and open the door to nonconventional threats, such as cyberattacks and hacking. AI plays an essential role in the surveillance of infectious diseases and defenses against outbreaks. In particular, artificial intelligence mechanisms progress exponentially, far outreaching the most developed countries to the most remote villages (Glauser 2018). Skeptics of change and a fear of artificial intelligence mechanisms drive significant transformational change, which intersects various life areas from health to security to finance. For example, the GLASS technology database lacks AI mechanisms in AMR data capture (World Health Organization 2017b). However, harnessing emerging AI technologies leads to effective AMR sharing, diagnostic mechanisms, and analytical and assessment tools (Ashley et al. 2019). Automatic data harmonization between laboratories, participating countries, and institutions provide effective scale-up, integration, and translation (Ashley et al. 2019; Callon, Law, and Rip 1986).

Moreover, AI significantly improves response to disease outbreaks by enhancing early warnings, forecasting epidemics, and enhancing decision-making for simulation tools and outbreak response (Ghebreyesus 2018). Therefore, the WHO supports AI and implements safeguards. While the GLASS platform does not incorporate AI mechanisms per se, the WHO's stance on AI indicates future AMR surveillance potentials. Nonetheless, codes, algorithms, high-performance computing, and AI mechanisms contribute to the notion of frontier objects, co-production, and interdependent activities in the actor network (Star 2010; Arvanitis 2009; Jasanoff 2004; Latour 1993; Callon, Law, and Rip 1986). The mechanism stems from the response, transmission, and contribution to knowledge production.

Moreover, co-production allows the sorting of hybrid networks between state and non-state actors (Jasanoff 2004; Latour 1993). It clarifies the different social order levels, such as health regimes, to drive global health and security. Natural technical objects (GLASS and IHR) and social objects (the WHO and participating countries) interweave in the actor network on the surveillance of infectious diseases. How do these material objects and institutions assign hybrids to their constitutional domains? The objects grant agency to nonhuman and human actors, which provides content regarding theoretical knowledge and technical objects (Jasanoff 2004; Latour 1993; Callon, Law, and Rip 1986).

In conjunction, cybersecurity emphasizes and co-creates objects in cyberspace. Inflation of processes around cyber in all corners of the world responds to the magnitude of the challenges we face. In the beginning, the idea of the Internet made regulation of it very difficult. However, today, "after years of standardizing protocols and digital languages, cyberspace has become an increasingly sophisticated site of regulation" (Albornoz 2020, 46). How would a global commitment to multilateral, public, and private cooperation on the tech front advance digital access? In the technology space, we have the Internet, owned entirely by the private sector; citizens are using technology, government or private sector technology, and the private sector has a vital role in these discussions about cybersecurity.

In response to cyber threats, actors track millions of data points across their infrastructure. As a result, threats to critical infrastructures are rendered ineffective in an isolated infrastructure, while cyberspace threats occur in a common medium such as a network or the Internet. Moreover, cyberspace opens a range of power projection tendencies to manipulate, whether in the social, public opinion, or technical sphere, when it targets critical infrastructure, governance, and legal frameworks tailored to a coercive community, creating challenges. Therefore, much of the manipulative activity is at risk of falling through the cracks.

The sociology of technology provides a reinforcing framework for theories and concepts. It raises risk factors in technologies and security issues against nonconventional threats, such as biological attacks, cybersecurity, and emerging technologies. Furthermore, technological advancements spread interdependence between the social and material complex world since data grows at the speed of light. Thus, the sociology of technology provides a reinforcement mechanism for promoting a health regime.

### 1.3.2. International Law: International Health Regulations (2005), the Glue that Binds an Institution and Nation-States to Promote a Health Regime

International law assists in dealing with a conflict between nation-states. It provides order during times of chaos and plays a vital role in the international system's structure due to its ability to respond to global change. The society of nations includes recognizing rights and does not obliterate the human demand for justice (Grotius 1901). The International Health Regulations

(2005) provide the legal framework for handling public health emergencies of global concerns. The IHR links the state to the legally binding instrument that provides global public health response guidelines.

On May 23, 2005, the World Health Assembly (WHA) adopted the IHR, a legally binding instrument that entered into effect on June 15, 2007 (World Health Organization 2016a). The IHR emerged in the context of an ever-increasing interconnected and interdependent world. Countries need to respond in a timely fashion to prevent public health threats (Kluge et al. 2017). The IHR seeks to prevent, protect against, control, and provide a public health response to the international spread of diseases (World Health Organization 2016a). Thus, the IHR encourages collaborative approaches toward global health and engages different actors.

Public policy refers to the laws, governmental actions, funding priorities, and regulations that reflect given positions, attitudes, cultural ideals, or accepted rules (Kilpatrick 2004). It processes information delivery in context with practical effect (Dryzek 2008) and sets specific measures (Page 2008). For example, spreading infectious diseases paves the way for nontraditional threats, such as using biological pathogens in biological warfare. *Bacillus anthracis* (otherwise known as anthrax), Ebola, *aspergillus fungi*, and other similar infectious diseases have destructive tendencies. The biological weapons prohibition regime in the multilateral disarmament treaty at the 1972 Convention on the Prohibition of the Development, Production, and Stockpiling of Bacteriological and Toxin Weapons and their Destruction Convention implements prohibitory norms against biological warfare (Kelle 2007). The convention supplements the Geneva Protocol, entered into force in 1928, which prohibits chemical and biological weapons (Kelle 2007; World Health Organization 2004). Regulatory tools include postmarketing surveillance systems, "organized by administrative or professional bodies like the FDA," and rely on jurisprudence set by court decisions that influence users' choices, doctor's prescriptions, and regulatory authorities (Gaudillière 2014, 67). Moreover, the law as an instrument functions as a regulatory policy that contributes to decision-making (Fontaine 2015), and states follow norms in "their enlightened self-interest" (Viotti and Kauppi 2020, 26; Grotius 1901). Therefore, regulatory policies help maintain order, prevent chaos, and prohibit behavior that endangers the nation and its citizens.

The spread of more legal institutions and practices tackles various issues, from infectious diseases to cybersecurity and emerging technologies, and raises concerns about jurisdictional privacy laws and legal globalism (Keohane and Nye 2012). A potential reference to complex interdependence encompasses change from technology to legal industries. When an extensive database integrates information from diverse international sources, the potential for data abuse increases exponentially (Bowker 2001). Institutions serve to reaffirm political culture. The legal system allows institutions more weight, a repertoire of solving problems, and methods to secure their credibility and manage dissent (Jasanoff 2004). Leadership and governance are paramount in improving the implementation of the IHR and the cornerstone of any effort to strengthen health security (World Health Organization 2016a).

Moreover, the IHR illustrates regimes because, as a binding international legal agreement, the IHR help countries work together to enhance public health security. Nonetheless, a regime lacking formal legality cannot command our allegiance (Kant 2006). An international society considers international law an institution since international law includes international regimes (Keohane 1988; Bull 1977). The IHR relates to the emergence of a health regime because it establishes rules to support global outbreaks such as infectious diseases and strengthen national surveillance. Rules remain important regulators to govern information in cyberspace to ensure intellectual property rights and legal text mobilize other instruments (Fontaine 2015; Keohane and Nye 1998). Therefore, the IHR serves as an essential legal instrument. They ensure health security on the security governance of data sharing and infectious diseases. Through open-source intelligence on the surveillance of infectious diseases, the possibility of promoting a health regime exists because diseases go beyond national borders.

### 1.3.3. Intelligence Studies: Infectious Diseases and National Security as a Kind of Risk Unrestricted to National Boundaries and National Frontier

Traditionally, national security interest includes threats other than infectious diseases. For instance, environmental degradation and bioterrorism did not rise to the national security level (Hodge and Weidenaar 2017). However, due to the rapidly changing times, data that grows at the speed of light, and emerging threats, the landscape and scope of national security interest begin to include new threats. Does the health paradigm become a determinant of war or conflict starter? Such a paradigm is an object of further articulation (Kuhn 1996). Knowledge of facts towards extraordinary investigations extends the success in the paradigm of infectious diseases and national security (Kuhn 1996). Therefore, actors push the boundaries of exceptional science to address pandemics and security crises.

Intelligence reduces uncertainty and does not exclude the use of open-source information. The competence of analysis, such as open sources, reveals information that opponents wish to hide (Clark 2020; Kent 1965). The internet also provides leaders and communities with the "ability to organize themselves and to benefit from the distributed intelligence that lies in the network" (Brousseau, Marzouki, and Méadel 2012, 6). Likewise, intelligence establishes facts, provides valid inferences such as hypotheses or conclusions, and strives for impartial analysis (Clark 2020; Kent 1965). Thus, intelligence connects to the complex process of understanding meaning in available information.

Similarly, under intelligence studies, interest in national security considers other issues over other topics, such as infectious diseases, bioterrorism, and environmental degradation. However, the scope of national security interests expand to include new nonconventional threats due to recent technological innovations, the changing times, and the emergence of new threats. Moreover, authors have noted links between infectious diseases, national security, and cybersecurity issues. We live in a world that is not only interconnected from one end of the spectrum to the other; that connectivity transcends borders, which no longer surprises us (Carril 2020). Infectious diseases cross boundaries.

Traditionally, intelligence follows an intelligence cycle that includes requirements or needs, planning or direction, collection or gathering information, processing, analysis, production, and dissemination (Clark 2020). However, larger organizations need help adhering to the intelligence cycle (Kent 1965). Intelligence officers jump back and forth during analysis from collection to requirement and back to research. As a result, organizations materialize as a very untidy process different from the traditional cycle (Clark 2020). Thus, intelligence officers conduct research in a particular abstract method and nonlinear approach.

Intelligence exists in both the traditional and nontraditional sense. For example, the type of techniques used determines the difference between intelligence officers and professional scholars. Scientific laboratories collect information to reduce uncertainty. Laboratories in academia would not send information that includes the interception of telephone communications, concealment, or deception. Professional scholars train "in the techniques of guarding against their intellectual frailties" (Kent 1965, 199). Intelligence supports a range of operations such as military planning, diplomatic and trade negotiations, policy, and law enforcement (Clark 2020). In intelligence, the type of customers acting on the information includes the decision-makers, executives, policy officers, law enforcement, and operating officers (Clark 2020; Kent 1965). Other actors that benefit from participating in GLASS or similar health surveillance networks through data sharing include nation-states (World Health Organization 2017b) and multilateral agencies (Edelstein et al. 2018). Thus, surveillance networks such as GLASS aid a diverse range of actors.

How do intelligence studies drive analytical thought on the risk and link between infectious diseases and national security? Literature shows a connection between U.S. national security and global infectious diseases (Hodge and Weidenaar 2017; Cecchine and Moore 2006). Various security initiatives in the United States, such as the Department of Homeland Security (DHS) and the National Defense Research Institute (NBIS), address infectious diseases. Likewise, APUA-Brazil in Brasilia promotes the control of AMR on a global level. Moreover, cyber threats challenge institutions, security governance, and laws due to concerns about the growth of adversarial technology knowledge that enhances threats to the security of the economy and the health of nations (Director of National Intelligence 2019). Emerging technologies, such as artificial intelligence and high-performance computing, pose a threat when placed in the hands of military and intelligence adversaries (Director of National Intelligence 2019). The intelligence community information environment includes different actors, from individuals to organizations, with the capacity to collect, process, and share information following law and policy (Director of National Intelligence 2019).

Secondary threats, such as climate change, add to enhanced security measures and intelligence analysis compendium. In 2015, health officials reported the spread of the Zika virus in Brazil. By 2016, infections had spread to over one million Brazilians, with speculations of inclement weather and poor water and drainage infrastructure (Lakoff 2017). Environmental problems have no frontier. For instance, malaria, an infectious disease, are sensitive to long-term climate change (high humidity and rainfall) (Arvanitis 2009). In addition, global attention increases because of infectious diseases concerning security (Cecchine and Moore 2006). Thus, a link exists between infectious disease transmission, climate conditions, and cybersecurity.

Societies value health and human security but misunderstand their connections and interdependence (Chen and Narasimhan 2003). Nonetheless, some authors concur on the links between national security and health, where infectious diseases substantially threaten interests (Cecchine and Moore 2006; Brower and Chalk 2003). Compared to other threats to national security, the former U.S. White House Homeland Security Adviser declared that infectious diseases pose the greatest danger to national security (Lakoff 2008). An implication of national security exists when the threat significantly increases and causes devastating global harm to health, life, and human security. Infectious diseases remain an existential threat that affects one nation and multiple channels that spread beyond national borders. Transparency enhances public trust and facilitates decision-making on information available through open sources while protecting information that harms national security (Director of National Intelligence 2019; Hodge and Weidenaar 2017). Greater state transparency remains indispensable in the security governance of infectious diseases and perceptions of nonconventional threats.

Moreover, when using the reference word "combat" in attacking the disease, this is not like a war zone. It does not take away from the fact that the threat is challenging, and we are trying to battle the danger, but using the word "combat" to address a threat raises the glass ceiling of heightened awareness. We are not fighting each other; instead, we are fighting infectious diseases. In turn, this incentive assists different fields and disciplines, such as the intelligence community, in their workflow to support, co-produce, and collaborate. Therefore, collaboration in the fight against the spread of contagious diseases addresses other nontraditional threats and expands the scope of national security threats to galvanize global response. This study shows that the WHO developed the GLASS. Would open-source intelligence include a technology database where global participating countries collaborate to report human bacterial pathogens' surveillance data? What type of intelligence do we consider a global surveillance system of infectious diseases?

**Partial Conclusions**

This chapter provided theoretical reflections on the research question. How does security governance through an open-source intelligence technology database promote a health regime on the surveillance of infectious diseases? It also explored existing published research and the development of the liberal institutionalism theory, ANT, and securitization theory grounded by the concepts of security governance, regimes, and complex interdependence. A more progressive all-encompassing actor-network approach serves as the analytical playground. Complex interdependence highlights the emergence of transnational actors. Regimes define the rules of the games and deal with diverse subject matters. Security governance provides a system of rules that includes actors' interactions for the collective purpose of responding to nonconventional threats.

Various factors sway states' minds to eradicate specific complex global issues since infectious diseases transcend national boundaries. Common interest serves as one piece of the puzzle. In contrast, countries prioritize their economy, political system, and citizens. Through a realist paradigm, nation-states serve as significant actors. However, more than a realist perspective is needed to solve the complexities of global threats, such as the eight human-priority bacterial pathogens or COVID-19. Common interest and collaborative security measures intertwine in promoting a health regime. Actors in the policy process push relationships beyond political and bureaucratic relations. The collaboration and interconnectedness of multiple channels and actors are paramount in the shared information exchange. To what extent is this information open to being placed in the wrong hands? Nontraditional threats exist past the vigilance of infectious diseases. For example, through an open-source intelligence database in the surveillance of human bacterial pathogens' antimicrobial resistance, security governance promotes a health regime. Value exists in monitoring the underlying global threat and the threat of diseases—beyond infectious and contagious diseases. The resulting norms characterized by the high involvement of actors in the elaboration process led to the "coexistence of different types of norms" (Brousseau, Marzouki, and Méadel 2012, 5) as principles, rules, and procedures—regimes. For instance, in opening the black box of a health regime, a security regime exists because of outside unconventional threats that connect actors in the co-production (collaboration) of information.

Some theorists err on the side of the promotion of a health regime with the existence of a heightened threat for collaborative efforts even in fear of risk-taking, political power, and economic imbalances (Bevir 2007; Fontaine 2015; Haas 1980; Keohane 1984; Puchala and Hopkins 1982; Ruggie 1975). Other authors differ on international regimes (Strange 1983; Waltz 1979), while others present mixed feelings about its promotion (Jervis 1982; Krasner 1991). Moreover, the theories and concepts provide interconnectedness. Complex interdependence connects to ANT through loosely structured network organizations (Keohane and Nye 1998). Complex interdependence connects to technology's sociology due to technology and the rapid spread of interdependence between the material and social (Star and Ruhleder 1996; Latour 1987).

In turn, the sociology of technology links to regimes where co-production provides more clarity in the social order, such as international regimes (Jasanoff 2004). Regimes connect with complex interdependence by exploring regime analysis and focusing on relationships between interdependence and institutions (Young, 1999; Keohane and Nye 2012, 1987), which treats regimes as an interdependent arrangement (Ruggie 1975) and a movement toward complex interdependence (Krasner 1982). In conjunction, regimes link to the liberal institutionalism theory because health regimes serve as institutions (Keohane 1988). Regimes broaden the focus of institutions (Stein 2008; Kramer 1982) and connect to complex interdependence since institutions increase due to a complex world (Coate, Griffin, and Elliott-Gover 2017; Keohane and Nye 2012). Lastly, security governance links to liberal institutionalism due to institutional capacity as a regulation system where institutions manage common interests (Bevir 2007; Pierre and Peters 2005). It also connects to the securitization theory, which provides a causal connection between securitization and security governance (Oliveira 2017). Neither theory serves better than the other. The ideas collectively intertwine in developing regimes in the modern complex world, such as the Gordian knot. Neither school of thought influences more than the other but interwoven provides a privy of theoretical discourse. The theoretical web develops regimes in such a complex world. Analysis, expansion, and exploration in these thought areas transgress in the following chapters.

## Chapter 2. Methodology

Data! data! data! I can't make bricks without clay.
The Adventures of Sherlock Holmes (1892)
—Arthur Conan Doyle

### Introduction

As previously mentioned in chapter 1, the focus of the study is to explain how the collaboration and interconnection of networks of relevant experts and knowledge production combine to build networks of surveillance of infectious diseases. Three objectives inspire this study: first, to open the black box of a health regime; second, to analyze the construction of a health regime through security governance activated by an unconventional threat; and third, to explain the exchange of open data, its risks, vulnerabilities, and resources present in the use of GLASS, and its contribution to the construction of a global health regime based on AMR analysis and the inclusion of COVID-19. My research centers around the main research question: why did security governance, through an OSINT database of the WHO, promote the health regime on the surveillance of communicable diseases in the northern and southern subcontinent of the Americas from 2015 to 2021? This chapter presents three sections. The first section discusses the research design methodology, the second section provides the study's methodological limitations, and the third section discusses the data collection for the quantitative and qualitative data structure. Section 2.3 will discuss in further detail the methodological procedure involved in the data collection process, which involves a six-step process: 1) level of analysis, 2) identifying the actors in the primary unit of research, 3) identifying actors in the network outside the primary unit but vital to the investigation, 4) connecting the actors in the network, 5) mapping the network and creating visual representations of interconnectedness, and 6) triangulation. Phase 1 of the quantitative data structure represents processes one to five, and phase 2 of the qualitative data structure addresses the sixth process.

### 2.1. Research Design

The underlying research philosophy of this study is positivism. I chose positivist epistemology since scientific methods provide facts that make claims of legitimate knowledge. For this study, I viewed reality objectively and observable evidence as the only form to defend the scientific results. Thus, the study used an objective ontology since only one reality exists independent of the observer. I also used deductive research since the study commenced with established theories and built onto them with the collected data. Therefore, the study incorporated a confirmatory approach.

Moreover, the study used an explanatory sequential mixed methods methodology to confirm the theories, map the network, determine actor collaboration, and analyze interconnectedness. The explanatory sequential design combines quantitative and qualitative methods to map the network and learn about collaborative performance and interconnectedness (Creswell 2014). The design combination allowed me to follow up the quantitative results with the qualitative data to interpret, analyze, and reinforce the information. The core research question focuses on "why," that is, what motivates actors' actions in the collaborative network? What reasons entail the need for the outcomes in the surveillance of infectious diseases? A combination of quantitative and qualitative data analysis provides the ability to answer the questions. It generates a complete story in analyzing the collaboration of different actors triggered by a nonconventional threat such as infectious diseases.

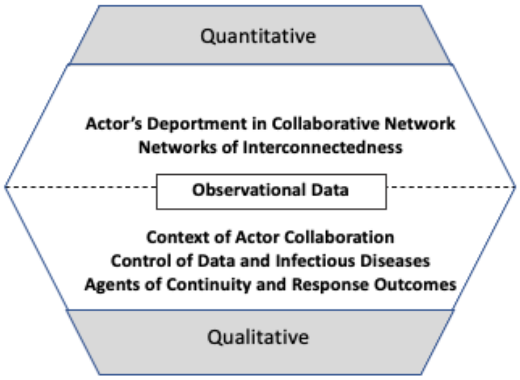
Based on the study's aims, the research strategy incorporates four action plans: network analysis, mixed methods, a case study model, and data and research-gathering tools. The network analysis approach has mathematical and visual properties that generate knowledge about relational data. A network analysis approach helps me to explain and understand how diverse actors interconnect with a common interest. Networks define a structure through patterns of relations between agents and "help to create interests, share identities, and promote shared norms and values" (Knoke and Yang 2008, 6; Hafner-Burton, Kahler, and Montgomery 2009). Networks represent nodes and ties, which illustrate interconnectedness. I coupled networks with qualitative analysis in the mixed methods methodology to build a grounded theoretical understanding of actor networks in the surveillance of infectious diseases. Likewise, the dissertation uses the intrinsic case study model suggested by Robert E. Stake (1995). A case study provides a deeper analysis of the interaction between actors and allows a researcher to establish a causal relationship with potential theoretical significance. Case study research aims to understand one case rather than a sampling investigation of other subjects (Stake 1995). I am interested in the difficulties of tackling a global health issue, the surveillance mechanisms, and the interaction of actors to address, develop, research, prepare, and respond to a global crisis. I am curious about the open exchange of information between actors with a common interest, a collective purpose, and the potential security concerns in the mix of complexity. Thus, I have an intrinsic interest in the WHO-GLASS case.

Moreover, the time horizon of the study was longitudinal since I collected the data for my research at multiple points in time. Therefore, the scope of my data collection focuses on the timeframe from 2015 to 2021. I will occasionally discuss events outside this period to provide research context or illustrate the effects of these occurrences. However, I will primarily focus on 2015 to 2021 because the period includes the early implementation phase of the GLASS—the first global collaborative effort on AMR surveillance standardizing collection and data sharing. Although COVID-19 emerged outside the scope of the selected GLASS pathogens, the novel infectious disease served as context evidence and a reinforcement mechanism for this research study. Therefore, this methodology intends to inspire analysis, analyze networks, and reflect on interconnectedness in the surveillance of infectious diseases such as AMR of human bacterial pathogens and COVID-19.

The research relies on three data-gathering tools to collect the necessary data: semi-structured interviews, document analysis, and framework analysis. These tools further facilitate the case study methodology, a "specific strategy of inquiry," during the qualitative research (Creswell 2014, 176). This dissertation also uses descriptive statistics to code the data in the quantitative study and content analysis to understand the qualitative study. This study extracts information from Gephi, the open-source network analysis statistical software, for analysis, visualization, and exploration to illustrate networks of interconnectedness (Bastian, Heymann, and Jacomy 2009). The quantitative data required some initial preparation, such as removing duplicates in the excel and .csv files. The network visualization reveals patterns and trends, highlights outliers, and tells the story of interconnectedness and actors' collaboration.

Moreover, this investigation incorporates a framework method to support the qualitative content. Drawing on the information in the explanatory sequential design model described above, figure 2.1 represents the research undertaken in this dissertation.

**Figure 2.1. Research Framework**




Prepared by the author.

The two elements above the dotted line represent the quantitative data structure analysis which includes the network analysis and content analysis approaches to explain the material that underpins collaboration and interconnectedness in security governance. This dissertation examines the two elements in greater detail in phase 1 of the data analysis in chapter 3, section 3.1.1. The three elements below the dotted line represent the analysis of the qualitative data structure. This study examines the analysis of the last three elements in phase 2 of the data analysis in chapter 3, section 3.1.2. Figure 2.1 illustrates observational data placed in the middle of the research framework because of its use during both phases. Through the specific case study in chapter 3, the research examines the context and control elements in greater detail. Lastly, this study undertakes the last element of continuity and response outcomes in chapter 4.

## 2.2. Limitations of the Methodology

One limitation of the study is that I restrained my curiosities and interests by having an intrinsic interest in a particular case study. However, the more we set aside curiosities for other similar case studies, "the more we will try to discern and pursue issues critical to the case study" (Stake 1995, 4). The benefit of focusing on a single case study is particularization rather than generalization (Stake 1995). Focusing on a specific case study allowed me to understand and analyze what the case study does, what it entails, and its uniqueness and knowledge production. Thus, expanding on these curiosities specific to the case study emphasized understanding the case study itself.

Another limitation regards solely using quantitative or qualitative approaches that materialize in the researcher, risking the investigation's outcome using only one method. While there is nothing wrong with using one method, this leads to insufficient information. Furthermore, solely using quantitative research presents a deficiency in the tone of the voice of the research subject and the experience the researcher sustains. "When researchers quantitatively examine many individuals, the understanding of any one individual is diminished" (Creswell and Plano 2018, 8). Likewise, quantitative methods are valuable in demonstrating the correlation between variables but lack in illustrating the process of causation (Lamont 2015; Denzin and Lincoln 2008), with data results potentially misleading (Mertens et al. 2016). Therefore, quantitative research alone amounts to being more impersonal and keeps the voice of the participants unheard.

Indistinguishably, qualitative research only provides indirect soft data, unlike the complex data supplied by its counterpart. Studying quantitative data collection or fewer subjects results in generalized confusion (Creswell and Plano 2018), lack of structure and consistency (Lamont 2015), and unmeasured numbers in the quality of entities (Denzin and Lincoln 2008). Although analysts translate qualitative data into quantitative information, Kitchin (2014) noted that the transition involves a significant reduction and loss of the richness in the original data, while Denzin (2008) added that the integrity of statements relies on quantitative facts. Therefore, researchers need to reinforce the information with quantitative numbers to verify the truthfulness of the qualitative statements. Thus, with a lack of a subject pool, relying on only a small number of participants limits the researcher's experience and outcome.

In conjunction, a limitation of mixed methods during the study was the arduous task of managing time. This study faced several challenges in using a mixed-method approach, and an explanatory sequential design presented certain drawbacks in the investigatory process during the COVID-19 pandemic. Much time involves receiving, sorting, and analyzing massive amounts of information in two separate phases (Creswell 2014). The study aimed to divide the time between obtaining quantitative and qualitative data and analyzing the programmed schedule. However, as time was of the essence, it took much work to organize the research within the given time constraint. Thus, mixed methods present challenges when researching for a limited period, needing the time to divide between quantitative and qualitative collections and coupled with a global pandemic to obtain the data.

In addition, mixed methods present challenges to the researcher in creating the overall design and time management when both types of methods are used simultaneously during the research process. Likewise, at any moment during the research process, the researcher gains more interest, experience, and skillset in one method. During the study, I emphasized the quantitative data structure due to my fascination with how the statistical data created a canvas of answers based on reality. Suddenly, I found myself down a rabbit hole in network analysis fascination. However, I realized that the qualitative data structure needed the same energy. In the end, the project's passion scale leaned towards quantitative analysis.

Nevertheless, I emphasized the qualitative structure upon realizing the tipped scale while under a time crunch. It is of lasting effect to maintain an analytical balance when conducting mixed-method research. Therefore, researchers must spend equal time and energy on quantitative and qualitative analysis. By contrast, mixed-method research provides a whole picture in the international studies field by explaining social facts through data-driven statistics and understanding humanistic reality through an interpretation of the social world. Using mixed-method research, combining qualitative and quantitative data, provides value in generating a complete picture and a better understanding of the research question. Creswell (2018, 12) suggests that the "strengths of one approach make up for the weaknesses of the other." This method gathers well-rounded information and enhances complementarity and triangulation. Mixed methods provide a more comprehensive collection and analysis of data. Furthermore, combining both approaches allow the investigator to obtain a greater knowledge of the unit of analysis. Thus, this research uses this type of method because it provides a variance in the study results..

Moreover, different industries steadily use mixed methods. "Mixing methods is an intuitive way of doing research that is constantly being displayed throughout our everyday lives" (Creswell and Plano 2018, 1). For instance, a broadcasting network creates a programming lineup based on its Nielsen ratings in the media industry. Thereby, the network uses Nielsen statistics to analyze its ratings. The network also uses qualitative marketing tools to understand which programs relate and connect better to its viewership. By incorporating both marketing and statistics, the station receives complete details. Thus, mixed methods prepare the station to improve current programming, acquire sponsorships, spike their ratings for the sweeps period, and readjust future programming.

Similarly, law firms use research software such as Capital IQ and Monitor Suite to gather quantitative information for company profiling and competitive intelligence reporting in the legal industry. Law firms reinforce data through qualitative research using secondary sources such as organizing client outreach events and follow-up calls to generate more business development. Thus, in the real world, a mixed-method approach is continuously used.

Mixed-method research blends two types of data collection, combining "at least one qualitative and one quantitative method in the same research project or set of related projects" (Hesse-Biber and Johnson 2015, xxxix). The definition of mixed methods evolves through time. In mixed methods, the researcher:

> Collects and analyzes both qualitative and quantitative data rigorously in response to research questions and hypotheses; integrates…the two forms of data and their results; organizes these procedures into specific research designs that provide the logic and procedures for conducting the study; and frames these procedures within theory and philosophy (Creswell and Plano 2018, 5).

On the one hand, qualitative methods provide a "detailed understanding of a problem" and a particularized canvas by looking beyond the numerical scope by reflecting with open-ended questions when analyzing the meanings of a text, image analysis, and interviews (Creswell and Plano 2018, 8). On the other hand, quantitative methods provide a general understanding, a bigger picture on the surface based on statistical analysis, and quantify facts by comparing scientific data and variables. While both approaches alone pass muster, mixed-methods transpire as "applicable to a wide variety of disciplines in the social, behavioral, and health sciences" (Creswell and Plano 2018, 7).

Also, triangulation and complementarity are two ways to design mixed-method research that adds value to the study results (Lamont 2015). According to Sanclemente (2018), recent scholars such as Lamont (2015) attributed complementarity to large-N quantitative work complemented by a small-N study and triangulation as corroborating findings concerning a process of investigation. The "combination of quantitative and qualitative data provides a more complete understanding of the research problem than either approach by itself" (Creswell and Plano 2018, 8). Nonetheless, neither approach stands to be more valuable than the other. For this study, mixed-methods provide a whole picture of my interdisciplinary approach focused on the social sciences, including international studies, law and policy, and science and technology disciplines.

Moreover, there are three strategic designs a researcher chooses within mixed-method research. The explanatory sequential strategy weighs heavily on quantitative data in the first phase, followed by qualitative data; the sequential exploratory strategy begins with qualitative data collection in the first phase, followed by quantitative data collection; and the mixed-method convergent design occurs concurrently whereby in one phase the researcher collects both qualitative and quantitative data to determine if the analysis results in convergence (Creswell 2014). Therefore, as indicated earlier, the dissertation used the explanatory sequential design to map the network and determine the extent of actor collaboration and interconnectedness.

In closing, using mixed-method research raises challenges when time, space, lack of training, and time management affect the study's results. For instance, a researcher spends more time on one method, resulting in a lack of added value to the study. Therefore, researchers who employ mixed-method research need to assess their limitations to analyze their data. Nevertheless, using more data tools, mixed methods research answers various research questions. Mixed-method allows a broader research problem analysis when combining qualitative and quantitative data. It informs and provides a better comprehension of the research question. Despite their limitations, mixed methods render a complete picture of the phenomenon under study.

### 2.3. Data Collection

There is nothing natural about emergencies and disasters during a pandemic that brings about stress. Which actors either interconnect or limit the network while conforming to a system of rules to fight nonconventional threats to promote a health regime? This section provides the data collection for the quantitative and qualitative data structure. The research includes a mixed-methods approach to analysis. The first stage of the data collection and analysis process commences with the quantitative data structure to establish interconnectedness and collaboration between actors to establish a causal relationship between security governance and the emergence of a health regime. The research measures the variables to map the network and analyze interconnectedness by creating the graphs and networks through the Gephi software program (Bastian, Heymann, and Jacomy 2009) and incorporates aggregated macro data sources from the GLASS platform and official government reports. The software program, Gephi, facilitates network analysis and visualization displays. Moreover, the software reinforces diverse collaboration of actors (nodes) such as infectious diseases, the GLASS database, and the IHR as boundary objects in the network.

Through a network analysis approach, this study also incorporates content analysis, which includes observational data for deeper insights. For example, infectious diseases and pandemics affect emergency control, disaster readiness, economic turmoil, and international relations. For Knoke (1982, 21), the "choice of methods for locating positions in an empirical network ultimately depends…on the substantive and theoretical problem the analyst is addressing." This study traces the actors using ANT inspired by Latour's (2005) advice to go slow, not jump, and keep everything flat. ANT sheds light on the limitations of the network. ANT allows me to focus by sorting through the data collection of actors and locating relevant positions in the network. Thus, to discover the breadth of the task at hand—to separate the relevant actors from the irrelevant—means to slow down, review the collection, analyze the information, and sort the data.

The quantitative data structure procedure identifies the actors in the network and relies on information from the GLASS surveillance platform and its interconnected actors. Data was collected and analyzed from the following sources: primarily using GLASS through the WHO and, as a secondary source, the Latin American Network for Antimicrobial Resistance Surveillance (ReLAVRA by its Spanish acronym) through the Pan American Health Organization (PAHO). A network is a relational link between objects, persons, or events (Knoke and Kuklinski 1982; Mitchell 1969). Three elements, i.e., sampling units, relational form and content, and level of data analysis (Knoke and Yang 2008, 1982), inspire the creation of the actor-network research design and quantitative data structure. The procedure entails five steps: choosing a level of analysis; tracking and sorting the GLASS participating countries with a common interest; identifying third-party actors with high visibility related to the network drawn from primary sources; identifying and linking the network actors based on interconnectedness, collaboration, and relation to the security threat; and creating visualization and statistical analysis of actor interconnectedness. The following section discusses the data collection methodology. Chapter 3 provides the data analysis and interpretation of the results through the specific case study.

### 2.3.1. Phase 1 Quantitative Data Collection Methodology: A Five-Step Procedure for the Identification of Actors in the Network

This dissertation seeks to address issues in network observation related to the fundamental problems of network boundary specification and entity/actor resolution. In this study, I make a methodological contribution to the empirical investigation of actor collaboration and interconnectedness that seeks to push a paradigm shift in network methods towards a progressive movement in identifying network actors. I propose a five-step procedure that incorporates content analysis with observational data and framework analysis of hierarchical data collection where the analyst:

1. Chooses a research level of analysis (macro, meso, or micro). Having a focal point early in the investigation allows the analyst to select the relevant actors.
2. Identifies actors within the primary unit of investigation. This research extracts actors linked to the primary locus. At this stage, researchers include subjective choices of actors depending on the data structure.
3. Identifies actors relating to the network drawn from sources outside the primary unit but considered fundamental to the research. This large pool of candidates encompasses a broader scope but removes the collection limits derived from the first procedure to create the network of interconnectedness.
4. Links the actors in the network based on their relation and interconnectedness about the object of a security threat. Essential to the network, this action focuses on collaboration (compliance or resistance) to address the security threat.
5. Showcases a visual representation of actor interconnectedness. An element of visual graphics points readers towards comprehending the information investigated.

#### *Step 1. Three Paths: At the Crossroads of Macro-Meso-Micro*

In step one, the researcher chooses one of three paths or a combination of the three levels of analysis: macro, meso, or micro. Paramount to the early stages of the investigatory process, this step allows the researcher to have a focal point and eases the stress of sorting through various actor data in the network. At a macro level, I investigate institutions and large-scale patterns of actors affected by national security threats such as infectious diseases. At a meso level, I am interested in the arrangement of security governance in analyzing groups of like-minded and interconnected actors in the surveillance of infectious diseases towards promoting a health regime. A meso-level of analysis recognizes both macro and micro levels. This dissertation does not analyze the minor group of actors at a micro level, such as one-on-one interactions between doctors and patients or diagnosing and curing infectious diseases in a healthcare system.

As I look to measure how actors conceive a system of rules (security governance) in response to threats to their security, my curiosity lies in how agents such as international organizations, NGOs, and private interest groups implement security governance in nontraditional security areas. In my quest to understand the interconnection amongst actors, I am also interested in analyzing whether other agents of continuity, such as policymakers, military, hazardous teams, and medical emergency teams, give real-time responses in the collaborative process to reduce strategic surprises. I also analyze how governments collaborate with private actors to combat infectious diseases while considering security measures. Therefore, this macro-and meso-level of inquiry allows me to focus on specific actors to create the network.

***Step 2. Unit of Investigation: Tracking and Sorting Actors***

In step two, after choosing the research level, the analyst identifies relevant actors within the primary unit of analysis linked to the focal point to design the network. My study extracts relevant actors linked to the focal point in collecting the data and designing the network. During this process, analysts include an arbitrary selection of actors depending on the data structure. This dissertation focuses on the analysis of the GLASS platform. The study extracts actors such as the participating countries and nonhuman actors such as the GLASS platform, the IHR, and infectious diseases linked to the technology database to compile the network.

***Step 3. High Visibility: Third-Party Actors and Primary Source Extraction***

In the third step, actors associated with the network drawn from sources outside the primary analysis unit were identified but considered central to the investigation. This dissertation sorts through interviews, official news outlets, observable actors, governmental events and meetings, and official government documents such as epidemiological situation reports (SITREP), congressional hearing reports, White House briefings, and the ministry of health reports. I decided which third-party actors in the data collection are most relevant to the network based on "one of the fundamental premises of global health security: the need for ongoing vigilance against the onset of an event that has never before occurred" (Lakoff 2015, 315). While there were several actors to choose from or samples to draw from, the sampling unit in this study comprises formal groups, individuals at an executive level, and organizations. This specific category of actors encompasses much of the research study since my investigation lies between a macro-and meso-level inquiry. Thus, this pool of candidates includes a targeted scope to create the network of interconnectedness but removes the broader range of actors collected in the first step.

***Step 4. Network Linkage: Global Relations and Collaboration***

The fourth step entails linking and interweaving actors based on their interconnected relationships between organizations and the willingness or discordance to collaborate in tackling the security threat. In other words, identifying actors in the network under consideration is based on their interconnectedness to other key actors. This study considers two actors to collaborate if they engage in substantive communication, such as information exchange or submitting surveillance information in adherence to a system of rules concerning task performance. Since the direction of the collaboration or interaction of actors based on document review was not uniformly apparent, I coded collaboration as an undirected network. In conjunction, no distinction was made between the different types or levels of collaboration since the documents did not specify to the full extent the collaborative nature of the relationship. The interconnection places the relational dimension of the network as a critical object. Thus, this study presents collaboration as a dyadic relation of discretionary actors.

***Step 5. Interconnectedness: Visual Representation***

The fifth step showcases the visualization process of the interconnectedness of actors. This study analyzes, transfers, and inputs the newly formed data collection and information into the Gephi software and uses descriptive statistics from the data compiled to obtain the statistical analysis. Lastly, this process creates a visualization graphics design collected to bring the visual and statistical analysis of actor interconnectedness. Thus, the optical element assists in supplementing the text, provide visual clarity, and aids readers in comprehending the subject matter.

### 2.3.2. Phase 2 Qualitative Data Collection Methodology

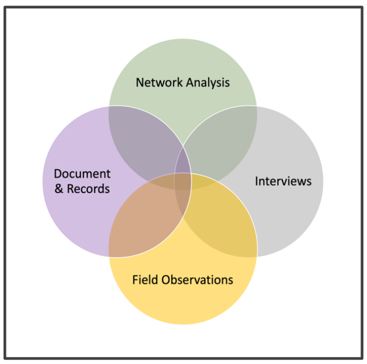
This section of phase 2 focuses on the qualitative data structure methodology, and chapter 3 presents a deep dive into the data analysis and results. The qualitative structure mainly consisted of semi-structured interviews and documentary analysis as data-gathering tools. I manually collected the materials for this data collection from a corpus of online documents from 2015 through 2021. I analyzed a range of public documents and official government documents. In addition, I conducted general research using the Internet, library visits, observations, and institutional visits. Finally, I used quantitative and qualitative approaches and data-gathering tools to conduct the case study. As the quantitative data structure illustrates in phase 1, a challenge in studying institutions and networks within a disrupted setting in international studies subsists, i.e., identifying different actors and the ties between each actor. As such, this section presents the data collection for the second phase of the dissertation's research design.

My fieldwork took place in the United States, and the data collection process included interviews, general internet research, and document review from diverse primary sources and publicly available information. I conducted semi-structured interviews with various primary sources, including government officials, NGOs, academics, and health, military, security, intelligence, and software development experts. Each interviewee possessed unique experiences and stories to share. I conducted data analysis by collecting data from the GLASS developed by the WHO. This study uses document analysis, semi-structured interviews, and framework analysis as data-gathering tools to analyze the context of collaborative actors, the actors' control of the diseases and the data during open information exchange, and the types of responders as agents of continuity during the surveillance of infectious diseases.

This section of the data collection process builds on the five-step procedure discussed in phase 1 of the quantitative data structure. In phase 2, the qualitative data structure involves triangulation, the sixth step in the methodological procedure, which involves data analysis between the interview data with data obtained from other sources. Mixing the most diverse sources allows models to discover knowledge hidden in the seas or the flowing rivers of data (Pando and Poggi 2020). I reviewed the data sources using documentary data and observational studies during the qualitative analysis. Perceptions bring additional analytical insight, and "observations work the researcher toward greater understanding of the case" (Stake 1995, 60).

I collected data from the U.S. ministry of health called HHS, the CDC, the PACCARB, congressional hearing reports, situation reports, and other official government documents, such as the U.S. government's global health security strategy. This research includes participatory analysis or direct observation review (Knoke and Kuklinski 1982). In addition, this study triangulates the data from the quantitative analysis of the actor nodes in the collaborative networks with information gathered from semi-structured interviews and documentary analysis. The diagram in figure 2.2 illustrates the methodological triangulations I used in this research study.

**Figure 2.2. Venn Diagram of the Methodological Triangulation in this Study**




Prepared by the author.

In this context, I conducted fieldwork to measure instances of collaboration in the security governance on the surveillance of infectious diseases and data control to promote a health regime. I created an analyzed dataset based on documentary analysis, comparison data, and observations. I also participated in institutional meetings, collected data from observable actors, and observed the regular pattern of relations between the network nodes. Subgroups, positions within a network defined by the patterns of relations, represent observable behaviors that connect empirical actors (Knoke and Kuklinski 1982). For this study, based on their official nature, the documents analyzed included:

- government-published white papers, briefings, and congressional hearing reports (chapters 3, 4, 5)
- military and intelligence unclassified reports and threat assessments (chapters 4, 5)
- health care infectious diseases and global health reports (chapters 3, 4, 5)

- epidemiological situation reports (SITREP) (chapters 3, 4, 5)

Observing and analyzing the practices and actions of actors influences a network's connectivity because knowledge is produced on the usefulness of technology, such as the GLASS database, and how actors collaborate to create greater global awareness of the importance of interconnectedness.

This study reviews and analyzes open-source materials by organizations and actors involved in responding to infectious disease surveillance. Infectious diseases arise as a nontraditional threat since they lie in a gray area of national health and well-being threats. By contrast, conventional security is reserved for military threats. Inspired by Goffman, I avoided potential biases connected to the materials produced for outside entities by using such backstage documents "where the suppressed facts make an appearance" (Goffman 1959, 69). This study examines how various actors (both human and nonhuman) interconnect in infectious diseases' security governance in promoting a health regime.

A determination of causality to measure security governance, such as the control of the diseases and data in the surveillance of infectious diseases, was a function of analyzing which of the eight selected bacteria with AMR data were considered as threat incidents by the member states on the surveillance platform from 2015 to 2021. I reviewed the GLASS platform and the statement reports from 2015 to 2021 related to AMR of the U.S. Department of Health and Human Services (HHS) as the ministry of health. The ministerial meetings helped to determine whether a country believed a pathogen to be a threat. Based on publicly available information, I analyzed how many times AMR was a subject of discussion by the HHS between 2015 and 2021 and how the HHS positioned the subject of AMR.

I also read summary reports of the HHS council, tracked how many times the HHS met, reviewed resolution statements, analyzed if any GLASS member states from the northern and southern subcontinents of the Americas met separately in AMR meetings and if they voted for or against any resolutions on these issues. In addition, the causal relationship includes tracking laws for safekeeping in the database by the ministries of health or nation-states that create security measures. Lastly, I reviewed statements on national security matters within the dissertation's scope, which illustrate instances of a causal relationship. Therefore, I tracked the ministry of health statements, counted how many times participating member states in the Americas declared one of the pathogens as a threat incident, whether the HHS conducted AMR-focused discussions, whether nation-states or an institution generated regulations on the global health problems, and how the statements related to the GLASS surveillance system landscape.

This study, detailed in chapter 3, also incorporates a framework method connected to a set of themes supporting the qualitative content. First, I conducted semi-structured interviews to deconstruct the openly constructed "capacity of a performance to express something beyond itself which may be painstakingly fabricated" (Goffman 1959, 69). The qualitative data structure builds upon the five-step quantitative data structure and involves an additional sixth step in the methodological procedure, triangulation. I triangulated the data through semi-structured interviews, official document analysis, and observational review. Finally, the research incorporates collaboration between actors in infectious disease surveillance and security governance. Thus, the qualitative data structure provides insights into understanding the security governance process in controlling the surveillance of infectious diseases and data sharing to promote the emergence of a health regime.

This dissertation collects diverse and extensive research materials based on theories grounded in empirical evidence. First, I accessed university and public research libraries. Second, I manually collected materials for this study by searching through online sources for documents related to the GLASS and AMR responses from 2015 to 2021. I identified the sources through various methods, including commercial search engines, such as Google, directly browsing through federal and state websites, and reviewing other organizational websites I considered potential responding agents of continuity. I continued this process throughout the data collection timeframe, retrieved information from the sources, and manually reviewed the materials. I collected and reviewed documents consisting of SITREP, maps, congressional hearing reports, White House briefings and statements, infectious diseases response reports, and other substantive materials of official government nature, such as the HHS and the CDC. Table 2.1 illustrates a tabulation of source institutions by type. The number of documents collected from the 21 source institutions approximates 1,500. Table 2.1 shows documentary data from government sources, consisting of federal and national governments. Under agencies, this research comprises regulatory, security, emergency management, and ministry of health agencies. Under the organizations' sources, this study includes intergovernmental, non-profits, NGOs, and other organizations.

**Table 2.1. Breakdown of Source Institution by Type**

| Type | Count |
|---|---|
| Governments | 8 |
| Agencies | 8 |
| Organizations | 5 |
| Total | 21 |

Prepared by the author with information from the field work.

During the collection period, I found that websites frequently reorganized information, such as in 2020 when the WHO revamped its website due to content updates and a web migration project (Appendix A, Figure 6). Highly specialized automated information search and retrieval browsing services, such as Argos, Spider, MathSearch, NEC-MeshExplorer, and Social Science Information Gateway (SOSIG), help look for new information (Kobayashi and Takeda 2000). However, an advantage to manual collection versus the information search and retrieval automated browsing services such as the crawlers mentioned earlier or intelligent agents (Kobayashi and Takeda 2000) is that the latter may not capture misspelling of URLs or organizations that change the post information and location. Thus, to adequately retrieve and document all relevant data, it was imperative to conduct a manual review and warrant the correct recovery of information.

In addition, I adopted a case study method and conducted semi-structured interviews drawn from fields that support international studies research: government officials, NGO experts, academics, institutions, healthcare experts, security experts, intelligence experts, and military experts. I interviewed people from various sectors and backgrounds who had well-established positions within their respective communities. The study revisits phase 1 of the quantitative data structure to extract information about relevant actors to conduct the interviews for the second phase of the qualitative data structure and subsequent chapters. During phase 1, I created four distinct collaborative network paths and visualization designs. As a tool, networks represent a pair of relationships in physical or social systems abstractly used to study the interconnection between components (Feng and Kirkley 2020). First, I reviewed the GLASS platform, the pathogens, and the AMR surveillance information which GLASS provides from participating member states. How are participating countries interconnect and collaborate in the exchange of open data? In this instance, global collaboration improves the understanding of AMR and informs "containment and mitigation strategies" of infectious diseases (World Health Organization 2017b, 5). Three types of information drive a source of collaboration: information commercially provided at a price, valuable strategic information that is contained unless placed in the wrong hands, and free information that actors create without compensation (Keohane and Nye 2012). In addition, data availability empowers emerging technologies such as artificial intelligence, algorithms, and high-performance computing. After analyzing the networks, I reviewed the categories with the highest and lowest degrees in the space of collaboration inspired by the third type of information driver, free information exchange between actors. Then, I narrowed down the key categories to prepare for the interviews. Finally, I conducted semi-structured interviews with diverse sources and offered full anonymity to the interviewees.

I arrived at a short list of thematic and issue-oriented questions (Appendix B, Semi-Structured Interviews) to receive a description of concepts, events, connections, links, understanding, or explanation. I analyzed the interviewee's insights and questions presented to all interviewees gained during the fieldwork to support the core research question. The semi-structured interview questions allowed an expansion of thought for each interviewee. For instance, one interviewee, an expert in policy and technology, emphasized the importance of surveillance mechanisms versus the information rights of individuals with powerful computers and the right to control the dissemination of information. Meanwhile, another interviewee, an expert in health and security, indicated the value of trust and trustworthy actors in collaboration. The interviewee emphasized the tendency to refrain from securitizing everything, even if the information generated through securitization often keeps to proprietary means.

Topics discussed during the interviewing process include what actors consider national security threats, the importance of securitization of certain matters, issues of bias in algorithms, privacy issues in data sharing, and the importance of regulatory matters, amongst other relevant matters to the dissertation. These interviews were essential and a source of additional direction relevant to my research. I interviewed 14 experts in total. I transcribed and categorized the interviews by these different themes. I chose the 14 voluntary participants based on the 16 actor-type categories enunciated in the quantitative data structure. The actor category types include academic, context group, country, funders, hazardous teams, individuals, institutions, intelligence, law enforcement, medical emergency team, military, nonhuman actors, policymakers, researchers, scientists, and security. Based on this category, I initially drafted a baseline blueprint broken down into five categories by interviewee practice in the collaborative network (see table 2.2).

**Table 2.2. Baseline Descriptive Actor Participants in the Collaborative Network by Practice**

| Academic | Healthcare | Intelligence | Security | | Military |
|---|---|---|---|---|---|
| | | | General | Cybersecurity | |
| • Professors | • Ministry of Health<br>• Medical Officer<br>• Epidemiologist | • Department of Defense<br>• Technology and Policy Expert | • Security and Information Technology Executive | • Communications<br>• IT Department<br>• Cybersecurity Expert | • Branch of U.S. Armed Forces |

Prepared by the author.

However, as I received more interviews and data collection, I expanded table 2.2 themes, and among the 16 categories, I spread the interviewees into seven categories. Some interviewees were experts in fields that also covered two to three types. Table 2.3 provides an overview of the interviewees spread out among the categories. Out of the sixteen categories, seven categories included 14 interviewees (academic, NGO, healthcare institution, intelligence, military, researchers, and security), and nine contained no interviewees. The interviewees included medical officers from the WHO, AMR lead executives from the WHO, officers from an NGO, special operations military executives, military officials, military officers from the Department of Defense, officers from the CDC, and a medical doctor and advisor from PAHO, professors in academia, intelligence consultant in sustainable development (Appendix B, Semi-Structured Interviews).

Furthermore, the interviewees were conducted by telephone, in person, and via electronic mail between 2019 and 2020. In addition, I created initial interview questions discussed and confirmed with my primary thesis advisor (Appendix B, Semi-Structured Interviews). These questions touched on specific keywords in connection to the subject matter of the study (health and security). The keywords included: surveillance systems, open-source, security governance, regulations, GLASS, private and public actors, interconnection, collaboration, national security, and dissident groups. Appendix B, Semi-Structured Interviews, provides the list of initial interview questions. From this initial set of questions, I allowed the interviewee to transgress organically, which led to further development and exploration of the research while, at the same time, not straying from the main research question.

These interviewees were chosen in the study because they are experts in the respective fields that align with health and security within the scope of AMR, the primary subject matter of the dissertation. However, the global pandemic presented limitations in conducting additional interviews. Section 5.2 details the limitations of the practice.

**Table 2.3. Spread of Interviews Among Categories**

| Category | Interviewees by category | No. of interviewees |
|---|---|---|
| Academic | 2 | 2 |
| NGO Institution | 2 | 2 |
| Healthcare Institution | 5 | 5 |
| Intelligence | 1 | 1 |
| Military | 3 | 3 |
| Security | 3 | 1 |
| Researchers | 2 | - |
| **Total** | **7 categories** | **14 interviews** |

Prepared by the author.

The data collection consisted of interviews with stakeholders in health and security in the private and public sectors and experts in the field, including local, national, and international government and non-government officials. Thus, based on the data formulated during the quantitative data structure network analysis, I interviewed specific actors according to categorical themes for the qualitative data structure phase and ensuing chapters.

**Partial Conclusions**

In conclusion, this chapter provided the blueprint for the empirical research of the study aimed to answer the research question. In the first section, I provided readers with an understanding of the research design methodology. The second section discussed the methodological limitations of using a mixed-method approach in this study. Finally, the third section focused on the data collection process, which included phase 1 of the quantitative data structure and phase 2 of the study's qualitative data structure.

This section concludes by noting that networks allow us to acquire more knowledge without adding more information. At the same time, qualitative analysis reinforces statistical aspects gained during network analysis. Thus, combining quantitative and qualitative information gives experts and researchers a better explanation and understanding of the complete story. Furthermore, mixed methods allow a broad range of thought, analysis, and results. Utilizing an intuitive research approach, individuals, multiple disciplines, and diverse industries have used mixed methods in their everyday lives. Thus, the process allows the collection, combination, and integration of a combined data collection.

Mixed-method research offers a comprehensive understanding of the research problem, but it also presents limitations that must be acknowledged. Managing time, generalizing data, and analyzing data from two different data points can be challenging. Moreover, when integrating the results of both data sets, the data can transform, and conflicting results between qualitative and quantitative data can challenge the validity and interpretation of the evidence. The imbalance in data representation is a disadvantage that can hinder the interpretation of the data results. Therefore, researchers must consider these limitations and develop strategies to address them in their mixed-method research design.

Nonetheless, the approach allows the investigator to balance out the limitations because mixed methods provide a richer source of information, clarity in knowledge production, and an amalgamation of content. The triangulation of information allows for the expansion and development in the study. A quantitative data structure provides an air of dry technical objective terms. The process of interviews and triangulation of documents within the qualitative data structure brings the technical aspect down to a more holistic subjective level. By combining qualitative and quantitative research, my study generates greater comprehension and a more complete picture of the phenomenon under study (emergence of a health regime in the surveillance of infectious diseases and AMR).

This study uses mixed methods to identify actors in the network and their interconnectedness. The quantitative research method allows multiple actors to connect to the primary unit of analysis and other relevant actors with as much common interest in the boundary object. This study creates four actor-network graphic designs as helpful visualization techniques for network analysis needs, detailed in the data analysis section of chapter 3. These distinct paths of interconnectedness illustrate surveillance and collaboration in combating infectious diseases. The designs also showcase context information of actors disassociated from the network but integral to network analysis.

The research shows that a network comprising of diverse key actors, who interconnect and exchange ideas and knowledge across different disciplines, can drive information exchange, knowledge production, and shape various industries in terms of science and security. By adopting a network analysis perspective that considers the overall structure of actor relations, a foundation can be established to develop the dimensions of security governance described in the subsequent chapter. The integration of quantitative and qualitative analysis through a mixed-method approach can provide valuable scientific support.

In conclusion, the ideas presented here have implications across various fields and disciplines. The methodology employed in this study can make significant contributions to research areas such as intelligence, security and strategic studies, military operations, disaster risk reduction, and strategic management. Using network analysis, researchers can study groups, people, and their interactions, which can help military, security, and intelligence analysts identify significant threats and relevant actors connected or linked to the threat. It can also aid decision-makers and stakeholders in identifying actors to collaborate and engage with an organization such as the WHO. Disaster management specialists can use relevant methodological data to identify appropriate actors in the organizational network to assist the organization in tackling and minimizing risks from those disasters. While mapping an actor-network creates an endless and exhaustive list, knowing the key players in the network is a good place to start organizing, knowing what to do, and collaborating with others when disasters or emergencies strike.

The following chapter contains additional information on the case study of AMR's WHO-GLASS surveillance system. It starts with a framework for security governance metrics and presents the results of data analysis and data collection. Furthermore, the chapter provides a thorough examination of the case study from the perspective of countries in the northern and southern subcontinents of the Americas. This analysis aims to reinforce the collaborative network map on infectious disease surveillance, evaluate the performance of collaborative actors, and examine their interconnectedness.

## Chapter 3. Case Study

> It is a serious thing just to be alive
> on this fresh morning in the broken world.
> It could mean something.
> It could mean everything.
> —Mary Oliver

### Introduction

This research focuses on a logical (deductive) model of explaining theories grounded in empirical evidence based on a specific case study. This chapter builds upon the data collection methodology from chapter 2 by reflecting on and exploring the five dimensions of security governance in the context of data exchange in an open-source database on the surveillance of infectious diseases. How do actors manage, coordinate, and regulate security governance in a global open-source database? This dissertation chose the case study of the WHO GLASS system that tackles AMR to illustrate the dimensions. According to the WHO, AMR is a "global health security threat that requires concerted cross-sectional action by governments and society as a whole" (World Health Organization 2014, XIII). Likewise, the WHO notes GLASS as a "system that enables standardized global reporting of official national AMR data" (World Health Organization 2015b, 7). Since the WHO declared AMR one of the top ten global public health threats (World Health Organization 2020b), the case study focuses on the GLASS system and AMR data on selected human bacterial pathogens in the Americas. The case analyzes establishing a security regime within a health regime through interweaving links between human and nonhuman actors.

In particular, the study analyzes publicly available information from the GLASS database to identify and examine AMR's actor collaboration. The case study identifies that security governance through OSINT promotes the emergence of a health regime to monitor infectious diseases through the following:

1. Diverse actors such as nation-states and institutions convene through conferences and meetings and adopt collaborative regulations;
2. An international health organization that facilitates collaboration on the control of infectious diseases;

3. A global threat of infectious diseases which structures the production of processes, rules, and institutions for global health governance; and
4. A global technology database that connects state and institution functions as a boundary object working as an inscription device that facilitates the transmission of information between actors.

Furthermore, the research analyzes the collaborative use of open-source intelligence or publicly available information from the WHO-GLASS surveillance system database to explore actor collaboration on threats of infectious diseases. In conducting research interviews, the necessity of more conceptual work became clear to understand how to structure a discussion of security governance in terms of the control of data and surveillance of diseases. Moreover, the inspiration for the study also involves the microbes themselves, how pathogens evolve, and the control of infectious diseases. Various global actors participated in the GLASS system to monitor infectious diseases. Although the initial case study focuses on AMR in the surveillance of the eight human bacterial pathogens, this dissertation also includes the previously unidentified coronavirus disease (COVID-19) as contemporary context research evidence of interconnectedness. Which actors conform to a system of rules (security governance) in response to a threat? How many WHO member states from the southern subcontinent of the Americas contributed to the GLASS collaborative system during the scope of the research? What type of security governance process through open-source information promotes the emergence of a health regime to monitor infectious diseases? An increased engagement of interconnected actors in this changing and increasingly globalized world provides forward movement. Moreover, actor interconnectedness adds to the regulation or security governance process: the WHO helped create solutions and acted as a bridge between member states and boundary objects.

The case study shows the promotion of a health regime through various factors such as states that raise the issue higher on the international agenda and conduct conferences on the subject matter, an international health organization that facilitates collaboration, a new threat such as an infectious disease that produces systems of rules in the governance of global health and security; the advancements of technology which facilitates the exchange of information; and additional security threats such as cyber-attacks that emerge from the initial threat. This chapter of the dissertation provides further details and a deep dive into the investigatory nature of addressing the core research question of why security governance through an OSINT technology database of the WHO promotes the health regime on the surveillance of communicable diseases in the Americas from 2015 to 2021.

As discussed in section 1.2.3, to answer the core research question, this dissertation analyzes the case study in conjunction with the five dimensions of security governance: heterarchy, interaction, institutionalization, ideas, and a collective purpose (Webber et al. 2004; Rosenau 1992; Holsti 1992). The dependent variable (output information), which causes the independent variable measures the perception of nonconventional threats in the emergence of a health regime. The independent variable (input information) is the security governance of communicable diseases through an open-source intelligence database. The study looks at the control of diseases and the data during information exchange through publicly available information in the surveillance of infectious diseases. As intervening variables or an intermediary that looks to disrupt the link between the independent and dependent variables, the case study also analyzes and reviews outside factors such as the potential manipulation of human bias, algorithms, restrictions in the spread of data exchange, lack of timely information, weaknesses in the policy instrument, or countries beset by internal administrative conflicts. Thus, through the lens of security governance, the case study seeks to explain the control of diseases and data and the results of the actions of actors that tips the socio-economic actor-network scales.

The scope of the data collection focuses on the timeframe from 2015 to 2021. During this timeframe, the WHO developed the GLASS for the surveillance of eight human bacterial pathogens. In addition, the GLASS results arise from a global collaborative effort in the surveillance of AMR (World Health Organization 2017b). Thus, the surveillance of AMR supports notification of infectious disease outbreaks, and the GLASS network supports data sharing and member states in their surveillance efforts of AMR at a global level.

Surveillance mechanisms inform “policies and infection control and prevention responses” (World Health Organization 2015b, 3). The key priority for a successful surveillance system in response to health security threats includes collaboration, communication, and harmonization between regional, national, and international organizations and actors. Like AMR, the coronavirus remains a focus of attention for health authorities, institutions, decision-makers, stakeholders, and government officials across countries. In addition, the novel infectious disease serves as context research and a reinforcement mechanism to the investigation due to the connection in the surveillance of infectious diseases. Therefore, the case study intends to inspire thought-provoking analysis and emphasize actor-network interconnectedness and the involvement of technology in the surveillance of the primary GLASS pathogens and other infectious diseases that appeared during the study, such as COVID-19, as context research.

This chapter divides into four sections. The first section, 3.1, provides the data analysis and results from the data collection in chapter 2. Based on the data analysis, a discussion of communicable diseases follows in section 3.2, showcasing the increase of nonconventional threats (infectious diseases) and the actors contributing to the collaborative network. The section also explains the pathogens that allow fluidity of thought in the remaining empirical work regarding the type of threat within the healthcare sphere that raises security concerns. The third section, 3.3, furnishes the security governance metrics framework, which acts as a blueprint and baseline for the final section. Finally, the last section, 3.4, discusses the security governance dimensions. Therefore, I collectively employ the data analysis, nonconventional threats, metrics framework, and features to capture future security governance mechanisms' potential risks and benefits in the collaboration and interconnectedness of actors.

## 3.1. Data Analysis and Results of Phase 1 (Quantitative) and Phase 2 (Qualitative) Data Structures

This section provides the data analysis and results in phase 1 (section 3.1.1) of the quantitative data structure and phase 2 (section 3.1.2) of the qualitative data structure to construct the collaborative networks and interpret the context of actors linked in the network through the monitoring of diseases and the control of data during information sharing.

### 3.1.1. Phase 1: Quantitative Data Analysis in Tracking the Interaction of Actors to Construct a Network

Significant emergency matters affect the health of individuals surpassing the risk of infectious diseases. Collaborating with different actors is fundamental in preparedness, response, and risk reduction during crises. This research views threats to national security, such as infectious diseases, through a philosophical lens. How people and things interconnect and collaborate in combating a threat presents a headspace for egalitarian thought. I broaden the horizon and trace the actor network by replacing "actors of whatever size by local and connected sites instead of ranking them into micro and macro" (Latour 2005, 179). The actors reveal the narrow collaboration space, and the network explains the trail of interconnectedness. Thus, while I sort the actors through the telescope of international studies using a macro-and meso-level inquiry of analysis, I also leave ample space to explore other realms of actor inquiry and investigation. Furthermore, I broaden the prismatic scope for this research with science and technology studies, followed by ANT as a theoretical lens and network analysis as composition. This interdisciplinary approach allows me the best methodological framework for sorting the relevant actors to map the network.

Which actors enhance and detract from the network? During the selection process of actors in the network, I incorporated contributions from ANT, such as technologies of translation and inscription, black boxing (erasing or normalizing), and network analysis. ANT focuses on heterogeneous networks of human and nonhuman actors constructed by defending change models and building collaboration. Latour (2005) indicates not to hold a bias of discriminating between the human and the inhuman, but instead to center on actors, such as human, nonhuman, skilled, and unskilled, that exchange properties. Adopting a holistic view allows the contribution of the human and nonhumans to flourish in network analysis. Things and objects have an agency that influences actors to do or not to do certain things (Latour 2005). Thus, this research includes policy instruments such as the IHR and infectious diseases as nonhuman actors participating in the collaborative network. The introduction of contagious diseases as a nonhuman actors in the network changes the thought process of production that redefines security threat and collaboration perceptions.

This research also includes actors such as nation-states and organizations that collaborate in the surveillance of infectious diseases. Moreover, in Winner's felicitous terms, "technologies are not merely aids to human activity, but also powerful forces acting to reshape that activity and its meaning" (Winner 1986, 6). Thus, used as context, technological entities such as the GLASS platform acts as another actor in the collaborative network. Furthermore, introducing the technology database as a node in the surveillance practice of infectious diseases transforms what participating countries do in the system. Therefore, this study focuses on all types of actors to map the network.

Moreover, this study uses the criterion of mutual relevance (Knoke and Kuklinski 1982; Laumann, Marsden, and Prensky 1982) to set the boundaries in the network. The realist approach draws upon four pieces of empirical evidence: positional, decisional, repetitional, and relational (Knoke and Kuklinski 1982). During the boundary specification process, I adopt the four empirical evidence by extracting from the data collection formal organizations with prima facie interests (positional), groups appearing at congressional hearings (decisional), influential groups (repetitional), and organizations named by organizational representatives during interviews (relational). However, I avoid a complete realist approach and lean towards a more progressive mainstream liberal institutionalist approach in establishing the boundaries. I include actors with no direct edge links to the interest in the substantive area but are part of the overall system because mutual relevance "does not always set precise and definite boundaries" (Knoke and Kuklinski 1982, 26). Limiting the network to only those linked and not including actors disregarding common interests creates a weakness in the network. Thus, a complete network of actors increases the productivity and process of production in the network analysis results.

Similarly, in addition to choosing a specific sampling unit, I decided that the relational form and content (Knoke and Yang 2008, 1982) are based on shared interests and modes of interaction in collecting the data. On the one hand, the content was based on the surveillance of infectious diseases and the reporting of antimicrobial resistance. On the other hand, it was based on the fight against novel threats, such as COVID-19. The actor's drive is to combat the global threat of infectious diseases since "microbes do not respect national boundaries" (World Health Organization 2017b, 7). The type of form used in selecting and narrowing down the different actors in creating the network was based on the modes of interaction to attain a social reality. Furthermore, during the selection process, this study focused on the actors' actions, observable actors conducting and participating in official meetings, the creation of official reports, interviews, or participation in the surveillance system of infectious diseases. I monitored these actions that brought veridical perceptions of the triggered security threat.

Likewise, it is essential to be aware of the limits of a technology application that includes threats to public health and safety, exhausts valuable resources, degrades environmental quality, and causes societal stress (Winner 1986). In removing the technology database from the network, would the actors still interconnect in the surveillance of infectious diseases? The COVID-19 outbreak illustrates the interconnectedness and collaboration of actors when a threat to national security appears with or without a surveillance technology platform. Along the same lines, the pandemic has shown that other innovations have developed in the technology ecosystem. While in other instances, when a nontraditional security threat arises, actors are forced to use technology platforms and adhere to a new norm to sustain economic growth. Thus, I limited the type of form to actors collaborating across the corresponding setting between nation-states and institutions. This study shows that participating nation-states inputted their country profiles and information onto the GLASS technology platform. The participating countries, delegates, and institutions met with HHS representatives to discuss issues on antimicrobial resistance. Stakeholders convened to discuss national security regarding the threat of infectious diseases. Thus, the study includes participating countries, institutions, and stakeholders in the actor-network design.

Collectively, the diverse content that includes social and economic interests and drives manifests through collaboration between participating countries and institutions. Through instrumental relations, actors (both human and nonhuman) link with each other to secure the adequacy of shared information while the human actors adhere to the rules implemented by the IHR. For example, my analysis shows that the WHO relies on countries' collaboration to "conduct their own national surveillance" to monitor and gather the data into the GLASS reporting platform (World Health Organization 2016b, 1). In the United States, the AMR surveillance system comprises three components: a national coordinating center, a national reference laboratory, and the AMR surveillance sites (World Health Organization 2016b, 3). This generic content or communication relation allows me to narrow down the relevant interconnected actors to create the network. Thus, the network includes the AMR, NRL, and NCC as actors linked to boundary objects.

Furthermore, my level of the data analysis lies in the intersection between an egocentric network and complete network analysis (Knoke and Kuklinski 1982). I use sources that include official government reports such as SITREP, congressional hearing reports, and ministry of health reports. I analyze the GLASS database and extract what I consider relevant actors interconnected in the network and linked to the boundary objects: GLASS, the IHR, and infectious diseases. Does a specific tie exist between the GLASS system and all other relevant actors? Similarly, is there a link between the IHR and the actors in the network? In switching focus from the GLASS database to the WHO as an institution being the center of gravity, does the landscape of interconnectedness promote a health regime change? What is the level of intensity or strength between the relations? Lastly, if we remove the GLASS surveillance platform as the primary focal point, would these actors still collaborate in the path towards the fight against new and emerging infectious disease threats? My findings reveal that the WHO, the ministry of health, the Pan American Health Organization, and nonhuman actors such as infectious diseases, the GLASS database, and the IHR are the main actors in the collaborative network.

However, further analysis reveals that private interest groups and NGOs, such as the Bill & Melinda Gates Foundation, academic institutions such as the Columbia University's Mailman School of Public Health, and other institutions such as the HHS and the CDC play a role in the collaboration and interconnectedness of actors. All these diverse but interconnected actors were imputed into the Gephi software program to create the graphs and networks. Since my dependent variable is the perception of nonconventional threats in the emergence of a health regime, I chose infectious diseases as the main focus of global actor interconnectedness. Thus, infectious diseases, and nonhuman actor, arises as a nonconventional threat to national security.

In conjunction, the actor nodes, *infectious diseases*, were inputted into Gephi, which allowed me to focus on a health regime as the central unit of analysis. Moreover, choosing this boundary object as the center of gravity in creating interconnectedness encompassed the GLASS human priority pathogens and the novel COVID-19 disease. Furthermore, a collective purpose or a common interest, such as combating antimicrobial resistance, triggers security governance. "AMR is a global health security threat that requires concerted cross-sectional action by governments and society as a whole" (World Health Organization 2014, XIII). Additionally, the security governance of data sharing in the surveillance of infectious diseases requires involvement from diverse actors, including at the top, the bottom, local, and national levels, public-private sectors, and various industries (Clark-Ginsberg 2020; Berthod et al. 2016). Thus, once a national security threat emerges, actor reaction, linkage, and deflection commence, triggering security governance.

Moreover, during the scope of the investigation, various meetings were held by the HHS, including council members and federal representatives, to discuss the global problem of antimicrobial and antibiotic resistance. For instance, in 2016, Argentina, Brazil, Ecuador, and the United States participated in a high-level meeting on antimicrobial resistance convened by the

President of the General Assembly of the United Nations. The participating countries enrolled in the GLASS database from the global south included Argentina and Brazil. In addition, in 2016, global leaders, heads of state, and heads of the delegation met at the United Nations General Assembly to commit to the fight against antimicrobial resistance. One of the panelists was the Minister of Health of Argentina. In addition, NGOs, civil society organizations, and academic institutions participated in the high-level meeting on AMR.

Indistinguishably, just as global leaders come together to combat the fight against AMR threats, the COVID-19 pandemic brought astronomical political, economic, and cultural repercussions. In March 2020, leaders of the seven wealthier nations, including Canada, France, Germany, Italy, Japan, the United Kingdom, and the United States, held the G7 summit via teleconference to discuss the impact and challenges of COVID-19 (U.S. White House Office 2020a). Likewise, in March 2020, the G20 leaders held an emergency videoconference to coordinate efforts in response to the COVID-19 pandemic (G20 Saudi Arabia 2020). Furthermore, in September 2020, the Presidential Advisory Council on Combating Antibiotic-Resistant Bacteria (PACCARB), supported by the HHS, held a virtual meeting to discuss the impact of COVID-19 and its effect on AMR (U.S. Department of Health & Human Services 2020a). Finally, in November, the 2020 G20 Riyadh summit was held virtually and included a discussion on handling global threats such as the COVID-19 pandemic (G20 Riyadh Summit 2020).

Global pandemics, cybercrime, and emerging technologies bring diverse actors together to combat nontraditional threats, which have come to the forefront of the international agenda as issues of concern for civil society and nation-states that serve them. For example, in March 2020, elite hackers attempted to break into the WHO (Satter, Stubbs, and Bing 2020). Not only did the world have to confront a pandemic attack, but countries, too, had to battle hacking attempts. Thus, my quantitative analysis began linking one primary actor (infectious diseases) to the rest of the actors with a common interest (surveilling the viruses, combating the diseases, and containing the outbreak) because but for the potential national security threat, actor collaboration and interconnectedness would not occur as quickly.

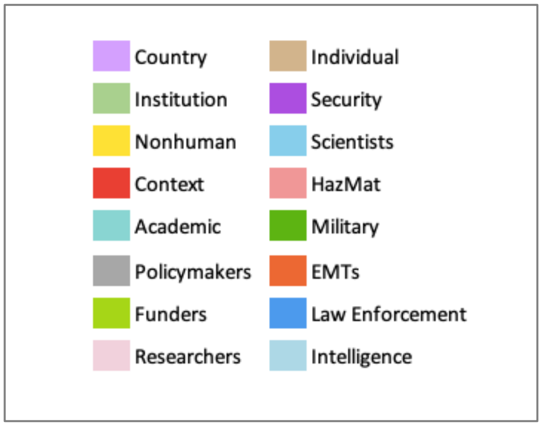
Choosing relevant actors to create the network entails opening the political and social network to understand the complex relationships that develop in promoting a health regime. Limiting the network to specific actors, such as choosing only executive, legislative, and private groups, does not explain the changes in the interconnection of actors and the reasoning behind actor participation when there is a common interest. Thus, my study showcases the interplay of diverse interests and collaboration, such as meetings on antimicrobial resistance and infectious diseases, funding streams, academic research avenues, forum involvement regarding national security issues, and sessions held between participating countries and institutions.

Moreover, intermediary groups such as private interest groups and academic universities with common interests skew and broaden the network. Thus, for purposes of creating the network, I encoded the data by categorizing the actors into sixteen categories: academic institutions, context groups, nation-states (country), funding partners, hazardous materials response teams (HazMat), individuals, genera-type institutions, intelligence, law enforcement, emergency medical teams (EMTs), military, nonhuman, policymakers, researchers, scientists, and security. The specific category list allowed me to build the network.

**Mapping the Network**

This section provides details of statistical analysis and scientific information. To create and map the networks, the premise of this study commences with two goals: (1) to develop maps that illustrate the relational links that actors have to infectious diseases, (2) to create a map that shows the interconnection of actors with each other based on a nontraditional security threat such as infectious diseases. I mapped four distinct network paths by the end of the quantitative data structure design process. This research created sixteen network actors categories represented by distinct colors, illustrated in figure 3.1.

**Figure 3.1. Actor Areas by Colors**




Prepared by the author.

The illustration shows the actor areas by their corresponding colors, which include the country (pastel purple); institution (asparagus green); nonhuman (yellow); context (red); academics (pale teal); policymakers (gray); funders (lime green); researchers (pastel pink); individual (pale brown); security (vibrant purple); scientists (sky blue); HazMat (salmon pink); military (clover green); EMTs (orange); law enforcement (blue); and intelligence (light blue).

Determining the appropriate methods and findings means concentrating first on one path, sorting through the mass of issues, such as those involving public health, and taking each separately to make sound judgments (Winner 1986). To create the visual representations, I created four types of nodes and edge paths involving public health and security in promoting a health regime. The nodes of the graphs represent objects, and the edges represent the relationships. Here, the nodes represent the different actors in the network. The edges, perceived as object A to object B, represent the interconnection of actors through the review, observation, and analysis of official meetings, events, or documents that exist from actor A to actor B, and so forth. This study's dataset includes nodes representing nation-states, institutions, nonhumans, individuals, context, policymakers, military, hazardous teams, EMTs, data scientists, researchers, academics, security experts, intelligence experts, funders, and law enforcement. Furthermore, these actors provide examples of theoretical representation to strengthen global health on the surveillance of AMR and the collaboration of data sharing to combat infectious diseases such as the GLASS pathogens and COVID-19.

The first network, CNPA, includes the GLASS database and the GLASS pathogens as nonhuman actors (nodes) and research context that helps shape the research. In this design, the nodes contain the actors connected only to the GLASS platform. The network excludes the nonhuman actor COVID-19, as the threat occurred during the latter part of the investigatory process. In this design, rather than separately listing the names of each of the selected GLASS pathogens, this study coded the eight bacteria nodes under one named pathogen.

The second network, CNPB, includes nodes where the focus is only the GLASS technology database. What happens to the network after removing the threat (infectious diseases) and the technology database created as the glue that links all actors? How is a database enough to hold muster in connecting or persuading actors to collaborate without disease as a trigger? This research removed the nonhuman actor, GLASS pathogens, and only included the GLASS technology database as the main actor. Therefore, technology remained the main focal point of design and how technological advancements connect all relevant actors in the network.

The third network, CNPC, includes nodes with only the GLASS pathogens as a known threat. In this design, I decided to flip the script. This study removes the GLASS database as an actor, includes the GLASS pathogens as the primary point of contact, and links relevant actors to the focal node. The study further breaks down the eight human bacterial pathogens connected to their respective target GLASS countries. This scenario illustrates how the threat is the common nuclei that fuse all relevant actors and the potential irrelevancy of a technological actor or technological advancements in the collaborative sphere. Therefore, this design strives to illustrate how a public health crisis triggers actor collaboration.

In the fourth network, CNPD, I decided to make the infectious diseases node the center of gravity or the focal point that connects all relevant actors to the boundary object. In this design, the study includes the COVID-19 coronavirus, an unknown novel threat to illustrate and reinforce the diverse but interconnected network of actors with a common interest: to eradicate a threat in the interest of national security. Thus, this path distinguishes the nodes as the GLASS database, GLASS pathogens, and the coronavirus. Furthermore, this design further breaks down the category into two different nodes: GLASS pathogens and COVID-19, by giving the nodes separate code names, which allows the expansion of analysis and comparison between the interconnection of actors from the perspective of the original pathogens versus the novel coronavirus. Thus, like CNPC, the threats trigger the actors to collaborate and interconnect.

**Displays: Network Visualization and Analysis**

The visualization displays were created in Gephi using the Force Atlas algorithm model. This force-directed layout brings connected nodes together inside the network and moves unconnected nodes outside the network. Network analysis "offers a powerful brush for painting a systematic picture of global structures and their components" (Knoke and Kuklinski 1982, 10). Network analysis accesses systems comprising node points that serve a function and edges, which are connections that link to the nodes (Clark-Ginsberg, Abolhassani, and Rahmati 2018; Kalyagin, Pardalos, and Rassias 2014). Furthermore, network analysis assists in revealing complex data patterns such as how interdependencies shape risks (Clark-Ginsberg, Abolhassani, and Rahmati 2018); in analyzing policy-making (Marsh and Smith 2000); in understanding social networks (Knoke and Yang 2008); and in studying statistical procedures in the economic market (Kalyagin, Pardalos, and Rassias 2014). Moreover, the statistical analysis illustrates the probability of comparing various events or scenarios (Winner 1986). Therefore, a myriad of different disciplines uses network analysis.

The first network, CNPA, includes nodes with the main focal points: technology database and infectious diseases. I ran a graph in Gephi to view which actors connected in the network. This actor-network design contains 117 nodes and 571 edges. The graphic design shown in figure 3.2 illustrates the various connection of actors in the network when the focus is on the GLASS surveillance platform and GLASS pathogens. This first network path acts as a primer as a canvas introduces new colors. Thus, this design acting as context research, sets the stage or framework of the overall network that influences the three path designs.

The results from the CNPA network show an undirected network interpretation parameter and graph density of 0.084 and an average degree of 9.761 (Appendix A, Data, Figure 1). Another centrality measure, PageRank, calculates which "important node receives connections from many other important nodes" (Lambiotte and Schaub 2021, 19). The results show parameters with a probability equal to 0.85 and an epsilon of 0.001, with most nodes clustered at the lowest count from 0 to 5 and 1 node reaching 90 counts (Appendix A, Data, Figure 1). Furthermore, the results show that the ego's network consists of two weakly connected components (Appendix A, Data, Figure 1). The results further illustrate an average clustering coefficient of 0.416 as the mean value of individual coefficients with a parameter of 100 iterations. This study employs two centrality measures, eigenvector centrality and betweenness centrality, as analytic techniques to understand the network results. The eigenvector centrality is based on a circular argument, where important nodes are, by definition, nodes adjacent to many important nodes (Clark-Ginsberg 2020; Borgatti, Everett, and Johnson 2013; Knoke and Kuklinski 1982). The following formula of the eigenvector centrality shows that e represents the score of the eigenvector centrality and lambda ($\lambda$) represents the eigenvalue, a proportionality constant (Borgatti, Everett, and Johnson 2013):

$$e_i = \frac{1}{\lambda} \sum_j \theta_{ij} e_j$$

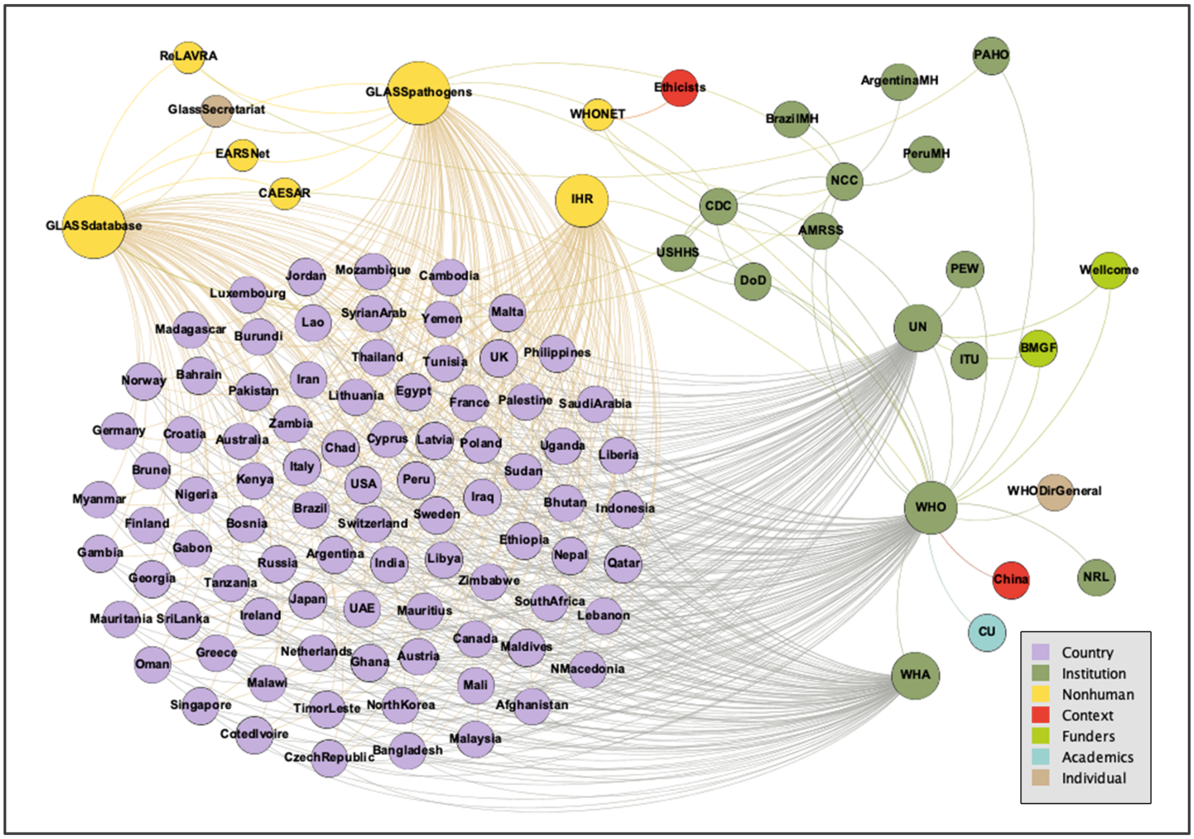
Moreover, the eigenvector illustrates the importance of the nodes within the network. In this study, the eigenvector centrality distribution (Appendix A, Data, Figure 1) shows nodes with a high score of 1, illustrating a greater level of influence in the network. The betweenness centrality measures how frequently a node appears on the shortest path between two network nodes (Clark-Ginsberg 2020; Borgatti, Everett, and Johnson 2013; Knoke and Kuklinski 1982). For example, the following formula of the betweenness centrality shows that g(ijk) represents the number of geodesic paths that connects i and k through j, and g(ik) represents the number of geodesic paths that connects i and k (Borgatti, Everett, and Johnson 2013):

$$b_j = \sum_{i<k} \frac{g_{ijk}}{g_{ik}}$$

In this research, the betweenness centrality distribution results in a diameter of 5, a radius of 0, and an average path length of 2.022 rounded off to the nearest tenth (Appendix A, Data, Figure 1). In conjunction, it is important to review the hubs' mutually reinforcing relationship (Kleinberg 1999), which looks at good relationships. Graphs with mutual relationships illustrate a strongly connected relationship (Borgatti, Everett, and Johnson 2013; Kleinberg 1999). The Hyperlink-Induced Topic Search (HITS) measures the quality of the node's link (Borgatti, Everett, and Johnson 2013; Kleinberg 1999). The results of the HITS metric report show, with an

E = 1.0E – 4 parameter, a hubs' distribution score of 0.5 ranging between 5 counts at the lower spectrum to 90 counts at the highest spectrum.

**Figure 3.2. Sociogram of Collaborative Network Path A using the GLASS database and GLASS pathogens as focal node context in the actor-network**



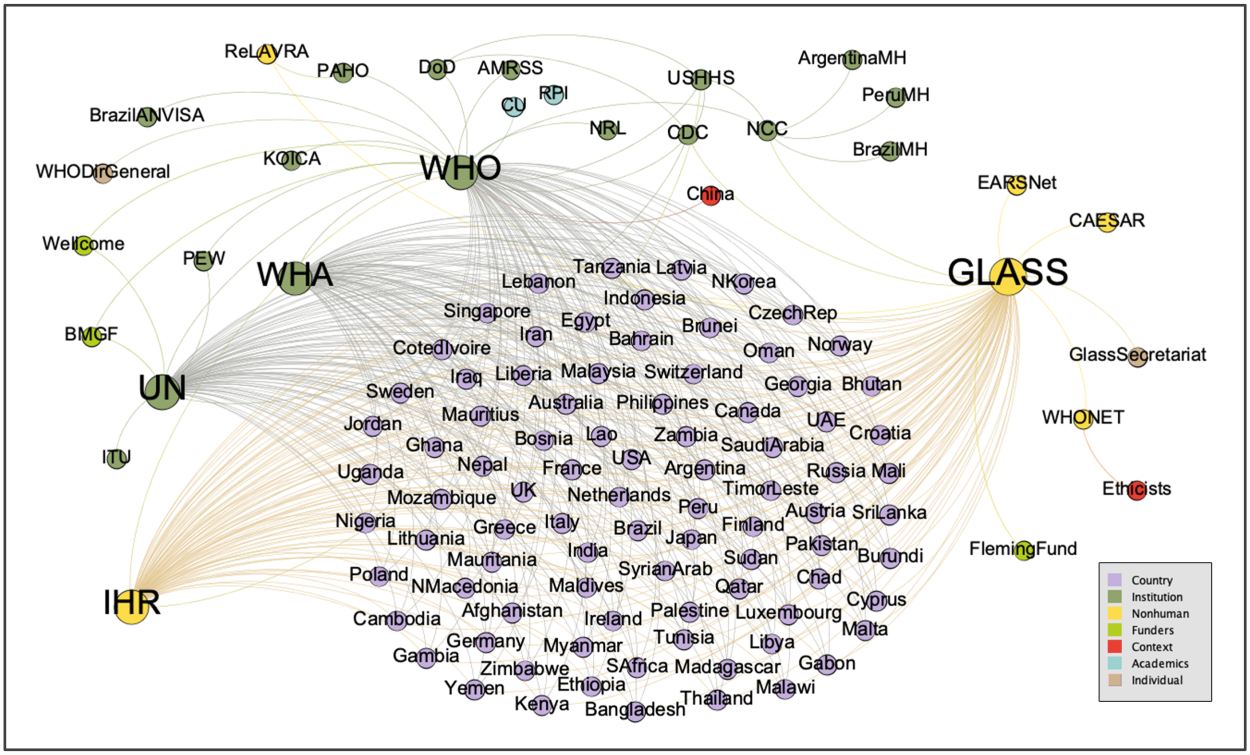

Prepared by the author.

Lastly, to review the network's vulnerability, I looked at the size distribution of the modularity or community detection (Borgatti, Everett, and Johnson 2013; Blondel et al. 2008). As another measure, modularity compares the edge density within a community to the edge density between communities. Modularity compares the number of internal links to an expectation of the number distributed at random (Borgatti, Everett, and Johnson 2013). It helps to analyze network communities by identifying densely connected nodes to each other (Blondel et al. 2008). A community ensues as a group of nodes more densely connected to each other than the rest of the network. Thus, modularity allows the study to obtain a general idea of the structure. The results of this study show modularity of 0.050 in five communities (Appendix A, Data, Figure 1). Since the results have a low modality, there are fewer vulnerabilities by having these actors interconnected in the network. Thus, the design shows a positive interconnection when the GLASS database and GLASS pathogens are the focal points. However, did the results skew as I inputted information, tweaked new actors, and switched the focal point into the research design during the data collection and analysis process? Next, I took the context from CNPA and created two more designs, CNPB and CNPC.

The second network, CNPB, includes nodes with only the GLASS database. This study removes the GLASS pathogens in graphic design CNPB. I ran a Gephi graph to analyze which actors connected to the network when removing infectious diseases from the scenario. This actor-network contains 119 nodes and 477 edges. The graphic design shown in figure 3.3 illustrates a visual graph with different connections of actors in the network when the focus is away from infectious diseases and instead towards advancements in technology. In this case, the main actor is the GLASS technology database. Now begins adding colors to the canvas and analyzing how the actor-network becomes a painting. Does the network begin to show further interconnectedness, or do the actors remain the same with lesser degrees of centrality?

The results from the CNPB network show an undirected network interpretation parameter and graph density of 0.034 with an average degree of 4.008 (Appendix A, Data, Figure 2). The results show parameters with a probability equal to 0.85 and an epsilon of 0.001, with most nodes clustered approximately from 0 to 9 counts and one node reaching 90 counts (Appendix A, Data, Figure 2). Furthermore, the results show that the ego's network consists of two weakly connected components and an eigenvector distribution with a high score of 1 (Appendix A, Data, Figure 2). The results also illustrate an average clustering coefficient of 0.393 as the mean value of individual coefficients with a parameter of 100 iterations (Appendix A, Data, Figure 2). The betweenness centrality distribution results in a diameter of five, a zero radius, and an average path length of 2.02, rounded off to the nearest tenth (Appendix A, Data, Figure 2). The mutually reinforcing relationship (Kleinberg 1999) of the nodes with the largest connections to many authorities results in a hubs' distribution of a little over 0.5 scores with a range from 0 to over 80 counts (Appendix A, Data, Figure 2). The HITS metric report shows no counts listed between the 10 and 80 range under a parameter of E=1.0E-4.

**Figure 3.3. Sociogram of Collaborative Network Path B using GLASS database as focal node in the actor-network**

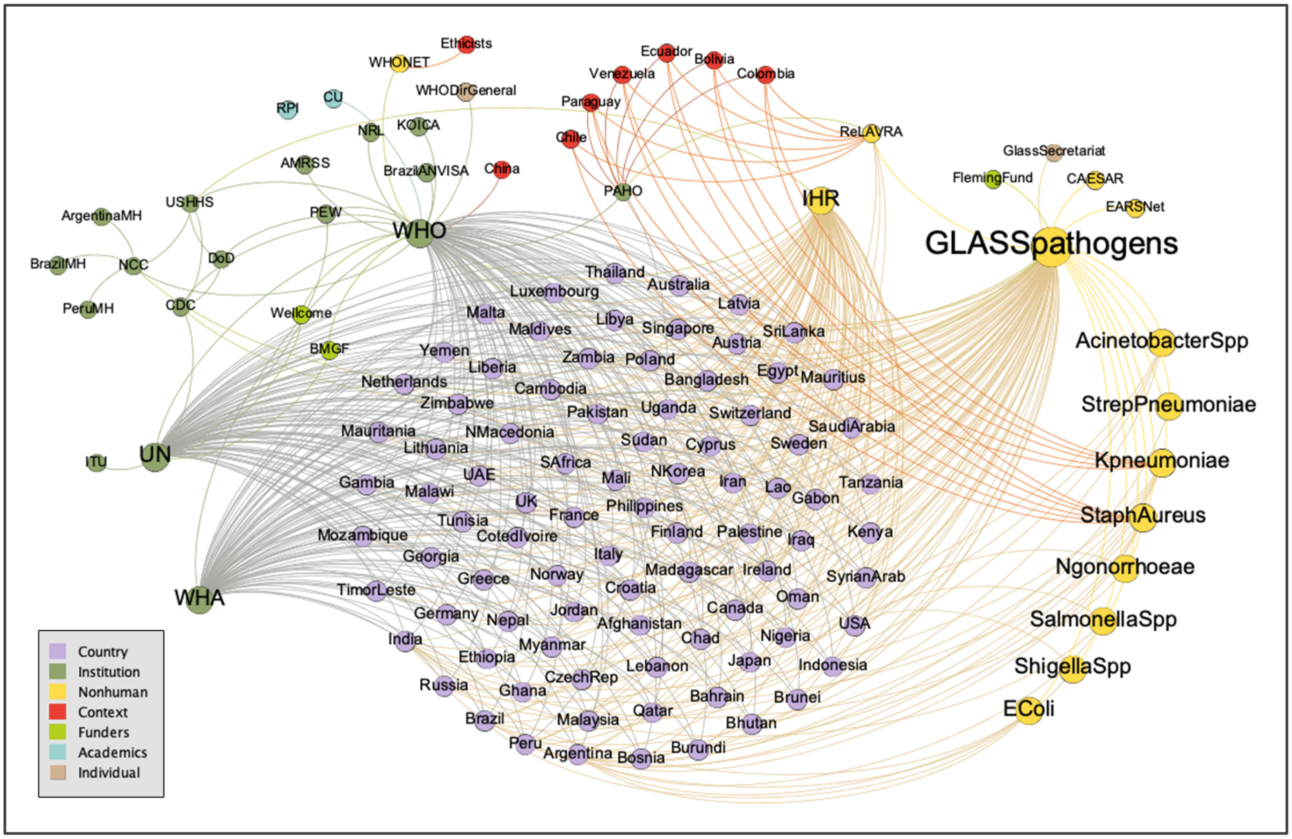



Prepared by the author.

To look at the network vulnerability, I analyzed the modularity report, and the results showed a modularity of 0.054 in five communities (Appendix A, Data, Figure 2). However, would results differ when looking at the interconnection of actors from a different perspective, that is, through the lens of the GLASS pathogens? As such, next, I created CNPC with the premise of removing the GLASS database. In this scenario, the main focal point is the GLASS pathogens. Here, the nodes created include all eight human bacterial pathogens to analyze, with more detail, how the actual threat as a common nucleus connects to different actors in the network.

The third network, CNPC, includes nodes with only the GLASS pathogens. The graphic design in figure 3.4 removes the GLASS database from the network. When removing a technology database, I ran a Gephi graph to analyze which actors connected to the network. This actor-network contains 133 nodes and 537 edges. The CNPC network illustrates how distinct actors connect in the network with the GLASS pathogens as the point of convergence.

**Figure 3.4. Sociogram of Collaborative Network Path C using the GLASS pathogens as focal node in the actor-network**



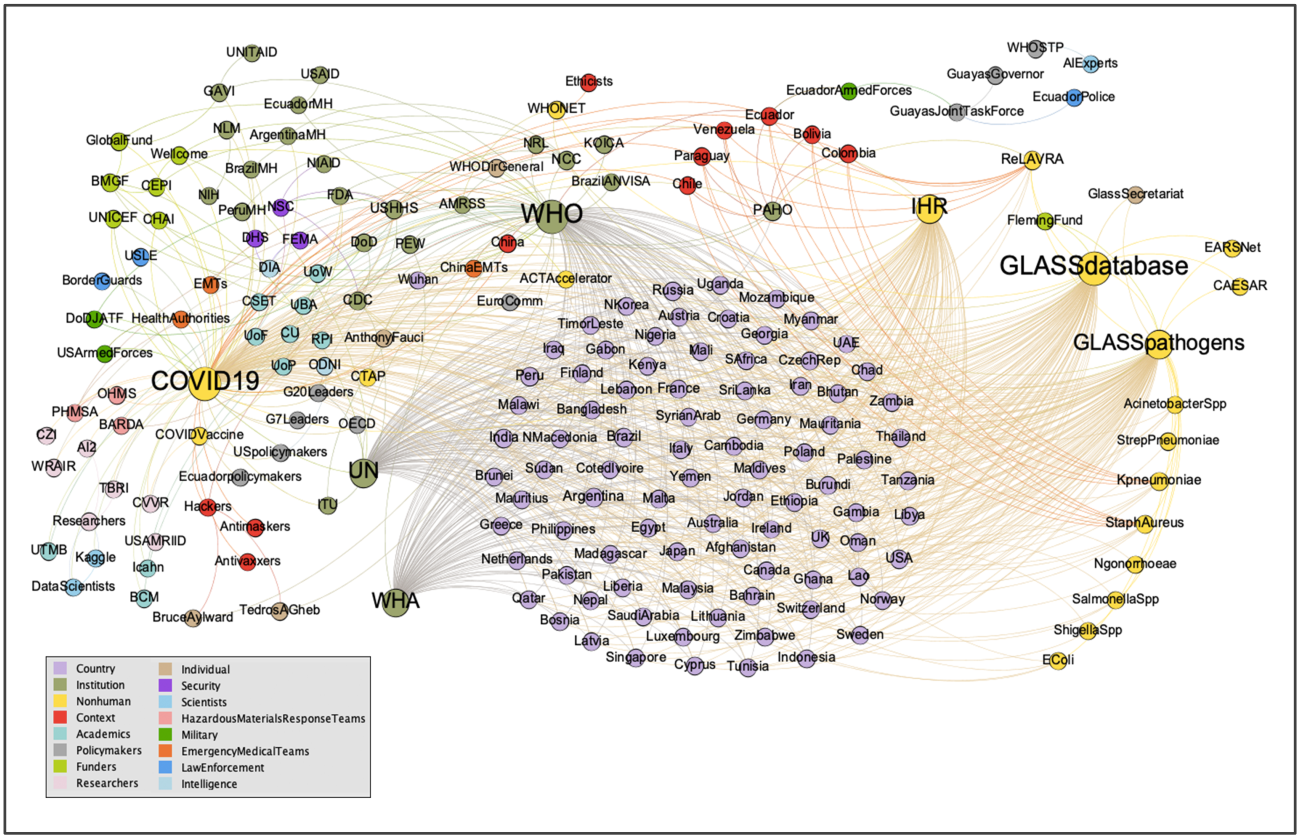

Prepared by the author.

The results from the CNPC network show an undirected network interpretation parameter and graph density of 0.061 with an average degree of 8.075 (Appendix A, Data, Figure 3). The results show parameters with a probability equal to 0.85 and an epsilon of 0.001, with most nodes clustered approximately from 0 to 6 counts and 1 node reaching 80 counts (Appendix A, Data, Figure 3). Moreover, the results show that the ego's network consists of two weakly connected components (Appendix A, Data, Figure 3). Furthermore, the results illustrate an average clustering coefficient of 0.382 and an eigenvector centrality with a high score of 1 (Appendix A, Data, Figure 3). The betweenness centrality distribution results in a diameter of four, a zero radius, and an average path length of 2.10, rounded off to the nearest tenth (Appendix A, Data, Figure 3). The mutually reinforcing relationship hubs (Kleinberg 1999) result in clusters with 0 and 0.5 scores in two distribution areas.

I analyzed the modularity report to review the network's vulnerability, and the results show a modularity of 0.175 in five communities (Appendix A, Data, Figure 3). How will the actor-network change in the subsequent design stage when the network introduces a new actor that mirrors one of the original primary actors? During the investigation, a novel infectious disease occurred, COVID-19. Like the GLASS pathogens, which interconnect actors amid a complex world, the global occurrence of COVID-19 served as a reinforcement mechanism for the research study. Since the coronavirus infectious disease influenced diverse actors in the international system, the following CNPD design includes the COVID-19 security threat.

The fourth network, CNPD, includes nodes interconnected with the GLASS database, GLASS pathogens, and the novel COVID-19. The premise of this design path showcases how threats such as infectious diseases significantly influence the interconnection and collaboration of actors in the network— known diseases (AMR pathogens) versus unknown diseases (COVID-19). Does the network landscape change with the introduction of a novel infectious disease? Do the actors continue to collaborate on AMR pathogenic issues or refocus the surveillance on the new threat? The CNPD network in Figure 3.5 includes all primary nodes of network actors to analyze which actors interconnect. This actor-network contains 201 nodes and 864 edges. The point of convergence consists of an infectious disease beyond the scope of GLASS pathogens and the GLASS database in the surveillance of an outbreak.

**Figure 3.5. Sociogram of Collaborative Network Path D using the GLASS database, GLASS pathogens, and COVID-19 as focal nodes in the actor-network**




Prepared by the author.

The results from the CNPD network show an undirected network interpretation parameter and graph density of 0.043 with an average degree of 8.597 (Appendix A, Data, Figure 4). The results show parameters with a probability equal to 0.85 and an epsilon of 0.001, with most nodes clustered approximately from 0 to 14 counts and 1 node reaching 80 counts (Appendix A, Data, Figure 4). Moreover, the results show that the ego's network consists of five weakly connected components (Appendix A, Data, Figure 4). The results also illustrate an average clustering coefficient of 0.458 and an eigenvector centrality measure with a high score of 1 (Appendix A, Data, Figure 4). The betweenness centrality distribution results in a diameter of six, a zero radius, and an average path length of 2.19, rounded off to the nearest tenth (Appendix A, Data, Figure 4). The mutually reinforcing relationship (Kleinberg 1999) results in a hubs' distribution where clusters appear between a score of 0 and 0.5 (Appendix A, Data, Figure 4).

Lastly, I analyzed the modularity report to review the network's vulnerability, and the results show a modularity of 0.256 in seven communities (Appendix A, Data, Figure 4).

**Let's Parley About Scientific Mumbo-Jumbo: Network Path Analysis**

In the preceding paragraphs, I wrote many scientific analyses and added visuals. So what? What does it mean? How do these quantitative results translate into more layperson's terms? How do the results apply to the real world for others to understand, relate to, and value? The visualization maps provide insights into the diverse actors in the network, the connecting subgroups, and the most influential players. In context, the maps illustrate how certain actors, such as infectious diseases and technology, embed in interconnection challenges. The results show that the greater the security threat, the higher the interconnection of actors. As AMR or COVID-19 challenges increase, other issues arise, problems heighten, and more actors introduce themselves into the network.

While mapping the networks, sixteen actor theme categories encoded the data. The network consists of nodes (entities that remain the same over time) and edges (relations, interconnections, or temporary connections). In this study, the CNPA path consists of 117 nodes and 571 edges; the CNPB path of 119 nodes and 477 edges; the CNPC path of 133 nodes and 537 edges; and the CNPD path of 201 nodes and 864 edges. In comparing each direction, the number of nodes increased as each network grew in connection. The transition between each network from CNPA to CNPD was nonlinear. This study treated each path independently from the other depending on the focal point. However, this research reveals that the more nodes are inputted into the software program, the higher the transgression between edge links and nodes increases. Thus, this study shows that the paths differed depending on the focal point. For instance, the CNPA contains 571 edges with the GLASS database and pathogens as focal points. Whereas, during the creation of the CNPB, the edges decrease with the GLASS database as a primary focal point. Similarly, the CNPD contains 864 edges when the graph network introduces the COVID-19 actor node into the system. Thus, the graphs are independent of each other.

Moreover, analysis of the CNPB with the GLASS database shows that the relational edges decrease because the actors in the network, such as the participating countries, were directly interacting with the GLASS platform but not each other. Thus, actors outside the database sphere were not counted regarding the network, reducing the number of edge links. This shows a global interconnection reduction because of the link between those associated with the platform. The CNPB's structural gap between the nodes and edges compared to the other paths creates an awareness of the closeness of the inner circle surrounding the GLASS platform of actors and the lack of global interconnectedness to a nonhuman actor such as a technological database. Disconnection from the platform encourages a linkage between actors.

By contrast, when the focal point changes to a global threat such as infectious diseases, for instance, the surveillance of AMR of the eight human bacterial pathogens, as illustrated by the CNPC network, an increased constellation of actor interconnection occurs. I also introduce the connectivity basis in the CNPD network by adding an additional node, the infectious disease COVID-19. The results illustrate that the network increases. All four paths show the influence of the connectivity basis of interconnectedness and collaboration between the different nodes. The different paths also show whom the most influential actors in the network tend to be. Thus, the commonality is another connectivity basis. I can choose a different perspective to analyze and influence the network by proposing another connectivity basis. However, for this study, I believe in collaboration and interconnectedness between actors in promoting a health regime. Table 3.1 summarizes the measurements and results of the four network paths with the following details.

**Table 3.1. Measurement Results of the Four Collaborative Networks**

| Network | Nodes | Edges | Density | Connected Component (union find) | Clustering Coefficient | Centrality Measure | | | Modularity Comm. Detection |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | Aver. Degree | Max Degree | Min. Degree | |
| A | 117 | 571 | 0.084 | 2 | 0.416 | 9.761 | 105 (WHO) | 0 (RPI) | 0.050 5 communities |
| B | 119 | 477 | 0.068 | 2 | 0.393 | 8.017 | 106 (WHO) | 0 (RPI) | 0.054 5 communities |
| C | 133 | 537 | 0.061 | 2 | 0.382 | 8.075 | 107 (WHO) | 0 (RPI) | 0.175 5 communities |
| D | 201 | 864 | 0.043 | 5 | 0.458 | 8.597 | 151 (COVID19) | 0 (RPI, USAMRID) | 0.256 7 communities |

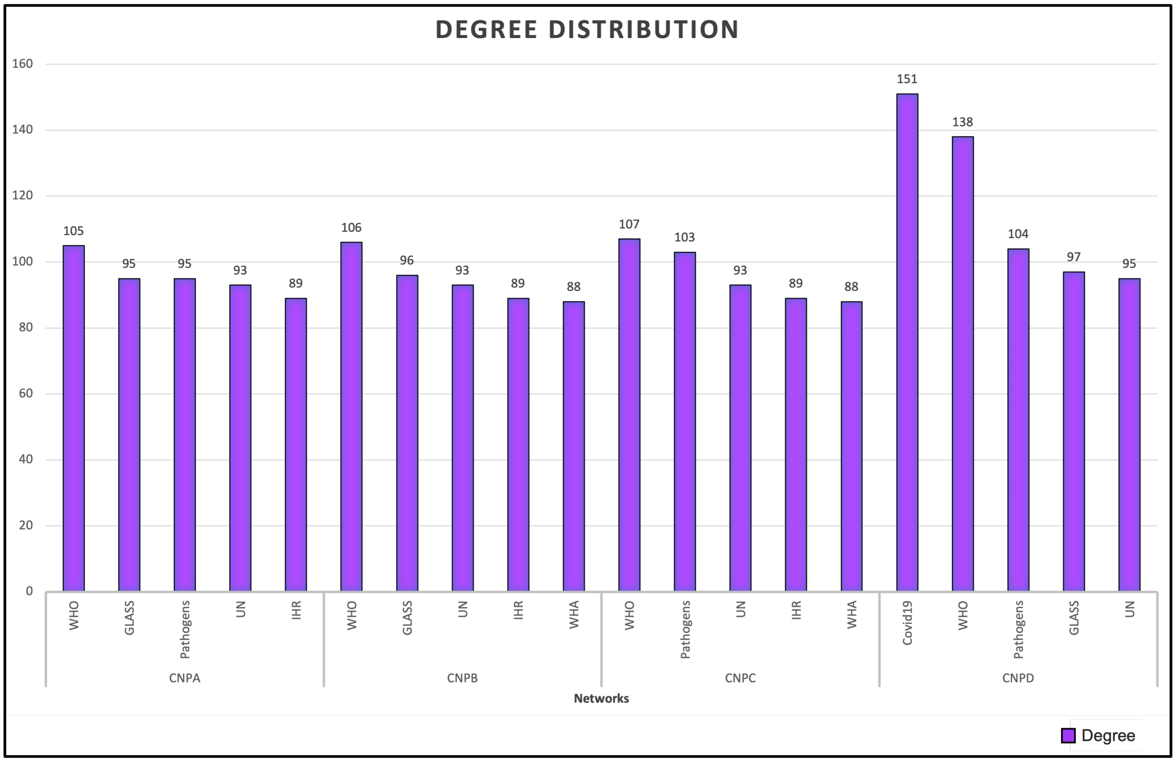
Prepared by the author.

The network-connected components illustrate the most shared ideology. In this case, collaboration in the surveillance or combating of infectious diseases is the most shared ideology. More specifically, all four networks share a common ideology and desire to collaborate in combating infectious diseases and data sharing. Therefore, CNPA contains two weakly connected components in the network; CNPB has two connected components; CNPC shows two connected components, and CNPD has five connected components. Overall, all four network paths have low union finds, which illustrates their strong connection to become interconnected when the shared ideology is based on the surveillance of AMR information, combating the COVID-19 coronavirus, or increasing global health.

Furthermore, the clustering coefficient shows the nodes most densely connected in the network. The coefficient measure compares the number of connections to other nodes with the potential number of links to different nodes in the group. Collectively, the CNPA, CNPB, CNPC, and CNPD networks reveal that the most densely connected subgroup in the network is the participating countries in the GLASS database. In addition, the four collaborative networks show how institutions also form different clusters interconnected to the WHO in addressing national security threats such as infectious diseases. Similarly, under the CNPA network, where the focus lies on the GLASS database and pathogens, the mean value clustering coefficient transpires as 0.416; CNPB includes an average clustering coefficient of 0.393; CNPC, whose primary focal point is the GLASS pathogens, has a clustering coefficient of 0.382; and CNPD an average clustering coefficient of 0.458. By comparison, the low value of the coefficients in each path indicates that all other actors in the network reference the nodes with the highest weight. For example, CNPC's main focal point is the GLASS pathogens and has the lowest clustering coefficient (0.382) compared to the rest of the paths. This study reveals that GLASS pathogens have a low clustering coefficient because of the link with the participating countries who collaborate by inputting AMR surveillance information on the GLASS platform.

In conjunction, the degree of a node illustrates the number of connections the node has to other nodes in the network. The higher the node degree, the more connected the nodes are to each other. Figure 3.6 shows the top five nodes' average degree for each network. The top five actors in the CNPA network are the WHO, GLASS database, GLASS pathogens, UN, and the IHR. The top five node degrees for the CNPB network stem from the WHO, GLASS database, UN, IHR, and WHA. The top nodes by degree for the CNPC network are the WHO, GLASS pathogens, UN, IHR, and WHA. The top actors with the highest degree for the CNPD network are the COVID-19, WHO, GLASS pathogens, GLASS database, and the UN. The WHO, an institution, plays a major role in the collaborative network as the results illustrate its placement with a high degree in comparison with other nodes. Overall, these top five actors have the most significant connections to the rest of the nodes in the network. Therefore, these actors have a heightened influence on the collaborative network.

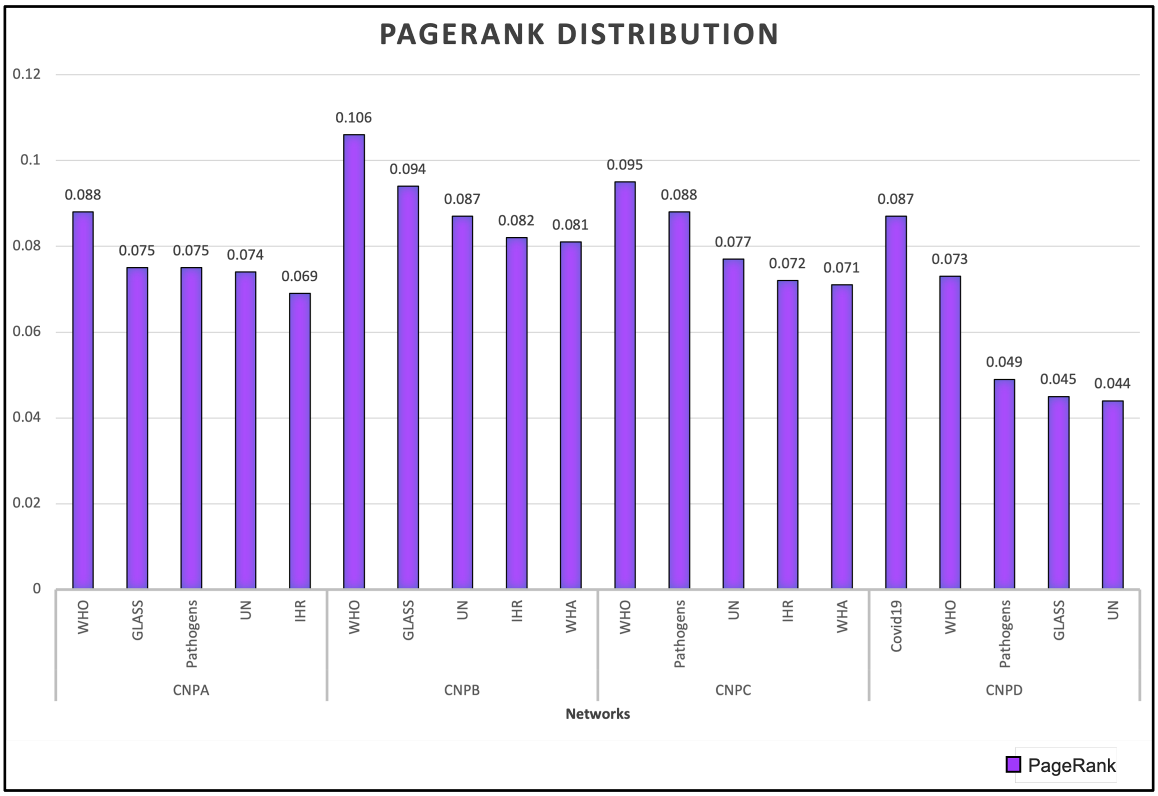
**Figure 3.6. Top 5 Node Degrees by Network**




Prepared by the author based on results from Gephi.

In addition, density illustrates the number of all ties divided by the number of all possible ties in the network and ranges between 0 (totally disconnected) and 1.00 (totally connected) (Knoke and Kuklinski 1982). The higher the density of links within a network, the greater the probability of collaboration. The density of the networks reveals the following: CNPA (0.084), CNPB (0.068), CNPC (0.061), and CNPD (0.043). The results reveal that the density of the CNPA network is considerably higher than the CNPD network. Likewise, although directed network analysis predominantly uses PageRank measures, the PageRank scores also extend to undirected graphs (Perri and Fortunato 2008; Abbassi and Mirrokni 2007) to "enlighten deep and robust network properties of the graph" (Iván and Grolmusz 2011, 405). PageRank scores the importance of a node in connection to other vital nodes, such as the most clicks on a link when surfing the web. The results of the study, shown in figure 8, reveal that the WHO has the highest PageRank in three of the four networks. In conjunction, the WHO came in as the second most important node in the fourth network. This means that many actors point to the WHO institutional actor. Another way to understand the importance of actors in the network is to view the analysis on the flip side. If an actor has fewer connections in the network, the quality of the collaborative contribution is low. Therefore, figure 3.7 shows the top five actors with the most PageRank importance in all four networks.

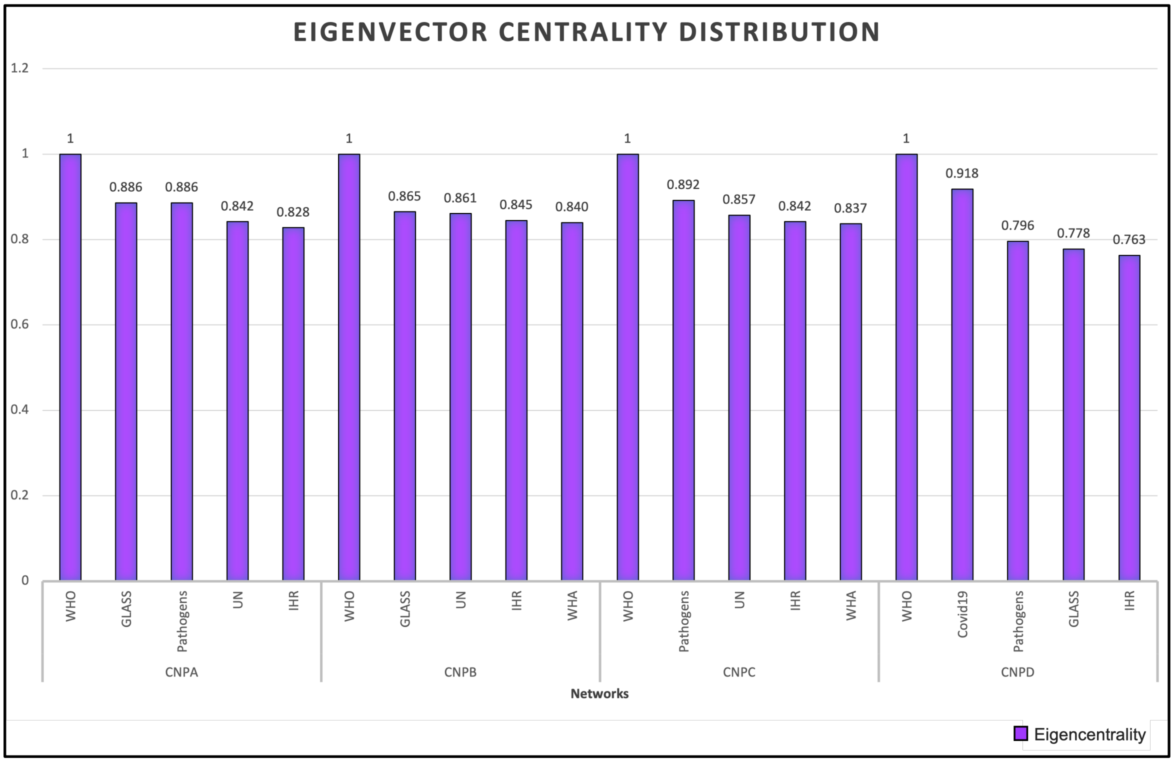
**Figure 3.7. Top 5 PageRank Nodes by Network**




Prepared by the author based on results from Gephi.

In conjunction, since eigenvector centrality measures a node's influence in the network, figure 3.8 shows that the WHO has the greatest influence in all four networks with the highest score of 1. Therefore, as an institution, the WHO has a wide-reaching influence in all four networks.

**Figure 3.8. Top 5 Eigenvector Centrality Nodes by Network**

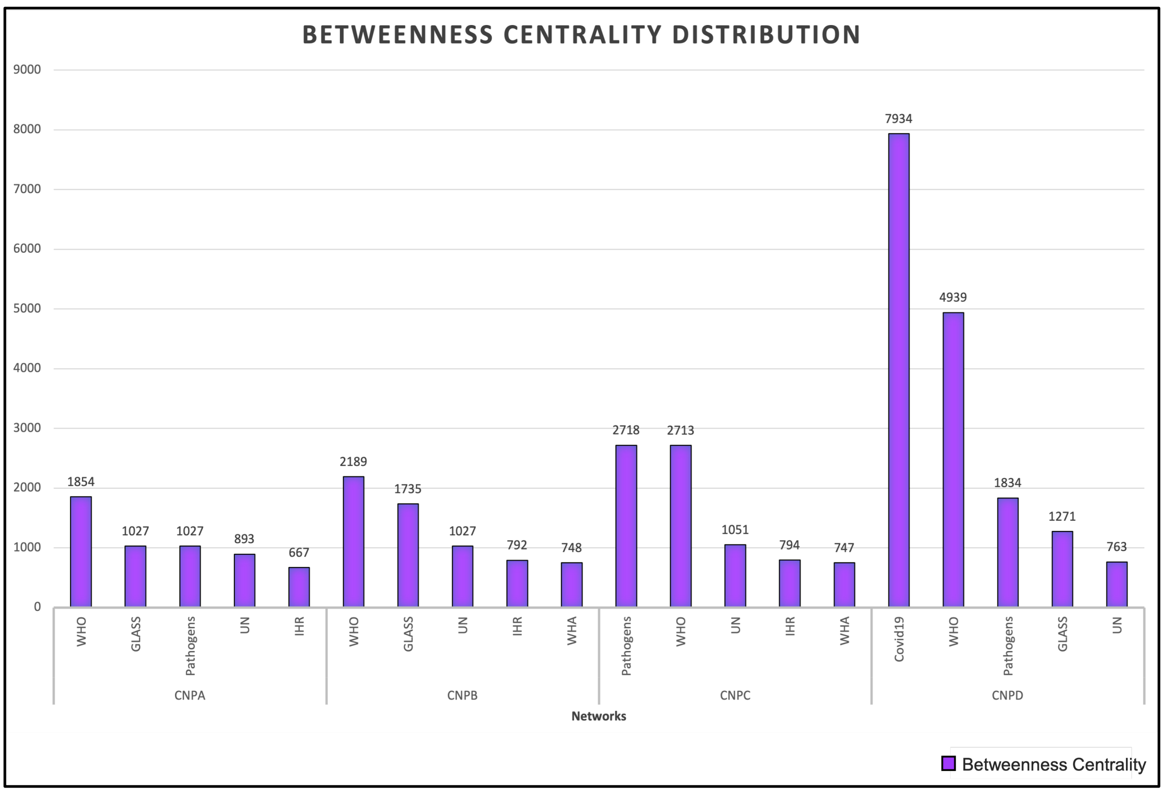



Prepared by the author based on results from Gephi.

Moreover, out of the sixteen actor categories, the institution's category had the most degree, with the nonhuman actor category second. Upon further analysis, the nodes most mentioned in all four paths are the WHO institution and infectious diseases because these nodes have the most significant number of connections in each network. Furthermore, the networks illustrate that human and nonhuman actors play a pivotal role in network interconnectedness and collaboration with other less-connected nodes.

Another critical measure of the node's influence in the network transgresses through a betweenness centrality analysis (see figure 3.9). While degree looks at the number of connections between nodes, the betweenness centrality chooses nodes randomly. It views how often the nodes appear in the shortest path between the two randomly chosen nodes. Moreover, the betweenness centrality looks at how the node connects to the entire network (Clark-Ginsberg 2017). The statistical analysis of CNPA provides the following nodes with the highest betweenness centrality: WHO, GLASS database, GLASS pathogens, UN, and the IHR. For CNPB, the actors with the highest betweenness centrality are the WHO, GLASS pathogens, UN, IHR, and the WHA. The study further shows that CNPC presents the following nodes with the highest betweenness centrality: GLASS pathogens, WHO, UN, IHR, and the WHA. Lastly, the highest betweenness centrality in the CNPD network corresponds to COVID-19, WHO, GLASS pathogens, GLASS database, and the UN. This makes sense because, for example, the participating member states funnel their AMR surveillance information into the GLASS system rather than connect. In addition, the WHO-GLASS department maintains contact with the participating member states. Therefore, the results show that high-betweenness actors bridge portions of the network that need better-connected.

**Figure 3.9. Top 5 Betweenness Centrality Nodes by Network**




Prepared by the author based on results from Gephi.

Comparing all four paths shows that the WHO and infectious diseases lead as primary actors, with a high degree and high betweenness centrality. The research indicates that the WHO, GLASS pathogens, and COVID-19 are well-connected within the cluster of the whole network. More specifically, infectious diseases such as the GLASS pathogens or COVID-19 have a high level of centrality, which indicates objects that play a significant role in the overall issue based on the combined function of the nodes as an occurrence and consequence. The centrality illustrates communicable diseases as a central problem to global health, national security, economic distress, and recession. Thus, for example, addressing the threat (infectious diseases) focuses on national security and civil society interests and vice versa.

Moreover, the research indicates that the WHO, GLASS pathogens, and COVID-19 actors have a strong local influence on the network and a global influence over the whole network. In addition, one node actor had a high betweenness centrality and low degree. In the CNPA, the NCC had a high betweenness centrality of 501 and a low degree of 9. This is not surprising since the NCC "establishes and oversees the national surveillance program, gathers national AMR data and communicates with GLASS" through a national focal point (World Health Organization 2017b, 9). Thus, while the NCC has fewer connections, the node's connections influence the entire network as the node is a central figure within the network.

In addition, modularity, or community detection (Blondel et al. 2008), helps identify densely connected nodes. The modularity of each of the paths allows me to analyze communities within the network. By comparison, the 117 nodes of network CNPA show a modularity of 0.050 partitioned into five communities. The 119 nodes of the CNPB network contain a modularity of 0.054 in five communities. The 133 nodes of network CNPC show a modularity of 0.175 in five communities. Finally, the 201 nodes of the CNPD network illustrate modularity of 0.256 partitioned into seven communities. The study shows that the GLASS participating member states do not have a significant deviation in the node cluster, the same size, and dense connection compared to the entire network. Furthermore, the four networks reveal that the common communities comprise three categories: nonhuman (GLASS database and pathogens), institution, and country. Thus, the study shows that all four paths have a small modularity measure (< 0.3), and the networks in different communities have strong segregation.

Furthermore, for Knoke and Kuklinkski (1982), network analysis considers "both the relations that occur and those that do not exist among the actors" (Knoke and Kuklinski 1982, 12). The networks allow seeing the dissimilarities between the actors, measured in the relational patterns with other actors (Knoke and Kuklinski 1982). For example, the results show that, out of the four networks, the actors that have a different pattern of ties with other actors in the network are, for instance, China, ethicists, cyber threat actors, anti-maskers, and anti-vaxxers. Created as a context in the network, these actors are different from each other and the network space.

Although these nodes disrupt the network, they do not necessarily hinder it. Instead, these actors illustrate the importance of network analysis, spurring innovation, and creating interesting interconnections and collaboration with the other actors in the network. The network, including the context actors that create gaps in the network, collectively reinforces aspects of collaboration. Thus, these disruptions in the network allow room for bettering actor collaboration and global interconnectedness toward the path of global health and security.

In conclusion, the statistical analysis illustrates the importance of identifying the most valuable parts of the network. More specifically, in mapping the four distinct networks, I extracted information on the most influential actors, reviewed clusters, and analyzed properties of the networks, such as the value of collaboration and interconnectedness. This knowledge production is valuable in improving a network's connectivity by seeing how different actors are interconnected. The visualization maps offer valuable clues on the collaborative network structure. Mapping the diverse networks result in an understanding that actors make crucial choices in limiting the promotion of a health regime by not adhering to governance or a system of rules. Technical capacities expand, and communications increase. They force actors to access massive amounts of information. Some actors choose not to share data on publicly available platforms on the surveillance of infectious diseases. Others choose not to participate in partial details in a surveillance platform.

In contrast, other actors raise concerns about privacy and security measures even when combating a threat to the global common good. The complex interdependence of actors changes the process of network creation. Thus, this study shows the importance of network analysis in viewing how certain actors disrupt the network and its value in helping to understand the rhetorics of interconnection. An in-network disruption removes the node actors from the network to create more power stability and balance. However, removing a node either strengthens or weakens an edge connection. By contrast, another recommendation is to include the actors while considering a skewed network and its influence on other actors in the network. The access to information derived from network analysis presents contributions to knowledge production for diverse fields. Tracking the interaction of actors and obtaining statistical data provides direct and concrete answers in an otherwise confusing and complex system of interdependence. Technology, innovation, social structures, and actor collaborations contribute to the values of international relations, global experiences, the international and local economy, and progressive accountability— efficiencies derived from networks.

In conclusion, although the IHR, GLASS, and the WHO are relevant actors that link to other actors in the network, this study chose a more prevalent boundary object—infectious diseases—to act as an anchor or bridge. The boundary object encompasses both the eight GLASS human bacterial pathogens and COVID-19. The results of this study reveal that actors immediately collaborate in promoting a health regime when the level of security threat heightens. Although in context, certain actors appear to disrupt the network, appearing outside of the collaborative network, such as by blanketing information or attaining an appearance of a hegemonic role in the international system, the actions stem from a common nucleus—a triggering of a nontraditional threat such as infectious diseases. Nonetheless, the research shows that countries' best interest is when actors work together and interconnect in the fight against global infectious diseases because such diseases go beyond national borders.

The technological innovation ecosystem begins to function at a macro level, and actors such as collaboration agencies influence the network system. At a macro-level (large systems), the collaborative network comprises actors with similar common interest backgrounds of known or unknown boundary objects. At a meso-level, actors in the collaborative network prefer to interconnect with others of similar interest for a specific known object (AMR). Network analysis bridges the gap between macro-and meso-level explanations. The scale of the collaborative network expands, but many economies need to be more involved to consider. The centrality of the network shifts as the level of threat heightens. Collaboration manifests at the meso-level (medium systems) with organizations of a higher degree in the network, such as the WHO, which influences larger systems. In conjunction, the bigger the security threat, the higher the collaboration when the threat is more concentrated and known, such as AMR. A lesser-known threat, such as the novel coronavirus, raises (in)securities and concerns, reducing collaboration manifestation. However, macro-level threats affecting grander scales, such as economic issues, increase collaboration.

### 3.1.2. Phase 2: Qualitative Data Analysis of the Case Study Selection of the WHO-GLASS International Collaboration and Interconnectedness on AMR Surveillance

I chose to study a specific case study: the GLASS collaborative effort in AMR surveillance of the WHO. Actors create databases with the aim of "working within communities of practice, modes of governance, and technical constraints" (Kitchin 2014, 22). The GLASS's key objectives include collecting surveillance information to estimate the encumbrance of AMR, reporting global AMR data, and detecting the spread of emerging resistance to antimicrobials. This qualitative single case study also encompassed the IHR and infectious diseases since the boundary objects expand in scale and scope. Through network analysis, the social environment expresses patterns in relationships among interacting units (Wasserman and Faust 1994). Some actors use advanced technology databases as "the service of an action" to surveillance actants considered global threats (Bowker and Star 1999, 298). Infectious diseases serve as boundary objects due to the consequential nature of diseases in institutions, nation-states, and civil society.

Scholars consider infectious diseases a new threat to the nation's security and citizens. However, the concept of *new threats* historically addresses concerns focused on the role of the military following the end of the Cold War in addressing international military alliances and enemies (Saint-Pierre 2017). The regulations assist in mediating subsequent actions by actors since technological efficacy and social dynamics intertwine. Infectious diseases serve to mediate actor reactions in the network. Thus, the boundary objects communicate with multiple actors through collaboration and interconnectedness.

Moreover, the success of any actor-network exists when it does not force the network (Balzacq and Cavelty 2016). In other words, the WHO does not force countries to participate and collaborate in the GLASS surveillance network. For instance, I discussed the participation of Brazil in the GLASS system with an interviewee who stated "it's not that the GLASS included Brazil. It's the other way around: Brazil enrolled in GLASS. It depends on the countries willingness or not to enroll in GLASS."[6] Thus, although the countries voluntarily chose to use

[6] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).

GLASS's standardized surveillance approach, the institution created an avenue of collaborative exchange through its communication platform in the connected ecosystem.

Institutions persuade the achievement of the surveillance network towards a resolution of the global threat through the collaboration of actors. Thus, the act of national security and pathogenic global threat befalls into the legal realm through the IHR as an inscription device to transform facts into a regime. The IHR provided the rules and regulations to collaborate in GLASS (World Health Organization 2017b). The decisions to contribute lie independently in the participating countries and the institution. However, interdependency co-exists amongst actors in a complex system to fight nonconventional threats. Complex interdependence contributes to security governance during a collaboration of resources and data sharing between different actors, governments, and international organizations. While a collaborative factor exists amongst global countries to monitor pathogenic threats, certain communities disrupt its initial premise. Rather than viewing such disruptive groups as not wanting to be part of the network, the disruption adds value to the development of the network. Without the bad, there is no righteous good. Likewise, the exponential growth of big data requires subject expertise and a command of computational techniques to "process, analyze and interpret this large-scale data" (Feng and Kirkley 2020, 1). Thus, diverse actors create a network prism of reality in promoting a health regime.

The situations where an international organization, such as the WHO, raised the threat level for AMR include a high level of antibiotic consumption and the global rise of AMR. For instance, the World Economic Forum identified antibiotic resistance as a global risk unmanageable by any nation alone (World Health Organization 2015b; Howell 2013). Furthermore, a 2015 report in the World Health Assembly to develop a global action plan on AMR indicated that close to 100,000 Americans, 80,000 Chinese, and 25,000 Europeans died yearly from hospital-acquired antibiotic-resistant infections (Howell 2013). Likewise, over 700,000 deaths are attributable to AMR, with projected AMR deaths to exceed 10 million and a reduction of 2% to 3.5% in Gross Domestic Product (GDP) by 2050 (Aggarwal et al. 2023; O'Neill 2014). In addition, in 2016, world leaders gathered at the UN General Assembly in response to the growing threat of AMR. During the meeting, Dr. Marc Sprenger, director of the WHO's AMR Secretariat, noted that there have been "discussions of AMR in WHO since the 1960s, and plans since 2000, but it is now shifting from being a technical problem to a much higher-level political issue" (United Nations 2016).

The events that triggered the creation of GLASS stem as far back as 2001 with the initiative of the WHO global strategy to contain AMR (World Health Organization 2001) and the AMR focus of the World Health Day in 2011 with the WHO issuing a six-point policy package calling for action by all global stakeholders (World Health Organization 2014). Through several resolutions, the World Health Assembly called for intense global strategy implementation and the need to strengthen AMR surveillance. Performing antimicrobial susceptibility testing, which informs AMR surveillance, fell into the scope of the IHR, stipulating the requirement for access by states to the capacity to investigate any disease outbreak that could represent an international public health threat (World Health Organization 2016a). Section 3.4.5 provides further analysis of the events that triggered the creation of GLASS since a harmonized system is needed to standardize the collection of official global AMR data. In 2014, the WHO created the first global report on national AMR surveillance for selected worldwide human pathogenic bacteria and examined the evidence base concerning the impact of AMR on health and the economy (World Health Organization 2014). Therefore, the results of the 2014 report developed the global system, and in 2015, the WHO launched GLASS.

During the scope of the investigation, meetings took place, which included various actors in promoting a health regime on monitoring communicable diseases and AMR surveillance. For instance, during the second meeting in April 2014, by the Strategic and Technical Advisory Group for Antimicrobial Resistance (STAG-AMR), a principal advisory group to the WHO on AMR, more than 30 participants included: "representatives of intergovernmental organizations, civil society, public health and regulatory agencies, industry associations, professional organizations, and patient groups" (World Health Organization 2015b, 7). In December 2014, a global consultation by the WHO GLASS brought together 30 member states representatives from the six WHO regions, international AMR experts, and WHO staff (World Health Organization 2015c). In April 2017, the second high-level technical meeting on AMR surveillance took place, which included directors of ministries of health, GLASS-enrolled member states, health regulatory agencies, epidemiologists, and WHO Staff (World Health Organization 2017e). The meeting also included collaborating centers such as technical universities, public health schools, and communicable diseases institutes (World Health Organization 2017e). In April 2021, a third high-level technical consultation and virtual meeting on AMR surveillance and the GLASS 2020 platform to generate evidence-based representable data for action (World Health Organization

2021d, 2020y). In addition to the actors previously mentioned, AMR technical surveillance officers, clinicians, partner institutions, and medical microbiologists from 21 of the 28 countries in the region of the Americas were also in attendance.

Moreover, during a meeting that determined the global priority list of antibiotic-resistant bacteria, the coordinating group in the meetings included experts in clinical microbiology, infectious diseases, public health, research and development (R&D), and infection control (World Health Organization 2017d). Furthermore, a group of 70 experts with diverse backgrounds and geographical origins in clinical microbiology, infectious diseases, public health, R&D, and pediatric and intensive medicine) were involved in the process of criteria weighting (World Health Organization 2017d).

Furthermore, as detailed in section 3.2, the criteria the experts looked to for each pathogen were by the species and the type of resistance and stratifying the results into three priority tiers (critical, high, and medium). Moreover, based on experience and previous prioritization exercises, ten criteria were selected to determine the level of threat (priority) of the pathogens. The criteria selected were prevalence of resistance, the 10-year trend of resistance, all-cause mortality, transmissibility, healthcare, and community burden, preventability in hospital and community settings, treatability, and current pipeline (World Health Organization 2017d). The experts extracted evidence of the criteria from different sources, including systemic reviews of published literature, databases of European-financed projects, 23 national and international surveillance systems of antibiotic-resistant bacteria, and international guidelines on the prevention and treatment of infections due to antibiotic-resistant bacteria (World Health Organization 2017d).

To support the early implementation of GLASS covering the period between 2015 and 2019, GLASS guided member states in compiling standardized AMR surveillance data and sharing the information to form a global picture (World Health Organization 2015c). Furthermore, to optimize and prepare for the surveillance of AMR, the WHO organized a sequence of online technical discussions on AMR and antimicrobial user phases with the participating member states. For instance, during the third high-level technical meeting on AMR surveillance, online technical discussions included how to disseminate and familiarize national technical officers in charge of AMR surveillance with the GLASS technical documents (World Health Organization

2020y). In addition, the meeting familiarized national technical officers in charge of AMR with new technologies, such as metagenomics, and approaches to enhance AMR surveillance. The meeting also allowed for exchanging experience within the WHO regions and between national technical officers from different countries. Likewise, the WHO GLASS provided four specific technical training revolved around the following themes: antimicrobial use and antimicrobial consumption methods, AMR surveillance methods, microbiology laboratory methods, and the One Health surveillance model (World Health Organization 2020y).

In addition, leveraging the COVID-19 pandemic, the WHO regional office provided "remote guidance and training to national focal points from all member states" to reinforce AMR surveillance (World Health Organization 2021d, 58). For instance, in the WHO region of the Americas, building on the ReLAVRA network, the regional office launched a training protocol on enhanced isolate-level AMR monitoring. Furthermore, a tripartite alliance of seven Latin American countries implemented the European Union-funded project, Working Together to Combat AMR. As a result, the WHO regional office held "a series of ten online training sessions on the role of molecular biology in integrated AMR surveillance under the One Health approach" (World Health Organization 2021d, 59). Also, the training included strengthening antimicrobial stewardship, teaching how to update their national essential medicine lists, and evidence-based selection of antimicrobials, as well as providing the tools to develop an essential medicines list for the treatment of critical patients with suspected or confirmed COVID-19 (World Health Organization 2021d).

Similarly, in the WHO African region, in 2020, regional capacity was reinforced with five webinars that included a roadmap for coordinating and implementing global AMR surveillance. Likewise, support was provided to Togo to implement a mentorship project for bacteriology laboratories (World Health Organization 2021d). Likewise, in 2020, the CAESAR network organized a series of technical webinars and GLASS virtual consultations (World Health Organization 2021d). Successful situations where international collaboration worked with partners and stakeholders include the "implementation in seven countries (Burkina Faso, Cameroon, Ghana, Madagascar, Nigeria, Zambia, Zimbabwe) of the *E. coli* tricycle project" surveillance system (World Health Organization 2021d, 58). Likewise, as of 2021, thirteen countries took part in the enhanced isolate level AMR surveillance phase through the ReLAVRA network, which enabled the countries to participate in GLASS: Ecuador, Argentina, Colombia, Chile, Costa Rica, Dominican Republic, Peru, El Salvador, Uruguay, Paraguay, Mexico, Trinidad, and Tobago, and Belize (World Health Organization 2021d).

Likewise, the surveillance protocol in several countries from the Americas was enhanced to include *Candida* through the collaboration of the WHO regional office and the WHO collaborating center on AMR with the ANLIS-Malbran Institute in Argentina and the WHO Collaborating Centre for Surveillance, Epidemiology, and Control of Foodborne Diseases and other Enteric Pathogens at the CDC. Thus, the international collaboration of actors in submitting AMR data to GLASS and adequate GLASS technical training on surveillance generated evidence base action and preparedness at local and global levels. The remaining sections in this chapter provide further empirical analysis of international collaboration and the interconnectedness of actors in the surveillance of infectious diseases and AMR.

How are actors conducting global collaboration and open information exchange on a surveillance platform? The early implementation stage of the GLASS database occurred from 2015 to 2019, which inspired a global collaborative effort on AMR surveillance (World Health Organization 2017b). In 2015, the WHO launched the GLASS system to surveillance specific human bacterial pathogens. Located on the WHO website, the GLASS system provides formal and informal data across multiple platforms. The WHO referred to GLASS as the "first global collaborative effort to standardize AMR surveillance" (World Health Organization 2017b, 5). The sixty-eighth WHA endorsed GLASS through resolution WHA68.7 (World Health Organization 2015b) and created GLASS to support the second objective of the WHO's Global Action Plan on AMR (GAP-AMR) "to strengthen knowledge through surveillance and research" (World Health Organization 2015d, 127). The model allows for an insightful analysis of participating country information in the surveillance of communicable diseases. Each participating member state[7] voluntarily enrolls in GLASS, submits AMR data, and reports information into a data management software called WHONET (O'Brien and Stelling 1995). As an official stated the "WHONET is now used in about 140 countries. We support indirectly maybe 3,500 labs or so, but we don't collect the

[7] This dissertation uses member states when describing participating countries' interaction with the WHO.

data."[8] The WHO receives the aggregated information at the national level for review. The WHO creates publicly available, GLASS reports, based on the aggregated statistics collected. Countries use the WHONET to prepare the GLASS submission and the "WHONET analyzes the isolate level data to prepare national aggregate statistics shared with WHO."[9] For instance, Ecuador's Ministry of Health and the National Institute for Public Health Research (*Instituto Nacional de Investigación en Salud Pública* (INSPI) in Spanish) use the WHONET to monitor bacterial resistance in the country (Ministerio de Salud Pública del Ecuador 2019b). The WHONET contains datasets and algorithms for outbreak detection (Stelling et al. 2010) and the interviewee added that the WHONET is "using a software called SaTScan that looks to detect outbreaks."[10] It incorporates a visual map, spreadsheets, and statistics developed with the close collaboration of actors. Contributions from participating countries and national focal point (NFP) centers provide information into the database system. The surveillance network consists of three core components: an NCC, an NRL, and surveillance sites that collect epidemiological data and diagnostic results (World Health Organization 2017b). However, GLASS relies on the participating member states to manage their national surveillance. Thus, structured heterogeneously, the data maps across geographical countries and diverse actors voluntarily participating in the surveillance network.

Regarding AMR data for 2016, the GLASS system on the WHO-GLASS website presented 38 countries with profiles when I clicked on the *select country* drop-down list (see Appendix A, Figure 5). Could discrepancies exist in open source or publicly available information? Does this type of open data raise concern for lack of veracity in data sharing? My data findings show that the system needed certain country profile overviews of participating laboratories. I looked to see whether this was a technical mishap, a lack of administrative software updates, or delays in the country submitting information. The GLASS report indicated: "the identification of the total

[8] Author's interview with Dr. John Stelling, Associate Physician with the Brigham and Women's Hospital, Co-Director of the WHO Collaborating Centre for Surveillance of Antimicrobial Resistance, Developer of the WHONET software, 24 January 2020.
[9] Author's interview with Dr. John Stelling, 24 January 2020.
[10] Author's interview with Dr. John Stelling, 24 January 2020.

number of surveillance sites submitting specimens to participating laboratories was not possible due to the setup of the national surveillance system" (World Health Organization 2017b, 26).

Moreover, the information reveals that the USA was enrolled in GLASS in December 2016 but still needed to provide data to GLASS during this reporting period (World Health Organization 2017b). Likewise, in 2016, the GLASS platform database revealed that global south country data was not entered during this reporting period (see Appendix A, Figure 5). In addition, the database indicated that of the GLASS country profiles listed in 2017, Brazil was enrolled in GLASS but unreported. Table 3.2 illustrates the number of countries enrolled in GLASS from 2017 to 2021 by data call.

**Table 3.2. GLASS Data Calls and Number of Country Enrollment**

| GLASS Data Calls | GLASS Country Enrollment | Date |
|---|---|---|
| None | 109 | May 2021 |
| | 107 | Apr 2021 |
| 4th Data Call | 94 | Aug 2020 |
| | 92 | Apr 2020 |
| 3rd Data Call | 86 | Oct 2019 |
| | 82 | Jul 2019 |
| 2nd Data Call | 71 | Dec 2018 |
| 1st Data Call | 50 | Dec 2017 |
| | 42 | July 2017 (End of first data call) |

Prepared by the author based on GLASS Reports, World Health Organization (2016-2021).

From April 1 to July 8, 2017, GLASS launched the first data call on the WHO-GLASS website (World Health Organization 2017b). As of July 2017, GLASS received 42 country enrollments during the initial data call, with only 40 countries submitting data on their AMR surveillance systems. By December 2017, there was a 19 percent increase (n=50) in participating member states enrolled (World Health Organization 2017b). In addition, the dissertation is not a controlled study since most countries provided incomplete data concerning the standards of GLASS. Nevertheless, the findings revealed that, during the preliminary stage, out of the

BRICS[11] countries which refer to the main emerging national economies, three of them (India, Russia, and China), were unlisted as of 2017. As I monitored the GLASS website in January 2018, the data revealed 51 enrolled countries. By May 2018, more than 25 percent of WHO participating countries enrolled in GLASS (n=58), with 39 countries submitting AMR information. In 2018, Brazil was the only southern subcontinent country of the Americas enrolled in GLASS, but it did not report AMR data. By the end of the second call in July 2018, GLASS contained 69 enrolled member states (World Health Organization 2018a). GLASS indicates that 67 out of the 69 participating countries submitted information on their surveillance systems, and 48 countries reported AMR data (World Health Organization 2018a). By December 2018, the number of participating countries that enrolled in GLASS increased to 71, including the enrollment of two additional BRICS countries, India and Russia (World Health Organization 2018a). Do Russia and India's late entry into the GLASS system in 2018 change the database's context and raise political awareness, especially concerning security? In 2018, GLASS revealed a "64% increase in country enrollment and more than twice the number of countries submitting AMR data" (World Health Organization 2018a, 5). At the end of the third data call in July 2019, the GLASS-AMR system contained 82 enrolled countries, with a 95% enrollment increase compared to 2017 (World Health Organization 2020g). It included a second country from South America, Argentina. By October 2019, the status of GLASS country enrollment increased to 86, and when I monitored the GLASS website, a third South American country enrollment appeared during this period, Peru. The GLASS enrollment by participating member states increased to 92 by April 2020, the enrollment number increased to 94 by August 2020, and China continued to be unenrolled in the system (World Health Organization 2020g). By April 2021, GLASS enrollment increased to 107, and within a month, "as of May 2021, 109 countries and territories worldwide had enrolled in GLASS" (World Health Organization 2021d, 4). Between 2015 and 2021, the number of member state enrollment in GLASS increased, and figure 3.10 visualizes the evolution of country participation in GLASS in the years: 2018, 2019, 2020, and 2021. Thus, more collaborative country enrollments increased during the period under study from 2015 to 2021. The amount of participating country enrollment surpassed the timeframe with increased

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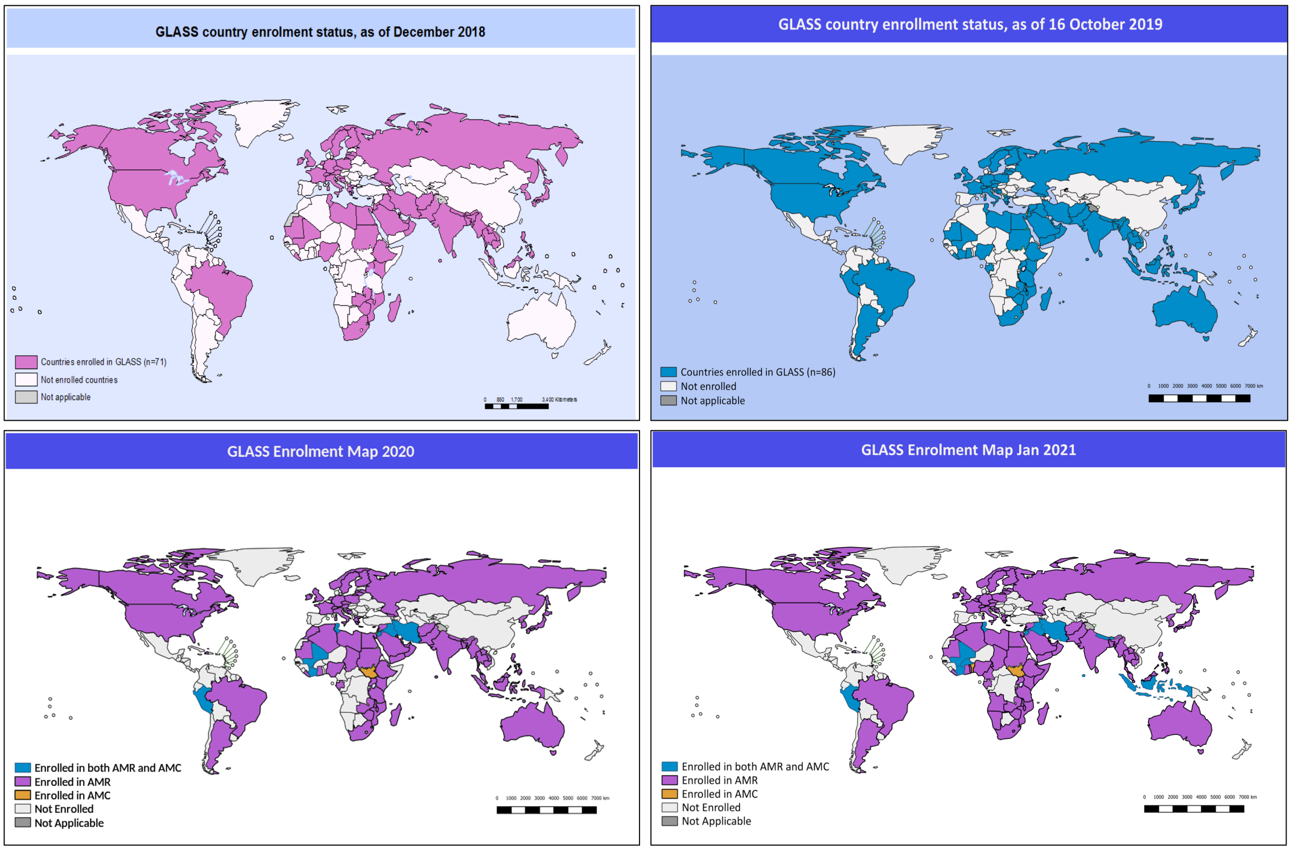
[11] BRICS is an acronym for Brazil, Russia, India, China, and South Africa.

knowledge production, awareness, and an understanding of the urgency to combat global health threats.

**Figure 3.10. GLASS country enrollment status, 2018 to 2019**




*Source*: Map production: information evidence and research, World Health Organization (2018-2021).

Moreover, as the number of GLASS enrollments increased, the results showed that between 2015 and 2020, the HHS met fifteen times to discuss issues relating to combating antibiotic-resistant bacteria, including AMR discussion. In 2020, the HHS held two meetings on the problems of AMR. Out of the two conferences held in 2020, the HHS organized a virtual meeting focused on COVID-19 and AMR.

Furthermore, based on the data collected from 2015 to 2021, I tracked interactions between the GLASS-enrolled actors and actors outside the GLASS platform relevant to the surveillance and security governance of infectious diseases to illustrate interconnectedness and collaboration. For example, in February and September 2020, a meeting was held by the HHS through the PACCARB, the latter to discuss AMR and the former to include the impact of coronavirus infectious disease (COVID-19) on AMR (U.S. Department of Health & Human Services 2020b, 2020a). Decision-making units, such as a nation-state, perceive threats even when they decide to operate in a regional cooperation regime to guarantee the security and well-being of their citizens (Saint-Pierre 2017). However, not all countries cooperate so readily due to socio-economic, historical, or political conflicts. Under the cooperation, actors change behaviors depending on the behaviors of the other country. Meanwhile, security measures, rules, or protocols answer the call to collaboration. For instance, from 2015 to 2021, GLASS-participating countries remained with steady collaboration on the well-known issue of AMR.

As the novel, COVID-19, entered the landscape, fears, and uncertainty increased, leading to a decrease in global cooperation while increasing collaboration for AMR and COVID-19 threats. In April 2020, a group of global health and private actors launched a landmark collaborative action committing to proactively engage stakeholders, align efforts, build collaboration, and devise transparent solutions grounded in science (World Health Organization 2020d). In 2021, the Group of Friends on Tackling AMR launched a call to action to raise global efforts to address AMR, which included 113 member state signatories and 38 supporting organizations, including Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela (World Health Organization 2021b). Likewise, I conducted an observational review in September 2020 during an official virtual meeting held by PACCARB on antimicrobial resistance and COVID-19 (U.S. Department of Health & Human Services 2020a). A diverse mix of private and public actors was present during the PACCARB meeting, including 15 voting members, 8 organizational liaisons, 11 regular government employees, 1 designated federal official, and 2 advisory council staff (U.S. Department of Health & Human Services 2020a).

Moreover, I incorporated data collection and analysis on COVID-19 as a source of additional information concerning the collaborative network of actors into the Gephi quantitative network analysis framework. I conducted a document review and analysis from the WHO SITREP. The study revealed the collaborative efforts of actors and country engagement with COVID-19 surveillance efforts. Table 3.3 illustrates the surveillance of COVID-19 and the collaboration of nation-states in reporting their total confirmed cases of COVID-19 in 2020 and 2021. The table concentrates on the USA and South America from the beginning of the outbreak until one year later, in 2021. The table showcases when each of the country's first reported cases of the coronavirus disease and how the outbreak quickly spread within a year. The table also shows when each country first reported a covid case, highlighted in dark gray. Brazil and the USA were the first countries from the northern and southern subcontinents of the Americas to report cases of the coronavirus disease. Table 3.3 displays that on February 27, 2020, Brazil, the first South American country, reported one confirmed COVID-19 case (World Health Organization 2020j), followed by Ecuador on March 1, 2020, with one confirmed case (World Health Organization 2020k); Argentina (1) and Chile (1) on March 4, 2020 (World Health Organization 2020l); Colombia (1) and Peru (1) on March 7, 2020 (World Health Organization 2020m); Paraguay (1) on March 9, 2020 (World Health Organization 2020n); Bolivia (2) on March 11, 2020 (World Health Organization 2020o); Guyana (1) on March 13, 2020 (World Health Organization 2020p); Venezuela (1) on March 14, 2020 (World Health Organization 2020q); and Surname (1) and Uruguay (4) on March 16, 2020 (World Health Organization 2020r).

**Table 3.3. Surveillance of Confirmed COVID-19 Cases in the Americas 2020-2021**

| Country | Beginning of the Outbreak | | | | | | | | | Mid-Year | End-of-Year | 1 Year Mark |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 27-Feb-20 | 1-Mar-20 | 4-Mar-20 | 7-Mar-20 | 9-Mar-20 | 11-Mar-20 | 13-Mar-20 | 14-Mar-20 | 16-Mar-20 | 31-Jul-20 | 27-Dec-20 | 21-Feb-21 |
| USA | 59 | 61 | 108 | 213 | 213 | 696 | 1264 | 1678 | 1678 | 4,388,566 | 18,648,989 | 27,702,074 |
| Brazil | 1 | 2 | 2 | 13 | 25 | 34 | 77 | 98 | 200 | 2,555,265 | 7,448,560 | 10,081,676 |
| Colombia | - | - | | 1 | 1 | 3 | 9 | 16 | 24 | 276,055 | 1,574,707 | 2,217,001 |
| Argentina | - | - | 1 | 2 | 12 | 17 | 31 | 34 | 56 | 178,996 | 1,574,554 | 2,054,681 |
| Peru | - | - | | 1 | 6 | 11 | 22 | 28 | 71 | 400,683 | 1,005,546 | 1,269,523 |
| Chile | - | - | 1 | 5 | 10 | 17 | 33 | 43 | 75 | 353,536 | 598,394 | 795,845 |
| Ecuador | - | 1 | 7 | 14 | 15 | 15 | 17 | 23 | 37 | 83,370 | 209,274 | 273,097 |
| Bolivia | - | - | - | - | - | 2 | 3 | 3 | 11 | 73,534 | 153,590 | 240,676 |
| Paraguay | - | - | - | - | 1 | 5 | 5 | 6 | 8 | 4,866 | 103,888 | 149,684 |
| Venezuela | - | - | - | - | - | - | - | 2 | 2 | 17,159 | 111,603 | 135,114 |
| Uruguay | - | - | - | - | - | - | - | - | 4 | 1,237 | 15,848 | 51,377 |
| Suriname | - | - | - | - | - | - | - | - | 1 | 1,607 | 5,880 | 8,854 |
| Guyana | - | - | - | - | - | - | 1 | 1 | 4 | 398 | 6,289 | 8,357 |
| Total North America | 59 | 61 | 108 | 213 | 213 | 696 | 1,264 | 1,678 | 1,678 | 4,388,566 | 18,648,989 | 27,702,074 |
| Total South America | 1 | 3 | 11 | 36 | 70 | 104 | 198 | 254 | 493 | 3,946,706 | 12,808,133 | 17,285,885 |
| SITREP No. | 38 | 41 | 44 | 47 | 49 | 51 | 53 | 54 | 56 | 193 | Weekly SITREP | Weekly SITREP |

Prepared by the author based on WHO situation reports (2020-2021).

By July 31, 2020, the WHO had reported 17 million confirmed cases of COVID-19 (World Health Organization 2020s). The epidemic intelligence collected information verified by the WHO, and as of December 27, 2020, confirmed over 79.2 million cases of COVID-19 (World Health Organization 2020f). On February 21, 2021, one year after the first confirmed cases of March 2020, the WHO reported over 111 million global confirmed COVID-19 cases (World Health Organization 2021c). By July 25, 2021, the WHO reported 194 million confirmed

COVID-19 cases and, as of October 24, 2021, 243 million confirmed cases (World Health Organization 2021e, 2021f). The pandemic conditions offered a more severe possibility for nation-states to establish practices and add security measures in response to the COVID-19 virus while also addressing AMR concerns. While the AMR of human bacterial pathogens remained a focus for health authorities and health officials, the COVID-19 pandemic endured immediate attention across country borders. Nonetheless, despite the challenges that the COVID-19 pandemic presents in health systems and AMR surveillance, "countries were able to maintain their capacity to detect and rapidly alert to any AMR threats of public health importance" (World Health Organization 2021d, 59).

In conclusion, this section focused on the qualitative analysis of the GLASS system and infectious diseases as boundary objects through interviews and document analysis. The qualitative data structure frames the procedure of the philosophical theories chosen in this study. Furthermore, the qualitative information connects to various disciplines and provides an understanding and explanation to enhance the quantitative data results. Thus, combining two distinct analytical-qualitative and quantitative datasets allows a movement beyond traditional statistical analysis toward a kaleidoscope of integrated and comprehensive data.

In collaboration, this research included discourse on using ideas and knowledge of diverse experts from the scientific, security, intelligence, health, military, and academic disciplines. These relevant figures are vital to the process of providing support pertinent to the core of the system. Subsequent chapters also include commentaries from various interviewees. The following section on the GLASS-selected pathogens and surveillance of AMR, the security governance metrics framework, and the five dimensions of security governance enables us to answer the research question further.

### 3.2 Communicable Diseases: From Antimicrobial Resistance of Bacterial Pathogens to the Novel Coronavirus (COVID-19)

In early 2022, the virus continued to cross oceans when individuals had to deal with a deadly pandemic and partisan divisions. On one end, the novel coronavirus increased while, on the other end, actors tackled another emerging pandemic, AMR. Therefore, infectious diseases continued to span oceans and borders, whether known or unknown. This section includes a description of the GLASS database, a discussion of infectious diseases, such as the eight human bacterial pathogens, and a brief dialogue on the COVID-19 coronavirus.

The WHO published a report in 2014 as a first look, from a global perspective, at antibacterial resistance (ABR) and AMR surveillance in common bacterial pathogens (World Health Organization 2014). The WHO produced the report in collaboration with member states and partners across different sectors. Antibiotic resistance pertains to strains of microorganisms that develop a resistance to antibiotics. AMR occurs when microorganisms such as viruses, bacteria, parasites, and fungi form a resistance to a previously sensitive antimicrobial medicine (World Health Organization 2015c; O'Toole 2013). Thus, ABR occurs when resistance to the agent kills bacteria. The report served as the baseline to measure data on pathogens and strengthen the collaboration of AMR surveillance. Therefore, the report, which included ABR information, served as the starting point for the modern vision of GLASS integrating AMR data in other areas such as animal-human interface, environmental AMR, and consumption of antimicrobials.

The GLASS system reported data through a customized software called the WHONET. The system obtains information from GLASS-enrolled countries for individuals interested in studying or learning about the surveillance of antimicrobials that cause human infections. The WHO established a priority list of pathogens, including two coronaviruses, the Middle East respiratory syndrome coronavirus (MERS-CoV) (de Groot et al. 2013) and the severe acute respiratory syndrome (SARS) (World Health Organization 2017d, 2017c). Although many other bacterial pathogens exist, the surveillance system focused on eight human bacterial pathogens. In 2015, the WHO developed the surveillance system of eight human bacterial pathogens and GLASS reports on the following bacteria which cause global common hospital and community-acquired infections: *Acinetobacter spp*.; *Escherichia coli* (E. coli); *Klebsiella pneumoniae* (Klebsiella); *Neisseria gonorrhoeae* (N. gonorrhoeae); *Salmonella spp.*; Shigella spp.; *Staphylococcus aureus* (S. aureus); and *Streptococcus pneumoniae* (S. pneumoniae) (World Health Organization 2017b). The WHO developed a global priority pathogens list that includes eight pathogens (World Health Organization 2017d, 2017c). Table 3.4 lists the pathogens by order of priority and type of resistance (World Health Organization 2017c, 5). A team of experts, which consisted of public health and pharmaceutical research and development, epidemiology, infectious diseases, and clinical microbiology, selected the bacteria to be prioritized into three tiers: critical [1], high [2], and medium [3] (World Health Organization 2017c).

**Table 3.4. WHO Priority Pathogens and Antibiotic-Resistance**

| Priority | Pathogen Species | Type of Resistance |
|---|---|---|
| 1 | Acinetobacter baumannii | Carbapenem |
| 1 | Escherichia coli | Carbapenem and Third Generation Cephalosporin |
| 1 | Klebsiella pneumoniae | Carbapenem and Third Generation Cephalosporin |
| 2 | Staphylococcus aureus | Methicillin and Vancomycin |
| 2 | Neisseria gonorrhoeae | Third Generation Cephalosporin and Fluoroquinolone |
| 2 | Salmonella spp. | Fluoroquinolone |
| 3 | Shigella spp. | Fluoroquinolone |
| 3 | Streptococcus pneumoniae | Penicillin-non-susceptible |

Prepared by the author with information from the field work.

While other global surveillance systems already produce data for infectious diseases such as tuberculosis, malaria, HIV, drug resistance, and influenza, the WHO-GLASS team chose the eight pathogens as gap-fillers. As an interviewee indicated,

> The idea of including only specifically known bacterial pathogens was based on the fact that other surveillance systems already existed and monitoring for instance other types of pathogens, viral pathogens, parasitic pathogens and tuberculosis. So, there is no prejudice against any other global threat, but to fill a gap that at the time we have seen.[12]

The bacterium, *Acinetobacter*, is found in water and contains opportunistic disease activity (O'Toole 2013). *A. baumannii* causes human disease, and the bacterium causes various infections, including pneumonia, wound infections, bacteremia, and meningitis (O'Toole 2013). *Acinetobacter* contains many species between the non-baumannii group and the *Acinetobacter* baumannii group, which consists of A. pitti, A. baumannii, and A. nosocomialis (World Health Organization 2017b). Immunocompromised individuals are most at risk of the infection, mainly inside healthcare settings and intensive care units (Brady, Jamal, and Pervin 2021; O'Toole 2013). *Acinetobacter* resists many antimicrobial agents because of its "selective ability to exclude various molecules from penetrating their outer membrane" (World Health Organization 2017b, 139). Nevertheless, the organism colonizes in patients that do not

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[12] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).

have symptoms and exists in open wounds, such as an opening in the front of the neck or tracheostomy (O'Toole 2013).

The bacteria *E. coli*, commonly present in milk, water, soil, and the intestines, causes "urinary tract infections, pneumonia, bacteremia, and peritonitis, among others" (Mueller and Tainter 2021, sec. 3, para. 1; O'Toole 2013). In addition, blood poisoning caused by the bacteria quickly causes a descent into shock or death of the individual (O'Toole 2013). More specifically, *E. coli* frequently causes community and hospital-acquired urinary tract infections and infections of the kidney, a cause of neonate meningitis, and one of the leading causes of global foodborne infections (World Health Organization 2017b). Furthermore, although infections from *E. coli* derive from the gut of the affected individual, AMR strains transmit from animals and spread between individuals (World Health Organization 2017b). Likewise, despite carbapenems remaining an available treatment option for severe infections such as *E. coli*, the WHO notes that "carbapenem resistance in *E. coli* is an emerging threat" (World Health Organization 2017b, 139). Thus, the WHO classified carbapenem on the priority list of AMR and considered *E. coli* a high-risk bacteria which causes complications such as developing life-threatening kidney failure.

The *Klebsiella* bacteria exists in cereal grains, water, soil, animals, and the human intestinal tract associated with pathological conditions such as pneumonia (O'Toole 2013). Diseases that result from *Klebsiella* include bloodstream, urinary tract, and lower respiratory infections, with the majority of human infections caused in a healthcare setting (World Health Organization 2017b). In addition, *Klebsiella* contains a resistance gene that renders penicillin ineffective and is the leading global reason of infections caused by carbapenem-resistant bacteria (World Health Organization 2017b).

Likewise, the next global public health priority pathogen includes *N. gonorrhoeae*, which causes gonococci or gonorrhoea, an acute sexually transmitted infection (Wi et al. 2017; O'Toole 2013). The WHO noted that not treating the infection results in severe complications, such as inflammation in the reproductive and genital tract leading to further damage and infertility (World Health Organization 2017b). In addition, *N. gonorrhoeae* also infects the gastrointestinal tract, such as the rectum and pharynx. The resistance to antimicrobials cancels the treatment of gonorrhea, causing the disease to evolve into a superbug. The study shows a likelihood that the global issue of *N. gonorrhoeae* AMR will worsen in the foreseeable future, and "the severe complications of gonorrhoea will emerge as a silent epidemic" (World Health Organization 2017b, 140). Thus, the WHO placed *N. gonorrhoeae* and its resistance to antimicrobials on the high-priority list to monitor, research, and develop an effective treatment.

In conjunction, ingesting contaminated water or food or through person-to-person contact transmits the pathogenic bacteria *Shigella* which causes gastroenteritis or diarrhea (World Health Organization 2017b; Wi et al. 2017; O'Toole 2013). Although patients recover within approximately seven days of contracting the disease, "shigellosis can be a life-threatening or fatal disease, particularly in children" (World Health Organization 2017b, 141). A growing concern regards the gaps in the type of information surveilled at the national level and the reliability of the local data to inform on the appropriate treatment. Therefore, due to a minimal recovery period, the WHO placed *Shigella* and fluoroquinolone AMR at the medium tier in the priority list to develop advanced and effective treatments.

The bacteria *Salmonella* "includes species causing typhoid fever, paratyphoid fever, and some forms of gastroenteritis" and widely distributes in animals, producing a disease that transfers to humans and results in food poisoning (O'Toole 2013, 1591). *Salmonella* infection arises through the consumption of foodborne illnesses deriving from contaminated water, food, or beverages. For example, a foodborne outbreak occurs when animal or human faeces contaminate the surface of foods (World Health Organization 2017b). Multi-drug-resistant strains of *Salmonella* have emerged worldwide, and fluoroquinolones have been used as a treatment drug for the disease. However, the "multi-drug resistant *Salmonella* enterica serotype typhimurium has been associated with a higher risk of invasive infection, higher frequency and duration of hospitalization, long illness, and increased risk of death" (World Health Organization 2017b, 141). Therefore, due to treatment failure, the WHO listed fluoroquinolone-resistant *Salmonella* on the priority list in the higher tier to develop better treatments of antibiotics.

The infectious pathogen *S. pneumoniae* causes community-acquired pneumonia and other human maladies worldwide (Dion and Ashurst 2021; O'Toole 2013). The cost to hospitalize patients with community-acquired pneumonia in the United States amounts to approximately $9 billion USD a year, with a 22% mortality rate. It is the leading cause of death in all infectious diseases

(Dion and Ashurst 2021). The pathogen also causes other diseases, such as infection of the middle ear (acute otitis media), infection in the bloodstream, and meningitis. Therefore, the WHO classified penicillin-non-susceptible *S. pneumoniae* as a medium priority tier in research and development for novel treatment.

The *S. aureus* pathogen presents global concerns due to its resistance to antibiotics which is generally found on the nose or skin of healthy individuals and is "responsible for a number of pyogenic infections, such as boils, carbuncles, and abscesses" (O'Toole 2013, 1685). In addition, the *S. aureus* human pathogen produces toxins that cause symptoms such as food poisoning and toxic shock syndrome (World Health Organization 2017b). Likewise, *S. aureus* causes a broad spectrum of clinical infections, which result in the direct invasion of bacteria in organs and tissue damage. The display of infection results in the "release of various toxins, either locally or systematically, and include[s] a range of diseases dependent on the location of the infection" (Zurita, Mejía, and Guzmán-Blanco 2010, S98). The human bacterial pathogen lingers as a challenge because of multi-drug resistant strains such as methicillin-resistant Staphylococcus aureus (MRSA) (Taylor and Unakal 2021), a particular "growing problem across Latin America" (Zurita, Mejía, and Guzmán-Blanco 2010, S97). In addition, MRSA presents cases of asymptomatic carriage. According to the CDC (2019), "approximately 5% of patients in the U.S. hospitals carry MRSA in their nose or on their skin" (CDC 2019b, para. 4). Long-time cases of MSRA colonization or infection last from approximately 260 days to 40 months (Scanvic et al. 2001) and asymptomatic carriers transmit MRSA (Worby et al. 2013). While community-acquired MRSA increases notably in many countries, some antibiotics control the MSRA strains. However, more complex multi-drug resistant strains continue to cause healthcare-associated MRSA infections (World Health Organization 2017b). Therefore, the WHO listed the *S. aureus* bacterium and AMR resistance to methicillin and vancomycin on the high-priority list to develop further treatments.

In 2018, the WHO revisited the original priority list and added the Zika virus and Disease X, referring to any new unknown virus that causes an epidemic. During the scope of the research in 2019, an unknown virus appeared, and the medical community ruled out MERS, SARS, and influenza. A novel global virus threat emerged: COVID-19. The rapidly growing outbreak of COVID-19 derived from the etiologic agent, severe acute respiratory syndrome coronavirus

(SARS-CoV-2), which according to the WHO, began in Wuhan city, Hubei province of China (World Health Organization 2020h; Sanche et al. 2020). On December 31, 2019, Wuhan City reported several cases of an unknown etiology (World Health Organization 2020t), and within the timeframe of this study, from December 31, 2019, to January 3, 2020, the WHO reported 44 cases of pneumonia patients of a yet unknown cause in China (World Health Organization 2020h). The virus belonged to the new coronavirus family in what the medical community temporarily calls 2019-nCoV. On January 27, 2020, the Secretary of the USA Health and Human Services, Alex M. Azar II, determined that a public health emergency existed (U.S. Department of Health & Human Services 2020c), and the WHO declared COVID-19 as an "outbreak to be a public health emergency of international concern" (World Health Organization 2020i). On January 31, 2020, the WHO reported 9826 globally confirmed cases (World Health Organization 2020i). On February 11, 2020, the WHO officially named the virus the coronavirus disease 2019 (COVID-19) (World Health Organization 2020x, 2020v). In March 2020, the institution characterized the virus as a pandemic (World Health Organization 2020w), and the WHO added COVID-19 to the priority list of infectious diseases. Thus, by the mid-year of 2020, the coronavirus spread rapidly across national borders, converting the disease into a global pandemic.

The investigation notes that the WHO GLASS does not include COVID-19 surveillance data as one of the eight human bacterial pathogens listed during the implementation stage since it was outside the parameters of the GLASS architect. Furthermore, when asked about the coronavirus and its connection to the GLASS surveillance of infectious diseases, a WHO interviewee remarked, "GLASS is about global surveillance of AMR, and it's outside the scope of GLASS."[13] Therefore, the coronavirus occurred outside of the selected GLASS pathogen realm.

How does the COVID-19 infectious disease shape reaction and response to the slow-moving but no less deadly glooming threat of untreatable bacterial infections, the silent AMR pandemic? Even though COVID-19 does not fall within the GLASS system, the WHO official added that it is relevant to this study because of the "link across several surveillance systems at a higher level for public health purpose of each governing body in charge of looking at infectious disease

[13] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).

burden."[14] Moreover, many surveillance systems of infectious diseases connect regarding health information due to the nature of global public health and the safety and well-being of civil society. Therefore, the case study includes COVID-19 information as context evidence and a reinforcement mechanism.

Moreover, since the WHO considers AMR a critical global public health problem deriving from the resistance to medicines used to treat infectious diseases (World Health Organization 2020b, 2017b), COVID-19's pandemic also complicated human and national security as a global public health crisis and slowed down research and development in many industries, including AMR surveillance. Therefore, infectious diseases such as the coronavirus remain the focus of attention for health authorities and decision-makers.

There is a threat level difference between a bacterial infection which patients cannot fight with medicine (AMR), and the COVID-19 viral illness, where antibiotics are ineffective. Nevertheless, the pandemic has had "a substantial impact on health systems globally, affecting the management of other health threats, such as antimicrobial resistance (AMR)" (Tomczyk et al. 2021, 3046). Moreover, after more than two years of tackling COVID-19, the threat of AMR is "not only still present but has become an even more prominent threat" (CDC 2022c, 3). For instance, in 2020, in a healthcare setting, the "bacterial nosocomial infections were more common in COVID-19 patients," and the most frequent bacteria identified as a percentage of all true bacterial tests in patients with COVID-19 was S. aureus, Klebsiella, and E. coli (Scott et al. 2022, 3). In addition, the CDC identified a high increase in infections in healthcare-associated pathogens, such as Acinetobacter (CDC 2022c). Therefore, bacterial superinfection occurred in many COVID-19 patients and enhanced the relevancy of the study in the connection between infectious diseases.

On one end, COVID-19 "results in a wide spectrum of disease from asymptomatic carriers through pneumonia, acute respiratory distress syndrome (ARDS) and death leading to many hospitalizations and ICU admissions" (Scott et al. 2022, 1). On the other end, the data analysis reveals that bacterial pathogens pose a threat and have been the cause of a disproportionate

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[14] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).

amount of human death and disease. Therefore, public health systems prepare to fight multiple threats simultaneously.

The various threat levels of infectious diseases coexist, and the connection between surveillance networks to the different fields and threat entities and the drive for open information sharing help to identify when global health is on the rise and inform outbreak response. In addressing one primary disease, states and institutions such as the WHO collaborate with different actors to target other infectious diseases. In addition, COVID-19 led to a need for more research progress in combating infectious diseases across many industries, including AMR. Thus, its impact after the scope of the case study and post-pandemic has been detrimental to global health policy matters.

Do we want to neglect the audience of valuable information on an infectious disease that caused a global pandemic, influencing the response, preparedness, research, and development of AMR and other bacterial pathogens? My study errs on knowledge production and data sharing to deal effectively with complex issues. Presently, COVID-19 is a major threat, and AMR is considered a minor threat, a silent pandemic lurking in the background, but both are equally important in promoting a health regime. Therefore, the best way to avert a pandemic caused by an antimicrobial-resistant pathogen is to identify gaps, which includes looking at the actors collaborating and interconnecting in the network and variables such as COVID-19 that have reshaped the world.

In conjunction, COVID-19, like AMR, represents a complex and system-wide public health concern where no silver bullet exists to slay the beast. More than relying on one factor, such as therapeutics, public behavior, diagnostics, vaccines, or surveillance, changes are required. Instead, a compilation of all these things is paramount to progress and solution. AMR ensues to be the next pandemic following COVID-19 in the foreseeable future. Acting at a slower pace but no less deadly over the long run. It threatens to undermine safe healthcare delivery and have a global influence significant enough to shift the economic scale in research, treatment, and development. It requires a sustained collaborative response across multiple sectors and geographies. No single country or person is safe from drug resistance and infections until many nation-states, actors, and stakeholders act. The combination of AMR and COVID analysis has a high value and is a prime example of preparedness forthcoming for future threats. This study focuses on AMR sprinkled with COVID-19 data, which provides essential information about interventions, preparedness, and connections. Therefore, this dissertation uses the coronavirus as a modern-day threat player as context research and a reinforcement mechanism to the investigation.

Likewise, new issues and contemporary threats inspire discourse and analysis in the decision-making process since cyberspace consists of many spaces (Balzacq and Cavelty 2016; Fontaine 2015). Moreover, science and technology retie the intractable problem of disentangling the impossible knot and crisscrossing the notion of the network—the Gordian knot (Balzacq and Cavelty 2016; Latour 1993). Delegates of the WHO and participating countries banded together through implementing the IHR. Imbroglios and networks, which once had no voice, now have a whole place. The production of nature and society allows changes in external truth and the subject of law without ignoring the co-production of science and society (Jasanoff 2004; Latour 1993). Representatives speak in the state's name, where actors, courses of action, and instruments all play a pertinent role in the complex world (Jasanoff 2004; Latour 1993). This control links to knowledge infrastructure and "who has the right to speak in the name of science" (Bowker 2001, 7). Thus, a network stops working when information from actors presents irrelevancy to the network. Therefore, the interweaving of science and technology and the nature of society create a magical quilt of social tasks and heightened security measures.

International collaboration includes the unique leadership role of stakeholders from private to public sector actors contributing to the collaborative efforts, including open data sharing and pandemic preparedness actions. Governmental instruments include collaboration to improve public health and fight nontraditional and global security threats. How do we incentivize from the bottom up to fit the form of continual knowledge production and information strategies? Strengthening the relationships at the top, such as a lateral level of interconnection comprised of multi-industry sectors, incentivize surveillance of infectious diseases and manage the security of data that trickle down to the bottom. The virus does not care about its location in a country and does not respect borders. Barriers do not stop the virus. Thus, international relationships are essential.

### 3.3. Measuring Security Governance to Promote a Health Regime

The research creates a security governance metrics framework to develop an adequate measure of security governance, such as in the control of diseases and the data, during information exchange in the surveillance of infectious diseases to promote a health regime. This dissertation analyzes security governance by measuring the perception of nonconventional threats. How to measure security governance? What boundaries exist in the success or failure of security governance? To develop or evaluate the effectiveness of security governance of open data sharing in the GLASS system in the surveillance of infectious diseases, I define the scope as the interest in understanding the operational characteristics of the GLASS network.

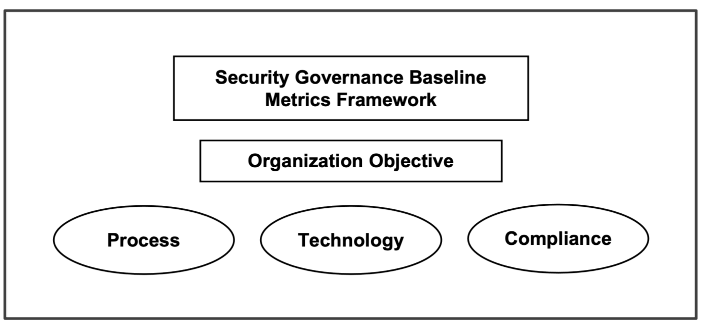
More specifically, where views on governance arise as the "sum of the many ways individuals and institutions, public and private, manage their common affairs" (Webber et al. 2004, 5), I look to the performance and reliability of the GLASS network and interactions of relevant actors. Fundamentally, in what ways do we have privacy? Does privacy even still exist? While technology continues to develop, how do actors maintain a modicum of privacy in our elementary activities? Have we lost the right to control the information that robust computing systems gather in our lives? Users of information, "openness, transparency, and fair use of personal data should be rights to us" (National Academies of Sciences Engineering and Medicine 2015, 6). Nevertheless, the data controller decides how and in what form to process data and shares an element of dominion that blankets openly available information.

The crucial concerns deal with the wedding of the WHO and algorithms originating from the WHONET imported into the GLASS results. Furthermore, the data enables the WHO, its practices, and algorithms to track the surveillance of AMR and bacterial pathogens. In this instance, "countries provide AMR data primarily for pathogens isolated from blood specimens, followed by urine, stool, cervical and urethras ones" (World Health Organization 2017b, 6). Does the WHO-GLASS network, including the WHONET technology, adequately protect the organizational process it purports to protect? To develop the measures for security governance activities, I had to think about communication efforts and focus on the type of audience since researchers analyze security governance in different ways. This research focuses on science, technology, and security leaders within an organization's operational, technological, and compliance elements.

This dissertation also looks at security and privacy experts within the healthcare industry. My research regards leaders who have more interest in the process, technology, and compliance measures to understand the effectiveness of the capabilities of the services delivered. In this case, how effective is the WHO-GLASS network, especially its AMR surveillance system, in delivering and exchanging information to the member states?

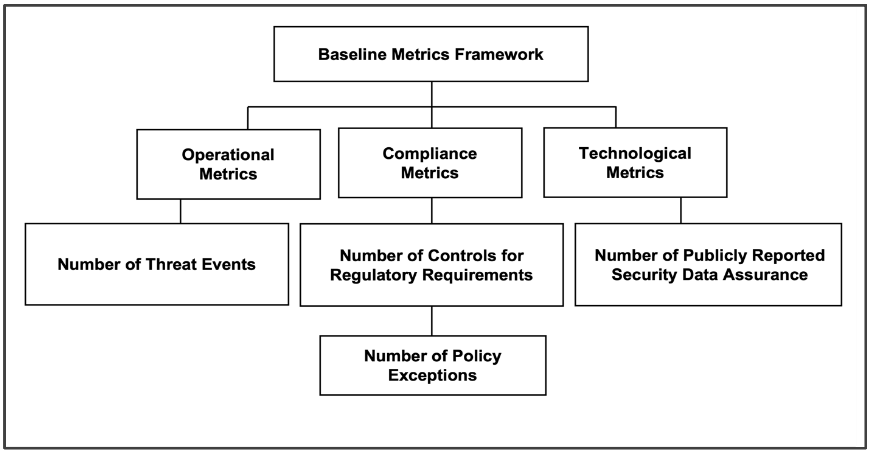
The methodology to create the metrics includes measuring the perception of nonconventional threats. John P. Pironti's (2007) information security metrics approach inspires this research. This study develops the measurements by establishing a baseline framework of metrics. Adopting Pironti's approach, I first drafted the blueprint for this study as the security governance baseline framework shown in figure 3.11. After establishing the baseline framework for each element, the study populates subcategories that account for "audience- and concept-specific metrics" (Pironti 2007, 2), which the security governance metrics framework illustrates in figure 3.12. These subcategories include operational, technological, and compliance metrics.

**Figure 3.11. Baseline Metrics Framework**




Prepared by the author.

**Figure 3.12. Security Governance Metrics Framework**




Prepared by the author.

The operational, technological, and compliance metrics by Pironti (2007) deal with implementing security control and processes at a program and systems level. Therefore, I chose to focus on these three metrics, which best align with the core research question of why security governance through an open technology database of the WHO promoted a health regime on the surveillance of infectious diseases in the Americas from 2015 to 2021. Thus, this dissertation chose the three taxonomies most appropriate for the research.

I focused on the key goals of the technology database in formulating the three metrics. The principal objectives of the WHONET are to enhance the local use of laboratory data, promote global collaboration through data exchange, and "support the WHO goal of global surveillance of bacterial resistance to antimicrobial agents" (O'Brien and Stelling 1995, 66). Based on the objectives, I started building metrics that set the stage and a reinforcement mechanism for establishing security governance in controlling diseases and data during information exchange. Building security through different metric tools in the surveillance of infectious diseases promotes a health regime. Thus, the metrics create the foundation of security governance reinforced by the subsequent section of the case study analysis.

### 3.3.1. Managing Security Threat: Operational Control of Infectious Diseases through a Surveillance Network

How did the WHO-GLASS network operate in the control of infectious diseases? Under the operational metrics, I track the number of threat incidents from 2015 to 2021 on the GLASS platform to measure the effectiveness of operational control of infectious diseases by the institution. In the operational metrics, I look to see if the WHO-GLASS dichotomy includes managing the diseases during their operational process. The actor's ability to direct the surveillance operation by tracking and monitoring the frequency of microorganisms transpires as operational control of the threat as a security means. Therefore, such action control connects to a heightened level of security that guides the threat's international surveillance.

Since different countries submit information on national AMR surveillance, a limitation of the study includes the complexity of comparing results by region or country. The GLASS notes the impracticality of comparing, for instance, 2017 with 2018 proportion data to monitor progress within regions since each country submitted data at different periods across the five-year scope of the study. For example, drawing on data from the first GLASS data call in 2017, the study shows the selected priority bacteria that cause human infections in the Americas region (see table 3.5). The results illustrate the top pathogens that present global public health threats to countries in the Latin American region, including *N. gonorrhoeae* and *Salmonella spp*.

**Table 3.5. Number of countries in the Americas region reporting data, by specimen, on specific pathogens in 2017**

**Americas Region AMR Surveillance of Public Health Threat Selected Priority Bacterias**

| **Region Americas** | **PATHOGENS** | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **n = 3** | Acinetobacter | E. coli | Klebsiella | N. gonorrhoeae | Salmonella | Shigella | S. aureus | S. pneumonia |
| Blood | X | X | X | X | 1 | X | X | X |
| Genital | X | X | X | 1 | X | X | X | X |
| Stool | X | X | X | X | 1 | X | X | X |
| Urine | X | X | X | X | X | X | X | X |

X = none reported
n = Number of countries by region reporting data.

Prepared by the author based on WHO (2018a).

While table 3.5 shows a few countries of the Americas reporting on AMR pathogens (n=3), the participation of member states illustrates the process of controlling and monitoring infectious diseases by submitting AMR data in the surveillance network. Likewise, the study shows other countries reporting AMR data, with 3097 hospitals and 2358 outpatient clinics reporting to GLASS (World Health Organization 2018a). Furthermore, according to the GLASS, 2017-2018 report, “45 (94%) countries submitted results from blood specimens, 24 (50%) from urine specimens, 21 (44%) from stool specimens, and 20 (42%) from cervical and urethral specimens” (World Health Organization 2018a, 15). Thus, the study shows that while only three countries from the Americas reported pathogenic AMR activity between 2017 and 2018, the total number of patients with suspected infection of an isolated pathogen reached a maximum of 859,002 patients per country (World Health Organization 2018a). Furthermore, according to the GLASS results, between 2017 and 2018, the two most frequently reported pathogens by participating member states in South America were *N. gonorrhoeae* and *Salmonella spp*. Thus, AMR surveillance of these infectious diseases generated perceptions of a global threat to public health in the region.

Moreover, other countries in South America focused on AMR monitoring through the PAHO, which serves as the regional office of the WHO, and the ReLAVRA. The chart shown in Appendix A, Table 1, illustrates the microorganisms subject to AMR surveillance in 2014 reported by nine countries in South America, each represented by an NRL. During the analysis, I focused on the eight human bacterial priority pathogens of the GLASS network also listed in the ReLAVRA platform and the countries that reported AMR data closest to the timeframe of this study. Thus, while the ReLAVRA platform provides AMR surveillance data from 2000 to 2014, Appendix A, Table 1 focuses on 2014 data. The countries, including Argentina, Bolivia, Brazil, Chile, Colombia, Paraguay, Peru, Uruguay, and Venezuela, reported AMR data of selected nosocomial, foodborne, and community-acquired pathogens. Out of the nine countries that reported AMR data on ReLAVRA, three countries enrolled in the GLASS network: Argentina, Brazil, and Peru. The study shows that Argentina reported 49,372 total isolates. The highest reported pathogen was *E. coli*, with a high rate of 50 percent and a total number of 32,101 for the infectious agent. Next, the research shows that Brazil reported 11,878 combined with the eight isolates. The most common pathogen reported by Brazil in 2014 was *Salmonella spp*., at a 39 percent high rate of the 5,666 total pathogens. Lastly, Peru showed a combined total of 1,998 isolates and reported *S. aureus* as the highest infectious agent in the country at a rate of 40 percent and 1,071 total.

In conjunction, the study revealed that during the 2018 GLASS data call, the GLASS report indicated that the USA had 5061 patients with positive samples for *N. gonorrhoeae* under surveillance (World Health Organization 2018a). In the 2019 GLASS data call, more information grew as the top pathogens posing a risk to the USA, as reported in an AMR data submission to GLASS, were revealed as *salmonella*, *shigella*, and *N. gonorrhoeae* (World Health Organization 2020g). Likewise, out of the eight human bacterial pathogens, the most urgent threats in the USA in 2019, indicated by the CDC, included carbapenem-resistant *Acinetobacter* and drug-resistant *N. gonorrhoeae* (CDC 2019a). The pathogens that posed the most serious threats to the USA in 2019 included *salmonella*, *shigella*, *S. aureus*, and *S. pneumoniae* (CDC 2019a). Thus, awareness and collaboration of AMR grew as surveillance of AMR and monitoring of pathogens increased.

In addition, I provide an analysis from a different perspective based on a country currently unenrolled in GLASS but adhering to the One Health approach as a WHO member state (World Health Organization 2015d). The One Health approach involves different actors and sectors to tackle global public health threats. Table 3.6 illustrates the country-specific AMR surveillance of Ecuador. As of the first GLASS data call in 2017, Ecuador had yet to submit AMR data in the GLASS network. Nevertheless, the Ecuadorian ministry of health and complementary private actor networks continued to monitor and submit AMR data through the WHONET to integrate bacterial AMR isolate-level data and facilitate data collection (Ministerio de Salud Pública del Ecuador 2019b). Table 3.6 illustrates the threat of microorganisms Ecuador faced during the AMR surveillance conducted by the Ecuadorian ministry of health in the highest percentage of isolates of hospital services from 2014 to 2021. Furthermore, the study shows that Ecuador reported from hospital services registered by the National Institute for Public Health Research (INSPI by its Spanish acronym) *E.coli* with the highest percentage (more than 60 percent), followed by *Klebsiella* and *S. aureus* (Ministerio de Salud Pública del Ecuador 2019b).

**Table 3.6. Ecuador AMR Surveillance of Infectious Agents Most Reported in WHONET**

Ecuador AMR Surveillance of Public Health Threat Infectious Agents

| Resistance % | < 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | > 2021 |
|---|---|---|---|---|---|---|---|---|
| E. coli | 58 | 64 | 63 | 61 | X | X | X | X |
| Klebsiella | 20 | 18 | 17 | 21 | X | X | X | X |
| S. aureus | 12 | 11 | 12 | 10 | X | X | X | X |

Prepared by the author based on Ecuador Ministry of Public Health (Ministerio de Salud Pública del Ecuador 2019b).

The AMR surveillance does not stop at GLASS but is carried out through other interconnected networks with GLASS. Therefore, the WHO Regional Office for the Americas and PAHO (AMRO/PAHO) encouraged ReLAVRA countries to participate in GLASS and capture additional variables to align with the GLASS methodology (World Health Organization 2018a). Thus, the GLASS and ReLAVRA interconnected networks included voluntary participation by countries and deemed a form of control and monitoring of infectious diseases in a global system of AMR surveillance.

### 3.3.2. Managing Data Security: Controls for Regulatory Compliance

In conjunction, are there regulations or a process system (security governance) that introduce new controls and protection in the GLASS network for the surveillance of infectious diseases? How does the rule relate to the GLASS provisions? From 2015 to 2019, the first GLASS phase was the early implementation stage of the GLASS process of AMR surveillance. The GLASS objective is to “combine data on the status of enrolled countries’ AMR surveillance systems with AMR data for selected bacteria that cause infections in humans” (World Health Organization 2017b, V). Moreover, GLASS aims to “launch the global surveillance system and provide guidance and technical support to countries on how to develop an effective national AMR surveillance system” (World Health Organization 2021d, 3). Under the compliance metrics, the study tracks the number of controls for regulatory requirements. For example, security includes how actors handle and control data. The compliance metrics are the foundational precursor to discussing the five key security governance dimensions discussed in the following case study section and on safekeeping laws or regulations in chapter 4. For instance, the investigation analyzes publicly available documents of official government reports such as the ministries of health or nation-states, which create security measures or protocols for safekeeping the information exchange ecosystem and controlling the spread of diseases.

**Table 3.7. WHO-GLASS Network Data Controls and Compliance**

| COMPLIANCE METRICS | | | | | |
|---|---|---|---|---|---|
| **GLASS Data Calls** | **Date** | **Number of Countries Enrolled in GLASS** | **Source** | **No. Countries Reporting AMR Data** | **Source** |
| None | May 2021 | 109 | (World Health Organization 2021d, iv, 3) | 107 | (World Health Organization 2021d, ix) |
| | Apr 2021 | 107 | | | |
| 4th Data Call | Aug 2020 | 94 | (World Health Organization 2021d, 13) | 70 | (World Health Organization 2021d, 19) |
| 3rd Data Call | Jul 2019 | 82 | (World Health Organization 2020g, 7) | 66 | (World Health Organization 2021d, 19) |
| 2nd Data Call | Dec 2018 | 71 | (World Health Organization 2018a, 3) | 49 | (World Health Organization 2021d, 19) |
| 1st Data Call | Dec 2017 | 50 | (World Health Organization 2017b, 8) | 22 | (World Health Organization 2021d, 19) |
| | End of first data call | 42 | | | |
| Early Implementation Phase | 2015-2019 | GLASS objective: To combine data of enrolled countries' AMR data and their AMR surveillance systems for eight selected human bacterial pathogens. | | | |

Prepared by author based on GLASS Reports, World Health Organization (2016-2021).

In compliance with the IHR to prevent, protect, and control the international spread of disease (World Health Organization 2016a), GLASS fosters surveillance of AMR and global antimicrobial consumption. Table 3.7 illustrates the GLASS data calls created during the scope of the investigation. Between 2015 to 2021, GLASS placed four data calls. During each data call, participating member states either enrolled or submitted AMR data to comply with the GLASS submission requirements and adhere to the IHR. Therefore, the WHO-GLASS network created aspects of controlling data by providing "sustainable control strategies to tackle the AMR threat" (World Health Organization 2020g, 118) and organizing the data from member states to compile the GLASS reports based on the data results.

### 3.3.3. Managing Technology and Safety: Risk Management Controls for Security Data Assurance

Under the technological metrics, I review institutional reports from 2015 to 2021 within the WHO-GLASS network to analyze risk management controls such as tracking the number of reported data providing security assurance. While using advanced technology, significant concerns include maintaining a database of client (customer) information and ensuring data security and integrity, credibility, and privacy. The GLASS network contains a support detection component called the Emerging Antimicrobial Resistance Reporting (GLASS-EAR) (World Health Organization 2018a). The GLASS-EAR supports AMR surveillance programs' detection, early warning, and risk assessment. It provides tools for transparent and secure reporting. I looked to see whether any WHO-GLASS reports or results included words such as [1] security, [2] safety, [3] privacy, or [4] data quality assurance as indicators of security assurances to countries in their submission and exchange of AMR data.

**Table 3.8. Baseline Reference Technological Metrics: Security Data Assurance Controls**

| AMR Surveillance Network & AMR Data Reports | Component | Data Security and Quality Assurance Security-Related Words | | Security | Quality Assurance | Safety | Privacy |
|---|---|---|---|---|---|---|---|
| | | | | Number of times the topic words mentioned in relation to data and information exchange | | | |
| GLASS Report 2021 | AMR | Code: [1] Security, [2] Safety, [3] Privacy, [4] Data Quality Assurance | 4 | 0 | 8 | 0 | 0 |
| GLASS Report 2020 | Early Implementation | | 4 | 0 | 4 | 0 | 0 |
| GLASS Report 2017-2018 | GLASS-EAR | | 1, 4 | 3 | 5 | 0 | 0 |
| GLASS Report 2016-2017 | Early Implementation | | 4 | 0 | 6 | 0 | 0 |
| 2014 WHO Global Report on Surveillance | AMR | | 4 | 0 | 4 | 0 | 0 |
| WHONET Manual | GLASS | | 1 | 1 | 0 | 0 | 0 |
| 2016 National AMR Surveillance System and Particaption in GLASS | GLASS | | 4 | 0 | 4 | 0 | 0 |

Prepared by the author.

I created the technological metrics in Table 3.8 as a baseline reference guide and a behind-the-scenes look to analyze data security and technical control mechanisms in implementing a surveillance system. I reviewed GLASS documents and the WHO-GLASS website for instances of data security assurance from publicly available information. The research shows that the terminology most used concerning security transpires to be *quality assurance*. The reports mentioned little about data exchange security, safety, and privacy. However, the GLASS 2017-2018 data results report indicated that the WHO provides a comprehensive and formal policy to securely manage all databases and information sources (World Health Organization 2018a). Therefore, the technology metrics allow the study to evolve broadly into the security hemisphere.

Moreover, the GLASS-EAR reactivates information sharing through the WHO's data security policy which includes "information security, technical and physical data security" (World Health Organization 2018a, 232). Likewise, GLASS requires data quality assurance and the data to be de-duplicated where one isolate represents one patient to minimize bias associated with reporting repeats (World Health Organization 2018a). In addition, during a high-level technical meeting in preparation for the implementation of the global surveillance system, the conference assured participating member states by noting that the "WHO had strict rules on reporting national data and very strict rules on data security" (World Health Organization 2017e, 13). Likewise, the WHO guided the confirmation of reports, the use of the IT platform, and adherence to best practices based on performance metrics (World Health Organization 2017e). For instance, the GLASS IT platform terms of use indicate that "access to the Web-based internet GLASS platform requires an electronic identification which consists of username, password and potentially other security measures" (World Health Organization 2015a, 2).

The terms also indicate that "all reasonable precautions have been taken to verify the content provided by the users into the Web-based internet GLASS platform" (World Health Organization 2015a, 2). Lastly, the GLASS incorporated a type of security checks and balances by checking the validity of the data through a "series of automatic checks built into GLASS" (World Health Organization 2017b, 17). Therefore, technology controls provide assurance and guarantees in protecting data from corruption or unauthorized access.

Furthermore, an essential point for clinical analysts to consider from an antimicrobial stewardship perspective is the necessity of having senior doctors sitting on the workbench. Having multiple reviewers conduct quality assurance to check the validity or security, for instance, a minimum inhibitory concentration (MIC) or the lowest concentration of a bacteriostatic agent, ensures the correct data entry and analysis entered into the surveillance system. The research shows that "countries are responsible for ensuring the validity, consistency, and completeness of AMR data submitted to GLASS" (World Health Organization 2018a, 249). In addition, communication is key between actors, such as senior officials and clinicians, in analyzing the data to ensure the accuracy of the information, label it as either sensitive, resistant, or intermediate and determine whether the resistance is an actual threat. In other words, is the virus coming from inside the patient, or is the problem with the sample collection?

Likewise, as a clinician obtains and enters relevant data contributing to a global surveillance network such as GLASS, is the bacteria triggering an infection? Thus, the communication between senior doctors and colleagues ensures openly shared data validity. In turn, the results of the collective data provide transparency for the recipients of the information. Therefore, a pre-analytic diagnostic check adds value to the overall global surveillance system of security governance in controlling the data and diseases during information exchange.

### 3.4. Security Governance Dimensions: Heterarchy, Interactions, Institutionalization, Ideas, and Collective Purpose

The five indicators of security governance are heterarchy; the interaction of multiple public and private actors (depending on the issue); institutionalization; relations between actors ideational in character structured by regulations or norms; and a collective purpose. I measure security governance episodes from 2015 to 2021 against the five leading indicators in the context of the WHO's GLASS surveillance system of AMR with COVID-19 as a contemporary frame of reference. The key to understanding governance lies in analyzing which actors, other than the government, contributes to a "modicum of order, of routinized arrangements [that nourishes] the conduct of global life," since arrangements encompass complex forms (Rosenau 1992, 7; Brousseau, Marzouki, and Méadel 2012). For example, one mechanism of governance includes a top-down state intervention approach. However, "states, as well as markets, can fail" (Jessop 2000, 13). Moreover, adapting to continuous innovations is valuable to security governance rather than hindering advancements (National Academies of Sciences Engineering and Medicine 2015). Therefore, the framework addresses the features of security governance in actor relations.

The concept of security governance involves multiple actors that conceive a system of rules in response to security threats. The set of processes guides international surveillance and structures collaboration. Governance includes acknowledging the importance of ideas, institutions, structures, and purposefully motivated actors (Webber et al. 2004). One interviewee connects the concept of security governance of infectious diseases with being global. Further, actors often keep information generated through securitization too restrictive, and this type of information is shared as "open access, rather than corporate and proprietary."[15] This section incorporates perspectives of security governance through document review and observational references of actors from the northern and southern subcontinents of the Americas to analyze the emergence of a health regime on the surveillance of communicable diseases. Through the specific case study, the following sections address the five dimensions of security governance. In addition, they include a discussion of the alignment between the control of the spread of infectious diseases and data sharing in the emergence of a health regime.

### 3.4.1. Heterarchy: The Existence of Multiple Centers of Power

Global problems such as infectious diseases, cybersecurity, and emerging technologies cross boundaries and involve coordinated actions taken by actors through multiple centers of power or heterarchy. The first indicator of security governance comprises heterarchy which involves relations of interdependence. It includes a multiplicity of coordinated and combined actions that respond to the complex challenges of conducting affairs by actors such as the people, state, or institution (Webber et al. 2004). Similarly, heterarchy ensues as networks of interdependent social relations which range from simple interactions between two actors to complex social divisions of activities (Jessop 2000). For example, the process of regulation or institutions that guide international surveillance involves diverse actors affected by the threat and potential sanctions by regimes to carry out compliance. The case study shows that the WHO's core responsibility includes "the management of the global regime for the control of the international spread of disease" (World Health Organization 2016a, 1). A plurality of actors or the existence of multiple centers of power stirs a movement of thought on inclusiveness which constructs "decisions through the accommodation of interests" (Webber et al. 2004, 20). Therefore, sanctions, delivery, and accommodations construct ideas and decision-making by including many actors.

Certain scholars of diverse perspectives tend to boost the role of the government, noting that states remain the agents which institute, finance, and realize the governance structures (Peters 2007) or act as primary actors in global affairs (Grieco 1988). Furthermore, others see the states

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[15] Author's interview with Dr. Nancy Campbell, Professor, Department Head of the Department of Science and Technology Studies, Rensselaer Polytechnic Institute, 12 November 2019.

as strong and dominant units through a military and political lens (Buzan and Little 2000) and non-state actors lacking a voice (Chorev 2012). However, a societal and economic perspective deems the states less prominent (Buzan and Little 2000). Thus, while certain scholars err on the side of the state as a primary player, governance is necessarily state-centric.

Governance involves formal institutions and informal arrangements with a perception that actors agree to be in their best interest. It also refers to any form of heterarchy of interdependent social relations, which range from simple dyadic interactions to complex social divisions of labor (Jessop 2000). In the area of security, traditionally reserved for the state, non-state actors play an essential role in monitoring and implementing security policies (Webber et al. 2004). In the area of security governance, both international organizations and states "remain the primary actors" (Webber et al. 2004, 6). Thus, states and international organizations play important roles in the international system.

I revealed different contexts in the study concerning the GLASS contribution and collaboration between centers of power on AMR surveillance of infectious diseases in which policy issues arise. For example, "a rise of authoritarian autocratic regimes and a democratic regime which has strong protection of civil rights and liberties,"[16] appears as one interviewee indicated. On the other hand, a hard-nail information regime leans toward authoritarianism, insisting on solid state-controlled capitalism. The interviewee added:

> When you have a system that is good at identifying individuals and communities using high-tech means, you can't assume that these tools will be used in accordance with the United Nations declaration of human rights or the fundamental principles of liberal democracy.[17]

However, the dissertation focuses on other forms of policy issues, such as a health regime where multiple states share data with a strong sense of responsibility and attention placed on global health, civil rights, human rights, and liberties. Therefore, each regime type presents levels of heterarchy mixed with multiple power players in connection to a common interest.

The case study shows that the WHA represents WHO's highest policy-making body. The WHA requested the WHO to establish the GLASS system through resolution WHA68.7 (World Health

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[16] Author's confidential interview, United States.
[17] Author's confidential interview, United States.

Organization 2015b). The WHO devotes energy to formalizing relations with nation-states. Collaboration implements through multiple channels. For instance, the WHO collaborates "bilaterally, through regional networks and the WHO regional offices, and through intergovernmental organizations and international bodies" (World Health Organization 2017b, 30). The WHO-GLASS brings new power centers in the surveillance network process. According to available data, data, the WHO has approximately thirty collaborative centers which work in a broad field of surveillance and resistance, lab capacity building, and external quality assurance. The collaborating centers form a network that provides expert technical advice to the WHO. The WHO creates protocols based on the technical advice from the collaborative centers. In addition, the WHO receives technical advice from various actors, including the Food and Agricultural Organization (FAO), the World Organization for Animal Health, the CDC, the European Centre for Disease Prevention and Control (ECDC), and the ministries of health. The WHA, which governs the WHO and constitutes worldwide Ministries of Health, gives the WHO broad directions. In turn, the WHO creates the plan, the WHA reviews the plan, and then the WHO ministries of health sign the plan's implementation. Likewise, through the GLASS technology system of AMR surveillance, the WHO adds to the security governance process by creating solutions where the member states of expert collaborative centers provide input based on the data submitted. Therefore, these diverse high-level power centers collaborate towards a common goal.

ANT assists in identifying the limitations of a network. Where multiple actors with a common interest jump on board and collaborate to respond to a threat, such interconnection in security governance of data and infectious diseases also "involves the incorporation of potential rivals" (Webber et al. 2004, 20). The study shows that 42 members enrolled in GLASS during the 2017 preliminary stage data call; 51 countries enrolled by January 2018; and 71 countries enrolled by December 2018, including Russia, but China did not report information in the surveillance system (World Health Organization 2021d, 2018a, 2017b). As of April 2020, 94 countries had enrolled, but China remained unenrolled in GLASS (World Health Organization 2020g). One interviewee argued that China's lack of GLASS enrollment was due to technical issues, rather than politically-driven.[18] Regardless, the study illustrates how participating and rival actors with

[18] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).

the potential to collaborate in the surveillance network jointly manage common security matters. Russia, one of the great powerhouses in the international system, enrolled in the system. China, another power-player had not enrolled, but by 2020 the mega-size of the country made it difficult for China to provide information from a system that provides aggregated data.[19]

Similarly, another of the great powers, the USA, considered AMR a national priority and took steps to fight the threat. For example, in 2014, the U.S. government established the U.S. National Strategy for Combating Antibiotic-Resistant Bacteria (U.S. White House Office 2014), in 2015, the U.S. National Action Plan for Combating Antibiotic-Resistant Bacteria (National Action Plan) (U.S. White House Office 2015), and in 2020 the second National Action Plan (CARB) (U.S. White House Office 2020b). The national action plan for combating AMR also sets targets for the actions of different government agencies to address the global issue, providing an example of common rules to follow and a set of principles that make up a health regime. Likewise, the U.S. government engaged in multilateral organizational support through the CDC and the United States Agency for International Development (USAID) to support the sharing of antibiotic-resistant pathogen data with the collaborating centers of other WHO member states, including members of the GLASS network (U.S. White House Office 2020b). In addition, the CDC collaborated with experts and world leaders to implement the National Action Plan. An interviewee remarked that the CDC used "several data sources and systems to track antibiotic resistance,"[20] including GLASS, to assess the scope of the problem and monitor AMR. Therefore, institutions such as the CDC look to AMR data from the WHO's GLASS surveillance system as a reinforcement mechanism or to review the scale of the problem.

Likewise, as the world becomes more complex and social and economic conditions emerge that nation-states or the market cannot manage, reliance on networks and heterarchy increases. The WHO supports the member states in strengthening infection control measures, preparedness, and response efforts to infectious disease outbreaks, and GLASS supports and fosters global and national AMR surveillance (World Health Organization 2021d). Digital transformation across all aspects of life and maintaining coherence are also significant. Institutions such as the WHO acts as a bridge between actors to ensure inclusivity among nation-states, keep the different processes

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[19] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[20] Author's interview with CDC staff, United States, by email, 17 February 2020.

together, warrant universal principles over time, and ensure we share information and engage in capacity building. The real value lies when institutions and a health regime facilitate pulling actors together, including sovereign entities. As we peel back on the onion, the liberal institutionalism theory notes that the states maintain a primary role. However, the institutions themselves, particularly a health regime that includes a global AMR surveillance structure, are built by actors who aspire to have a supranational governance structure, such as the UN and undertake regional efforts towards common goals. The GLASS network, in which various member states enrolled and participated, is an example. This health regime works due to multiple centers of power. The institutions, therefore, are just as significant actors in the international system. Thus, a more robust and substantial commitment to collaboration, enhancing digital literacy, and clarity on data distribution and results help solve various challenges from AMR to a pandemic and digital sphere.

### 3.4.2. Interaction of Public and Private Actors

The second indicator of security governance involves the interaction between public and private actors working together. The multiplication of actors involved at various levels adds to security management while diffusing a global health crisis. Moreover, each actor brings a different set of potential "incentives to the resolution of the crisis" (Webber et al. 2004, 11). Getting other customer perspectives, such as officials or citizens, is critical because diverse voices are essential at the table. Thus, a minimal working relationship between public officials and private actors creates a positive engagement in crisis management.

In addition to institutional multiplication, "the process of delivering security involves many actors whose inputs were previously negligible or non-existent" (Webber et al. 2004, 16). Tackling a global issue involves reassembling and collaborating resources from non-governmental and private actors. Diverse actors include economic investors, judges, construction companies, police officers, medical professionals, charities, and administrators (Webber et al. 2004). The network analysis conducted in section 4.2.1 identified the diverse actors in the network and their interconnectedness. This research considered multiple types of actors which connected directly to the primary unit of analysis and other relevant actors with as much common interest in the boundary object.

The case study shows private interest groups such as philanthropic organizations that participate in the collaboration and interconnectedness of information sharing of the GLASS and the software, WHONET, that manages data that countries use to prepare the information submitted to GLASS. For example, private actors interconnected with the GLASS system and the WHONET include the Bill and Melinda Gates Foundation, and as one interviewee remarked, "in the area of tuberculosis, the IUTLD or the International Union Against Tuberculosis and Lung Disease, and Doctors without Borders."[21] Likewise, the Pew Charitable Trusts (PEW), an NGO, focused on domestic policies but looked to connections and information from sources such as the WHO's GLASS data and network to maintain and raise awareness of global efforts. A Pew executive commented:

> On its face having increased additional information on what kinds of resistance are being seen at the country level, worldwide, and being able to use that data to look at patterns and to identify areas where additional work is needed, is helpful and useful and you've seen that in other communicable disease spaces. So, surveillance is definitely an essential aspect of any sort of global effort to address the spread of resistant.[22]

In addition, the PEW and WHO have worked closely on a pipeline in the creation of antibiotics and demonstrate what drugs showcase in the Food and Drug Administration (FDA) development process. The PEW set up the pipeline and criteria, the WHO communicated with PEW to understand the process and subsequently, the WHO created their own pipeline to expand globally based on the information which PEW shared.[23] Therefore, the example discussed the collaboration between a private actor (PEW) and the WHO, which worked together to highlight the challenge and problem of limited pipeline existence. Similarly, in 2020, the Global Antibiotic Research and Development Partnership (GARDP) participated in a session organized by the HHS on combating AMR, further detailed in section 3.2.4. The basis of GARDP, an independent foundation founded by the WHO, is nonprofit collaborative approaches. The GARDP conducted research and development and clinical development of AMR treatment based on the collection of surveillance data from the WHO GLASS surveillance program (Piddock et al. 2021). The GARDP provides a delivery path for innovations developed by the U.S. private and public

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[21] Author's interview with Dr. John Stelling, 24 January 2020.
[22] Author's confidential interview, United States.
[23] Author's interview with Kathy Talkington, 29 January 2020.

sectors (U.S. Department of Health & Human Services 2020b). The WHA gives observer status to these private actors, which present statements, advice, guidance, and funding. At times philanthropy, governments, and international bodies have backed institutions' sheer drive to ensure that funding gaps close as quickly as possible, the regulatory environment works as efficiently as possible, and there will be ready global markets and supply chains.

The case study further shows that the number of member state enrollments increased to 109 countries and territories by May 2021 in the GLASS network (World Health Organization 2021d). In addition, the study reveals that Brazil, Argentina, and Peru enrolled in GLASS from the southern subcontinent countries of the Americas between 2015 and 2021. Ecuador used WHONET but was unenrolled in GLASS by the end of 2021. The National Institute for Public Health Research of Ecuador noted that until 2010 there were 22 public and private hospital laboratories coordinated by the private Hospital Vozandes in Quito to monitor bacterial resistance worldwide (Instituto Nacional de Investigación en Salud Pública 2021). The INSPI is the national reference laboratory of the Ecuadorian ministry of health (Instituto Nacional de Investigación en Salud Pública 2021). In addition, the INSPI interconnects with other institutions like the U.S. CDC. For example, due to the COVID-19 pandemic, the CDC has sent diagnostic materials such as primers and positive controls to countries in reference laboratories, such as the INSPI in Ecuador, rather than private laboratories to conduct their tests. Therefore, the link occurs between governmental ministries of health through their respective national reference centers.

The growing awareness of the threat that AMR poses to public health motivated the first meeting held in 1998 in Caraballeda, Venezuela, organized by the PAHO and the Pan American Association for Infectious Diseases with the support of the Venezuela ministry of health (Salvatierra-González and Guzmán-Blanco 1999). As a result, the union of Latin American countries formed for the first time to organize bacterial resistance surveillance (Salvatierra-González and Guzmán-Blanco 1999). The conference established that the public sector actors oversee managing the networks. Each country began monitoring the resistance through its respective national reference centers. For this case study, I interviewed one of the conference attendees, Dr. Jeannete Zurita, a medical doctor, and microbiologist. Dr. Zurita created a small network with five friends from different laboratories because they had to be vigilant on AMR since Ecuador lacked knowledge about the resistance to bacterial pathogens such as Shigella. Dr.

Zurita, who worked in the private sector, was invited to the Carabellada meeting by PAHO, a regional organization that knew about the small Ecuadorian AMR network group. During the meeting, the members committed to monitoring resistance and sending the data to PAHO. As a result, Dr. Zurita created the National Bacterial Resistance Surveillance Network of Ecuador (Red Nacional de Vigilancia de Resistencia Bacteriana del Ecuador in Spanish (REDNARBEC)) to monitor AMR in the country and to contribute as a member of the WHO network on the surveillance of worldwide bacterial resistance (Instituto Nacional de Investigación en Salud Pública 2021). The REDNARBEC commenced with ten laboratories sending data to PAHO. By 2010, under the coordination of Hospital Vozandes and Dr. Zurita, REDNARBEC grew to 22 public and private hospital research centers (Instituto Nacional de Investigación en Salud Pública 2021).

When asked for a reason for the abrupt stop of the Ecuadorian AMR surveillance data since 2010, Dr. Zurita, who worked in the private sector of the hospital Vozandes at the time, indicated the hospital was initially the reference center where the doctor received the data from the peripheral laboratories. Dr. Zurita explained: "I analyzed the data, cleaned the data, and all the information that was published up to 2010 was sent to the Pan American Health Organization."[24] The doctor noted that, when the Correa government (2007-2017) came into power, it nationalized everything, and wondered how a private laboratory held data in a global surveillance network.[25] Nevertheless, for the WHO, "the involvement of private hospitals is crucial to generate more representative AMR surveillance data" (World Health Organization 2021d, 19). Likewise, during the second high-level technical meeting on AMR surveillance for local and global action in the facilitation of data sharing by national bodies and stakeholders, countries in the Americas region indicated that the private sector and academics report to the national authority, which then report to WHO (World Health Organization 2017e). Thus, the Ecuadorian private hospital collaborated to exchange pathogenic information and network structure with the Ministry of Public Health. After training the new government personnel on how to enter and extract the data from the REDNARBEC, Dr. Zurita claimed that

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[24] Author's interview with Dr. Jeannete Zurita, Medical Doctor, Microbiologist, Temporary Advisor of Antimicrobial Resistance to PAHO, Washington, DC, Professor, Faculty of Medicine, Pontifical Catholic University, Quito, Ecuador.
[25] Author's interview with Dr. Jeannete Zurita, 25 February 2022.

"REDNARBEC disappeared, everything went to the government, and AMR surveillance went to INSPI in 2011."[26] Therefore, a private sector actor (Vozandes hospital) collaborated in sharing data with a public sector actor (INSPI) in the surveillance of bacterial pathogens.

The more than ten-year gap between the last data submitted to PAHO by the Ecuadorian AMR network and to present-day creates data discrepancies. Dr. Zurita noted that the time-lapse data problem is that "you have to make use of that health data so that they have an impact and make public policies."[27] Furthermore, "they have to be super clean, well-filled data, because the one who types can input wrong information, make mistakes, and get things that are not correct."[28] Therefore, the lack of updated or published information on resistance provided by the country poses significant issues.

Many factors contributed to the failure to post timely sequential data. For instance, Dr. Zurita believed the information was missing because "the administration does not have money or enough personnel, we are not blaming the public sector, but it is challenging—everything is a lack of public policies."[29] Nevertheless, a blanket of political corruption covered the Ecuadorian public health system. The doctor added that they placed officials who are not experts in epidemiology or antimicrobial resistance, and "they place officials because he is a friend of the cousin who voted for the president or vice-president, totally corrupt."[30]

Under the Sixty-Eighth World Health Assembly Global Action plan on AMR (2015), member states, including Ecuador, committed to developing their national action plan to adhere to the objectives of the "One Health" approach, including tackling antimicrobial resistance (World Health Organization 2015d). Accordingly, the Ecuadorian ministry of health created its National Plan for the prevention and control of AMR (Ministerio de Salud Pública del Ecuador 2019a). Furthermore, the Ministry of Public Health counts on monitoring AMR through the Sistema Integrado de Vigilancia Epidemiológica (SIVE) or the Integrated Epidemiological Surveillance System in English by notifications from the WHONET system (Ministerio de Salud Pública del Ecuador 2014). In addition, the microbiology laboratories of hospitals of both the Ministry of

[26] Author's interview with Dr. Jeannete Zurita, 25 February 2022.
[27] Author's interview with Dr. Jeannete Zurita, 25 February 2022.
[28] Author's interview with Dr. Jeannete Zurita, 25 February 2022.
[29] Author's interview with Dr. Jeannete Zurita, 25 February 2022.
[30] Author's interview with Dr. Jeannete Zurita, 25 February 2022.

Public Health and the Ecuadorian Social Security Institute (IESS in Spanish), the Security Institute of the Armed Forces (ISSFA in Spanish), Social Security Institute of the National Police (ISSPPOL in Spanish), and a complimentary private network work with the WHONET database (Ministerio de Salud Pública del Ecuador 2019a, 2019b). In turn, the INSPI developed the techniques to detect pathogens of resistance and updated the WHONET, which manages and analyzes microbiology laboratory data.

Unfortunately, Dr. Zurita said the last surveillance data came from the private actor-network REDNARBEC in 2011. Nevertheless, the INSPI submitted the AMR data in a 2014 AMR Global Report on Surveillance reported by the WHO. The data from Ecuador focused on antibacterial resistance (ABR) surveillance in common bacterial pathogens. The report's results served as the basis for GLASS to integrate AMR data (World Health Organization 2014). Furthermore, according to an official government document, Ecuador "still does not have data on the consumption of antibiotics and those used in infectious diseases in the field of human and animal health" (Ministerio de Salud Pública del Ecuador 2019a, 14). Thus, the lack of systematic tracking of AMR data leads to the scarcity of some member states, such as Ecuador's enrollment, data submission, and exchange in GLASS.

Implementing AMR surveillance means that actors must collaborate, influence, and work towards integrating the policy instruments with a number of other actors, perhaps even outside the WHO-AMR sphere. For example, during an observational review of an official virtual meeting by the PACCARB on antimicrobial resistance and COVID-19, a diverse set of public and private actors attended the meeting (U.S. Department of Health & Human Services 2020a). The meeting included the following actors: one designated federal official, two advisory council staff, eight organizational liaisons, 11 regular government employees, and 15 voting members (U.S. Department of Health & Human Services 2020a). Therefore, the study reveals that a more significant interaction of intelligence sharing between diverse actors adds to collaborative interactions and exchanging ideas in response to the crisis on infectious diseases and AMR.

Furthermore, caution lies in striking a balance between the rights of the public sector regarding privacy and data protection with the private sector's need to leverage big data. On the one hand, actors such as the WHO and the GLASS system prioritize privacy while implementing AMR surveillance. We are dealing with a target in intelligence just as the WHO developed GLASS.

The targeted entity in the surveillance network comprised eight human bacterial pathogens with antibiotic resistance. On the other hand, nation-states allow technology unicorns to be born. For instance, during the COVID-19 pandemic, telemedicine, digital meetings, and digital products increased. To disrupt the coronavirus's transmission chain, governments in the global south adopted new mobile applications: Argentina (Cuidar), Bolivia (Bolivia Segura), Brazil (Coronavirus SUS), Chile (CoronApp), Colombia (CoronApp), Ecuador (ASI Ecuador), Paraguay (COVID-19MX), Peru (PeruEnTusManos), and Uruguay (CoronavirusUy) (Pan American Health Organization 2021; Government of the Province of Loja 2020; Presidency of the Republic of Colombia 2020; Presidency of the Republic of Uruguay 2020). Thus, closing the digital divide between the public and private sectors entails collaboration, transparency, and security reliability.

Similarly, the prevalence of a worldwide spread of infectious diseases brought forth the involvement of additional actors, such as intelligence and security officers, to deliver security and other networks. As a result, stakeholders introduced security-related elements, such as increased think tanks during the COVID-19 pandemic focused on security issues. In addition, media attention regarding security measures increased from the immediate transition into the digital space. Likewise, focusing on the subsequent silent tsunami of antibiotic-resistant infections opened the door to other actors, such as research and development centers, biotechnology companies, microbiologists, investors, and financial institutions, responding to the threats.

The sudden outbreak of the new virus and various actors' actions to combat the disease reinforced collaborative and interconnected global responses, which have been quicker and more transparent than the 2002 SARS. Here we have these organizations in this complex system having to address a risky scenario. In 2019, once China informed the WHO of the nontraditional threat, the USA and other global countries began close surveillance. Various actors, including the ministries of health, the CDC, the military, and the healthcare community, banded together to combat the threat. In January 2020, the second meeting of the Emergency Committee by the WHO Director-General under the International Health Regulations (IHR) took place in Geneva to determine a Public Health Emergency of International Concern (PHEIC). In February 2020, the WHO convened a global research and innovation forum in Geneva to mobilize international action in response to COVID-19, which brought together key actors from the ministries of health, research funders, scientists, and public health agencies. In March 2020, global policymakers held an emergency call where G7 leaders discussed economic response mechanisms tied to the outbreak. In April 2020, the G20 leaders held a virtual conference to discuss ways to combat the pandemic. Therefore, multiple public and private actors have become essential in preparedness and response to calamities in response to threats.

The pandemic experience demonstrated how essential connectivity was and the harsh digital divide. Private sector actors working with governments and agencies have helped increase economic development to close the digital divide. A sense of security is essential to generate assurance and significant steps. For instance, the NRL acting as core components "secure the correct flow of information to national bodies and GLASS and are essential in data preparation and submission" (World Health Organization 2021g, 17). Likewise, the first GLASS data call in 2017, which held 40 participatory countries to more than 100 country enrollments, secured a strong commitment and close collaboration with AMR regional networks. While this is a minor example, it showcases important steps of dynamic changes.

### 3.4.3. Formal and Informal Institutionalization

The third indicator of security governance entails the employment of institutions, such as the observance of norms and a frequency of actions and decisions (Holsti 1992, 50). Actors create a system of governance through an agreement in the pertinence of institutions in carrying out governance tasks (Holsti 1992, 36). For one interviewee, security governance includes "monitoring because you want to detect quickly whenever there is some sort of an outbreak and that is done by various means, such as taking temperatures."[31] Likewise, attention to institutions, transitional organizations, corporate interests, civil society, the state, and government characterize governance perspectives (Pierre 2000). Nonetheless, the significance of security governance includes the gray area that results from developing informal and formal institutions—from participating countries to non-members in the core surveillance system. Therefore, the WHO has strived to form associations with diverse players.

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[31] Author's interview with Colonel, United States Army (Ret) Patrick J. Mahaney Jr., Department of Defense, United States Special Forces Officer (Green Beret), 14 February 2020.

The results of section 3.2 mapped four distinct networks, which included the most influential actors in the collaborative network. Mapping the networks resulted in an understanding of which relevant institutional actors were predominant in the collaborative network of the surveillance of AMR. At an institutional level, to strengthen multisectoral actions to tackle AMR and deliver on the 2030 Agenda for Sustainable Development, during the 75th session of the UN General Assembly, the co-chairs of the Group of Friends on Tackling Antimicrobial Resistance launched the "Call to Action on AMR" (World Health Organization 2021b). As of December 2021, the Call of Action included 113 member state signatories, including Argentina, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela from the global south, and 39 supporting organizations, including the private sector and civil society (World Health Organization 2021b).

At a practical level, the WHO informally engages with each participating member states through consultations in meetings and activities regarding common interests such as tackling infectious diseases and AMR. The case study shows that during the coronavirus pandemic, from November 28 to December 9, 2020, PAHO, in collaboration with WHO headquarters, held four online regional consultations (World Health Organization 2021d). The informal online sessions aligned with the framework of online consultations to prepare for the third high-level technical consultation and meeting on AMR surveillance and its use for concerted action (World Health Organization 2021d). A diverse audience attendance of over 100 online participants connected to each session, including "microbiologists, epidemiologists, clinicians, public health professionals from ministries of health and partner institutions" (World Health Organization 2021d, 59). PAHO, as the WHO regional office for the Americas and the WHO headquarters online actions illustrate the accomplishment of the strategic global action plan objective, which includes understanding and improving awareness of AMR, as well as "to provide support and technical assistance to countries, with a specific focus on low- and middle-income countries" (World Health Organization 2015d, 19). Furthermore, the collaboration by participating attendees in providing feedback on the GLASS documents and system enforced the technical cooperation of countries. Therefore, gathering informal online meetings contributed to the development of continued strength in AMR surveillance in the Americas.

Moreover, the WHO assumed an important role in connecting with other institutional actors such as funders and NGOs. For instance, according to the WHO Situation Report 85, groups of funders, manufacturers, doctors, and scientists pledged to collaborate with the WHO to push for the accessibility of a vaccine for COVID-19 (World Health Organization 2020e, 2020u). As an institutional structure, the WHO has become a conduit for dialogues and consultations relating to global health, safety, and security and an informal and formal link to other actors, especially at the UN. Therefore, adding new institutional actors adds to the complex interdependent channels that connect societies.

For one interviewee, "on the GLASS side, the WHO follows the principles and rules which respond to the whole UN system."[32] Three critical aspects to consider during a continuum of engagement with nation-states and international organizations worldwide include a committed democracy, privacy, and respect for individuals. The WHO works with the member states and the ministries of health (World Health Organization 2018b). According to a WHO official, the organization accepts data from the member states through official channels, and "the data coming to GLASS comes through official focal points appointed by the national branch of government, the ministry of health."[33] For another interviewee, "if you don't have some kind of organization managing it, to manage people's participation, their curation of the data, then it's going to be abused resource."[34] The case study reveals that under the WHO, the GLASS "applies a set of rules to its data analysis to ensure reliability of generated results" (World Health Organization 2018a, 6).

Moreover, "surveillance National Focal Points (NFP) have been identified in all countries, working closely with the GLASS Secretariat alongside WHO regional offices, country offices, and regional networks" (World Health Organization 2017b, 5). For instance, with regards to the enrollment of Brazil in the GLASS system, an official indicated they have "a national focal point officially appointed by the Brazilian government and one of the national institutions responsible for the coordination of national surveillance system, so that is the formal regulation."[35] Likewise, the GLASS system "collaborates with existing regional and national AMR surveillance networks to produce timely and comprehensive data" (World Health Organization 2015b, 7). Furthermore,

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[32] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[33] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[34] Author's interview with Lieutenant Colonel Arnel P. David, United States Army, SO1 Strategic Analysis Branch, United States Special Assistant to the Chief of the General Staff, Deputy Assistant Chief of Staff G5 (DACOS G5) in the NATO Allied Rapid Reaction Corps, 10 February 2020.
[35] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).

institutions such as the WHO have acted as a bridge or accelerator in some bottom-up approaches to ensure coherence by bringing the different actors together.

In addition, the regional surveillance networks collect aggregated data provided by NRLs. For example, the GLASS report notes that in 1996 “the WHO Regional Office for the Americas Pan American Health Organization (AMRO/PAHO) established the Latin American Network for Antimicrobial Resistance Surveillance (ReLAVRA)” (World Health Organization 2017b, 124). Moreover, in the beginning, the ReLAVRA surveillance network was limited to reporting AMR data on foodborne pathogens. However, the network expanded to cover AMR surveillance of the GLASS-selected pathogens (World Health Organization 2017b).

Likewise, an example of informal institutionalization occurred between the AMRO/PAHO and the ReLAVRA participating countries in the ReLAVRA surveillance network. AMRO/PAHO ensured the “continued communication within the network, bimonthly Web-Ex meeting with ReLAVRA participants take place, joint by technical experts and partners” (World Health Organization 2017b, 124). Furthermore, the PAHO office worked with the regional countries and encouraged ReLAVRA participants to enroll in the GLASS network. Therefore, the connection and fostering of the networks such as GLASS and ReLAVRA have expanded global monitoring of AMR to address global health threats.

Nonetheless, one interviewee presented areas of concern by noting that, on the one hand, intelligence testing through open data assisted in collecting information to address a problem. Nevertheless, on the other hand, actor mindfulness in reporting information during categorization is essential. The interviewee indicated that intelligence testing is used “to determine the abilities and characteristics of certain people and groups and we form public policies based upon wise spending of money.”[36] While shared health data does not link the identities of individuals to the information per se, the organization reporting and information presented while careful not to connect the data to ethnic groups, you have a “supposedly neutral technique, which turns out not to be neutral.”[37] The study shows that GLASS aggregates statistics based on country and a limited number of antibiotics. For example, GLASS wants to know for *staphylococcus aureus*,

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[36] Author’s confidential interview, United States.
[37] Author’s confidential interview, United States.

according to an official interviewee: “The percent MRSA at the national level. So, there is nothing by region, nothing by facility. They would like it to be feasible by male, female, age group, and infection origin.”[38] The interviewee added that the WHO “does not want to know the name of the hospital or the names of the patients,”[39] but rather the GLASS asks for high-level summaries of things often associated with surveillance for advocacy purposes. Focusing on “interdependence, divisions of knowledge, reflexive negotiation, and mutual learning” (Jessop 2000, 18) in the exchange of publicly available data on the surveillance of AMR to reduce the incidence of infectious diseases creates new network paradigm shifts towards partnerships and the informal sector. Thus, analysts and data scientists consider data gathering and judgments made about groups of people or countries during the intelligence testing process.

On multiple occasions, institutions reveal their frequency of actions and decisions in response to threats to their security. For example, the case study shows that the WHO declared AMR “one of the top 10 global public health threats facing humanity” (World Health Organization 2019b, 2020b, n.p.). The WHO also stated that antibiotic resistance is “one of the biggest threats to global health, food security, and development today” (World Health Organization 2020a, n.p.). Therefore, by 2019, as a securitizing agent, the WHO officially listed AMR as one of the top ten threats to global health. Similarly, in January 2020, the WHO declared COVID-19 a public health emergency of international concerns, and the Secretary of HHS declared a public health emergency in response to COVID-19 (U.S. Department of Health & Human Services 2020c; U.S. President 2020). In March 2020, the WHO characterized the virus as a pandemic (World Health Organization 2020w). As a securitizing agent, President Trump declared the COVID-19 outbreak in the USA a national emergency (U.S. President 2020). In addition, the administration granted all fifty states, tribes, territories, and the District of Columbia emergency disaster declarations and protective measures in response to the coronavirus outbreak (U.S. Department of Homeland Security 2020a). Therefore, in both scenarios, the actions of the securitizing agents created the perception of a security threat by showing the world through its frequency of activities that it was facing multiple health challenges.

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[38] Author’s interview with Dr. John Stelling, 24 January 2020.
[39] Author’s interview with Dr. John Stelling, 24 January 2020.

### 3.4.4. Ideas Between Key Actors Driving a Surveillance System

The assembling of information and ideas between actors evolves with time. As vast amounts of data overflow amass the information ecosystem coupled with technology advancements and global threats, time is essential in understanding the means to the end. The fourth indicator of security governance involves the relations between actors that are ideational in character and structured by understandings and norms. It relates to understanding the importance of actors' actions during the governance process on the surveillance of infectious diseases as it relates to interactive ideas, their relevancy in the network, and the actors' relationship in connection to the ideas and resulting actions. The ideational indicator encompasses a consensus between actors on governance tasks (Webber et al. 2004; Holsti 1992). Scholars in different disciplines study the role of ideas in public policy, introducing an ideational approach (Kisby 2007). Some stress the importance of ideas surrounding a network (Marsh and Smith 2000). In accordance with this approach, analyzing security governance needs to consider the role of ideas promoted by relevant network members. The ideational characteristic of governance by institutions protects, preserves, and promotes ideas through inscription devices such as legal instruments. Thus, part of the collaborative network on security governance builds on the ideational context through which relevant actors operate.

A proliferation of government initiatives worldwide exists, whether in the USA or the global south. Each nation-state develops its regulatory framework. For instance, the IHR brought together member states for a common framework to inform AMR surveillance through the capacity to perform antimicrobial susceptibility testing. The IHR stipulated "the requirement for access by States Parties to capacity for investigation of any disease outbreak that may represent an international public health threat" (World Health Organization 2014, XIX). Likewise, the WHO's GLASS system brought together participating member states to foster and strengthen AMR surveillance systems in each country to guarantee the knowledge and systemic production of reliable data. The case study revealed that the WHO developed GLASS, in accordance with the WHA resolution, "to support the implementation of the Global Action Plan on Antimicrobial Resistance adopted at the Sixty-eight World Health Assembly in May 2015" (World Health Organization 2015e, 1). The participating member states favored a GLASS system of surveillance, including the relevant task of transmitting information onto the WHONET. At a more focused scale, the ideational characteristic includes enlargement (Webber et al. 2004).

Enlargement develops into actions of actors that increase in nature. For instance, the ongoing development of new tools and capacity-building included expert consultation on the burdens of AMR, which took place in 2021. An expert network was established in 2021, which focused on the application of the surveys in countries. A new WHO academy was created to explain the surveillance standards and data requirements; WHO is projected to reach 10 million global learners by 2023. Additionally, GLASS developed comprehensive training on AMR surveillance for policymakers and professionals in 2022 (World Health Organization 2021d).

Moreover, the instrument remains a boundary object when diverse actors collaborate independently and interpret the GLASS system differently to promote a health regime in actors' complex interdependent power relations. Actors create a system of "ideational consensus" (Holsti 1992, 36) based on ideas or norms which underpin governance (Webber et al. 2004), such as avoiding past issues of pandemic disasters and eradicating infectious diseases. One academic interviewee noted that "in regard to legislation and regulation, there ought to be open debate of relevant people with useful knowledge and then there ought to be debates from different points of view."[40] This study reveals that from February 26 to 27, 2020, the HHS organized a session to hear experts discuss innovations to combat AMR (U.S. Department of Health & Human Services 2020b). Listed on the meeting summary were 64 invited participants, including public health institutions, academia experts, military, patient advocates, research institutions, media editors, pharmaceutical companies, and NGOs (U.S. Department of Health & Human Services 2020b, 36-38). The study revealed that a diverse group of actors came together to discuss their ideas on health innovations and the rapid spread of COVID-19, which illustrates civil society's vulnerability to emerging infectious diseases. Dr. Martin Blaser, Chair PACCARB, presented that "building the infrastructure for combating AMR will help address COVID-19 and other such threats" (U.S. Department of Health & Human Services 2020b, 1). The exchange of ideas in the meeting revolved around innovations to fight AMR, such as alternative therapies, new antibiotics, vaccines, diagnostics, and animal health management products. For instance, the meeting expressed interest in novel technologies to reduce pathogens on surfaces. Participants suggested that the Bill and Melinda Gates Foundation invests in developing a vaccine for streptococcus in the neonatal health initiative. A key representative of the foundation indicated

[40] Author's confidential interview, United States.

that "the foundation has funded development of two vaccine candidates that are currently in preclinical and clinical trials" (U.S. Department of Health & Human Services 2020b, 11). Likewise, GARDP addressed its clinical research and development of treatments to treat drug-resistant infections in hospitalized adults, infants, and children. In addition, it focused on the CDC and the WHO priority pathogens also researched in GLASS.

Furthermore, the meeting's purpose intended to "gather information and exchange ideas about One Health issues and AMR" (U.S. Department of Health & Human Services 2020b, 1). The sharing of information by critical executives brought viewpoints that ensured the updated National Action Plan, released by the HHS at the end of 2020, reflected the current state of AMR threats (U.S. White House Office 2020b). Therefore, the ideas exchanged by diverse characters during the session reinforced the process that guides international surveillance of infectious diseases.

In consideration of security governance as a system of rules, the WHO, through the GLASS surveillance system, served as a conduit between actors to collaborate on the idea of surveilling infectious diseases. As one official indicated, "for us, the primary purpose of the GLASS system is not the global data collection, it's supporting countries in building their national systems."[41] Another interviewee noted data ownership, access, and use of WHONET: "data belongs to the country and the WHO is the steward of the data, manages the data, and with the permission of the country."[42] Thus, as an institution, the WHO acted as a communication channel and guided the international surveillance of AMR, supported by nation-states.

At the forefront of preparedness and response are efforts to address threat challenges, including sharing ideas for knowledge production in network communities to tackle AMR, addressing the COVID-19 pandemic, and overcoming financial or regulatory barriers. Furthermore, an ideational interaction between customers or key officials generates alternative ideas. However, the challenge is security channels that keep progress and innovation from moving. For one interviewee, security governance entails:

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[41] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[42] Author's interview with Dr. John Stelling, 24 January 2020.

> If you wanted to have the medical service and even the medical testing, as the affected individual, you ought to be certainly informed. If the data with the ability to trace it back to that particular individual were part of the package, then you ought to have an oversight and right to a voice, including denial.[43]

The case study shows that, in submitting AMR data, users of the Web-based internet GLASS platform agreed that the "data submitted have been collected in accordance with applicable national laws, including data protection laws aimed at protecting the confidentiality of identifiable persons" (World Health Organization 2015e, 1). Moreover, the WHONET contains a feature that assists software users in setting up passive surveillance systems that pool and analyze users' files collaboratively (O'Brien and Stelling 1995). Likewise, the WHONET provides "file encryption options to ensure confidentiality before data are pooled and analyzed" (O'Brien and Stelling 1995, 66). Therefore, institutions and nation-states consider a critical aspect from the beginning of the data collection surveillance process regarding how to build out these applications so that procedures, such as de-identification, balance the data collection results.

Likewise, the manual for early implementation of GLASS on the surveillance of the resistance in human bacterial pathogens reveals that the WHO provided reports during the WHA to member states and ensured "respect for member states' laws on surveillance, data collection, storage and reporting, and patient confidentiality" (World Health Organization 2015c, 15). Therefore, when distributing the WHO-GLASS manual to participating member states, the enrollees are notified that private identifiable information will not be exposed when enrolling or submitting AMR data GLASS surveillance system.

The state of global affairs in the last ten years for the USA "represents a particularly powerful and hegemonic vehicle for the projection of certain ideas of democracy, markets and institutional commitment" (Webber et al. 2004, 7). For example, in March 2020, Pfizer called on all members of the innovation ecosystem, including small and large biotech companies, government agencies, and academic institutions, to come together and address the global health crisis (Pfizer 2020b). As this example shows, the idea of safety, health security, and taking collaborative measures to combat a global threat has been at the forefront during health crises. On September 8, 2020, nine

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[43] Author's confidential interview, United States.

biopharmaceutical companies, AstraZeneca, BioNTech, GlaxoSmithKline, Johnson & Johnson, Merck, Moderna, Novavax, Pfizer, and Sanofi, pledged to work as a unit across the industry harnessing scientific expertise and technical skills to combat the crisis (Pfizer 2020a). Thus, these agents of continuity have striven to reduce safety and security concerns through collaborative efforts inspired by the idea of addressing present and future global health threats.

At the other end of the spectrum, complications arise in pushing forward ideas or an agenda to stabilize healthcare issues such as AMR. For instance, in Ecuador, ideas seem to be transitory in the political sphere and change with the sea's tides as each new administration brings about new ideas. For the interviewee Dr. Zurita, "you can have a law that is very good, but the Ecuadorian assembly does not approve it because they have no political interest."[44] Similarly, as officials and the ministry change positions in Ecuador, the information saved in the network disappears with the old administration. The new administration does not build upon what scientists have created. Instead, she added, "an official enters, and all of the prior research is wrong with no design policies."[45]

Nevertheless, in the past ten years, Ecuador improved surveillance mechanisms such as monitoring animal resistance. The idea of recognizing the impact of resistance as a significant health threat pushes tracking the use of the colistin antibiotic medication in animals to the forefront. Individuals have commonly used antibiotics such as colistin, quinolones, and fosfomycin in poultry production in Ecuador (Ortega-Paredes et al. 2020). However, the WHO lists these antibiotics as critically important antimicrobials for human medicine (World Health Organization 2017a). In 2019, the Ecuadorian administration banned colistin in food animals (Ortega-Paredes et al. 2020). For Ecuador, "the most important source of animal protein with a per capita consumption of poultry meat of 30.4 kg/year" is its poultry products (Ortega-Paredes et al. 2020, 2). However, who indeed conducts the surveillance for these antibiotics not to be used by citizens? For instance, if a farmer owns 40,000 chickens that are going to die because of an outbreak of infectious disease, they will give their chickens colistin because they may not care about resistance. The farmer wants to save their 40,000 chickens, and, according to Dr. Zurita,

[44] Author's interview with Dr. Jeannete Zurita, 25 February 2022.
[45] Author's interview with Dr. Jeannete Zurita, 25 February 2022.

"there is a lot of corruption there when you pay the person not to report you."[46] In Ecuador, for Dr. Zurita, "those controls are what the country lacks, or they hide the cows from you and don't tell you they have brucellosis."[47] While ideas make actors work together to address common threats, some stop them from occurring for selfish purposes rather than the greater good.

In addition, while actors agree or disagree with community, societal, institutional, or administrative norms, they bring forth an improvisational perspective of security governance, where ideas are inclusive. The case study reveals the idea of security at a grander scale in relation to multiple actors. An epidemiologist cares about a pathogen due to its antibiotic resistance and increasing threat to global public health. A military officer has a keen interest in someone weaponizing a biological agent, which means the official goes after the criminal in a counter-terrorist setting. However, both scenarios create the same effect: a pathogen that spreads rapidly around countries and people and is hard to control is considered a threat. In the USA, division appears everywhere from politics, vaccinations, power, money, class status, buying a house to renting, academics versus non-academics; even linguistics has now taken a beating where to some, the educational system has marginalized the use of words to fit particular norms—an endless list of divisions. So too, enters the world of security, where in the "United States, we divided out security and safety as if they are two different things."[48] To some individuals, security equates to people with guns, while safety is the crossing guard, fire department, or building safety director. However, let us look at security from the perspective of Latin America, from a Spanish romance language perspective. Security or *seguridad* intuitively provides us with a more holistic understanding of the problem and how to address the issue. We have separated the idea of security when a holistic viewpoint of security considers all aspects, such as biological, health, and safety-security. As one interviewee pointed out, "The answers to some of what we're looking for in the national security realm come from different realms."[49] The same interviewee added that it was "much easier to achieve cooperation, whether internal to the US, our allies, or even internationally, with people we are not partnered with or allied."[50]

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[46] Author's interview with Dr. Jeannete Zurita, 25 February 2022.
[47] Author's interview with Dr. Jeannete Zurita, 25 February 2022.
[48] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[49] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[50] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.

Therefore, the idea of security between nation-states connects to collaboration, which depends on the *who* and case by case. Security governance aspires to uphold the emerging health regime, which in the process of surveillance contains aspects of not being exposed to danger, an appearance of a secondary set of principles, that is, a security regime. The case study shows that, while GLASS conducts a job more aligned with the coordination of the surveillance of member states' AMR surveillance system, nevertheless, during the process of coordination, the institution monitors and controls the information through checks and balances. For example, the WHO-GLASS returns the same AMR data to the respective member states for analysis, validation, and quality assurance checks if found with errors. Likewise, the WHONET database that contains the information ensures confidentiality and provides encryption files before data pooling. Some argue that these are simply safety checks that do not rise to the level of security per se. However, if we follow the lead of the romance language of Latin America to include *seguridad*, safety, and security interconnect. Why must we have a divide even in the name of security? In this sense, the GLASS results in a more trustworthy form of surveillance. The idea of protecting the data is enough to make sure the information presented publicly and coherently takes the same actions and relations between the actors towards the next level of safety-security. Therefore, a security regime transpires within an emerging health regime.

### 3.4.5. Collective Purpose: Purposeful Momentum

The fifth feature of security governance involves a collective purpose and how actors interact. A lawyer knows the law. A doctor knows medicine, a plumber knows about plumbing, a mechanic knows about mechanics, etcetera—an endless list of professional knowledge. When different industries come together where diverse experts collaborate and share information, doors open from all points of view to tackle an issue. For example, for a collective purpose, the greatest influential minds, Nobel laureates, gathered during the fifth Solvay Conference in 1927 to discuss photons, electrons, and quantum theory.

Similarly, the WHO partners across many sectors to develop a global action plan to mitigate AMR (World Health Organization 2014). Likewise, during the COVID-19 pandemic, groups of global health actors such as the Global Fund, UNITAID, Wellcome Trust, the WHO, and private sector partners launch a call for collaboration to accelerate the development and equitable global access to health technologies (World Health Organization 2020d). Furthermore, in engaging creative solutions, the actors mobilized a call towards interconnectedness and inclusivity, collective problem-solving, stakeholder connections, and shared knowledge and expertise (World Health Organization 2020d). Thus, collaboration empowers actors to use their talents for expression, achieve their collective purpose, and do things that benefit themselves and other actors and society.

The fifth indicator necessitates a collective purpose in the collaborative network of interconnectedness. Governance entails a system of rules (Rosenau 1992), and actions of "other members of the collectivity in an interdependent system" determine the rewards (Young 1992, 189; 1969). Governance maintains the collective order, the collective processes of rule, and the achievement of collective goals (Webber et al. 2004; Rosenau 2000). Furthermore, security governance entails a "legitimacy of collective outcomes" (Holsti 1992, 50) where "all broad issues required collective responses" (Rosenau 1992, 41). In conjunction, purpose connects to the outcome of the process in the interaction of actors (Webber et al. 2004, 8). The WHO, a specialized UN agency, coordinates and directs authority for international public health. The WHO provides a purposeful representation of worldwide health issues, connects people, partners, and nations to scientific evidence, and promotes health (World Health Organization 2022).

Furthermore, it sets norms and standards, articulates policy options, provides technical support to nation-states, and shapes the global health agenda (Chorev 2012). In October 2015, the WHO launched the GLASS, a collaborative effort of diverse actors to standardize the surveillance of AMR (World Health Organization 2017b). The GLASS system provides a joint collaborative effort from participating countries and AMR regional networks. As it indicates, the purpose is to foster national AMR and harmonize global standards, monitor selected indicators to estimate the extent of global AMR, collect surveillance data to estimate burdens, analyze and report global AMR data, detect resistance, and assess the impact of interventions (World Health Organization 2017b, 7). The WHO's strong alliance with reporting countries, regional offices, country offices, and collaborating centers has enhanced global surveillance and research. Therefore, concerning the study, the GLASS collaborative initiative has brought diverse actors together with a common interest that drives the collective purpose to improve and develop new treatments for AMR.

Moreover, the WHO institution has launched projects such as the GLASS system to foster the importance of global health and surveillance of infectious diseases. In addition, official documents such as the IHR furnish the norms to define the acceptable behavior to be followed by the participating member states. Furthermore, due to an increasing threat to public health and its impact on the world economy, the WHO undertook various activities concerning AMR. For example, in 2001, the WHO issued the Global Strategy for Containment of AMR, which inspired regional and national AMR strategies (World Health Organization 2001). Furthermore, in 2008 the WHO established the Technical Advisory Group on Integrated Surveillance of Antimicrobial Resistance (AGISAR), which advises the WHO on the surveillance of AMR in the food chain (World Health Organization 2017b). In addition, during the 2011 World Health Day, the focus of attention was AMR which called for action by global stakeholders. Likewise, during the same year, the tripartite collaboration between the WHO, the World Organization for Animal Health (OIE), and the FAO claimed AMR as a priority health risk at the intersection of the human, animal, and plant ecosystem (World Health Organization 2017b). Lastly, by May 2015, the WHO's efforts to respond to AMR led to the WHA approval of the Global Action Plan on AMR (GAP-AMR) to tackle AMR at a global level (World Health Organization 2017b). In particular, GLASS aims to address two GAP-AMR objectives: "strengthen the evidence base through enhanced global surveillance and research" (World Health Organization 2017b, 7) and to "strengthen the capacity of all countries, in particular developing countries, for early warning, risk reduction and management of national and global health risks" (World Health Organization 2021d, 2). These norms serve to inform the member states of how to conduct surveillance. The health regime which establishes the rules creates shared common principles based on the collective purpose. Nevertheless, part of the issue is raising awareness. For one interviewee:

> If more countries are demonstrating the problem, whether that's through GLASS or other existing surveillance systems, or through their hospitals or whatever and agriculture, if there's heightened awareness to the point where countries are implementing their action plans and they're developing rules and regulations around that in a sort of systematic way, then that could lead to more global awareness, recognition of the impact of antibiotic resistance, and push for the increased development of antibiotic.[51]

[51] Author's interview with Kathy Talkington, 29 January 2020.

Any international effort to surveil AMR and infectious diseases includes countries from different places coming together to address a common issue. The IHR provides broad rules allowing activity from countries with varying resources and infrastructure built around AMR issues. Therefore, spreading awareness enhances the purpose, societal context, vigilance, and preparedness for a potential global health crisis.

The rapid increase of country enrollment in GLASS and active participation in a global surveillance system that monitors bacterial pathogens reflects a "collective understanding and engagement to support the global effort to control AMR" (World Health Organization 2017b, 135). The case study shows a 64 percent increase in country enrollment in 2018 compared to the first data call in 2017 (see compliance metric, Figure 8). In addition, the case study reveals that surveillance of AMR for human bacterial pathogens resulted in 42-member enrollment in 2017 by the end of the first GLASS data call and an increase to 94 country enrollments in 2020 by the end of the fourth AMR data call (World Health Organization 2021d, 2017b). By May 2021, the number of enrollments increased to 109 countries and territories (World Health Organization 2021d). Therefore, more countries began working towards achieving a purpose to report and systematically share data.

Actors conduct a collective agreement of wanting good quality microbiology laboratory data. The GLASS platform helps countries build their national surveillance from scientists and different institutions whose data usually goes as far as peer review journals. The platform creates a collective purpose "to link all the efforts to collect the data to control the AMR."[52] At a meso-level, the information generated by the local institutions and scientists helps address the issue; however, at a macro-level, governments responsible for fighting global AMR find difficulty in gaining access to data from local institutions. The GLASS platform connects diverse actors who collectively desire to control the threat. Thus, the mutual principles also serve as a foundation to explore and expand on security.

The gray area of security versus data development, advancement of technology, and supporting a collective goal creates tension. For one interviewee:

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[52] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).

> You have to somehow find a balance between the possible good that might be derived from large datasets from research on various maladies and medical applications and so forth, in balance with discrimination, including, at crucial points, that the individual has the data about them as persons protected in that they ought to have a say in how the data is an informed consent.[53]

In conjunction, for some actors, the collective hope that turns towards figuring out how illicit agents turn pathogenic information into weaponized mechanisms takes time to unravel. This case study focuses on monitoring AMR in common high-priority bacterial pathogens that cause human infections. For instance, the case study reveals that the reported median resistance for cotrimoxazole, a first-line UTI treatment drug, was 54.4% for *E. coli* and 43.1% for *K. pneumoniae* (World Health Organization 2021d). Similarly, the GLASS reports reveal resistance against ciprofloxacin to be consistently high, with 43% for *K. pneumoniae* (World Health Organization 2021d). While the results reveal a high resistance to pathogens, "you have to be able to mill that pathogen into a weapon and that's really hard in a way that is effective."[54] For example, theoretically, a person takes a vector, puts them into a bomber, flies out into a city, lets the device dispense, and drops. However, many other biological and chemical weapons exist, such as ricin milled. Thus, the GLASS pathogens are more effective in executing the end goal of the vector hypothetical.

Moreover, if North Korea, for instance, developed a biological weapons program, Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr. explained that:

> They're probably working on enough bad pathogens out there that they do not need your eight pathogens from that one database. They are not going to want to have something that everybody's looking at.[55]

Actors with bad intentions desire something that is a nightmare scenario to the level of creating an apocalypse. They would want something like ricin and something even nastier than ricin. But unfortunately, the 43 to 54 percent AMR resistance level of certain pathogens does not rise to the fatality these actors aspire to attain for the masses. Regarding the WHO-GLASS system, the interviewee indicated:

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[53] Author's confidential interview, United States.
[54] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[55] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.

> The system is focused on an area that is a very common health concern that is hard to weaponize. Theoretically, it could be done, but frankly wouldn't be worth it, and so, right there, it's a great use of open-source intelligence of picking up what's going on.[56]

For another interviewee from the US army, the sharing of open information regarding global public health through worldwide country surveillance results in a net positive. Regarding the GLASS AMR global surveillance, the interviewee remarked that the system is a generally good thing:

> That different states are collaborating with these new technologies and tools to share information to analyze across regions because, as we found out, with the coronavirus, these things spread fast, and if you don't have a way to map and figure out what's going on in these networks it will be there before you know it, and you can't deal with it.[57]

Nonconventional threats affect a more extensive picture because diseases go beyond national borders. Likewise, Nontraditional security threats lead to dangers because of their ability to transcend national boundaries while undermining security measures developed by individual nation-states. Thus, the threat goes beyond the control of a nation when working with individualistic actions but collectively monitored to prevent a virus's spread.

The case study shows a way of achieving a collective purpose to assess the spread of AMR and to strengthen knowledge through research and surveillance. The data collection which the open-source or publicly available information from GLASS member states achieves the common good agreed upon by the actors. The information transforms into valuable intelligence. The collective and global public shares data to advance innovation. Nevertheless, security experts must protect the data shared by the worldwide collective from cyber-attacks. Concerning global health issues, people generally all want to ensure public safety and avoid the spread of diseases that kill people, as an interviewee explained:

> You're basically dealing with the same dynamics, except something much easier to understand, not the science of it but the case of it. Nobody wants people to die of horrible sicknesses.[58]

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[56] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[57] Author's interview with Lieutenant Colonel Arnel P. David, 10 February 2020.
[58] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.

This shared concern explains the rapid yearly increase in country GLASS enrollments. The COVID-19 pandemic and its variants likely generate growth in other surveillance systems. Likewise, the post-pandemic may be characterized by the rise in the number of member-state enrollments in the GLASS network. The WHO considers the GLASS selected microorganisms as common bacterial pathogens, which is why:

> People are waking up to the fact that these are hard to control. They are a threat, and they can get around very quickly. We all must be vigilant on this and the good news: it's something we can largely all agree on.[59]

Thus, actors promote the health regime because of the threat to global public health security. The actors create the regime to channel disagreements in surveying communicable diseases so that the network can meet the common collective purpose despite the conflict among countries or other political issues. Therefore, the collective interest is better served by open collaboration among the actors with a common purpose. As a result, the collective is on alert for the health and security of the people, the public, and the whole.

**Partial Conclusions**

The study illustrates how the WHO links actors in the collaborative network. Through an open exchange of information sharing and data exchange, the WHO's AMR surveillance project presents the platform for other vital agents of continuity to respond to and address AMR surveillance and infectious diseases. The set or process of regulation through the IHR forms the basis of governance to secure the threats. The WHO builds security governance in global health matters as a critical agent. Specifically, as an institution, the WHO includes a regulatory component through the IHR. Likewise, the WHO-GLASS system has a regulatory part through its organizational infrastructure, including links to non-member actors. Thus, the WHO engineers security matters among various actors.

The spread of threat awareness organized by institutions such as the WHO has shaped the context of security governance. Alternatives that shape neutrality include the threat itself, which creates the drive for change, and institutions and executive leaders pushing the global spread of infectious diseases as a referent object higher on the national agenda. Examples of successful

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[59] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.

approaches to tech security governance include a framework where a multistage holder engagement of companies and governments creates a system in the event a threat, such as AMR or infectious diseases spread, occurs. Actors prepare the wide broadcast of the crisis, thus, reducing the incentive for the threat to spread and increasing awareness of affected actors. In addition, actors address global security threat issues by working together and rethinking the boundaries of actor roles.

The case study reveals how institutions and nation-states blend to form dominant security actors in the surveillance of infectious diseases. In this case, the WHO developed AMR global surveillance with participating countries that follow the established rules of the IHR. The research reveals how the WHO created an illusion of heterarchy or multiple centers of power through its GLASS system in AMR surveillance. The interaction of multiple public-and private-sector actors within the provision of security and diverse forms of institutionalization captures the building of a collaborative network. Likewise, more collaboration to address the issue develops as infectious diseases extend across continents. The process of regulation that guides international surveillance accompanies an exchange of ideas and data by an inclusive actor-network toward a collective purpose.

Multiple channels connect societies, giving actors effective means of communicating with infection outbreaks. The WHO shared the message of AMR surveillance to different groups via different channels, which include in-person or virtual meetings, mass media, enforced regulations such as the IHR, and information handbooks or guides such as the GLASS reports. In addition, the WHO provided security implementation in the GLASS reports to communicate security measures effectively. Thus, the case study shows that actors collaborated to promote a health regime for common interests, such as eradicating infectious diseases. As the security threat level heightened, interactions between public and private actors increased. That said, for reasons other than science, such as lack of scientific awareness, hesitation, or fear of the unknown, some nation-states and institutions took time to interconnect and, at times, did not at all.

The case study also illustrates the importance of systems of rules, the interaction of actors, relations between actors based on ideas and concepts, and the purpose behind the drive to reach the end goal. For example, actors need to have an awareness and understanding of how to implement ideas and exercise decisions based on the collective common interest to prepare for and avoid a crisis. Similarly, a comprehension of the perceptions of reality allows fluid movements in the output of the perceived data, which increases the trust in the actors' capabilities, such as institutions that implement the platform that provides the data and the technology that passes the information to the collective. Therefore, the data has a purpose; the gathered information leads to security strategies, priorities, and potential resources for different groups, such as intelligence and security officers, decision-makers, stakeholders, researchers, analysts, or scientists.

Moreover, during the development and deployment of technologies, stakeholders, actors in the private and public sectors, the research community, and policy-makers develop ethical norms to govern conduct and ensure they use the technology platform responsibly. Bringing together stakeholders for productive discussions leads to recommendations and clarity of identified focus areas, such as the intersection of health and security. Therefore, without norms, emerging technologies, such as AI, are used by malicious actors in a way that brings harm by destabilizing fundamental aspects of civil life.

Civil society struggles with change and doubts modern technology as it advances and evolves. Transparency becomes a significant issue in a system of security governance that is ever-more reliant on technology platforms. The information exchange surveillance databases facilitate fact production and necessities in addressing infectious diseases and AMR resistance. It also maintains an environment that encourages innovation in the preparedness for future pandemics or global health crises. The institutions which create the technology data exchange platform decide whether the algorithms need modification for the health, safety, and security of its participating member states. Intelligence monitoring does not stop at AMR or infectious disease surveillance. Still, it looks towards the type of platforms used during the information exchange process, even if the software installs from a personal computer. This security governance goes beyond the data and diseases and towards the digital space dichotomy. To err on safety includes looking for critical issues, such as potential cybercrimes or infectious diseases, in formulating mechanisms and a set of processes that guides international surveillance. Hostile groups have an increased ability to manipulate even the most innocent publicly available information, such as the surveillance of common organisms to control the digital space. Therefore, we must comprehend the system from all angles for intelligence, not just what platforms present at face value.

The purposeful construction of a security governance framework results from the awareness of the inadequacy of individual change or national solutions. For example, tackling a global threat alone is insufficient since infectious diseases know no boundaries. Security governance also ensues from the limitations of traditional policies. Therefore, the process of heterarchical centers of power, multiple actors, institutions, and exchange of ideas drives a purposeful momentum where multiple channels connect societies to eradicate the threat and develop change. As new threats appear, such as the COVID-19 coronavirus, the modern-day pandemic reinforces the study of GLASS in the alignment of data sharing in the emergence of a contemporary health regime. In adapting reality to theories and not theories to reality, the pandemic triggered emergency actions from diverse actors and groups. Throw a plate of poisonous food in the middle of the round table of a board room meeting, and an instant reaction of stakeholders commence to take a pass and not eat. The immediate response of actors to reality and in the moment gets even greater weight when the object is a more significant threat. Instantly actors in the network, both human and nonhuman, take action to address the threat. The theory of securitization appears as nation-states and institutions question security measures. More actors appear alongside the primary actors in the information exchange, awareness, preparedness, and response process. Actors from nation-states to civil society in the international system stir the reality of a modern-day pandemic, the emotions, and the senses of diverse discourse. While theories adapt to research, the modern truth from a new infectious disease to the subsequent AMR tsunami stirs senses and shapes ideas.

# Chapter 4. Discussion: Collaboration, Security, and Effective Preparedness

It may be that while we think we are masters of the situation
we are merely pawns being moved about on the board of life
by some superior power.
—Sir Alexander Fleming

## Introduction

In the space of uncertainty, a sense of urgency commences: if we do not control the spread of pathogens, our people will get sick and die. This chapter builds on the security governance measures discussed through the case study in chapter 3. Although hesitation and precaution appear during an outbreak, international collaboration increases the need to end isolation. Nonetheless, in the wake of an unexpected pandemic that rapidly spread across global regions, significant social, political, and economic turmoil arises. An urgency for pandemic preparedness reduces disaster risk where diverse actors collaborate on pressing issues with a common interest. The interconnectedness of actors also presents security issues in global data sharing. However, which actors make up the network of collaborative efforts to reduce risk and build resilience to confront disasters? Could a health regime transpire through a set or process of regulations that guide international surveillance of infectious diseases? This chapter discusses the objectives of the dissertation, building upon the case study to address the core research question. This study's core research question is: Why did security governance through an OSINT technology database of the WHO promotes the health regime on the surveillance of infectious diseases in the Americas from 2015 to 2021?

The first objective is to open the black box of a health regime in the first section of the chapter in section 4.1, which discusses the strengths and weaknesses of instruments such as the IHR and the GLASS. It also looks at the relevancy of publicly available information to the intelligence community (IC) and culture and the collective action problem of topic-relevant factors such as infectious diseases. The second objective is to analyze the activation of security governance by emerging an unconventional threat based on collaboration and open data exchange. Section 4.2 does so in three ways. First, it analyzes health and security issues in the areas of unconventional threats (AMR and COVID-19). Second, it looks at the *sui generis* (unique) disruptors that enhance or detract from the network; and third, it discusses the interweaving of health and security and the system of rules in the emergence of a health regime. The third objective is to explain why security governance works to secure a health regime in the surveillance of infectious diseases through OSINT. Section 4.3 does so by first describing the different types of risks and challenges in using a database with publicly available information; second, the vulnerabilities and weaknesses of a system; and third, the resources that enhance the global action plan on AMR and infectious diseases.

Regarding topic-relevant actors, such as AI mechanisms connected to national security and intelligence analysis, this study considers, within the realm of health and security issues, the interconnection of human cognitive bias, algorithms, and advancements of emerging technologies such as AI and its subset of machine learning (Sanclemente 2021; Fulmer 2019; McCarthy 2007). Machine learning, artificial intelligence, and robotics manipulate the consistently changing innovation ecosystem. Could machine learning and AI capacities detract from or enhance the output of data exchange for analysts in the IC culture? How does bias advance through knowledge production and education reinforced by technological advances to further cognitive development? Transversely, how do research scientists' thought processes influence the outcome of an AI mechanism? Diverse scholars interpret the cognitive process in human function for intelligence analysis (Wastell 2010; Thompson, Hopf-Weichel, and Geiselman 1984; Hendrickson 2008) since intelligence reduces uncertainty during conflict or crises (Clark 2020). Similarly, "implicit biases in data and systems can arise because of unmodeled or poorly understood limitations or constraints on the process of collection of data" (Congress.gov 2016, 16). Thus, advancing technology empowers socio-economic benefits, innovation, and creativity while stirring doubt, fears, and skepticism.

Moreover, this section also addresses the security governance of a health regime and the changing scales in which the security governance occurs. The mixed healthcare economy based on research and development provides a blended economy where collaborative networks of diverse actors become essential. This mix depends on "institutional legacies, the balance of political forces, and the changing economic and political conjunctures" (Jessop 2000, 21). Modes of information production land on a primary scale that actors decide on regarding social policies and economics. On the one hand, the importance of health innovations and tackling global issues such as infectious diseases and AMR presents value to nation-states and individuals. However, on the other hand, as actors create regulations and security governance of data and diseases, "economic and social policies are politically mediated and the scales of political organization may not coincide with those of economic and social life" (Jessop 2000, 13). Therefore, the need for other supplementary mechanisms balances the economies of scale.

In addition, as technology develops and advances at a larger scale, technology creates the ability for individuals to swiftly communicate from point A to point B, cooperate, and collaborate. While states maintain the primary role in the international system, when we leverage the system with the proper incentive structure, such as a health regime that includes a global surveillance system for infectious diseases, institutions develop a network in which actors collaborate.

### 4.1. Opening the Black Box of a Health Regime

The first objective is to open the black box of a health regime beyond a mere description. In order to open the black box, the study discusses the strengths and weaknesses of the policy instruments that produce inscriptions to address nontraditional threats. Next, it shows that a surveillance system of OSINT or publicly available information of data collection exists to monitor infectious diseases. Furthermore, this dissertation briefly discusses OSINT, the intelligence-gathering discipline of the intelligence cycle, to consider nontraditional threats, for example, infectious diseases, cybersecurity, and emerging technologies such as artificial intelligence and high-performance computing. Lastly, this section includes and analyzes context information, such as other actors that disrupt yet enhance the network.

The black box provides answers to the unexplained. The operation of a black box reduces to a few well-defined parameters giving way to a swarm of new actors such as scientists, engineers, entities, firms, or social groups (Callon, Law, and Rip 1986). Likewise, cyberneticians use the word "black box" to refer to a complex set of commands (Latour 1987). In opening the black box of a health regime, security concerns exist because of outside unconventional threats that connect actors in the co-production of information. Therefore, entry into a health regime transpires through the back door of the new GLASS system of AMR surveillance in the making and not through ready-made technology.

While analyzing the research question and gathering the information, I noticed the implementation of diverse practices in the organizations, agenda, and regulations from the study, but how are these systems of rules (security governance) conceived by actors? By opening the black box of a health regime, I observe the installation of a security regime within a health regime since a regime within a regime needs an explanation, and "it is important to open the 'black box' of why and how a particular outcome was actually reached" (Guzzini 2011, 332). Who are the actors that interconnect in the network? What are the actors' agendas? How do actors normalize issues within the specific agenda? The path depends on the actions of the actors in the collaborative network.

#### 4.1.1. Collaborative Grounding: Instrumental Influencers Governing the Security of Data and Infectious Diseases

This study uses the actor-network theory as a point of departure to open the black box of a health regime. In opening the black box, a simplified entity and network (Callon, Law, and Rip 1986), I examined the forces that shaped a health regime in the preceding case study chapter. The study focused on the complicated interplay between local, international, and nonhuman actors. ANT considers the interactions between human and nonhuman actors. In this vein, I set out to analyze neglected aspects in the black box of a health regime, such as security governance and its security measures. Unraveling the black box provides insight into the effectiveness of open-source data within a collaboration. For example, the dissertation analyzes the strength and weaknesses of boundary object instruments such as the IHR and the GLASS; the relation between the subject of the security threat, the infectious diseases such as AMR and COVID-19; and how these instrumental influencers ground the collaborative process of interconnection. Regulations "serve […] the market and government through the code, since it has become a regulator, a definer of the terms in which places can be occupied in cyberspace" (Albornoz 2020, 53).

A scholar defines *cyberspace* as "the global network of interconnected information technologies and the information on it" (Segal 2016, 34). Likewise, codes condition how to access and interact with digital objects. However, virtual world subjects cannot change the regulations governing these spaces or demand a balance of everything the code takes away from them (Albornoz 2020, 53). While regulations imply control, participation by the member states in the Global Action Plan on Antimicrobial Resistance (World Health Organization 2015b; 2015d) allows the participants to be aware of the health regime.

This study addresses the IHR as a boundary object and instrument of "governance tool for managing outbreaks of new pathogens on a global scale, as they were revised in 2005" (Lakoff 2015, 301). According to one of the interviewees, "at the global level there are the International Health Regulations that is the most important document and the only legal framework that really affects all the countries and is the strongest legal document the WHO actually has."[60] Considering how slow policy development and implementation in the global surveillance of AMR or other infectious diseases occur, many governments implement a digital ecosystem for other countries to match. At an institutional level, the IHR, as an instrument of international law, creates the health regime through its rules and principles. In response to deadly epidemics, the IHR binds every participating WHO member state with obligations to report on public health events (World Health Organization 2016a). The interviewee further added a strength of the IHR as a policy instrument and system of rules by noting that the IHR acts as a blueprint and builds the capacity needed to implement the IHR at a global level with the responsibility of the member states to comply to the IHR.[61] Other examples of security governance or system of rules conceived by actors in response to threats of infectious diseases or cybersecurity, as another interviewee indicated, includes Europe's General Data Protection Regulation (GDPR) and the United States Privacy Act of 1974.[62] Nevertheless, the IHR provides an interesting opportunity to set the principles which member states agree to endorse and help implement. Getting the norms (regime) is essential, but the underlying infrastructure of how one enforces the norms of a nation-state is just as necessary. Through each country's ministry of health and multi-state groups, the goal is to take these ideas and elaborate on them.

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[60] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[61] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[62] Author's interview with Dr. Pablo Breuer, United States Special Operations Command, United States Department of Defense, Sr. Global Network Exploitation & Vulnerability Analyst, Information Assurance Officer, Assistant Operations Officer, 31 January 2020.

Moreover, the UN established a twenty-five-member group of experts to address international laws on cyberspace called the Group of Governmental Experts (GGE) to advance responsible state behavior in cyberspace in the context of international security (UN General Assembly 2021). This group of experts includes Brazil and Uruguay in South America. The world depends more on information and communications technologies (ICTs), including spaces that contain open-source data. The GGE reaffirmed the value of an "open, secure, stable accessible and peaceful ICT environment essential for all and requires effective cooperation among States to reduce risks to international peace and security" (UN General Assembly 2021, 6). Thus, instruments such as the IHR and GGE add to the maintenance of security and objectives in the surveillance of infectious diseases through information exchange in cyberspace.

Likewise, surveillance systems, an essential data-sharing instrument to detect and manage new public health threats, include "informing policies and interventions, including stewardship and infection prevention and control" (World Health Organization 2020g, 3). In 2020, the COVID-19 coronavirus arose as the new target threat to national security and public safety. The global outbreak of the COVID-19 coronavirus pandemic reminded us that public health events in one isolated location spread rapidly to become a global crisis. The intelligence cycle includes the needs, planning, collection, processing, analysis, and dissemination (Clark 2020; Kovacs 1997). The intelligence community played a vital supporting role in public health. The more diverse the team of actors that coexist in the collaborative network, the greater an organization performs and the closer to de-escalating the national security threat. Infectious diseases control through public health AMR surveillance such as GLASS presents an effective way to help achieve monitoring and preparedness in spreading communicable diseases. In most systems of microbial monitoring, "countries provide routine surveillance data to multilateral agencies, which analyze and disseminate information on disease trends at the regional or global level" (Edelstein et al. 2018, 1324). One interviewee noted that the "surveillance standard is to help make empirical treatment policies."[63] In addition, the case study reveals how GLASS, an instrument for global data sharing, knowledge production and system of surveillance, raises awareness and expansion of ideas of the AMR crisis. Other regions have established AMR surveillance networks, such as in

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[63] Author's interview with Dr. Jeannete Zurita, 25 February 2022.

Latin America (Rede Latinoamericana de Vigilancia de la Resistencia a Los Antimicrobianos, ReLAVRA), Europe (European Antimicrobial Resistance Surveillance Network, EARS-Net), and Central Asia and Eastern Europe (Central Asian and European Surveillance of Antimicrobial Resistance, CAESAR) (World Health Organization 2017b). However, prior to GLASS, countries and laboratories did not coordinate a global surveillance system to standardize the collection of AMR data. The GLASS created an intersectoral approach which enables harmonized global collection and reporting of AMR data and infectious diseases control. Another interviewee, a CDC official, added that surveillance systems complement each other "to provide a comprehensive understanding of known and emerging antibiotic resistance threats."[64] Furthermore, the interviewee tacked on that to prevent the spread and slow resistance, the AMR surveillance systems provided "containment and prevention outbreak response, and drug and diagnostic development."[65] For neoclassical realist Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., international health regimes such as the case study makes perfect sense:

> My main interest as an American is that I think that the regime will help protect my country, my people and keep open the lines of trade and commerce, which I believe in, and it's a positive thing.[66]

Nevertheless, the research shows the limitations of conducting routine public health surveillance data, such as scientists ending up with significant biases. However, despite potential biases, scientists continue the surveillance of pathogens. For instance, the appropriate way for scientific actors to conduct a study includes obtaining random patient samples. However, in the course of random sampling collection, an official executive interviewee indicated: "from a scientific perspective, you want to control everything to make this a research project; the problem is it's not sustainable."[67] Therefore, the data needs to be a targeted, narrow subject with specific questions.

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[64] Author's interview with Centers for Disease Control and Prevention (CDC), United States, by email, 17 February 2020.
[65] Author's interview with Centers for Disease Control and Prevention (CDC), United States, by email, 17 February 2020.
[66] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[67] Author's interview with Dr. John Stelling, 24 January 2020.

Public health surveillance includes expanding more broadly, and while the research process contains levels of biases, the interviewee added the need for "good quality science, but that's hard to do, and routine low-quality science still has value."[68] The WHO validates GLASS reports rather than relying on open access to the underlying data since it comes down to the interpretation of data. Therefore, a scientist who interprets the data sometimes obtains data with biases and incorrect information. However, the underlying reality of the information remains, and epidemiologists realize the value. For instance, rather than choosing three high-quality hospitals, A, B, and C, in the country, preference lies in obtaining data from all labs in the country—an ideal scenario for surveillance. However, if hospital D is not part of the five-hospital network during an outbreak in hospital A, the out-of-network hospital D is unaware. Therefore, scientifically, routine data surveillance presents many issues regarding testing quality and the results' representation. Nevertheless, such problems do not slow the progress of science and the exchange of information between actors. Thus, while a scientist encounters issues with connectivity, lack of outbreak awareness, and biases during data collection in the surveillance process, this does not mean the information is not to be used, but instead that one needs to be aware of data limitations.

Managing security controversies of collaboration in the exchange of open data includes concerns about obtaining new reports from low-resource countries because of the potential to miss quality microbiology results. However, a greater value appreciation of the limitations distinguishes the difference between routine public health surveillance and high-quality, controlled, expensive short-term research. As one interviewee noted, surveillance serves different objectives, such as "treatment guidelines, detection, advocacy, fundraising, baseline awareness, and situational awareness."[69] Therefore, surveillance protocols help serve various objectives. However, individuals wake up to surveillance nightmares. For one academic interviewee:

> The space that was once occupied by an open and resourceful research and debate within the general rubric of public interest, science and technology went into the inner spaces by politically

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[68] Author's interview with Dr. John Stelling, 24 January 2020.
[69] Author's interview with Dr. John Stelling, 24 January 2020.

> naive, innovation hungry, money hungry, mainly white male nerds—they gave us the systems that we see today.[70]

Nevertheless, for the interviewee, the alternative model is to also "open it up to the citizenry on how these things are studied, debated, voted upon, made public issues for people to vote on in regard to information systems that have the capacities for surveillance."[71] Therefore, input from diverse expert sources has paved the way to strengthen and improve public health and encouraged good practice.

The world has moved into the digital sphere, and there is no going back. The COVID-19 pandemic has demonstrated that employers and employees conduct roughly half of their jobs online. During the height of the pandemic in 2020, nation-states continued to enroll and submit AMR data on pathogens. Implementing surveillance or monitoring systems such as the GLASS system requires input from several diverse departments. The departments communicate clear goals, processes, and rationales to avoid negative conflict. Where push-back occurs, the WHO can act as a bridge and interaction between actors to resolve consequential conflicts. Nevertheless, surveillance systems in monitoring global AMR identify risk factors and guide policies. Therefore, the GLASS system provides the channel for global interconnection.

#### 4.1.2. Intelligence Context: To Err on the Side of Openness blanketed by Closeness

This section discusses the intelligence collection discipline, OSINT, and the discipline's importance in the interweaving structure adding to the process of opening the black box. Emerging technologies and global health issues create threat challenges for the intelligence community during the workflow cycle. The issues drive the demand to access reliable computational platforms. COVID-19 presented unique opportunities for the intelligence community. For example, the Bureau of Intelligence and Research (INR) commences its analysis with open-source and publicly available information, cables, and other reporting. Sometimes, the intelligence community moves forward with tasks regarding a workforce set at home. Intelligence operators and analysts have roughly 15 to 20 years of experience, speak multiple

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[70] Author's confidential interview, United States.
[71] Author's confidential interview, United States.

languages, and provide assessments based on open-source reporting, research, and geospatial information. However, as more information emerges, “problems of managing large and differentiated data streams and intelligence intensify” (Sanclemente 2021, 9). Turnover within the intelligence community arises from issues that the analysts encounter in working with an extensive, structured dataset.

Traditionally, intelligence follows a cycle of requirements or needs, planning or direction, collection or gathering information, information processing, analysis and production, and dissemination (Clark 2020). For example, an intelligence customer is a stakeholder, the Secretary of Defense, the president, the National Security Council executive, law enforcement, the military command center of operations, or the Department of Homeland Security, all of which present their request (Clark 2020). During the collection or gathering information cycle, the analyst gathers all of the research tools and data to their knowledge to answer the question. However, the analyst needs more time to reflect on time-sensitive deadlines. Therefore, analysts try to execute a quick turnaround while considering the source of information collected. Such *collation* (Clark 2020) organizes relevant information coherently, taking the context and source of the data into consideration. The analyst collects raw intelligence from several intelligence collection sources, including OSINT. OSINT concerns literal information in a form that humans use for communication, defined as “information of potential intelligence value that is available to the general public” (Clark 2020, 178). Therefore, an analyst considers which information is quickly obtainable within the shortest time with accuracy and reliability.

How can a pandemic and infectious diseases influence intelligence gatherings such as antimicrobial-resistant pathogens and COVID-19? How do intelligence analysts pivot during a time of crisis? As life progresses, “big data provides massive amounts of information in a continuous stream that dissects and analyses a constant traffic inflow” (Sanclemente 2021, 3). How do security practitioners, policy-makers, and professionals harness the power of OSINT via big data? This section focuses on the strength, weaknesses, and relevancy of OSINT or publicly available information.

OSINT collects and analyzes data gathered from open sources (overt and publicly available sources) to produce actionable intelligence. Business intelligence, national security, and law enforcement units receive value in OSINT. In addition, analysts and researchers who use the information to answer intelligence requirements can incorporate OSINT into the analytic process. Likewise, OSINT techniques create an opening for nefarious actors, such as malicious hackers, as reconnaissance before launching an unlawful attack. Publicly available information or open-source, which contains a vast amount of information exchange, is a likely target of cyber-attacks "because it has value."[72] Open-source contains information that is useful for criminals since they would want to de-anonymize the data. An intelligence expert interviewee indicated that open-source data is first anonymized but added that:

> There are ways to de-anonymize health data that could be of interest to sell in the black market, and of interest for some nations who do not have access to it to hack.[73]

As Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr. noted:

> Anything of value that can be accessed by cyber means is going to be a target, either to create a disruption, to seize it for ransomware purposes, or to deface. Everything is going to be a target because somebody always figures out some incentive to do something bad.[74]

Thus, while the actions of criminal actors are illegal, the OSINT tools are a legal and valuable asset in assisting individuals with research, analysis, or identifying published work and data on public streams.

Open-source for one academic interviewee means that the "source codes are open so that they can be used and adapted to a variety of applications that would not be possible if you had closure, proprietary rules and so forth."[75] However, the path to promote a health regime stirs a need for open-source surveillance systems. As one official remarked:

> If you really want to act upon any data, you must have access to the data, but also have a full understanding of the quality and real liability of the data. They build a mechanism on the data

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[72] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[73] Author's confidential interview with Intelligence Expert, United States.
[74] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[75] Author's confidential interview with Academic Expert, United States.

> collection, data analysis, and data use to follow rules of transparency when all the limitations and advantages are clear, but the most important thing is that they could be used for action by people who must know the data and could act upon the data.[76]

The interviewee indicated the need for open-source information where the government gains full access to the data to address pertinent human and public health issues.[77]

In order to address AMR threats, the WHO created the mechanism of collecting data through the development of the GLASS system while making sure to be as transparent as possible. Could information on the internet, which is placed on a healthcare surveillance platform, be open? For instance, some information on a platform such as GLASS contains aggregated information, meaning the data forms by combining several elements. In other words, anyone outside the WHO-GLASS realm and participating member state groups do not have access to the raw data but views summarized or aggregated data. While steering clear from defining open-source, one executive noted: "all data that is cleared by a country to be published in GLASS is available for anyone who wants to see the data from the individual countries."[78] Thus, the participating member states provide the information to GLASS. In turn, the GLASS representatives review the data which contain mistakes, return the information to the respective countries for correction, and then publish a summary of the findings on the GLASS website and reports. According to the interviewee, the GLASS system resembles open source but produces a frequent data call to participating member states in which:

> There are mistakes, and we need to go back to the country so they can correct it. Once all datasets are corrected, this is what's published. The GLASS reports present the summaries, and the individual details are available on the website.[79]

Therefore, on the one hand, the act of actors such as the WHO and GLASS posting information on the database for viewers to read and analyze come under open-source the moment the data uploads to the platform.  On the other hand, in obtaining aggregated information, after finalizing

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[76] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[77] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[78] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).
[79] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).

the data with edits and corrections, the act of only publishing summaries does not necessarily amount to information obtained as open-source.

Another official first considered the GLASS database an open-source of information. However, when asked to define open-source, the interviewee noted: “We prefer to use terms like ‘publicly available’ or just ‘open.’ There are so many other synonyms we can use, but basically to define the database, we use public domain.”[80] While another official indicated that the “GLASS database is not open,” but that the WHO offers a free annual GLASS report in form of a portable document format (PDF) to anyone in the world summarizing key findings which is “available through a public website.”[81] Furthermore, the interviewee provided reasons why they do not want the information directly open by indicating the need for some degree of validity checking and issues of biases to correct the data but not represented in the results.[82] Thus, the interviewees correlated open-source to synonyms such as public, free, or publicly available in providing information to the world.

Although the WHO interviewees noted that the GLASS might not necessarily be open, when we think about security governance, the governing of data, and infectious diseases, the information that the WHO provides through the GLASS system and its reports is open and available to other groups such as intelligence analysts. Therefore, during intelligence gathering, the research aims to be inclusive. Nevertheless, according to the intelligence expert interviewee, “when you add many pieces that are in different parts of the open-source world and you put them together, that’s where it could become a risk.”[83] Thus, depending on the targeted assignment, the data is a source of accessibility in analyzing threat levels in fulfilling intelligence requirements.

However, the WHO indicated that the initial layer of data sharing is not open information to the public because they had to review and validate the data first, but actor action illustrates a form of control. One interviewee indicated that “there is a broader questionnaire, and the result of the broader questionnaire is not in the public report.”[84] Once the WHO antimicrobial resistance division feels that its data is adequate to release to the public, it becomes reliable. What is trustful

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[80] Author’s confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[81] Author’s interview with Dr. John Stelling, 24 January 2020.
[82] Author’s interview with Dr. John Stelling, 24 January 2020.
[83] Author’s confidential interview with Intelligence Expert, United States.
[84] Author’s interview with Dr. John Stelling, 24 January 2020.

and reliable when an institution opens the results as they are but only after analyzing the data? This type of information watchfulness also translates to controlling the output. Those in control of these spaces, such as in collective repositories of information, "can de facto exclude or include relational networks, which allow the imposition of norms" (Brousseau, Marzouki, and Méadel 2012, 29). The control of data prior to official publication creates a security actor. This feature of the security process within a healthcare setting is a method of crisis management. Therefore, the set of norms (a security regime) appears by controlling the information space before placing the health data in an open space.

Although the WHO-GLASS looks to provide trustful information, the system excludes information that WHO staff feel will need to be more trustful. This means of data control offers a new layer of power control. Even if the actor has good intentions to make sure the preliminary reports before publication do not look bizarre, we do not know the politics behind the purposeful choice because it is part of the black box, and only the WHO knows it. Since "human minds create new algorithms, code systems, or develop rules" (Sanclemente 2021, 7), only the WHO has designed the algorithms to analyze the data. In the present case, the WHONET software contained algorithms rather than AI for outbreak detection. We will likely never know with certainty the actual product's position of the GLASS reports and the WHONET database since the research scientists who collect, analyze, and present the data only need sufficient certainty to meet their objectives. The actors will reach a point to accept the reality of their product model. As the GLASS reports are made publicly available or open to the world, those who reveal the information do not need to pursue it until the next round of reports. The product continues to be used by researchers until growing doubts about its accuracy, such as when additional member states enroll and submit new AMR data, which leads to re-opening the black box of the health regime and revisiting the assumptions of global resistance in AMR surveillance. If the algorithms are not open, there is a layer of opacity in deciding which layers are open to the public and which ones are not since not all that is open is genuinely open. Thus, unrestricted actors take publicly available or open-source information with a grain of salt and caveats since the original creator conducts edits behind the scenes before public transmission.

In addition, the medical doctor and co-director of the WHO collaborating center for surveillance of AMR indicated that the WHONET tried to integrate some elements of data mining[85] and has worked with the Waikato Environment for Knowledge Analysis (WEKA), an open-source software (E. Frank, Hall, and Witten 2016; Hall et al. 2009). Recognized as a landmark system for machine learning and data mining, WEKA provides the toolbox and framework to learn algorithms and reduce the uncertainty of data manipulation and scheme evaluation (Hall et al. 2009). However, what is the best algorithm? The interviewee added that with multiple hospitals, each hospital contains different algorithms which "may not be the same algorithms that work the best but depends on the volume and underlying variability."[86]

Moreover, different communities within the information ecosystem operate in the context of involuntary radical transparency, which "refers to a state of unintended data availability or openness" (National Academies of Sciences Engineering and Medicine 2015, 3). Analysis of data and insights are crucial for intelligence community agencies to perform their mission. Analysts obtain insights from a combination of data from many sources as the data volume increases and interconnects. In addition, there is an increasing need to collaborate across agencies, industries, and academia. Security-relevant data assist in balancing the risks associated with information sharing against the benefits of sharing the data.

#### 4.1.3. Issues of Data Sharing: Collective Actions of Topic-Relevant Actors

An active community of data sharing depends on a sophisticated interconnected network of mutual collaboration. Science is just beginning to unravel how data ecosystems communicate. The preceding section focused on the need for OSINT and surveillance systems in an era of radical transparency as traditional security loses effectiveness. When an individual logs into a network and releases their data for any service, it is akin to throwing a bottle into the sea—no one will know where the bottle will end. Thus, the data becomes anyone's property. As a result, data floating around the information ecosystems, with no holds barred, presents heightened avenues of security questions. What do actors consider to be a national security threat? When does the data become a national security issue? How is this same mechanism used for health, and

[85] Author's interview with Dr. John Stelling, 24 January 2020.
[86] Author's interview with Dr. John Stelling, 24 January 2020.

why does it become an issue of national security? What is the importance of securitizing certain matters? In opening the black box of a health regime, this section discusses the collective actions of topic-relevant actors such as infectious diseases, cybersecurity, and emerging technologies. This section also discusses security concerns posed by these nontraditional threats in data sharing.

Technology is infused in every aspect of life, whether agriculture, such as payments for farmers in rural areas, or data science advances that transform every part of our lives. It is essential to be able to operate in a global world. This study questioned an interviewee on the impact of security by removing borderlines, rising epidemics, and shared data. Regarding data sharing, a medical officer at the WHO remarked that the "WHO believes there should be no barriers to data sharing."[87] There is value in being connected, but our social values must reflect in technology. Society needs to hold technology companies and organizations accountable for the promise of the products and how they use them in practice. Likewise, actors need accountability for how they use products, which includes focusing on the greater good of combating infectious diseases and keeping in mind the type of data to distribute so as not to fall into the wrong hands.

However, "national security means different things to different people mainly because of the changing nature of the threats and security risks" (American Association for the Advancement of Science, Federal Bureau of Investigation, and United Nations Interregional Crime and Justice Research Institute 2014, 10). For instance, an interviewee indicated that the "threat to national security sometimes manifests itself as a threat to public safety."[88] Meanwhile, another interviewee noted:

> I think of national security as a political discourse that has done a lot of damage in our country because we often mobilize under national security to not share information, excluding people, policing, and surveilling populations that we think of as threatening.[89]

For another interviewee, "anything that endangers the health, wellbeing, or internal affairs of a nation-state is a national security threat."[90] For an intelligence expert interviewee, part of

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[87] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[88] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[89] Author's interview with Dr. Nancy Campbell, Professor, 12 November 2019.
[90] Author's confidential interview, United States.

national security includes education because educational failure places a country's safety and future economic prosperity at risk.[91] Meanwhile, for a security expert, there has been a paradigm shift for security since the seventies, when "it was a military-oriented definition and the concept of national security was mainly in terms of military threats."[92] Today, national security is all-encompassing and the interviewee remarked that "economic security is a very vital component of the concept of security and within the subset of economic security you would have health and health security."[93]

National security issues fundamentally threaten the state's survival and are not simply political problems for governments but work in lockstep with allies and partners who share a common interest. For example, securitization functions with a political concern that becomes a security threat when actors such as states securitize it. In addition, potential issues deriving from bias in emerging technologies have national security implications with infectious diseases and cybercrime. Therefore, for intelligence analysts, understanding the consequences of human bias helps shape how analysts obtain, analyze, and deliver information to customers.

In conjunction, the world forum traditionally included security threats such as terrorism and climate change on the global agenda. However, threat topics have evolved to where bacterial resistance appears in the world forum, and AMR is one of the top ten global public health threats (World Health Organization 2020b). Therefore, the resistance has become more critical because of international organizations' pressure. A number of interviewees discussed the idea of threats and national security. Depending on the context, they deemed threats essential to certain nation-states while undervalued by others. As one official indicated, "the communicable diseases caused by multi drug-resistant pathogens are more dangerous than others and one of the recognized health security threats."[94] Another interviewee, Dr. Zurita, considered AMR a national security threat since it is "within the groups of threats worldwide" and in Ecuador, "right now, the threat is the multidrug-resistant salmonella infantis."[95] The WHO produces a list of the most important health threats (World Health Organization 2017d). One WHO official explained that the

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[91] Author's confidential interview with Intelligence Expert, United States.
[92] Author's confidential interview with Security Expert, United States.
[93] Author's confidential interview with Security Expert, United States.
[94] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[95] Author's interview with Dr. Jeannete Zurita, 25 February 2022.

"communicable diseases are a threat by themselves when pathogens become resistant to the accessible drugs."[96] For another interviewee national security threat includes "what's known about the means of transmission and the extent to which one can have a reasonable prediction that this malady is crossing national lines" and added: "I would consider a national security threat an infectious disease of some kind that was known to cross borders."[97] Likewise, Dr. Zurita explained that one in three individuals who travel out of Ecuador returned with their intestines full of bacteria. Therefore, a risk develops since the infection already colonizes in the intestine once the patient gets sick, and people bring pathogens back to their home country when they travel abroad. Thus, according to the interviewee, pathogens colonizing the human body while traveling abroad presents a national security risk to the country once the citizen returns home due to specific diseases which affect citizens while traveling.

Another health and security threat regards the control and treatment of infectious diseases, evidenced as "the world is increasingly interdependent, and that human health and survival will be challenged, *ad infinitum*, by new and mutant microbes, with unpredictable pathophysiological manifestation" (Henderson 1993, 283). For instance, sanctions create the inability to obtain quality medical products necessary to address AMR concerns. An official interviewee remarked: "another health threat is the communicable diseases themselves caused by pathogens and problems with controlling and treating them."[98] The countries provide the data on the surveillance of antimicrobial resistance, but selling quality antimicrobial drugs carries resistance in which the official added that there is "pathogen resistance with very high rates of antimicrobials and gaining access to these antimicrobials is sanctions, trade, etcetera and that's the threat for the countries."[99] In attempting to rush access to the antimicrobials, faulty algorithms or skewed data present a challenge that adds to unmanaged security risks. Thus, removing checks of an unbalanced algorithmic formula allows more focus on disease diagnosis, detection, and preparedness.

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[96] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[97] Author's confidential interview, United States.
[98] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[99] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).

### 4.2. Building a Health Regime through Security Governance

The complex interdependence of the shared goals among actors or participating member states affects the actors' collaborative process. For example, the surveillance process of infectious diseases places a higher priority on shared goals than on the department or individuals. In other words, the focus relies on getting the job done (such as collecting the surveillance AMR data and sharing the information on a public source) and less on security or whether one discipline differs from another. Although arrangements form regimes "for sustaining and regulating activities across national boundaries" (Rosenau 1992, 8), various health and security issues transpire. Who is being affected? What controversies exist between the collaboration of different actors for data sharing in building a health regime? The key to interconnectedness is reviewing problems such as the economic and social costs and the need for regulations due to privacy and security concerns in building a health regime.

#### 4.2.1. Issues in Health Security: Infectious Diseases Awareness from AMR to COVID-19

According to the Population Division of the United Nations Department of Economic and Social Affairs (UNDESA), as of July 1, 2015, the world population was 7.349 billion. According to the WHO, by 2030, one in six individuals worldwide will be 60 years of age or over, and by 2050 the world's population of 60 years and older will reach 2.1 billion (World Health Organization 2021a). Most of the increase leads to greater stroke rates, lung diseases, dementia, osteoarthritis, and hearing and visual impairments. In turn, the conditions increase markets for medical devices and health care. Despite the diverging national interests of individual players, actors "recognize in rhetoric and decision calculations a greater interest, a common good, and an obligation to do things" (Holsti 1992, 41) to tackle an issue. Likewise, AMR, a severe global health problem, affects different sectors, such as human health, animal health, the environment, agriculture, and trade. Many factors favor the selection and dissemination of antibiotic resistance. Inappropriate and indiscriminate use of antibiotics is one of the main factors contributing to this phenomenon and poor control of bacterial infection.

The WHO considers AMR a "global health and development threat" (World Health Organization 2020b, para. 1) and a "global health security threat that requires concerted cross-sectional action by governments and society as a whole" (World Health Organization 2014, XIII). As previously discussed in section 3.2, from the end of December 2019 to early January 2020, the WHO reported 44 cases of pneumonia patients of an unknown cause in China (World Health Organization 2020h). By January 2020, the Secretary of HHS determined the existence of a public health emergency (U.S. Department of Health & Human Services 2020c), and the WHO declared COVID-19 a public health emergency, characterizing the virus as a pandemic (World Health Organization 2020w). As a global pandemic spread rapidly, a natural phenomenon such as AMR emerged through the overuse and misuse of antibiotics resulting in the spread of resistance, ineffective treatments, and persistent infections in the body (World Health Organization 2017b). Therefore, the inappropriate use of antibiotics played a role in the emergence of antimicrobial resistance has increased the risk of infectious disease spread.

As one interviewee commented:

> All surveillance systems are there for public health purposes, and they are linked. It's at a higher level that countries be made aware of the burden of TB, the burden of HIV, the burden of influenza, malaria, common bacterial pathogens, and resistance to these common bacterial pathogens.[100]

Regarding health and national security, another interviewee said that "one of the top things to be concerned about is needing to have infrastructure in place to have the surveillance, but to have systems in place to address a variety of potential threats that are too critical."[101] Moreover, although the participating member states ratified the IHR, which requires them to share information, another interviewee added that the "securities jeopardize only when data are not disclosed in time and not really shared."[102] Therefore, actors place greater emphasis on larger infectious diseases as important issues at improving national security efforts.

**Economic and Social Costs**

Countries worldwide face pressure to reconfigure their healthcare system to rein in costs and deliver care more efficiently since "infectious diseases account for a large percentage of healthcare expenditures" (Figge 2018, 21). According to the OECD, the size of the nation-state economy varies based on the amount of health spending and economic growth. The OECD notes

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[100] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).
[101] Author's interview with Kathy Talkington, 29 January 2020.
[102] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).

that the average share of GDP health spending increased from 8.8% in 2019 to 9.7% in 2020 due to the pandemic crisis (OECD 2021). Therefore, health spending increased as the COVID-19 crisis severely restricted economic activity.

In 2019, before the COVID-19 pandemic, OECD nation-states spent approximately 8.8% of their GDP on health care (OECD 2021). For instance, in 2019, the U.S. spent most on healthcare costs, with 16.8% of its GDP. In Latin America, Brazil spent 9.6%, Colombia 7.7%, and Chile 9.3% of their GDP, respectively (OECD 2021). At the same time, countries such as the People's Republic of China spent 5.1% and India 3.6% of their GDP on health (OECD 2021). By 2020, estimates of healthcare spending significantly increased to combat COVID-19. For instance, in 2020, countries spent an estimated higher percentage of their GDP on healthcare due to the pandemic crisis, such as the U.S. (17%) and Chile (9.4%) (OECD 2021). Thus, economic spending on healthcare escalated as the pandemic threat heightened.

Furthermore, the WHO and pharmaceutical companies have a common interest, including the use of high and good quality drugs, access to medicines, and the protection of intellectual property rights. Nevertheless, the maintenance of access and distribution of medicine presents issues or controversies between different actors in the emergence of a health regime. For instance, one interviewee noted that "the pharmaceutical companies are pushing the sale of their drugs, and WHO tries to push the sale of the cheaper drugs and alternative drugs."[103] One general recommendation the interviewee added was that antibiotics be made available by prescription to reduce the burden of economic health costs. However, the social cost of limiting access to certain medicines only through prescription orders is that people in low-resource countries would not access to it because they often do not have the means or the facility to obtain a prescription. Nation-states privileged with access to treatment, advanced technology, and transportation infrastructures have the ease of resources, but underdeveloped countries do not have the same luck.[104] While the actors' interests matched in this case, they had different objectives. The pharmaceutical companies viewed the issue from a commercial perspective, while the ministries of health had a public health perspective. In general, the world views AMR and its influence on the market. However, the coronavirus experience reveals that individuals do

[103] Author's interview with Dr. John Stelling, 24 January 2020.
[104] Author's interview with Dr. John Stelling, 24 January 2020.

not always think about the terms of national security threat that a pandemic and AMR resistance combined destabilizes the financial markets, which touches many people.

**Global Surveillance: Regulation and Legal Necessity**

The need for regulations such as the IHR, code of law, and its interconnected nature creates a balance between fairness in health innovations and acknowledgment of technology advancements while being aware of security concerns that conflict with those of other fields. Furthermore, "sharing public health surveillance data across borders has legal implications when the type of data shared is protected by national or international law" (Edelstein et al. 2018, 1328). No matter how well-intended both sides present their case, the code does not enable healthcare or technology actors and recipients of the information to lead a life free from confusion. On the one hand, researchers and scientists need to filter, clean, and purge the data before sending it onto a publicly available or open platform. On the other hand, transparency allows viewers to find truthfulness and integrity in the information presented. The two worlds, health and security are interconnected, but accomplish both without taking one from another is challenging. Linking both presents complications. During one of the fieldwork interviews, the respondent discussed the importance of regulations and unions between health and security:

> We will have to educate, improve all official administration, have more technical individuals, have personnel who last and endure the governmental system, keep the technical parts, and make sure it does not change each time the administration changes, change the whole way of being political in the country, and create public policies that last over time.[105]

Balancing security measures and health innovation while addressing the international system's non-systematic, socio-economic, and inter-and intra-relations provides significant meaning for primary actors. For example, setting a legal or scientific precedent has a "very important theoretical weight in most legal systems," as well as a vital practical weight (Wiener 1989, 107). Moreover, the marriage of health and security are critical unions to maintain in preparation for any novel issues threatening the family bond. Therefore, blending health and security is vital to bettering nation-states and civil society.

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[105] Author's interview with Dr. Jeannete Zurita, 25 February 2022.

Likewise, another interviewee noted:

> Certain small countries believe that some manufacturers benefit from getting access to the data because they will start producing vaccines of antimicrobial drugs and then sell it back to the countries for a fortune. At the same time, of course, it is to be regulated, but if the countries don't have the capacity to do this themselves then they will have to share so some will be able to produce the vaccines, and this is really a complex issue.[106]

Actors who contribute information into a global surveillance system of infectious diseases raise concerns during the process of surveillance, particularly on how groups are identified and tracked. The case study shows that the WHO receives national aggregated data from the participating member states and official national focal points (NFP). One official claimed that "they have no individual data in the database. So, it is absolutely impossible to obtain any personal information from the data."[107] Nevertheless, another interviewee cautioned:

> If you know any kinds of data information from a country, whether it's their demographics or numbers and it might not be about individuals, but it could be quantitative data on things, it's going to paint a picture about a country's state and well-being.[108]

The research shows the intersection of health and security. The study further shows that information in a network such as GLASS collects aggregated data from participating countries that does not contain personal patient information. In addition, through the regional country office, the member states select the relevant data. Then, they pass the data to the GLASS network and are thus aware of its depiction in the final open reports. Nevertheless, the information derives from country surveillance of selected pathogens. Therefore, data management is vital in protecting how countries are depicted during the analysis results and ultimately placed in an open-source database.

#### 4.2.2. Sui Generis Disruptors: The Interplay between Femtorisk and Influential Actors

This section explains the relevancy of out-of-network actors since, at face value, certain actors appear to disrupt, slow down the process, or "move forward in a more controlled and deliberate

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[106] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[107] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[108] Author's interview with Lieutenant Colonel Arnel P. David, 10 February 2020.

manner" in the network.[109] Actors such as malicious and non-malicious groups and internal and external groups slow the progress of AMR surveillance. For instance, non-malicious internal groups such as ethicists, doctors, engineers, or regulators indicate that a project is not ready or safe for production. In the preceding chapters, this study mentioned the various actors in the network of collaborative relationships. For example, the recent coronavirus pandemic showcased the complexities of international affairs and diplomacy posed by technological, political, and financial developments. Unfortunately, two different but essential actors appeared to disrupt or slow down the collaborative surveillance network. The first are influential actors operating on long-time scales, constantly in the mainstream, and competing in the international system. The second one is *femtorisks*, which are smaller actors compared to nation-states or international institutions that nevertheless catalyze substantial changes and pose challenges to international relations.

Sui generis disruptors, such as COVID-19 and the pandemic, allow room for understanding global collaboration. We can look at COVID-19 as a nonhuman actor that disrupted the network regarding AMR surveillance, but also as an example of interconnectedness. This actor has a different connection pattern from other network actors. The COVID-19 pandemic influenced the global health system affecting the research, development, and management of other health threats such as AMR (Tomczyk et al. 2021). Although this node interrupts the network, it does not precisely hinder the network. The ANT theory shows us to consider all actors (human and nonhuman), and while COVID-19 presents a limitation of the network, it also illustrates the importance of network analysis, spurring innovation. For example, the CDC identified a high increase in resistant infections during hospitalization from 2019 to 2020 in Acinetobacter with a 78 percent increase and staphylococcus aureus with a 13 percent increase (CDC 2022c). These are two of the eight human bacterial pathogens under study. Thus, considering actors inside the network (WHO member states) and actors outside the network (COVID-19) helps to understand a network's construction.

This study analyzes the influence of other actors that disrupt the network, such as the agency of China and hacktivists because "for every group to be defined, a list of anti-groups is set up as

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[109] Author's interview with Dr. Pablo Breuer, 31 January 2020.

well" (Latour 2005, 32). Countering groups also include "deviationist behavior, running counter to expectation" (Wolfers 1962, 13), and "dissent is inevitable in collaborative efforts" (Clark 2020, 92). The network analysis in chapter 3, document and observational research, and results from the data collected from the semi-structured interviews indicate that these *sui generis* actors report no ties in the network during the scope of this study. Collaboration requires a common ground where a group of individuals has shared understandings and mutual knowledge of the problems (Feng and Kirkley 2020). However, due to technical, political, economic, motivational, ethical, and legal barriers, actors do not always collaboratively share surveillance data (Edelstein et al. 2018).

Nonetheless, an actor that does not appear to collaborate does not necessarily provoke a disruption in the network. Could disrupters work to glue the network together? Do disrupters enhance the dimensions of security governance? Consequently, practices, ideologies, and state actions that do not conform act as obstacles that disrupt the network or social order and threaten security. However, what constitutes conformity? The disruptors may have the correct norms or ideologies to address the threat. Thus, this section addresses the misalignment of open-access data sharing, non-participation in a global health surveillance system, lack of sharing information, and control of data.

**China: The Influential-Disruptor Actor in the Surveillance System Network**

As Bruno Latour sagely remarks, the hyphen in actor-network "is not there as a surreptitious presence of the context but remains what connects the actors together" (Latour 2005, 180). Context provides "another dimension giving volume to a too narrow and flat description" (Latour 2005, 180). For instance, the regime of China works to glue the network together. China's refusal to turn over raw data for analysis during the period under study frustrated members of the WHO (Hernández and Gorman 2021; Buckley and Lee Myers 2020). Likewise, only 15 member states from the Western Pacific Region, including China and Hong Kong SAR (China), have developed their national AMR action plans (World Health Organization 2018a). As of early 2021, nine countries enrolled in GLASS (World Health Organization 2021d, 2020g). By 2018 "only Japan, the Philippines, and the Republic of Korea reported AMR data to GLASS" (World Health Organization 2018a, 240), and until 2021 China continued to be unenrolled in GLASS. Therefore, context data such as China's potential resistance to providing information during the onset of the coronavirus outbreak and lack of enrollment in GLASS offers another dimension to the collaborative network.

During the scope of the research between 2015 and 2020, China was not enrolled in the GLASS network. Did the lack of enrollment by China or any other country disrupt the collaborative network? As already discussed in section 3.3.1., when asked about the country's exclusion, one official interviewee remarked that China's lack of enrollment in GLASS was due to technical difficulties.[110] The WHO collects nationally aggregated data from small countries in which the data are easier to manage. However, how does the WHO interpret numbers from a country as large as China with more than 1.4 billion people in 2019 (United Nations 2019b), that has multiple surveillance systems such as the China Antimicrobial Surveillance Network (CHINET) and the China Antimicrobial Resistance Surveillance System (CARSS) (People's Republic of China 2021; Institute of Antibiotics, Huashan Hospital, and Fudan University 2021; Wang et al. 2020)? One official remarked that "the calculation is different in [each] area. So, they are simply trying to figure out how we can make the data that is coming from China interpretable."[111] Due to the country's sheer size, "this is purely a methodological issue," the interviewee added, "there is nothing political."[112]

Moreover, what would a country such as the USA not do to help China, medically or logistically, by providing medical information or epidemiological research? On the other hand, suppose part of a surveillance system connects to being political, and the system is used to further isolate, for instance, the Uighurs in western China. In that case, it is a different scenario where actors are sensitive to not enrolling or contributing data to a global surveillance system. According to the WHO interviewee, China's lack of information sharing in the GLASS network was due to technical rather than political reasons. This is consistent with the view of the WHO Director-General regarding China's lack of provision of data early in the COVID-19 case to the WHO, which, according to him, "expressed the difficulties they encountered in accessing raw data" (World Health Organization 2021h, n.p.). As the case of China shows, technical and other issues prevent countries from accessing data on AMR and sharing it with others. A disruption in the

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[110] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[111] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).
[112] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).

process complicates knowledge production and sharing regarding a global pandemic or slows down AMR resistance surveillance efforts.

Nevertheless, distractions or disruptions in the network help understand the rhetorics of interconnection. In the grander scheme, the WHO brought the actors' lack of information sharing to assist in tackling a global health threat to the attention of the actors withholding such information. During the member state briefings, the actors also expressed the importance and expectation of future collaborative studies and more comprehensive data sharing (World Health Organization 2021h). Does a country such as China understand the dynamics of global sharing and the expressions presented by the member states?

Does the failure of a country's collaboration disrupt the entire foundation? The study reveals that the GLASS network continued with or without China as more and more countries continued to enroll in AMR surveillance. Nevertheless, as the coronavirus showed the urgency of global health threats, including an actor such as China in the network, a lack of revealing information still enhances the international system even with a skewed network.

**Hacktivists: The Femtorisks-Disruptor Actor of Health Information towards Health and Security in the Surveillance System Network**

This study recognizes the significance of cybersecurity challenges to health information over the cyber ecosystem. Cyber security preparedness requires collaboration between different actors in the collaborative network, from nation-states to private actors and diverse sectors. However, "the globally interconnected nature of the Internet also means that cyberattacks have the potential to produce unpredicted and inadvertent problems far beyond damage to the intended target" (Segal 2016, 12). Likewise, the "challenges posed by increasing interdependence in the international sphere" include different actor interactions from the influential to the micro (Frank et al. 2014, 17356). Therefore, interdependence in the cyber ecosystem presents a paradox of relevant and comprehensive complex architecture.

A term known as *femtorisks* refers to threats "that confront international decision-makers as a result of the actions and interactions of actors that exist beneath the level of formal institutions or operate outside of established governance structures" (Frank et al. 2014, 17356). These semiautonomous agents behave and act in their local environment, a private club of disruption, per se. Furthermore, *femtorisks* are pictured as small fissures inside nodes grouped in different network topologies. These actors appear to wake up when the system typology needs a new alignment, and they decide it is time for a change, that is, a disruption. Their appearance is internal or external, regional or global, inside or outside the node or network, “but the effect is the same” (Frank et al. 2014, 17356). Examples of human agents posing as *femtorisks* include aggressive financial innovators, rogue traders, groups of dissidents, or terrorists. Examples of nonhuman *femtorisks* agents are forms of “climate change, communications technologies, or socioeconomic globalization” (Frank et al. 2014, 17356). This study includes hacktivists as *femtorisks*, particularly the bad hackers that create systemic changes. Negative hacktivists present invisible risks that do not appear until after the system’s exploitation and damage. Therefore, these actors alter the interactive dynamics between social events, international relations, and human interactions.

An essential part of the study is to differentiate between the three main types of hacker groups by intent and capabilities since not all hackers are criminals. On the one hand, there are ethical hackers (white hats) that use their skills to defend against a threat. A second type of hacker, known as grey hats, sometimes operates legally and other times illegally. The grey hats, for random reasons such as boredom or curiosity, find ways to hack into computer networks without malicious intent. On the other hand, evil hackers (black hats) with malicious intent to steal sensitive information cause chaos by accessing a secure network without authorization. For instance, black hats submit suspicious email messages to companies masking them as institutions, otherwise known as phishing. These actors exploit “unexpected and unknown vulnerabilities in networks to wreak damage and destruction” (Segal 2016, 25). Victims unknowingly click on the links or attachments through the method, believing the email stems from the institution. As a result, malware installs in the computers, and criminals obtain sensitive information, such as passwords and usernames. In 2020, black hats and cyber scammers increased their presence by taking advantage of the vulnerabilities of the coronavirus pandemic. In one instance, the WHO addressed the issue and implemented an email security control called Domain-based Message Authentication, Reporting, and Conformance (DMARC) (World Health Organization 2020c). Nevertheless, as one interviewee indicated, “certain adversaries, regardless of whether they are individual actors or hacktivists or a terrorist group or nation state, can have these effects on how we are moving the ball."[113] Therefore, the WHO implemented DMARC to diminish fraudulent messages.

Disruptions form part of the various *dispositifs* and boundary objects in connection to the GLASS network. These changes pose great challenges to the security governance and management of support systems for global public health. These dissident players heighten the level of security and how actors (both institutional and sovereign) continue to create information exchange platforms through open-source avenues. Certain actors' pushback and disruptive manner provide reinforcement mechanisms to improve the system of rules or processes. Hacktivism always presents a risk, but with the proper checks and balances, individuals quickly realize, for instance, that the data submitted to a global surveillance system from the health care institution located regionally or abroad was different from the data initially submitted. Quality assurances and quality data control assist in double-checking the information transmitted. By having active community participation in the surveillance system, especially during the information exchange, disruptors such as black hats are red-flagged. Having a cybersecurity system, such as the WHONET, in place (O'Brien and Stelling 1995), helps to be installed on personal computers and away from the prying eyes of a cyber predator. Therefore, femtorisks allow actors such as decision-makers, intelligence analysts, security experts, or the military to understand that not only large influential actors interrupt the system but also smaller ones. Thinking outside the box allows for greater examination and interconnection of thought processing and building.

#### 4.2.3. Benefits: Security Governance Assessment

The value of security governance, or a system of rules created by actors in response to safety, increases when a pandemic brings isolation, uncertainty, and confusion. Governance prevails in the "lacunae between regimes" (Rosenau 1992, 8) when more than one regime overlaps. Security governance pretends to control both the disease and the data. Where a health and security regime co-exist, governance accommodates competing interests. Through the actions of diverse actors,

[113] Author's interview with Dr. Pablo Breuer, 31 January 2020.

the economic scales shift. Therefore, this section discusses the benefits of economies of scale in the security governance of open data on the surveillance of infectious diseases.

Moreover, this study shows the influence of technological innovations using surveillance mechanisms of infectious diseases. Would technological advancements tip the economic scales in favor of better production? How do state actors benefit from large institutions, such as the WHO, during the exchange of open-source data? Finally, how does a collaborative network benefit from a set of processes and institutions which guide the international surveillance of infectious diseases? This section builds on the case study of chapter 3 discussion of the security governance dimensions to assist in answering these questions. It assesses the benefits of security governance by analyzing the concept of economies of scale, technological influence, and heterophily.

On the one hand, when actors are aware of a threat, a likelihood of collaboration transpires. Nonetheless, upon reflecting on theories and countering the liberal institutionalism theory, this research shows that when an unknown threat, such as the COVID-19 coronavirus and its variants, breaks out, non-state actors' influence decreases while nation-state power increases. These fluctuating state and non-state actions place weight on a realist theory. On the other hand, under realist theories "avowedly rationalistic" (Keohane 1988, 381), reactionary isolation to a pandemic brings inward attention, which makes the focus on nation-states. Thus, countries' security transgresses beyond civil society's safety and security and more towards a selfish act of power and control.

This research studies institutions in contrast to realist theory. Therefore, on the other hand, focusing on national security interests and the safety and well-being of citizens, nation-states maintain and nurture outside connections to reel in a more progressive liberal institutionalism theory. The idea of interconnection is necessary for the cycle of social, economic, and political healing. An interweaving and collaboration of actors' movements come about through the connections; moreover, in addressing COVID-19 or the next AMR-type pandemic, fixing the issue at a collaborative level shifts the economic scale. A healthier civil society stimulates the economy; one country alone does not solve the issue. However, the collaboration of institutions and private actors contribute to the balance of scales and actions of diverse actors.

Economic growth stems from an innovative environment for different nation-states. Moreover, an essential part of the developmental process derives from scientific and engineering contributions. Therefore, a collaboration of diverse actors intersects with the push toward economic growth. At the crossroad of economic growth and biological science, contributions lie the bioeconomy. The White House Office of Science and Technology Policy (OSTP) defines bioeconomy as the “use of research and innovation in the biological sciences to create economic activity and public benefit” (U.S. White House Office 2012, 7). In 2016, the bioeconomy accounted for approximately USD 959.2 billion or 5.1 percent of the U.S. GDP (National Academies of Sciences Engineering and Medicine 2020), 10% of the industrial GDP in Ecuador (Zambrano 2018), and 15.4% of the GDP in the Argentine bioeconomy (FAO 2018). Therefore, the intersection of the economy, data, and biological materials provides space to innovate. In addition, different industry actors, such as healthcare and defense, are interested in developing strategies for the bioeconomy. Thus, strategic security measures also emerge as the bioeconomic sector grows.

**Benefits of Balancing the Economies of Scale**

The WHO reported, as of December 9, 2021, approximately 268 million confirmed cases of COVID-19 and 5.3 million global deaths (World Health Organization 2021g). Regarding AMR, more than 35,000 people die each year due to more than 2.8 million antibiotic-resistant infections that occur yearly in the USA (CDC 2019a). The study shows the difficulty in calculating the economic cost of antibiotic resistance in the USA. However, “infections require extended hospital stays, follow-up visits to healthcare providers, and the use of treatments that may be more costly and potentially more toxic” (CDC 2019a, 5). In conjunction, while the scale of economics depends on the coincidence of national economy, state, and society, and the survival of nation-states as a sovereign body, the structure has weakened, and the national economy has been undermined by an increase of multi-tiered networks (Jessop 2000). Strengthening cross-border collaboration in the Americas has brought a scale economy of investment and innovation to healthcare facilities, more cost-effective expansion of security mechanisms, and global public health benefits. Security translates into cooperative efforts in economic development to generate an environment of interdependence in a complex system. The scale of collaboration increases with the size of the institution. The greater the institution’s size, the higher the number of associations by other actors. The number of collaborations by agents of continuity, such as participating countries, medical experts, academic experts, and research and development teams, increases as the institution grows. The WHO launched GLASS in 2015, a relatively new network. However, since its launch, GLASS has expanded in coverage. As of 2021, within five years and in the middle of the coronavirus pandemic, GLASS enrollment increased to 109, including countries and territories worldwide. These actions illustrate the economies of scale as increasing the output lowers the threat level as more and more information is disseminated and exchanged.

Similarly, the more actors produce, the cheaper it becomes to obtain an outcome. However, the scale reaches a point where it becomes more expensive to produce, such as in the case of the surveillance of infectious diseases. Along the same lines, in the present case adding more participating member states to the surveillance network increases the scale of the agenda. In certain circumstances, at a macro-level, resolving global conflicts, such as combating infectious diseases, generates higher costs for a state. Nonetheless, from the perspective of the AMR issue, the study shows that collaborative efforts add little cost since the GLASS platform creates the foundation, and the IHR provides the rules. It only results in greater profits: global surveillance of AMR through the collaborative efforts of diverse actors. Therefore, the probability that the GLASS system affects human security reduces.

Nonetheless, from a technological perspective, a large institution such as the WHO, which has more prestige and funding, can adopt production technologies, for instance, the GLASS platform. On the other hand, collaboration places the scales of the economy at risk in terms of transaction costs. Participating countries can contribute to knowledge production and use the platform, but smaller member states need more resources to afford it. However, large-scale countries may have the finances to invest in the surveillance system in the research and development of infectious diseases. Although smaller countries do not achieve greater economies of scale, they achieve external economic scales through collaboration and interconnectedness. Likewise, on a geographic scale, smaller countries benefit from a shared platform of open information by contributing to the platform, which, in turn, assists in their research and development in response to bacterial pathogens in their respective countries.

Moreover, medium enterprises and start-ups drive a large part of the bioeconomy, and their ability to influence licensing lands on a different scale than their traditionally large corporate firm counterparts (National Academies of Sciences Engineering and Medicine 2020). Concomitantly, “the cost of AMR to the economy is significant” (World Health Organization 2020b, para. 5). Global actors react responsively to the power dynamics of economies of scale since “misuse and overuse of antimicrobials are the main drivers in the development of drug-resistant pathogens” (World Health Organization 2020b, 1). Antibiotic resistance affects the agriculture, veterinary, and healthcare industries. Therefore, the ability of actors to respond in tackling a health issue drives the scale of reactivity.

**Benefits of Technological Influence**

I digress by reflecting on the theory of path-dependence, where it is often easier to stay on a similar course of action with the hopes that accumulated random variations of the same path lead to better results (Keohane 1988; David 1985). A path-dependent sequence of economic changes exerts important influences on eventual outcomes by happenchance or remote events (David 1985). However, in certain scenarios, it does not make sense to remain on the same course of action based on historical use because the 2020 coronavirus pandemic has shown that continuing along the same path with the hopes of creating a new approach does not work.

Concerning the surveillance of infectious diseases, “path-dependence occurs under conditions of increasing rather than decreasing returns” (Keohane 1988, 389). Chapter 2 illustrated the positive externalities of the contributing actors, enhancing the advantages of a collaborative network from the convergence of an established standard. For example, the GLASS system, an instrument of production, depends on the software created by the WHONET (O’Brien and Stelling 1995). The IHR, as established international standards, lead the process which guides the member states toward their collaborative nature. Although technology is neutral, we cannot call technology inclusive or non-inclusive. The rapid pace of technological progress suggests that inclusivity depends on how actors implement technology. For instance, global health professionals use electronic health records (EHR) to help physicians track patients’ health, check for possible harmful drug interactions, and provide medical support. Thus, the digital divide is a cause of concern for poorer countries, given the lack of affordable crucial technology in the health field.

**Global Efficiency: Appreciating Heterophily to Collect Data from Diverse Groups—Amor Al Diferente (Love of the Different)**

As we have seen in this dissertation, actors appreciate obtaining a collection of data from diverse groups, and their actions promote a health regime. Likewise, "progress toward greater collaboration in security, economic, environmental, and social fields depend on one development— the continued reluctance of great powers to embark on war with each other because of the costs of nuclear war" (Zacher 1992, 61). The preceding sections noted how technological advancements led to unprecedented economies of scale for global actors which, in turn, resulted in greater global efficiency. Thus, this section discusses heterophily (love of the different) by showing how different *dispositifs*, boundary objects, and actors work together and connect to the GLASS surveillance system.

My study shows a tendency towards heterophily, where actors from diverse industry backgrounds, such as security, healthcare, intelligence, and military, collaborate. This heterophilious collaborative network is better able to spread innovation and tackle security threats through surveillance and information exchange via open-source or publicly available information. While moving data offline or outside a shared network is an ideal dream for security experts, the hindrance creates less data accessibility for innovation. Thus, more data exchange and actor collaboration are needed to speed up progress and innovation and identify bad actors.

In conclusion, an acceptance of security governance seems possible in the presence of strong technological interconnection, scale economies, and an appreciation of the inclusion of different actors in the grander scheme. Institutions have scalable projects which influence the economy. As large institutions form greater collaborations, higher impact visibility, and growth occur at a faster rate. Why share information on an open-source platform with potential risks to an actor's security? Why contribute to a collaborative network in the surveillance of infectious diseases where unmasking opens the doors to other security threats? Transparency and data exchange offer avenues for innovation. An increased number of participating member states and other external actors act as agents of continuity, which increases the chances for preparedness and response to present and future threats to their security (safety). Thus, following a set of processes guides the international surveillance of infectious diseases and benefits the larger picture of global health, security, and well-being.

### 4.3. Alignment of Managed Big Data Sharing

This section focuses on the third objective of the dissertation and explains why security governance works to secure a health regime in the surveillance of communicable diseases through OSINT precisely because it identifies risks, challenges, vulnerabilities, and resources due to the complex way in which multiple actors mutually depend on each other in the exchange of data. By creating a system of rules in response to a threat, does the exchange of data and use of publicly available information on the surveillance of communicable diseases secure a health regime? Do a surveillance program that identifies risks, vulnerabilities, and resources create a push to secure a health regime? Multiple actors often depend on each other to exchange information by following a process of regulation, which explains why security governance works to secure a health regime. Thus, this section is divided into three parts. It looks first at the risks and challenges in using a database with publicly available information, second at exploited vulnerabilities in applications, and third at the resources, such as supporting the global action plan on AMR, tackling infectious diseases, and helping inform decision-making.

#### 4.3.1. Risks and Challenges

This study illustrates how risks and challenges arise in using databases containing open information. This section discusses cyberbiosecurity, bioeconomy, data manipulation in algorithms, and the repercussions of data when placed in the wrong hands.

**Negative Outcomes: Risks of Exposure to Threats and Open Data Technology**

The risks of exposure to threats when multiple actors provide information on an open-source surveillance platform and data sharing generate actions which result in a negative outcome. Acceptable and unacceptable risks exist. As one interviewee indicated, “you want to do things in a way that you’re not in unacceptable risk, and the acceptable risks that you’re taking are well known and well understood, and it’s deliberate.”[114] Understanding the risks helps groups, such as the IC, to consider how much to trust the data results stemming from open sources. For example, publicly available platforms such as the GLASS surveillance reporting database, on the one

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[114] Author’s interview with Dr. Pablo Breuer, 31 January 2020.

hand, contribute to the building of a health regime but, on the other hand, present higher security risks because of open data sharing.

Regarding the health and security of individuals, scientists obtain samples from people with the worst disease for treatment failures. In this scenario, the risk includes the tendency to "underestimate the disease because most people don't get a sample, but you overestimate resistance because of the biases."[115] In addition, the risk includes applying the data directly from a treatment guideline where the doctor incorrectly recommends a brand-new expensive drug when a cheaper drug is more appropriate. According to a medical doctor and co-director of the WHO collaborating center for surveillance of AMR, "without an understanding of the data, without an understanding of the biases, you may incorrectly switch to new expensive drugs too early."[116] Therefore, for the scientific and medical industry, of paramount importance is not wasting new agents but instead keeping the agents in reserve for possible more significant threats in the circumstances such as the pandemic of COVID-19 and variants.

Liabilities of overseas production present risks associated with international operations, which include volatile political and economic conditions, trade barriers, difficulty with the training staff, foreign currency exchange rate unpredictability, and complex government regulations for foreign companies. Likewise, for a WHO medical officer, "the only risk is that we need to be transparent."[117] Committing to collaboration poses a risk to actors from diverse disciplines and social levels regarding balancing the scales of economic cost and collaborative benefits. Another concern is the risk of exposure to information in a global surveillance system, including whether the data is secure in identifying named individuals or particular social groups.

**Positive Outcomes: Challenges Posed by Collaboration, Interconnectedness, and Security Governance in New Pandemic Scenarios**

A major challenge in studying network formation during a global health emergency or disaster entails identifying which actors collaborate and the link between the actors during a constantly disruptive setting. Analyzing interconnected actors is feasible in a centralized surveillance system such as the GLASS database and a known threat such as the AMR pathogens. Where

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[115] Author's interview with Dr. John Stelling, 24 January 2020.
[116] Author's interview with Dr. John Stelling, 24 January 2020.
[117] Author's confidential interview with a Medical Officer at the World Health Organization, by telephone (Geneva).

there is a novel threat, such as the COVID-19 coronavirus, the action to analyze collaboration is less feasible with heightened insecurity, misinformation, and fear of the unknown. In addition, where the research information obtained traces from open sources or publicly available information produced by the organizations, creating a directed network does not make sense for a massive scale of information constantly evolving. Thus, analyzing collaboration and interconnection in the security governance in the exchange of open-source information on the surveillance of infectious diseases makes better sense through an undirected network.

The challenge of collaboration in data sharing in an open source or publicly available information outlet brings challenges in accomplishing complicated tasks. For instance, “data vary considerably in terms of quality and completeness” (World Health Organization 2017b, 5). Complex problems of data access and privacy, both technologically and on a policy level, remain a challenge on a cross-national domain level for regulatory and compliance environments. Technology regulations have become more important in the current context for different reasons. Technology regulations are migrating rapidly toward the virtual world for cultural, political, and social reasons. The role which digital platforms play in society is not affected in the same way in certain sectors of activity.

On the one hand, regulations reorganize economic, labor, and political participation towards a complete digital avenue that occurs rapidly in years to come. On the other hand, the issue of regulating freedom of expression and the mobilization of thought in social networks happens with more force in the context of a pandemic. For example, fake news on social networks and hacking of institutions to obtain vaccination research on the COVID-19 coronavirus increased during the COVID-19 pandemic. The regulation of the technological infrastructure or ICT in the virtual world are questions that have become more important than ever in contexts of pandemics, which set the stage for the governance of security matters for future threats.

Moreover, for intelligence analysts, in considering open-source, care must be taken when reading the information in the public domain. For instance, the GLASS results provide limited information from the participating member states. Furthermore, regional differences within a country are not reflected in aggregated data at the country level. Thus, the number of surveillance sites and isolates tested affects data reliability.

A trustworthy system of a health regime includes an interconnected global collaborative network to address global public health, such as the GLASS case study. The challenge of having multiple actors from diverse fields come together to tackle a global issue is like having many generals to one soldier. The challenge presents the demand for time, amount of effort, and experts' contribution to participating in the surveillance process. One interviewee noted: "I would like to think the decision makers would call on experts."[118] For instance, the GLASS surveillance system on AMR requires calling on doctors to figure out what information needs to be shared, lawyers to figure out the type of data that the customer cannot share, or security experts to advise how to secure the data. At the end of the call, the project ends or stalls since a massive amount of information needs to be published immediately, or the stakeholders moves forward without multiple expert collaborators. The same interviewee added that "it's always going to be a compromise, and the more interested parties that are in there, the more watered down the compromise has to be or tends to be."[119] Therefore, disagreements exist within those groups even if all those experts came from one country and the decision-makers believed them. Thus, finding a middle-ground assist in tackling the challenge.

Although the challenges posed by collaboration, the enormity of the COVID-19 challenges has shown the nation-states' political will to fix the problem of an outbreak, to rapidly get things done, and unblock the barriers to progress. For example, efforts from diverse actors, including the private and public sectors, to support the development of vaccines during the COVID-19 pandemic illustrate international collaboration to eradicate the threat and recognize the importance of tackling an intrinsically global issue. However, some key challenges are misinformation, ill-informed policies, vaccine hesitancy, and opposers.

Further challenges include "collecting robust surveillance data, particularly in countries with limited resources" (World Health Organization 2017b, 7). In addition, the analysis of massive amounts of information brings challenges, which include the:

> Lack of standardized language found in datasets, the availability of technologies and computing power to support Big Data analytics, the security of the cyber infrastructure and data repositories, the privacy and confidentiality of individuals, and overfitting the analytic model to the data on

[118] Author's interview with Dr. Pablo Breuer, 31 January 2020.
[119] Author's interview with Dr. Pablo Breuer, 31 January 2020.

> which it was developed (American Association for the Advancement of Science, Federal Bureau of Investigation, and United Nations Interregional Crime and Justice Research Institute 2014, 9).

Moreover, a challenge is to think about security frameworks and how tech policies keep up with the rate of technology change around the world and do so in a way that builds global frameworks. Likewise, an even more significant challenge to the worldwide health surveillance system is the initial reluctance to get involved. As with all new things, hesitation, confusion, or misinformation are culprits to the successful efforts and development of ideas and innovations. The same technologies or the intention to share information for the great good is also a potential for destruction. The creators of the technology place their capabilities into the hands of diverse actors, whether human or nonhuman, increasing the chances for the system to crumble. However, we must consider the challenge of sharing too much information or letting people die. For this case study, the type of health regime and global surveillance system of common pathogens and its structure outweigh the challenge of having an overflow of information and the potential of the data to get into the wrong hands.

Another challenge regards the binary codes we have developed to facilitate governance: the distinction between military and civilian, hard and soft power, external and internal, and peace and war. In addition, the line increasingly blurs when dealing with multi-purpose dual-use technologies. Finally, we need more multistakeholder engagement. Therefore, only some actors solve the magnitude of the challenges.

### 4.3.2. Vulnerabilities

This section touches upon the weakness or controversies in the system or application that malicious actors exploit. How do actors comprehend vulnerabilities regarding "unwanted intrusions and nefarious activities in the life science" (Murch et al. 2018, 2), as well as in cyberspace, to assist the intelligence community in identifying or responding to possible exploitations? The life sciences permeate the health, industrial, medical, food, and agricultural industries running to research and develop new medicines due to the pandemic and increasing infectious diseases. While actors take action in research and development, disruptions in the global supply chain concerning raw materials result in the modern healthcare system. In addition, they are placing precautionary values in other areas, such as biosecurity, to lessen the risk of using science to the detriment of humans, animals, plants, and the environment through the intentional release of infectious disease agents assists in detecting vulnerabilities in the system. Concomitantly, cybersecurity focuses on the "security of information technology-based systems, from personal computers and communications devices to large infrastructures and networks" (Murch et al. 2018, 2). A heightened awareness of the vulnerabilities and prioritizing the risks benefit customers such as stakeholders, high-level executives, boards of directors, clinicians, microbiologists, or infection control workers.

Vulnerability, at times, is "not clearly identifiable, often linked to a complex interdependence among related issues, and does not always suggest a correct or even adequate response" (Liotta 2002, 478-479). Nevertheless, vulnerability is "defined as an actor's liability to suffer costs imposed by external events even after policies have been altered" (Keohane and Nye 2012, 11). What policies deter other countries from being able to exploit vulnerabilities? What kinds of infrastructures and lessons to learn? There is a chance that the technology actors use has some security risks, with an included cost of revamping or patching. As cyberbiological capabilities appear, coming together and sharing information help actors tackle global issues such as AMR and infectious diseases. Technologically advanced actors are compelled to think ahead, such as quantum computing, to avoid becoming offline.

Regarding human system vulnerabilities and data translation, "vulnerabilities…always have human dimensions" (Clark-Ginsberg, Abolhassani, and Rahmati 2018, 2). While the WHONET software development team applies the algorithms and tells the WHONET software what algorithms to run, issues of objective bias occur. For instance, an interviewee noted that if a scientist only tests an antibiotic such as imipenem on resistant strains, "you'll have an accurate number for the resistant strains, but not an accurate number for the population overall," which results in selective testing. [120] Likewise, issues of selective sampling exist. For example, a medical doctor explained that in cases of urinary tract infections, a common infection in the microbiology lab affecting mainly women, only a few patients get a culture. In this scenario, many women take antibiotics independently and recover, and the scientists never get an adequate sample. The interviewee indicated that out of a hundred women with urinary tract infections, "you'll often get five or ten samples and those tend to be the women with treatment failures,

[120] Author's interview with Dr. John Stelling, 24 January 2020.

complicated medical histories, or recent discharge."[121] Thus, the results turn out very biased, and human system vulnerabilities translate to a need for conducting a higher interpretation. Therefore, such biases create vulnerabilities, overestimate resistance, and individuals create treatment guidelines based on biased information.

Likewise, surveillance system vulnerabilities include scientific controversies. For one interviewee, "the controversies are that you can't really assume a universal set of conditions prevails and you have to get good information about the specific situatedness of the threat."[122] Similarly, for emerging and systematic vulnerabilities, artificial intelligence systems increasingly integrate in society and our daily lives from cell phones to healthcare technologies. As a game-changer for every industry, AI is no longer the future, but the present. Regarding data security, as one interviewee remarked:

> As long as it's compliant with the established norms for cybersecurity which does change and includes periodic updates of software, anti-malware, and anti-viral software, then I think if we keep up with it as part of the standard regime, we are good to go.[123]

However, an increase of potentially complex new threats and vulnerabilities escalate. Likewise, AI attacks represent a systematic and emerging vulnerability influencing the security of a country. Similarly, vulnerabilities in the data infrastructure and cyber ecosystem lead to inappropriate access to information. Therefore, the specifics, structural, political, and economic conditions shape how, when, where, and to whom the threats manifest.

Other unwanted surveillance vulnerabilities exist in an emerging hybridized discipline, such as cyberbiosecurity at the intersection of cybersecurity and biosecurity aimed to safeguard the bioeconomy. Some authors have defined cyberbiosecurity as:

> Understanding the vulnerabilities to unwanted surveillance, intrusions, and malicious and harmful activities which occur within or at the interfaces of comingled life and medical sciences, cyber, cyber-physical, supply chain and infrastructure systems, and developing and instituting measures to prevent, protect against, mitigate, investigate and attribute such threats as it pertains to security, competitiveness and resilience (Murch et al. 2018, 1).

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[121] Author's interview with Dr. John Stelling, 24 January 2020.
[122] Author's interview with Dr. Nancy Campbell, Professor, 12 November 2019.
[123] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.

Other scholars define cyberbiosecurity at the intersection between biosafety procedures and cybersecurity (García Lirios 2021). A revised version of cyberbiosecurity encompasses "biological, medical and genomic information security vulnerabilities that arise from the interfacing of living and non-living systems, and the integration of living (animate) and non-living (inanimate) information substrates" (Dixon 2021, 688). In connection with the dissertation's research, actors use publicly available information to synthesize biological threats. As earlier indicated through participating interviewee discourse, weaponizing common pathogens such as those included in the GLASS surveillance network render it challenging to attain. Nevertheless, malevolent actors encode malware into DNA sequences leading to compromised systems. A trustful network like GLASS to secure a health regime creates an enhanced global space for research, development, and growth.

Nevertheless, cyberbiosecurity can protect "against threats resulting from the intricate relationships between computational and experimental workflow" (Peccoud et al. 2017, 4). Moreover, the biotechnology industry relies on nonhuman actors such as software, databases, and computer-controlled instruments to develop products. However, these vulnerable instruments have the potential for cyberattacks. Therefore, it is neither prudent to remove technologies for fear of cyberattacks nor let the technology beast free without some security measures while keeping in mind not to slow down the process of innovation, data sharing, and production of health products. The risks of cyberbiosecurity entail, for instance, the interception of shipments which result in the injection of nefarious products that comprise a facility's operation, and the production of infectious agents due to the corruption by altering sequences in a bioinformatics database (Peccoud et al. 2017). While malicious actors slow down the progress of a network and science, the disruptor of the network allows us to understand the interconnection of the human and nonhuman dichotomy. Furthermore, the complex way multiple actors connect in the GLASS system allows us to understand the possible vulnerabilities that exist at a grander scale. For example, the research reveals that during data submission in the GLASS network in monitoring common human bacterial pathogens, the actors did not encounter malicious cyberattacks on the computer system. Every malevolent activity and every malicious actor requires the actor-network to innovate in order to strengthen collaboration and innovate.

In terms of finding the balance between cybersecurity, urgent security issues, the level of open data, and country data rights in the interest of national security, the study reveals that the more open actors create a database, the more data actors ingest, share, and collaborate. However, the more open the source becomes, the more vulnerable. A military expert expressed the importance of taking security measures during information exchange and the value of privacy in the interest of national security and civil society. The interviewee noted that “you have to invest in the right security measures to ensure that people can’t steal or manipulate the information.”[124] Thus, actors need to invest in the ability to collaborate equally.

#### 4.3.3. Resources: Building Resilience Against Nontraditional Threats

During the initial impact of a global health emergency or disaster, many actors, including organizations and nation-states, come together to tackle the issue. In some instances, widespread illness leads to more severe disruption and forced interruptions for actors to communicate and share resources leading actors to act autonomously. What efforts must be made across sectors to promote collaboration in creating and implementing technology? How do we ensure that it is done so in a way that addresses concerns around global security, individual rights, and sustainable and equitable development? In other instances, global threats incentivize many actors to collaborate, pool their resources, and leverage their capacities. For example, a global system like GLASS succeeds “through continued data sharing as well as global collaboration, harmonization, and coordination between partners” (World Health Organization 2017b, 6). Thus, through GLASS, the WHO creates a cross-border system that member states use to report AMR data.

In the context of a health regime, resources include advice, support, accommodation, and work. Likewise, resources are “obtained in positive ways such as exploration, discovery, and trade or through negative means such as theft, murder, coercion, and fraud” (Omohundro 2019, 54). For instance, one party prevents another from doing something by withholding some resources. Nevertheless, resources, organizations, regulations, and statutes keep actors linked together (Latour 1999). In addition, “the drive to use resources efficiently seems to have primarily positive consequences” (Omohundro 2019, 54). Resources help inform decision-making, foster innovation, and support the global action plan on issues such as antimicrobial resistance.

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[124] Author’s interview with Lieutenant Colonel Arnel P. David, 10 February 2020.

Similarly, resources exist in a few concentrated areas, such as the knots of a mesh. Subsequently, the connections to the knots or resources transform into a massive net extending in all directions (Latour 1987). Resources created from the AMR surveillance collaborative activity results sometimes fail to perform but open the black box. The launch of GLASS moves towards a focus of an inquiry by other actors and organizations spreading the leaves in the tree of resources. Therefore, the box pries open even if a health regime is black-boxed in the surveillance process. Nation-states, institutions, researchers, scientists, and other actors use the content of GLASS reports for their interest and awareness.

For one interviewee, the virtual GLASS information is "useful for advocacy, gap identification, awareness, and fundraising."[125] Pooling resources builds resilience, connects knowledge across different fields, and enables the development of new methods, questions, and analysis. As another interviewee noted:

> It's a prima facie case to me as a realist that this type of cooperation is in our national interest, in the interest of our allies, friends, and consistent with our national values where we don't want people to die from diseases around the world. It doesn't help the world economy; it doesn't help the earth.[126]

As a military interviewee remarked, "it's worth the risk of having this collaboration platform to collaborate then to not do it and risk not solving one of our worlds human security challenges."[127] Countries sharing their public health surveillance data help to identify an outbreak source when at a national level, it is difficult and improves the capacity for infectious disease detection and response (Edelstein et al. 2018). Thus, collaborating with diverse actors enhances performance because of the greater pool of resources, matter, and accessible information to share, facilitating development.

On the one hand, nontraditional threats such as infectious diseases pose global challenges. On the other hand, these nonconventional threats also present opportunities within the collaborative network to respond better to threats and multipliers. At a macro level, "there is a need for

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[125] Author's interview with Dr. John Stelling, 24 January 2020.
[126] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[127] Author's interview with Lieutenant Colonel Arnel P. David, 10 February 2020.

understanding what the relative importance of all of these health issues is so that the government prioritizes actions and application of resources."[128] Another interviewee noted:

> I think it's a great case of collaboration for common good that is consistent with our norms and values, laws of the United States, and our interests of the United States. It's another tool for national governments and alliances to enhance the security of their population whether it's their citizens or not. It's also a simple way to cooperate and to show collaboration in a positive way that does not cut down on your national sovereignty.[129]

A further interviewee remarked:

> If we, do it right, there's a tremendous benefit to information sharing and increasing knowledge in the medical community. But, still, there's also an enormous danger if we're not careful about how we do it.[130]

Therefore, monitoring infectious diseases within a health regime creates security for individuals and nation-states, and the case study of the global AMR system of surveillance presents a perfect example of how international collaboration and cooperation arise, which significantly enhances concrete results both for the institution and nation-states.

Information exchange on an open database is necessary to counter nontraditional threats. Furthermore, information exchange improves the situational awareness of inherent nontraditional threat challenges. The essential interaction of different actors, organizations, and disciplines increases a synergistic collaboration to mobilize resources. The interaction between various agents of continuity, such as the military, policy-makers, medical emergency teams, hazardous teams, and intelligence experts, increases situational awareness and real-time responses to reduce the impact of strategic surprise. Thus, this cross-fertilization is an effective technique to counter nonconventional threats.

Moreover, through shared resources and capacity building, an urgent need arises for governments, institutions, and private sector organizations to know more about how to keep their systems secure on a practical side, the type of data they transmit, and the surveillance

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[128] Author's confidential interview with a Team Lead of Antimicrobial Drug Resistance at the World Health Organization, by telephone (Geneva).
[129] Author's interview with Colonel, U.S. Army (Ret) Patrick J. Mahaney Jr., 14 February 2020.
[130] Author's interview with Dr. Pablo Breuer, 31 January 2020.

mechanisms of AMR pathogens. The GLASS network and further initiatives emerge globally to attempt to categorize all of the research on AMR and antibiotics to identify worldwide happenstance. As a security effort, AMR surveillance assists researchers, scientists, shareholders, executives, leaders, and other actors in not recreating the wheel and understanding the gaps. Resources, for instance, through the GLASS collaborative network, also assist in figuring out the investigatory nature of microbes and what kind of resources and the type of research are available. Ministries of health connect to government-to-government relations and work with global private-sector organizations. Therefore, the connections extend to understanding the methods of nation-states, institution responsibilities, what activities not to undertake, and which added activities and resources reinforce and strengthen practices.

**Partial Conclusions**

In conclusion, this chapter analyzed security governance measures in the emergence of a health regime. Security governance is a crucial issue in health regimes, such as the one under study, because of the need to be globally connected and legally protected. However, as global threats increase, variables such as the potential manipulation of human bias, blockages in information sharing and exchange, the lack of information knowledge and awareness, algorithmic mishaps, and cybercrimes challenge global health and security. This chapter shows how using various *dispositifs* and boundary objects, for instance, a technology system such as GLASS, policy instruments such as the IHR, and non-human actors such as infectious diseases, connects to a global surveillance system. Collectively, this study shows the necessity of different actors' actions to use resources such as open-source to balance the economic scales and tip the scale in favor of preparedness and response actions.

Obtaining and interpreting open data and collaborating in response to a threat present challenges because, while everyone works together, many things that individuals work on are counterproductive. Nevertheless, information gathered through a collaborative effort of actors enables a better comprehension of the capacity to monitor infectious diseases and provides a mechanism for global reporting across nation-states. Regarding the equitable development and use of technology, the challenge lies in implementing and operationalizing norms. Likewise, technology is a curse and a blessing. On the one hand, innovations inspire creativity and, on the other hand, introduce new risks and dangers (Kurzweil 2019). This chapter also discussed the potential weaknesses in policy instruments. The IHR and international laws on cyberspace (UN General Assembly 2021; World Health Organization 2016a) are a solid basis to start, and over time hope for more. However, the IHR developed norms and principles of behavior, and now is the time to drill down, analyze the details, and bring it down to a granular level. To be more systematic entails getting those at the front line, such as the private sector, civil society, academia, and the science sector. It also includes the private sector running the infrastructure to see new attacks emerging.

The COVID-19 pandemic illustrated the dynamic environment of malicious cyber operations. Understanding how bias functions and cybercrimes disrupt systems and integrating better mobility, problem response time, and awareness helps the intelligence workflow culture. Incorporating a broad range of experts, such as auditors to review bias scrutiny, a security team to review safety, and data scientists to offer transparency, reduces risks, modifies bias, and mitigates turnover in environments such as the intelligence community culture (Clark 2020). Therefore, bringing diverse actors systematically, not just in meetings or conferences, is vital in driving the implementation of norms forward to leverage their expertise and practical experiences in using technologies.

# Chapter 5. Synthesizing the Contributions

Logic will get you from A to B.
Imagination will take you everywhere.
—Albert Einstein

## Introduction

The study's research design used a sequential explanatory strategy to map the network linking the nodes or agents and learn about actor collaborative performance and interconnectedness. The mixed method is an intuitive research approach used in everyday life, multiple disciplines, and diverse industries. In this study, the method allowed the collection, combination, and integration of quantitative and qualitative data collection and analysis. The mixed-method approach framed the procedure of the philosophical theories chosen for this study. The method provided a complete understanding and explanation of the research problem. I combined two distinct analytical (qualitative and quantitative) datasets to move beyond traditional statistical analysis toward a kaleidoscope of integrated and comprehensive data. The study used Gephi as the statistical network analysis software and created four network paths. It also used three data collection tools: semi-structured interviews, document analysis, and network analysis. The data collection mixed-method methodology brought valuable insights by providing similarities and differences through four distinct collaborative network paths in four different contextual scenarios. Finally, I reviewed the nodes with the highest degrees as an essential part of network analysis. This step of the process helped to identify the pertinent details of the collaborative network. The knowledge of identifying the actors with the highest degrees was used as a source to improve or disrupt a network's connectivity and interconnectedness. The paths highlighted the need to account for a collaborative network in a complex interdependent world.

This chapter is divided into four sections and synthesizes the study's contributions. The first section provides a summary of the findings. The second section examines the limitations throughout the investigation and offers various reflection points on the study. The third section touches on the relevancy of the study concerning the central research question. The fourth section provides potential ideas and recommendations to contribute to the literature on health, security, and science and technology studies. This section also includes final thoughts on global health issues, new security threats, and the involvement of technology.

## 5.1. Summary of Findings

In a perfect utopian world, I summarize the findings inspired by three theories in one paragraph: under the liberal institutionalism theory, while the states maintained a primary role, other actors, such as institutions, also played a significant role in the surveillance of infectious diseases and AMR. The ANT theory captured the *dispositifs* that facilitated the inscription and translation process through networks of human and nonhuman actors to break into the objects. The study revealed, for instance, that the IHR working as a dispositif, provided the rules to facilitate the process for participating member states to act and collaborate in surveying infectious diseases. The GLASS database concerned common bacteria that have become resistant to antibiotics. As such, the bacteria became a menace, and the WHO declared AMR a global public health threat. Motivated by the securitization theory, the study showed that the WHO raised the referent object at a higher threat level on the political agenda. As a result, the IHR and WHO cemented their value in security. The feeding of AMR information by member states into GLASS as a venture of the WHO, in turn, manages and feeds the database networks. I also examined the expansion of the network to global south countries. As a boundary object, the actors act as the bridge between member states' participation and submission process in surveying the pathogens and AMR. GLASS also assisted the inscription devices through the WHONET in producing, sharing data, and monitoring human bacterial pathogens. In addition, the WHO declared each pathogen in designated priority threat levels, creating a blanket level of dangerous security. Likewise, internal WHO GLASS officials reviewed the submitted AMR data before making the GLASS reports for open availability. As a result, there was a level of data control and management, adding to the layers of security. A heightened awareness of global problems and new security threats based on technical data was presented through the interconnection of diverse actors and collaboration. Therefore, this study investigated a central topic regarding the connection between security and health through implementing and securitizing large databases and co-creating a security regime within a health regime.

Nevertheless, with such a complex subject matter, I present additional details of the summary of findings and empirical chapters in the remainder of this section. The dissertation is analyzed based on the development of the theoretical framework centered around three complementary theories. Based on the theoretical approach, the analysis of the thesis continued to unravel through three conceptual processes that emerged in international studies from the study of health and security: complex interdependence, regimes, and security governance. The research also interwove additional concepts (collaboration, boundary objects, *dispositifs*, and inscription devices) to bridge the theories and concepts.

ANT assisted in thinking beyond the box of actor normalcy in the network by incorporating a hybrid of human and nonhuman actors. The theoretical perspective of ANT provided a better understanding of the social process between actors, reinforcing the liberal institutionalism theory where nonstate actors transpire as essential entities. The results of the study showed that regarding selected bacteria causing infections in humans, the WHO institution considered AMR a critical threat to human health (World Health Organization 2020g) and looked to global collaboration as a source for containment strategies (World Health Organization 2017b). At the same time, during the study between 2019 and 2020, a novel virus (COVID-19) appeared on the global spectrum. In the wake of the coronavirus pandemic and the threat of emerging infectious diseases, the USA declared a national emergency (U.S. President 2021, 2020). Other nation-states expanded on public health emergency matters in virtue of the global pandemic declared by the WHO concerning the coronavirus (Argentina President 2020; Brazil President 2020; Ecuador President 2020; Peru Presidency of the Council of Ministers 2020). ANT also assisted in providing the limitations of the network because the pandemic created a standstill in many industries worldwide, including AMR research and development. The data revealed that not all actors could input data into the system, and there was difficulty in collaborating due to a global pandemic and the ability to gain access to information. Nevertheless, by 2021, more actors came together to tackle COVID-19 and AMR response, such as creating the Global Antimicrobial Resistance Lab and Response Network with 19 partners implementing collaboration in more than 38 countries. Therefore, ANT allowed a better understanding of the dynamics inside the network and how outside factors, nonhuman actors (pandemic), provided limitations and hindrances to the network.

Through the liberal institutionalism theory, the study showed how an institution such as the WHO and its GLASS architect allowed peace-building mechanisms between participating countries to address common interests. The findings showed that the WHO pushed the boundaries for more collaborative actions of actors through its WHO AMR Surveillance and

Quality Assessment Collaborating Centers Network, the regional surveillance networks, and the WHO regional offices. The liberal institutionalism theory emphasizes international organizations, global governance, and shared goals, such as AMR's surveillance or the fight against COVID-19. The results revealed that diverse actors, including states, participated in the collaborative network.

Moreover, this research focused on international organizations and a health regime based on norms such as the IHR. The IHR illustrated security governance or a regulation process that structured collaboration and addressed global health security concerns. The main findings revealed that the IHR connected 196 global countries as parties to the IHR (World Health Organization 2007). Certain IHR-participating countries also participate in the GLASS system. The IHR helped govern the interaction between different nonstate and state actors to improve the reporting of public health emergencies such as AMR and COVID-19. The IHR established heterogeneous regulatory conditions that showed collaborative conditions amongst actors in the GLASS platform. The findings revealed that with each member's voluntary involvement in the surveillance system, there was an increase in collaboration to follow and adhere to regulations such as the IHR in monitoring communicable diseases. Therefore, the IHR contributed to promoting a health regime because it provided the game rules to ensure global health security.

Likewise, the securitization theory showed us the importance of referent objects and how actors tackle infectious diseases in the health and wellness of citizens and nations. The collaborative attribution of the GLASS data exchange in cyberspace revealed multiple nodes and edges (actors and links). The theory opened the door to causal analysis of security governance in data and infectious diseases by reviewing the formality, efficiency, and material instruments through the operational, compliance, and technical metrics that added value to the global surveillance system. The findings showed that regulation of this space depended on the actors' level of responsibilities, the type of actions, and the different data sources. Thus, despite asymmetrical interests, operational measures enforce securitization considering the new existential threats and their future global influence.

The complex interdependence between network actors promoted a health regime. Complex interdependence presented the alignment and harmonization in sharing massive amounts of data. During the scope of the study, the case study of the GLASS surveillance system commenced with 42 participating countries in 2017. The surveillance system gradually increased over three years, with 96 participating countries by 2020, and by 2021, the number of worldwide enrollees increased to 109 (World Health Organization 2021d). From 2015 to the second quarter of 2019, Brazil was the only country in the global south listed in the publicly available GLASS report to participate in the GLASS database voluntarily but did not report AMR information. As of October 2019, two additional countries of the global south, Argentina and Peru, enrolled in the GLASS surveillance platform. However, neither country reported data on AMR.

Furthermore, by 2018, out of the major BRIC countries, Russia and India had become part of GLASS. During this period, China neither participated nor reported information into the GLASS database. The results revealed that gap-creating actors such as China and hackers appeared during the fieldwork research with different ties than the other network actors. The case study reinforced network analysis and showed the intricate formation of actor nodes interconnected. Therefore, the network analysis revealed the formation of interconnected clusters that encode indisputable complexity levels beyond a ternion.

The study found that both human and nonhuman actors interconnect in infectious diseases' security governance towards promoting a health regime through mapping the network inspired by the actor-network theory that focuses on human and nonhuman actors' heterogeneous networks to build collaboration and reinforce interconnectedness. I used the Gephi software application to map the network, whose algorithm pulls strongly connected actors together and pushes weaker connected actors apart. The network visualization revealed patterns and trends, highlighted outliers, and captured the story of interconnectedness and collaboration of actors.

Furthermore, this research extracted various statistical measures for network analysis, including connected components, clustering coefficient, density, degree, centrality, and modularity. The study's results showed that out of the four visualization path designs created during the quantitative data structure, the fourth network design, CNPD, presented the biggest network, which focused on the eight GLASS human bacterial pathogens and the novel COVID-19 coronavirus infectious diseases. The findings revealed that the GLASS pathogens, COVID-19, WHO, GLASS database, UN, IHR, and the WHA results as the main actors in the network. Furthermore, private interest groups and NGOs, such as the Pew Charitable Trusts, leaned towards the middle of the interconnected, collaborative network. Other actors, such as academic institutions including Columbia University (Mailman School of Public Health and School of International and Public Affairs) and the Rensselaer Polytechnic Institute (RPI), when incorporated into the network analysis, play minor roles in the GLASS network. Nonetheless, academic institutions contributed to advancing research, science, technology, and consultancy to the WHO on global health, AMR, and health and security.

Moreover, the degree of centrality illustrated the connections to all other actors in the network. The nodes with the highest betweenness centrality in the CNPA network are the WHO, GLASS database, GLASS pathogens, UN, and the IHR. The actors with the highest betweenness centrality for the CNPB network are the WHO, GLASS pathogens, UN, IHR, and the WHA. The CNPC network reveals the highest betweenness centrality for the GLASS pathogens, WHO, UN, IHR, and the WHA. The highest betweenness centrality in the CNPD network corresponds to the COVID-19, WHO, GLASS pathogens, GLASS database, and the UN. The investigation illustrated that these actors play significant roles in the collaboration and interconnectedness toward promoting a global health regime. Moreover, while comparing all four network designs, the study revealed that the WHO and infectious diseases continue to lead as primary nodes for having high degrees and high betweenness centrality in connection to other nodes. The data showed that these actors are well-connected within clusters of the entire network.

Collectively, the collaborative network paths showed the GLASS participating countries as the most densely connected subgroup in the network. The findings revealed the average clustering coefficient with the respective network focal point: 0.416 clusters in the CNPA network (GLASS database and pathogens), 0.393 clusters in the CNPB network (GLASS database), 0.382 clusters in the CNPC network (GLASS pathogens), and 0.458 clusters in CNPD network (GLASS database, GLASS pathogens, and COVID-19). The coefficients' low value revealed that all other network actors reference the most significant weight nodes. The study showed that the GLASS pathogens have low clusters because of their interconnection with the GLASS participating countries, who collaborate by submitting AMR surveillance information through its NCC into the GLASS platform.

The network's connected components show the common ideology amongst the actors, such as combating infectious diseases. The study revealed that CNPA, CNPB, and CNPC networks had two weakly connected components, and the CNPD network had five weakly connected components. This information revealed the network's strong connection in becoming interconnected based on the shared ideology of battling infectious diseases, sharing information to combat the threat, and increasing global health.

The network density reveals the number of actor ties divided by all possible network ties. At the same time, the node degree lists the node connections to comparable nodes in the network. The density of network CNPA is 0.084, and the actors with the highest degrees are the WHO, GLASS database, GLASS pathogens, UN, and the IHR. The density of network CNPB is 0.068, and the actors with the highest degrees are the WHO, GLASS database, UN, IHR, and the WHA. The CNPC network density results in 0.061, and the actors with the highest degrees are the WHO, GLASS pathogens, UN, IHR, and the WHA. The density of network CNPD is 0.043, and the actors with the highest degrees are the COVID-19, WHO, GLASS pathogens, GLASS database, and the UN. This network density reveals the nodes with the most significant number of connections in each of the networks. Thus, human and nonhuman actors play a vital role in network interconnectedness compared to nodes with less contact.

The research further revealed the modularity of each of the paths as follows: the CNPA network composed of 117 nodes with a 0.050 modularity partitioned into five communities; the CNPB network consisting of 119 nodes with a 0.054 modularity in five communities; the CNPC network composed of 133 nodes with a 0.175 modularity in five communities; and CNPD network consisting of 201 nodes with a 0.256 modularity in seven communities. The analysis collectively revealed the strong segregation of networks in different communities, primarily concentrated in the institution, nonhuman, and country categories.

The findings showed that while collaboration exists between nation-states at a macro level when there is a high degree of threat, additional actors such as institutions, funders, and private actors also contribute to data sharing and transparency. Meanwhile, at the meso level, actors such as security and intelligence, military and hazard teams, and data scientists and laboratories are paramount to knowledge production. Likewise, working with big data, algorithms, and intelligent technology also contributed to the dynamics of actors' human and nonhuman collaboration. Therefore, working in tandem with many different disciplines, diverse theories, and basic concepts delivers fruitful outcomes for communities and civil society. Sharing public health surveillance data enables timely response and preparedness for global emergencies.

### 5.2. Limitations

In this section, I distinguish between the shortcomings in the study and practice and include additional reflections on the research.

**Limitations of the Study**

There are several limitations of the case study with GLASS obtaining the data. First, the study emphasizes that GLASS is at its early stage. It began collecting information on the enrolled countries with the early implementation phase (2015-2019) and the end of the first data call (2017). In several countries, GLASS faces major barriers to having reliable and representative data from the countries. A challenge arises in patients needing access to health care, which is only sometimes the case in many countries. Thus, there is a connection between combating AMR and assisting with health coverage, and vice versa. Adequate health coverage would facilitate access to health care, which would assist with testing the etiology. Likewise, when a patient has a suspected infection, it can negatively interfere with the results. Therefore, the quality of microbiological tests which are performed could be more reliable. Testing can be costly for countries, and the reality of the need for lab strengthening in low- and mid-income countries is a challenge. The representation of data that is submitted to GLASS presents limitations. Thus, for GLASS, the culture of surveillance to provide recorded, analyzed, and timely data is challenging.

Another limitation regards the GLASS system and its challenges with certain countries where an interviewee remarked:

> It's just tough to get the data that they need to make it a meaningful evaluation of what's going on. That's an ongoing challenge and it's probably not unique to antibiotic resistance data but they have their limitations.[131]

Furthermore, other limitations are to develop comparative studies across different areas, such as the private sector, to draw broader conclusions about the role of networks in the surveillance of infectious diseases, data exchange in open-source access, and actor interconnectedness in health and security regime measures. What is required to work with and support the private sector and improve progress in delivering the collaborative tools needed? Like COVID-19, how do we

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[131] Author's interview with Kathy Talkington, Project Director, Antibiotic Resistance, The Pew Charitable Trusts, by telephone, 29 January 2020.

grapple with establishing suitable mechanisms to ensure innovations are accessible to those who need them worldwide?

Moreover, while security reduces the possibility for data to flow freely, we know that, domestically and globally, political will is vital to making progress. Looking beyond the COVID-19 response, how do we reestablish that political will and gain fresh momentum in the AMR response? Likewise, we need to gain awareness of the content that develops behind the making of databases or their shared existence, as the creation of databases has no margin of human power. However, our minds and experiences condition our actions, and why not interconnect during the creation process into a kaleidoscope of elegant new opportunities?

Regarding the role of civil society and the general public, how will public attitudes toward global health issues like AMR change in the post-pandemic era? Will we see more ambitious, national, and international efforts to fix global health problems? What more will we learn about the role of civil society organizations in mobilizing responses to significant health challenges at the frontline at a grassroots level? Pre-emptive measures to suppress a global pandemic require interconnection and collaboration from entities that include state and non-state actors. While nation-states maintain a primary role, it is not just one central actor but a combination of global actors, including NGOs, institutions, researchers, and academies, forming a worldwide collaborative network against the battle of infectious diseases.

**Limitations in Practice**

In this section, I provide the problems and limitations in the practice of researchers, data scientists, or intelligence analysts, as well as the problems in the practice of surveillance and public policy. For instance, a limitation presented in practice as a researcher related directly to the study was conducting mixed-method research in a 3-year doctoral program. To successfully pull this type of research within the timeframe of the academic program, I had to hit the ground running from day one. The challenge was needing a framework at the beginning of the program since the first year usually dedicates to learning theories and concepts and attending full-time classes. Nevertheless, one thing is sure: to focus on the qualitative data structure in obtaining the interviews. Interviews will take a tremendous amount of time and energy, and sometimes interviewees may cancel interviews at the last minute. Therefore, a researcher needs to have patience and flexibility in the process of building the qualitative data structure. Thus, reaching out to potential interviewees early in the process is essential, as sometimes scheduling delays and sudden unexpected circumstances, such as a global pandemic, hinder the collection process.

Another limitation to improving mixed-method research involves researchers needing to look at outcomes and identify the shortcomings in practice. A lack of sufficient training and knowledge prolongs mixed-method research (Creswell 2014; Hesse-Biber 2010). For instance, of value to the university or institute is to offer the investigator appropriate training and resources to conduct a mixed-method study since projects or academic schedules have a fixed period for completion. In turn, a researcher relies on the university or institution with little time or expense wasted rather than utilizing secondary sources, such as YouTube, to obtain basic training in the assumption that the primary source correctly teaches a mixed-method approach. Instead, YouTube, Google, or any other secondary sources are avenues that supplement the training obtained by the institution. This extra training is a waste of time for the researcher involved in a short program, and it would be more valuable to place the energy on the actual investigation.

On the other hand, suppose the institution lacks quantitative or mixed-method teachings and has strength in social sciences or qualitative methodology or vice versa. In that case, it may be better for the investigator to avoid a mixed-method approach. Therefore, there are limitations in having insufficient mixed-method preparation, as lack of time and training puts forth the possibility of obtaining unbalanced results.

Another limitation was conducting fieldwork during the COVID-19 pandemic and obtaining additional interviewees to encompass the remaining categories. At times it took much work to get further interviews, especially with high-level players that may require a security clearance. For instance, one interview alone at the WHO took over one year to connect with the AMR department, and it was the initial virtual meet and greeted action per se to build trust. It then took an additional year to obtain the interview, with restrictions on submitting the questionnaire beforehand. Time is of the essence in a three-year doctoral program coupled with an unexpected global pandemic. Thus, unfortunately, researchers must work with the information obtained, which results in limitations to the findings.

Nevertheless, the best strategy is quality over quantity when a global pandemic hinders further research development. In this research, I valued the need for more time in the mixed methods study. However, the doctoral program needed improvement in time, and the pandemic presented challenges in connecting and obtaining interviews. Thus, I made sure to obtain interviews from top-scale industry experts specific to the single case study. As the borders begin to open and travel restrictions lessen, for the future, post-pandemic, I can include additional interviewees from diverse fields and global actors in various countries. Similarly, post-pandemic, having more time and relaxed executive schedules may allow the opportunity to conduct further virtual interviews.

A limitation in the practice of a global surveillance system included that certain countries need more infrastructure to submit information through lab work, more lab equipment, more sophisticated surveillance equipment, or the lack of appropriate transportation from the lab to the network. In addition, surveillance data "are not always freely shared because of perceived or real technical, political, economic, motivational, ethical, and legal barriers" (Edelstein et al. 2018, 1325). The GLASS network strived to allow countries to submit AMR data while understanding that not every country has the same robust information.

Likewise, essential infection control starts with surveillance to track down the geographic and time spread, telling us about the incubation period. Next, controlling the threat (virus) includes locating the source, isolation, or quarantine. Education is also paramount in the collaboration process, not just for the public but for healthcare professionals and public health officials to address and combat the threat. Finally, an institution creates a high level of legitimacy to gain trust in the system. Without confidence, participating countries would not include their information in a technology database to share data on human bacterial pathogens' surveillance. Information governance to promote a health regime occurs for trust and legitimacy in the institution. However, in data sharing and information exchange through open-source, concerns with potential privacy issues are associated with the data. For example, although information exchange exists on platforms intended to be released publicly, problems arise regarding whether the data is used for good or bad intentions.

A public policy limitation that was revealed during the study arose, for example, from an Ecuadorian medical doctor and microbiologist who explained that:

> The obstacles arise because there are few infectious disease doctors, and you must educate. If you don't know something, you have to teach because errors occur since people do not know—it comes from the lack of education.[132]

Therefore, for some South American countries, the need for more expertise in infectious diseases hinders the ability to submit appropriate and timely AMR information to the GLASS architect. The limitations in the study and in practice are situations that challenge actors such as decision-makers, stakeholders, researchers, and scientists working on completing objectives. However, these same challenges are learning curves and experiences as planning tools to improve operational efficiencies.

### 5.3. Relevancy

This section addresses the dissertation's significance to the central research question and theme: why did security governance through an open-source intelligence technology database of the WHO promote the health regime on the surveillance of infectious diseases in the Americas from 2015 to 2021? Are the subject matter of infectious diseases, health and security, and the involvement of technology a waste of space and time as a contribution to literature? Today, more than ever, these topics interweave. The issue is of great relevance, both in international studies and in the field of global health. The topic of AMR and the surveillance of infectious diseases is on the regional and international agenda and constitutes a contribution to the knowledge and health policy field. Likewise, our experience of the COVID-19 pandemic, its variants, and future health crises has taught us the importance of response, preparedness, and collaboration.

The findings in this study benefit various industries and stakeholders. Likewise, the magnitude of global health and digital, and its interconnected security challenges, the preparedness and response in context and dynamics be similar. In addition, sensibility includes stakeholders considering expectation management. At times, the idea of a panacea or a belief that one idea or a norm will solve all issues, but a utopian ideology is improbable. A dynamic process appears more probable.

Likewise, the study shows the importance of safety and security measures in the surveillance process as a critical factor in understanding the information exchange process and its influence

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[132] Author's interview with Dr. Jeannete Zurita, 25 February 2022.

on the international system. Finally, this research illustrates the value and heartaches of a collaborative network and how some countries have fewer resources with weaker data available. Therefore, the dissertation presents health and security values and challenges, the push and pull of two diverse worlds that work together to promote a health regime, and how actors use data for global health change.

While the focus lies on global health and technology issues, other emerging technologies, such as artificial intelligence, have entered the playing field. Moreover, AI uses its implements exponentially, which brings about new opportunities and challenges. Networks are a powerful tool to fill a gap in the cyber security field, which aligns between assets, risks, and business. Networks assist in bridging the semantic gaps to standard building blocks for detection systems. In conjunction, reflecting on diverse theories and ontologies while looking at the different actors in the network, a concept such as community detection or modularity helps identify the nodes densely connected and analyze communities within the network. Depending on the theoretical perspective, network analysis and its concepts are valuable. For example, networks allow us to see the patterns of relations, and community detection is a helpful technique in machine learning to recognize groups with shared interests and properties. Thus, the key to addressing questions, opportunities, and challenges includes a collection of diverse actors and approaches from the bottom-up to top-down with mindfulness to obtain solutions cautiously.

### 5.4. Recommendations

This study offers new proposals, potential ideas, and recommendations in health, security, science, and technology since threats are all around us and will continue. In 2002, severe acute respiratory syndrome (SARS) appeared and quickly spread worldwide. In 2009, the H1N1 influenza pandemic emerged. In 2013, we had the West Africa Ebola outbreak. Some of the same issues during these epidemics appeared during the COVID-19 pandemic. Over the past twenty years, significant regional and global infectious diseases have spread. What lessons do we learn from these recent pandemics to translate for the next known or unknown pandemic? Public health planners, strategists, researchers, and security and intelligence analysts must test before implementing public health policies. How do we succeed now and in the future? Listening to public health and security experts contributes to the solution. Experts continue to work on refining problems but also need political leadership to make the deals that close the gaps. For example, we need to improve at taking advantage of sharing healthcare data or the AMR surveillance information provided through the collaboration of scientists. Thus, placing science and health security experts at the forefront of the level of governance is essential.

Furthermore, there is a multitude of information dispersed. However, information needs to be communicated to the public to make it meaningful. Hence, there is less division and more comprehension to help protect themselves and reduce the risk of exposure. During the pandemic, it is paramount to see greater power collaboration and interconnectedness and less power competition. Viruses are invisible and transcend national borders. The asymptomatic nature of many viruses also challenges the public health system. In order to prepare for the next outbreak, looking at platform technologies that enable us to respond rapidly to a range of different types of threats, whether diagnostics, developing new vaccines, or managing security issues, is of value. Investing in international collaboration is essential. Bringing scientists, security, intelligence, military, and legal experts from different countries together will help to communicate during a crisis. There must be a combination of different entities, not just NGOs or funders. For instance, a collaboration of diverse actors shares and disseminate information as widely as possible to make the best-informed decision on the actual risks. Another suggestion for greater intelligence is the actors' appreciation for each other's contribution to the network and the value in the open exchange of information, which influences the continuity of collaborative interconnection. Therefore, we need to improve multistakeholder integration and more meaningful engagement.

Likewise, in context and dynamics, preparedness and response are paramount to match the magnitude of global health, digital, and interconnected security challenges. In addition, expectation management is vital for stakeholders to consider. Managing the expectations in addressing a global health concern includes open and transparent communication, in simple rather than technical terms, so that all parties involved clearly understand what to expect from the process. Therefore, open communication makes the process of collaboration more promising.

Lastly, we need to change the culture of public health and make it a national security issue. Nevertheless, economic awareness is paramount in understanding that escalating and diversifying means a substantial investment in innovation, research, and development in response to the threat of infectious diseases and antimicrobial resistance affecting all countries. These ideas enhance the support of the global action plan on antimicrobial resistance in the fight to combat emerging threats, help inform decision-making and harmonize action for human, animal, plant, and global environmental health.

### Partial Conclusions

For research institutions and governments to interconnect and for leaders to come together and collaborate, I suggest an immersive network that spans organizations and sectors rather than a specific agency. A network of actors that tackle alternative security measures while operating within the context of open source or radical transparency is feasible. For example, adaptable data security measures include advanced management systems or sources of access control instead of relying on traditional encryption methods and creating a trusting network by increasing communication and transparency. The latter of which assists in identifying malicious actors and decreasing possible threats. A collaborative union is pertinent to dissipate the threat in a world full of corruption, power-mongering, and greed, where nation-states face enormous national security challenges such as global infectious diseases. Interconnectedness (or network analysis) broadens partnerships, builds diplomatic relationships, and brings awareness of the potential repercussions of security breaches when multiple collaborative measures exist.

Networks open the lens of existing problems to promote a health regime in the security governance and surveillance of infectious diseases through open-source intelligence or publicly available information. In addition, norms provide value to de-escalate issues such as spreading false public health information, addressing existing and future threats, and mitigating the security risks in the healthcare space created by malevolent actors and data attacks.

### Conclusions

In conclusion, the specific case study addressed the research question: why did security governance through an open-source intelligence technology database of the WHO promote the health regime on the surveillance of infectious diseases in the Americas from 2015 to 2021? The study validated the hypothesis, thus suggesting that a new contemporary health regime is built based on security governance to combat nonconventional threats. Finally, I reiterate the three objectives previously mentioned in the introductory chapter, which inspired the research into the culmination and conclusion of this study. First, the dissertation opened the black box of a health regime by studying the open data exchange in the GLASS surveillance system and its role in surveying infectious diseases. Second, the study analyzed the construction of a health regime by illustrating the emergence of an unconventional threat that activated security governance based on collaborative dynamics, *dispositifs*, and boundary objects through open information exchange. Third, the research explained why security governance secured a health regime in the open exchange of *ingentis* data, its risks, vulnerabilities, and resources presented in the use of GLASS to contribute to the construction of a health regime in the surveillance of communicable diseases.

A final thought comes to mind as this research closes. We need sustainable changes in the workflow and be open to changes to encourage a health regime to monitor infectious diseases while tackling secondary nonconventional threats. Let us think outside the box and use the global GLASS structure as a foundation for how actors at an even larger scale collaborate to address global issues. As a result, we understand the potential of the interconnection of things when dealing with complicated issues in a complex interdependent world.

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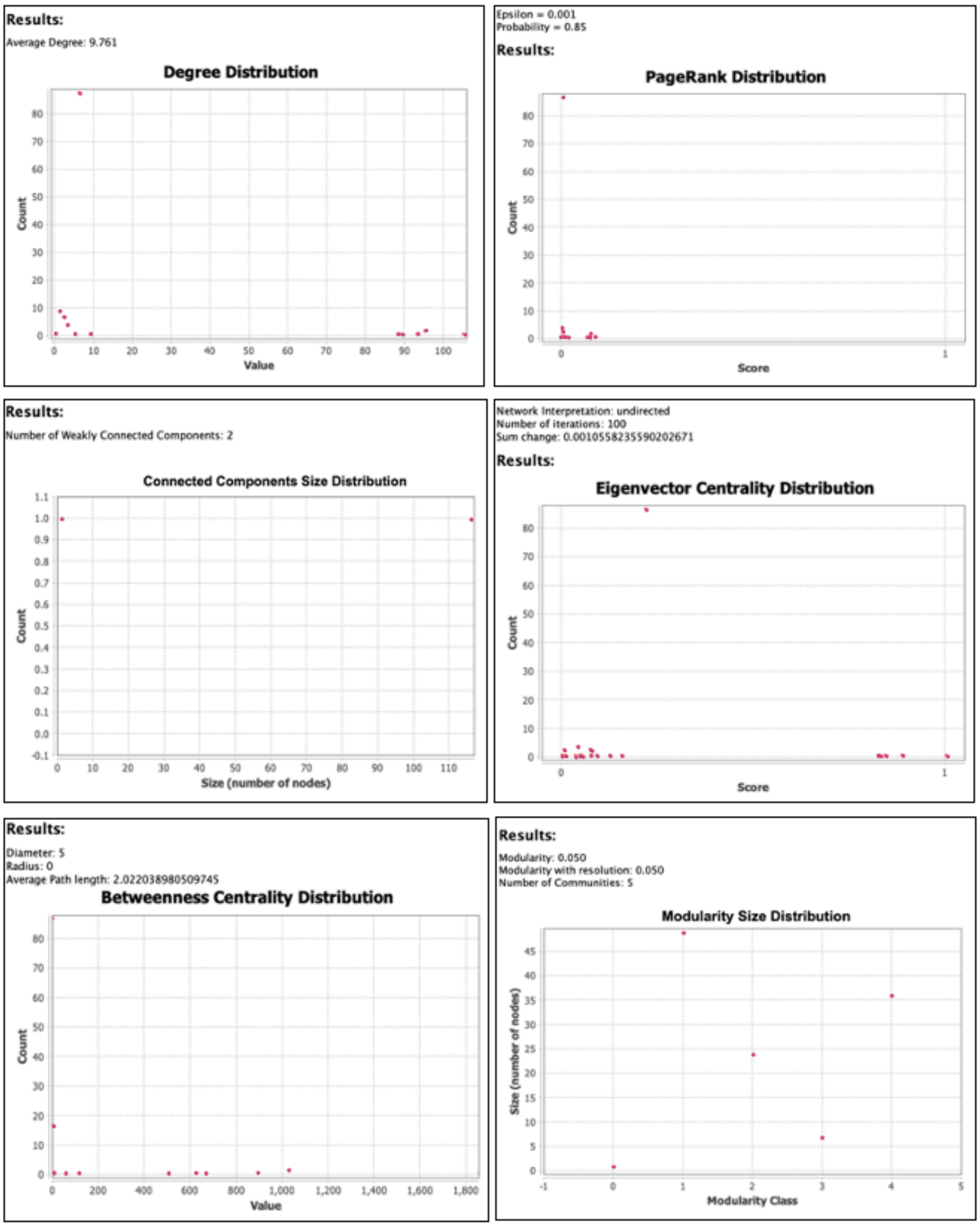
## Appendix

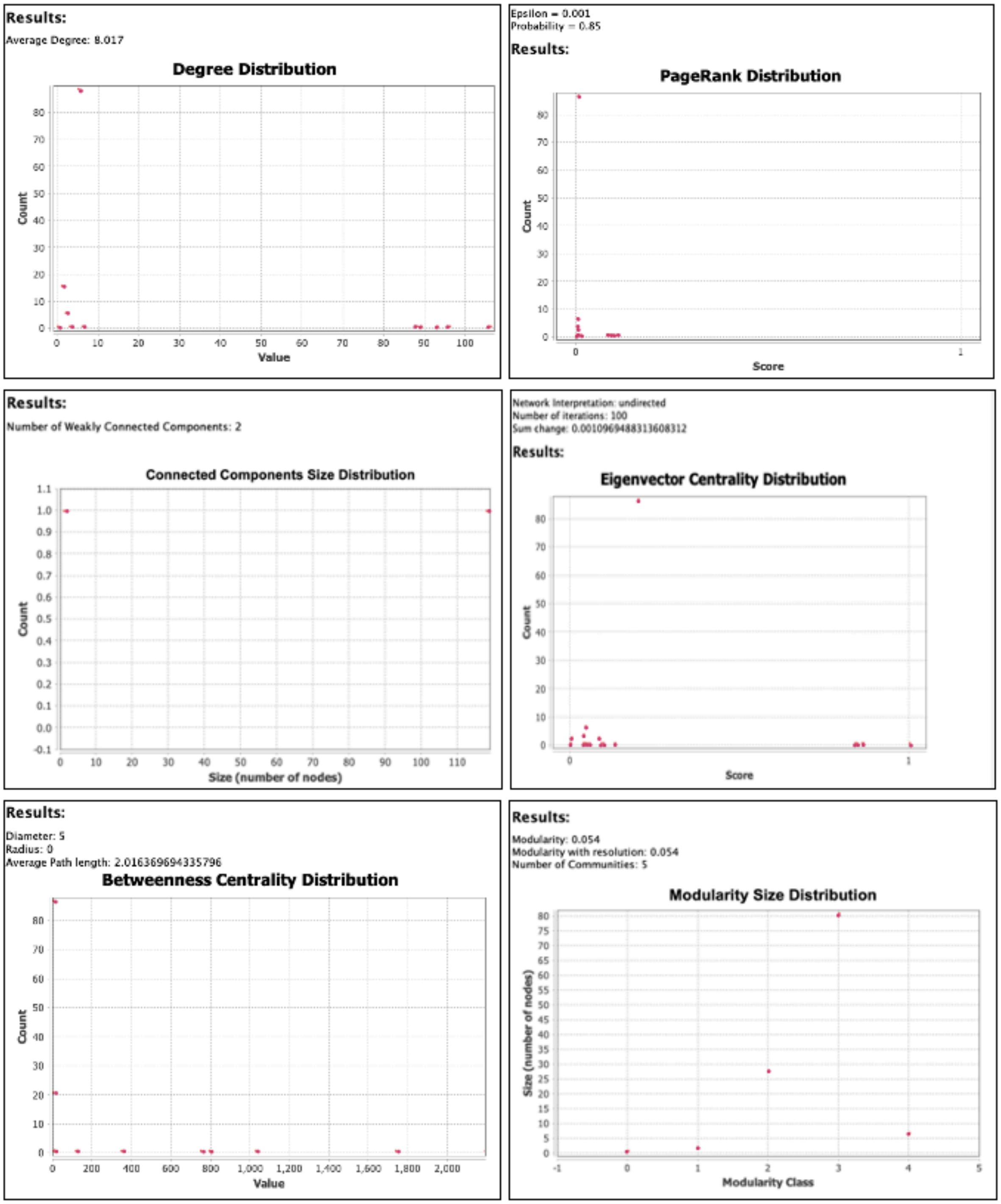
## Appendix A: Data

### Appendix A, Figure 1. Collaborative Network Path A Stats Report




*Source*: Statistical output in Gephi.

## Appendix A, Figure 2. Collaborative Network Path B Stats Report




*Source*: Statistical output in Gephi.

**Appendix A, Figure 3. Collaborative Network Path C Stats Report**

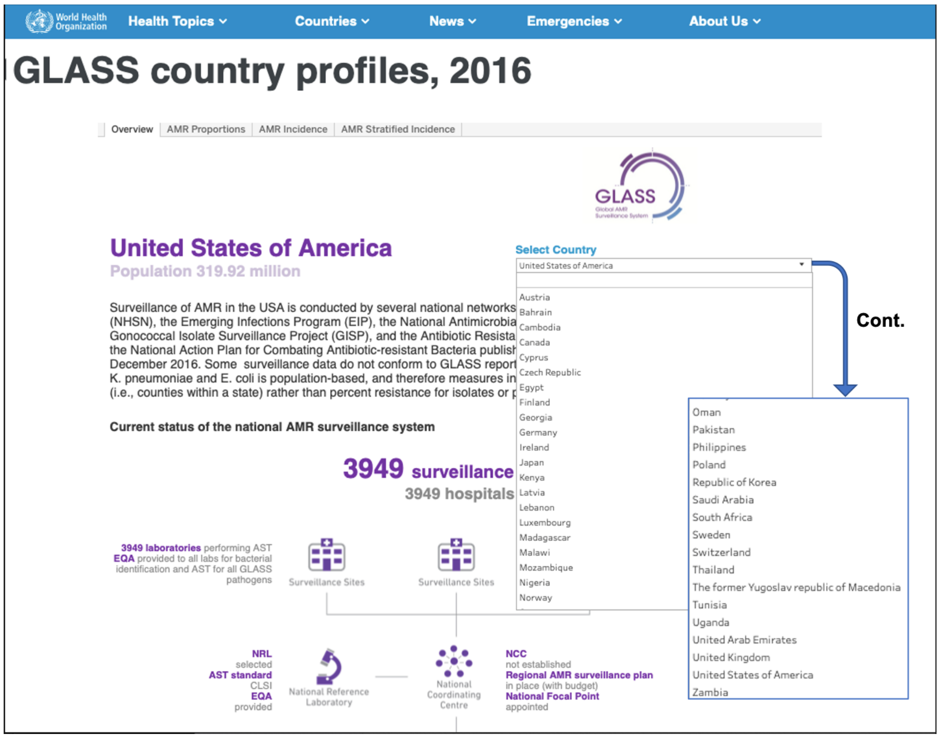

*Source*: Statistical output in Gephi.

**Appendix A, Figure 4. Collaborative Network Path D Stats Report**


*Source*: Statistical output in Gephi.

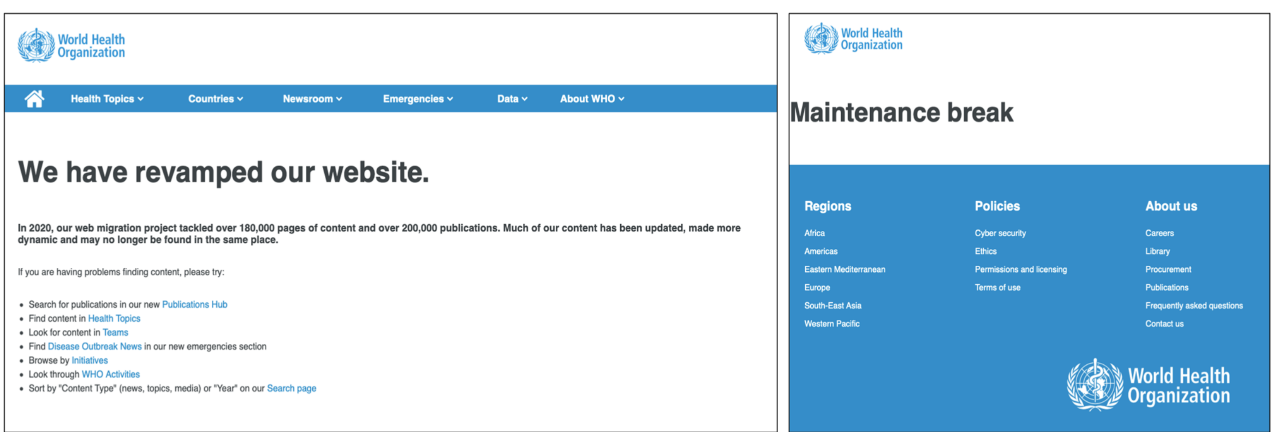
## Appendix A, Figure 5. GLASS Country Profiles in 2016

The image illustrates the GLASS country profiles in 2016 which contains 38 countries from the drop-down menu, excluding enrollment from South America.




*Source*: World Health Organization (2016).

## Appendix A, Figure 6. Example of Problems with the Original Source Website




*Source*: World Health Organization (2020).

## Appendix A, Table 1. Total Selected AMR Pathogens in 2014 Reported by Country in South America

**Public Health Threat: 2014 South America AMR Surveillance of Infectious Agents**

| Country | Acinetobacter | E. coli | Klebsiella | N. gonorrhoeae | Salmonella | Shigella | S. aureus | S. pneumonia | Total Isolates Reported |
|---|---|---|---|---|---|---|---|---|---|
| **Argentina** | | | | | | | | | |
| Number of Isolates Reported | 1,649 | 32,101 | 1,560 | 679 | 646 | 2,778 | 9,549 | 410 | 49,372 |
| Total % of AMR Isolates Reported | 2.77% | 53.97% | 2.62% | 1.14% | 1.09% | 4.67% | 16.05% | 0.69% | |
| **Bolivia** (Plurinational State of) | | | | | | | | | |
| Number of Isolates Reported | 374 | 6,245 | 559 | 5 | 32 | 85 | 2,150 | 16 | 9,466 |
| Total % of AMR Isolates Reported | 3.48% | 58.08% | 5.20% | 0.05% | 0.30% | 0.79% | 19.99% | 0.15% | |
| **Brazil** | | | | | | | | | |
| Number of Isolates Reported | 1,296 | 808 | 611 | X | 5,666 | 49 | 3,422 | 26 | 11,878 |
| Total % of AMR Isolates Reported | 8.83% | 5.50% | 4.16% | X | 38.59% | 0.33% | 23.30% | 0.18% | |
| **Chile** | | | | | | | | | |
| Number of Isolates Reported | X | X | X | 1,184 | 123 | 61 | X | 661 | 2,029 |
| Total % of AMR Isolates Reported | X | X | X | 46.09% | 4.79% | 2.37% | X | 26% | |
| **Colombia** | | | | | | | | | |
| Number of Isolates Reported | 1,594 | 22,059 | 11,513 | 83 | 1,099 | 323 | 17,273 | 433 | 54,377 |
| Total % of AMR Isolates Reported | 2.16% | 29.96% | 15.63% | 0.11% | 1.49% | 0.44% | 23% | 0.59% | |
| **Paraguay** | | | | | | | | | |
| Number of Isolates Reported | 788 | 1,906 | 985 | 39 | 62 | 176 | 1,989 | 59 | 6,004 |
| Total % of AMR Isolates Reported | 9.54% | 23.08% | 11.93% | 0.47% | 0.75% | 2.13% | 24.08% | 0.71% | |
| **Peru** | | | | | | | | | |
| Number of Isolates Reported | 175 | X | 498 | 32 | 101 | 121 | 1,071 | X | 1,998 |
| Total % of AMR Isolates Reported | 6.50% | X | 18.49% | 1.19% | 3.75% | 4.49% | 39.77% | X | |
| **Uruguay** | | | | | | | | | |
| Number of Isolates Reported | X | X | X | X | 220 | 28 | X | 188 | 436 |
| Total % of AMR Isolates Reported | X | X | X | X | 43.65% | 5.56% | X | 37.30% | |
| **Venezuela** (Bolivarian Republic of) | | | | | | | | | |
| Number of Isolates Reported | 183 | 7,031 | 1,058 | X | 198 | 242 | 3,412 | 180 | 12,304 |
| Total % of AMR Isolates Reported | 1.23% | 47.19% | 7.10% | X | 1.33% | 1.62% | 22.90% | 1.21% | |

Prepared by the author based on data aggregates reported by ReLAVRA 2014.

**Appendix B: Semi-Structured Interviews**

**TOTAL NUMBER OF INTERVIEWS**

**United States**

- 14 individual interviews

**LOCATIONS/DATES OF INTERVIEWS**

**United States**

- New York:
  - November 4, 2019
  - November 9, 2019
  - November 12, 2019

- By Telephone:
  - January 17, 2020
  - January 29, 2020
  - January 24, 2020
  - February 26, 2020
  - January 31, 2020
  - February 10, 2020
  - February 14, 2020
  - April 10, 2020
  - February 25, 2022

- By Email: February 17, 2020

**INTERVIEWS**

**United States Fieldwork Interviews**

- Dr. Nancy Campbell, Professor, Department Head of the Department of Science and Technology Studies, Rensselaer Polytechnic Institute, New York, 12 November 2019.
- Dr. John Stelling, Associate Physician with the Brigham and Women's Hospital, Co-Director of the WHO Collaborating Centre for Surveillance of Antimicrobial Resistance, Developer of the WHONET software, 24 January 2020.
- Kathy Talkington, Project Director, Antibiotic Resistance, The Pew Charitable Trusts, 29 January 2020.
- Dr. Pablo Breuer, United States Special Operations Command, United States Department of Defense, Sr. Global Network Exploitation & Vulnerability Analyst, Information Assurance Officer, Assistant Operations Officer, United States, 31 January 2020.

- Lieutenant Colonel Arnel P. David, United States Army, SO1 Strategic Analysis Branch, United States Special Assistant to the Chief of the General Staff, Deputy Assistant Chief of Staff G5 (DACOS G5) in the NATO Allied Rapid Reaction Corps, United Kingdom, 10 February 2020.
- Colonel, United States Army (Ret) Patrick J. Mahaney Jr., Department of Defense, United States Special Forces Officer (Green Beret), United States, 14 February 2020.
- Centers for Disease Control and Prevention (CDC), CDC's National Contact Center, United States, 17 February 2020.
- Dr. Jeannete Zurita, Medical Doctor, Microbiologist, and Temporary Advisor of Antimicrobial Resistance, Pan American Health Organization (PAHO) Washington, DC, Ecuador and United States, 25 February 2022.

**Confidential Interviews**

- Rensselaer Polytechnic Institute Professor, New York, 9 November 2019.
- Intelligence Consultant of Security Issues and Sustainable Development, New York, 4 November 2019.
- World Health Organization Officer, by telephone, 17 January 2020.
- The Pew Charitable Trusts Officer, by telephone, 29 January 2020.
- Team Lead, Antimicrobial Drug Resistance, Office of the Director General, World Health Organization, by telephone, 26 February 2020.
- United States Special Operations Command Advisor, by telephone, 10 April 2020.

**INITIAL INTERVIEW QUESTIONS**

1. What are different models of surveillance systems and open-source information?
2. How do you define security governance of communicable diseases?
3. Do you know which regulation or law in the country promotes the health regime in the global action plan's surveillance of communicable diseases?
4. What type of risks, vulnerabilities, and resources is presented in using the GLASS technology database?
5. Do you know actors (private or public) who have participated in GLASS's collaboration in collecting AMR data?
6. What are the links between the institutions, participating countries, NGOs, and private interests with the WHO database which have benefitted from GLASS?
7. How does GLASS generate interconnection amongst various actors?
8. What do you consider a national security threat?
9. What type of security threats benefit from open-source information?
10. What are the disadvantages of open-source information?
11. What dissident groups hinder the global action plan's surveillance network of communicable diseases?