Emerging Infectious Diseases: Preparedness and Response to Fight

By

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A project submitted to the School of Pharmacy in partial fulfillment of the requirements for the degree of Bachelor of Pharmacy (Hons.)

School of Pharmacy

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Declaration

It is hereby declared that,

1. The thesis submitted is my/our own original work while completing degree at BRAC University.

2. The thesis does not contain material previously published or written by a third party, except where this is appropriately cited through full and accurate referencing.

3. The thesis does not contain material which has been accepted, or submitted, for any other degree or diploma at a university or other institution.

4. I/We have acknowledged all main sources of help.

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Approval

The project titled "Emerging Infectious Diseases: Preparedness and Response to Fight" submitted by Fatema Rahman Mithila (20146061) of Spring, 2020 has been accepted as satisfactory in partial fulfillment of the requirement of the degree of Bachelor of Pharmacy (Hons.) on May 2, 2024.

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Ethics Statement

This review does not involve any kind of trials on either animal or human models.

Abstract

The multifaceted impact of "Emerging Infectious Diseases (EIDs) and their Preparedness" is explored in detail in this thorough review paper, which highlights the need for proactive preparedness measures against notable pathogens like COVID-19, Ebola virus, Dengue virus, and Nipah virus. This project has clarified the vital role that pharmacy specialists play in the management of EIDs by emphasizing their contributions to patient education, medication dispensing, and cooperative engagement with healthcare stakeholders. The review highlights the significance of individual preparedness by stressing the need to comprehend personal risk factors, maintain good hygiene, and follow vaccination recommendations too. Furthermore, the utilization of telecommunications technologies at remote locations has culminated. Despite providing preemptive actions to address issues that need to be prevented. On the contrary, the review has also suggested incorporating these instruments into a framework that improves the creation of tactical and strategic plans for developing risk readiness.

Keywords: Emerging Infectious Disease (EID), Hygiene, Pathogen, Pharmacy, Telecommunication, Vaccination.

Dedication

This work is dedicated to my parents and Md. Habibur Rahman mama for their unconditional support, inspiration, and encouragement.

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Before anything else, I want to express my profound appreciation to Almighty Allah.

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List of Acronyms

AI	Artificial Intelligence
CDC	Center for Disease Control and Prevention
CEPI	Coalition for Epidemic Preparedness Innovations
DENV	Dengue Virus
DHF	Dengue Hemorrhagic Fever
DNA	Deoxyribonucleic Acid
EBOV	Ebola Virus
EID	Emerging Infectious Disease
EVD	Ebola Virus Disease
GIS	Geographic Information System
GP	Glycoprotein
GVDF	Global Vaccination Development Fund
NiV	Nipah Virus
NP	Nucleoprotein
PPE	Personal Protective Equipment
RNA	Ribonucleic Acid
SARS-COV-2	Severe Acute Respiratory Coronavirus
VH	Vaccination History
VPD	Vaccine Preventable Disease
WHO	World Health Organization

Chapter 1

Introduction

1.1 Definition of EIDs

As a collective term, "emerging infectious diseases" (EID) describes infectious disease conditions that have either been known to exist in a population for a long time but are now rapidly expanding in frequency or geography. To put it briefly, these could be novel infections resulting from the evolution or modifications of already existing organisms, established infections that disseminate to uncharted territories or populations, unknown infections that emerge in areas experiencing ecological changes, or obsolete infections that reappear as a result of resistant mutations in previously identified agents or shortcomings in public health protocols (McArthur, 2019). Diseases classified as Emerging Infectious Diseases (EIDs) are those that have hadn't previously pierced a human; those that have but only afflicted a tiny percentage of people in distant regions; and those that, although they have happened in human history, which were recently identified as either distinctive diseases or as emerging mutant species (Wang et al., 2021). In the premodern era, infectious diseases spread widely due to colonization, warfare, and slavery, both with terrible outcomes. Before vaccinations were created, human diseases like smallpox, polio, tuberculosis, and diphtheria were widespread and caused plenty of deaths and disability (Baker et al., 2021). There are numerous zoonotic and synoptic emerging diseases. Such as Nipa virus infection (Zoonotic), Hantavirus pulmonary syndrome (Zoonotic), Dengue virus (Vector-borne), COVID-19 (Respiratory, affected from person to person), Cholera (Waterborne), Diphtheria (Respiratory, affected from person to person), Typhoid (both Foodborne and Waterborne).

Humans are exposed to the pathogens that cause zoonotic diseases, also known as zoonoses, from animals. Hazardous microorganisms transported by animals have the potential to infect

people, resulting in diseases referred to as zoonotic diseases or zoonoses, propagating due to the proximity between humans and animals. Besides, Synoptic emerging diseases are sicknesses caused by pathogens like viruses, bacteria, fungi, or parasites likewise zoonotic diseases. Unlike zoonotic, synoptics have either recently emerged within a population or been there for some time, but their frequency or geographic range is rapidly growing. Both zoonotic and synoptic EIDs can be spread through food, fluids, vectors, or other means, or vectors. Even healthy people can contract these. However, some people are more susceptible than others. Compared to other people, these people are more likely to get certain diseases, get severely ill, and possibly die. These people are divided into the following categories including-

- Children younger than five.
- Adults over sixty-five.
- Individuals with compromised immune systems.
- Expectant mothers.

1.2 Historical Perspective on EIDs

In recent times, there has been the existence of several new emerging infectious diseases. Among them COVID-19, Ebola outbreak, Dengue fever, and Nipa virus are notable.

1.2.1 COVID-19 Virus

The newly discovered human coronavirus condition with COVID-19, that number makes five pandemics officially reported since the 1918 flu pandemic. COVID-19 rapidly expanded over the globe after its initial report in Wuhan, China. SARS-CoV-2, or severe acute respiratory syndrome coronavirus, the official name of the virus given based on phylogenetic analysis by the International Committee on Taxonomy of Viruses. The hypothesis behind SARS-CoV-2 is that it started as an animal coronavirus before developing the ability to spread between humans.

Owing to its high contagiousness, the virus spreads swiftly and is constantly evolving among humans (Liu et al., 2020).

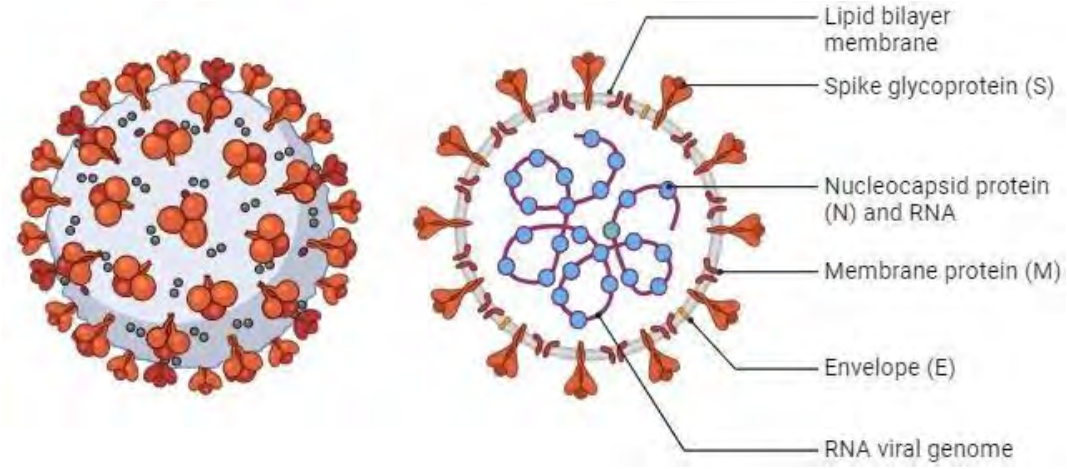

Figure 1: SARS-COV-2.

1.2.2 Ebola virus

In 1976, there was the first recorded Ebola outbreak in Zaire. The Zaire index case is believed to have made a deal with the virus at the bank of Ebola River, hence the name "Ebolavirus," which was linked to the prototype strain of the disease. Simultaneous outbreaks in the Sudan and the United States were being reported at the time; however, their relationship was not immediately apparent. Researchers from the US Centre for Disease Control and Prevention (CDC) and the Ministry of Health in Zaire have recognized a novel virus that was initially believed to be the Marburg virus, also known as malaria. However, it was later found to be a related but genetically distinct filovirus. Later research revealed that the viruses causing these outbreaks were unique and contributed to the current knowledge of two of the five ebolavirus species. There were high death rates in both outbreaks, with Zaire reporting as high as 88% of deaths. There was another outbreak in the Democratic Republic of the Congo in 1995, another in Uganda in 2000, and yet another in the Congo in 2003. The CDC and the World Health Organization (WHO) confirmed that a different species was identified in the Bundibugyo

district in western Uganda, which led to a following outburst in Uganda in 2007 that resulted in the Bundibugyo ebolavirus species. In 2012, the Bundibugyo ebolavirus species was linked to a second outbreak in the Congo that resulted in 57 confirmed cases and 29 fatalities. These communities have deep-rooted taboos and fears, and aid workers frequently need to spend a lot of time educating these communities because they are ignorant of the disease and how it spreads. The public's mistrust of foreign aid workers, government and non-governmental organizations, and medical groups that provide care in affected areas and villages has increased because of the recent outbreaks in Guinea (Harrod, 2015).

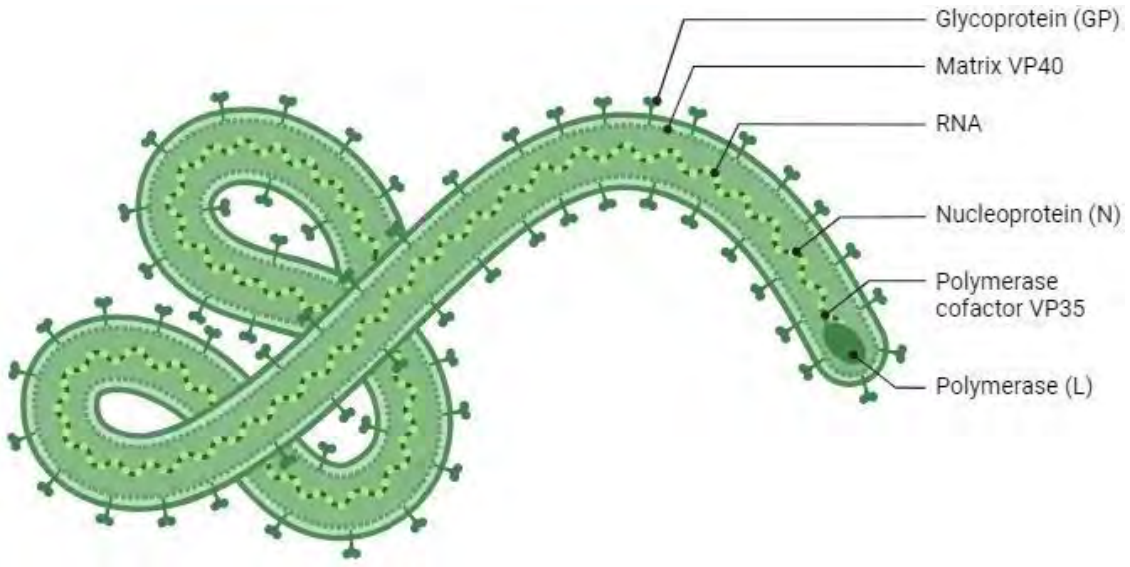

Figure 2: Ebola Virus.

1.2.3 Dengue virus

In 1953, the Philippines became the first country to report cases of Dengue Hemorrhagic fever (DHF), which spread to other countries in the Western Pacific and Southeast Asian regions. The primary pathophysiological characteristic that separates DHF from DF is plasma leakage. Acute feverish illness known as dengue is caused by germs with the dengue virus (DENV), a single-stranded RNA flavivirus that belongs to the family Flaviviridae (Wang et al., 2020). Primary transporters of the dengue virus are respectively *Aedes aegypti* and *Aedes albopictus*

through which the dengue virus spreads among females in the genus Aedes. *Aedes albopictus* was known to unleash devastating arbovirus disease epidemics in recently invaded countries, particularly involving all four dengue serotypes (DENV 1-4). The first biting female Aedes albopictus was found in Southern Cameroon in 1999 (*Fever Dengue*, n.d.). According to WHO estimates, there are currently 2.5–3 billion people are staying in dengue-transmitted areas. The precise causes and mechanisms of DHF, however, are still up for debate. There are currently no approved vaccines or specific medications accessible to treat dengue fever in any of its clinical manifestations (Wang et al., 2020).

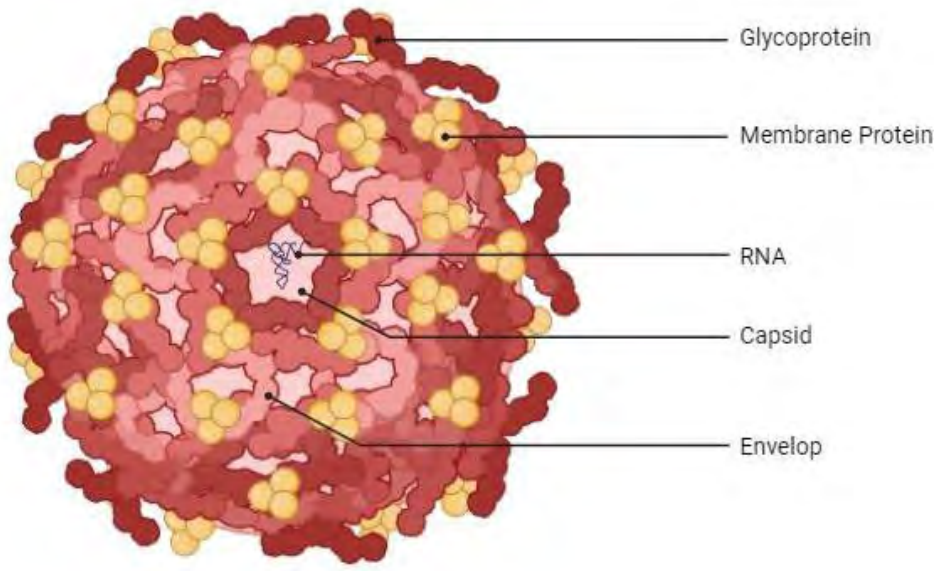

Figure 3: Dengue Virus.

1.2.4 Nipah virus

With the highest death rates in certain cases, Nipah is regarded as one of the deadliest viruses in the world. Acute respiratory distress can be fatal in some cases, and It has been reported to induce encephalitis. Lately, reports from Malaysia, Bangladesh, Singapore, and India have indicated that the bat-borne pathogen Nipah virus (NiV) is responsible for catastrophic encephalitis in humans. Included in the order *Mononegavirales* along with other fearsome viruses, Among the lethal zoonotic viruses this is the one that are emerging. According to

doctrine, the virus naturally exists in Pteropus fruit bats. Humans in Sungai Nipah, Malaysia, were exposed to the virus through pigs, which are the virus' intermediate hosts. In 1998, the virus's first known outbreak was detected in this village. Since 2001, yearly reports of persistent NiV outbreaks in various regions of Bangladesh have been made. The infection was caused by absorbing undated palm sap of dates tainted with bat saliva and excrement. First, in Siliguri, West Bengal, in 2001, there was an outbreak primarily from nosocomial contact; this was followed by another outbreak in Nadia, West Bengal, in 2007. The Keralan district of Kozhikode recently experienced an outbreak of NiV in 2018, with the index patient reportedly acquiring the virus from fruit-eating bats. Most of the spread was due to nosocomial infections; however, there was no clinical or statistical proof to support the incidence. The death toll from all the outbreaks has been high, with the most recent outbreak in Kerala recording a 91% death rate (Pillai et al., 2020).

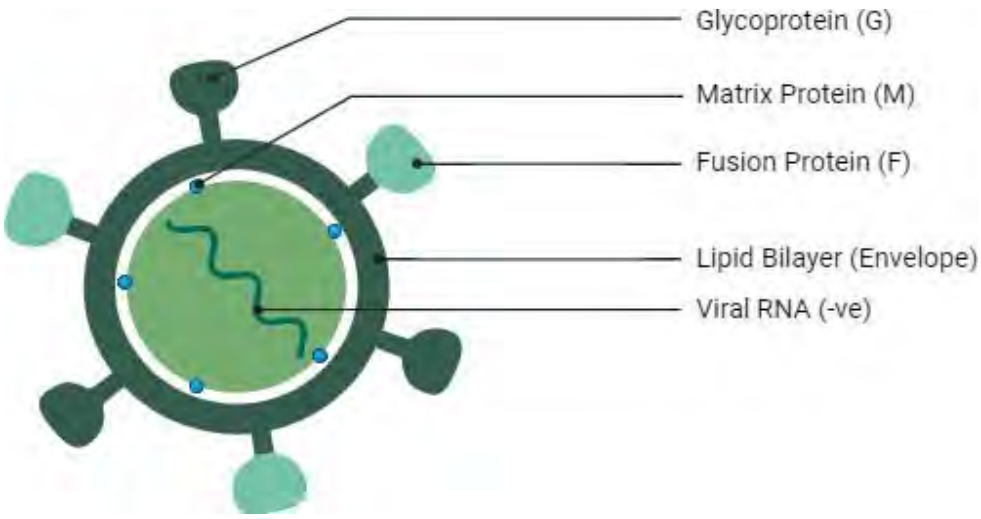

Figure 4: Nipah Virus.

1.3 Importance of Individual Preparedness

The phrase "EID preparedness" refers, regardless of the infection, to a range of actions performed to enhance the management and prevention of high-impact EID events, where the

privilege of preventing the event's consequences far outweigh the expenses incurred in doing so. Traditionally, the focus of these endeavors has been tactical planning. Surveillance has been the cornerstone of EID preparedness, helping to prevent the resurgence of known infectious diseases by early implementation of control measures. Additionally, it has been applied to recognize early socioeconomic status, chronological, and spatial patterns of unfavorable health events suggestive of an EID. In conjunction with this increased awareness of the wide range of risk factors linked to this phenomenon and the increased frequency of EID events, the scope of preparedness has expanded (Brookes et al., 2014). Individual preparedness for Emerging Infectious Diseases (EIDs) is crucial for several reasons:

- **Early Detection and Response:** Prepared individuals can recognize symptoms early, seek medical help promptly, and adopt preventive measures to limit the expansion of the disease.
- **Reduced Transmission:** By practicing good hygiene, such as handwashing and wearing masks, individuals can minimize the transmission of pathogens to others, thereby preventing outbreaks from escalating.
- **Protecting Vulnerable Populations:** Individuals who are prepared can take measures to protect themselves and vulnerable groups, such as the elderly, children, and those with underlying health conditions, who are at the compromised state to severe illness from EIDs.
- **Minimizing Impact on Healthcare Systems:** Individual preparedness can reduce the burden on healthcare systems by preventing unnecessary visits to hospitals and clinics, allowing healthcare providers to focus on treating severe cases, and preventing the overwhelming of healthcare facilities.
- **Community Resilience:** When individuals are prepared, communities become more resilient to outbreaks. Preparedness fosters a sense of collective responsibility and

encourages cooperation in implementing public health measures to control the spread of EIDs.

Overall, individual preparedness helps to mitigate the effects of EIDs in a crucial way, reducing transmission, protecting vulnerable populations, and promoting community resilience in the face of infectious disease threats.

1.4 Significance for Pharmacy Professionals

Pharmacists are crucial healthcare providers, providing information on vaccination, transmission minimization, and treatments. They advocate for proper vaccination and assist during outbreaks. Community pharmacists expand vaccination access, while hospital pharmacists educate and recommend vaccine practices. The CDC states that pharmacists are essential for maintaining healthy lifestyles and educating the population on immunizations. They identify patients with disease symptoms during outbreaks and provide recommendations for transmission prevention. The recent measles and novel coronavirus outbreaks have further emphasized the importance of pharmacists in preventing transmission (Guerci et al., 2020).

Chapter 2

Overview of Emerging Infectious Diseases

2.1 Characteristics of Coronavirus

When coronaviruses (CoVs), which are positive-sense single-stranded RNA (+ssRNA) viruses under an electron microscope, are viewed, they resemble crowns because their envelopes contain spike glycoproteins (coronam is the Latin word for crown). The Coronaviridae family (order Nidovirales) contains four genera of coronaviruses that are members of the subfamily Orthocoronavirinae. These are referred to as follows: Alphacoronavirus, Betacoronavirus, Gammacoronavirus, Deltacoronavirus.

The novel betaCoV known as Severe Acute Respiratory Syndrome Coronavirus (SARS-CoV)-2 belongs to the same subgenus as the previously recognized SARS-CoV and Middle East Respiratory Syndrome Coronavirus (MERS-CoV). Its elliptical or round form, often pleomorphic, has about 60 to 140 nm of diameter. It responds to UV light and heat just like other CoVs do. The SARS-CoV-2 inactivation temperature is being investigated by researchers. 90% of SARS-CoV-2 must be rendered inactive on a stainless-steel surface kept at 54.5°C (130 °F) in air for about 36 minutes. It can withstand temperatures as low as 0°C. Nonetheless, these viruses can be functionally inactivated by lipid solvents such as ethanol, chloroform (apart from chlorhexidine), peroxyacetic acid, ether (75%), and chlorine-containing disinfectant (Cascella et al., 2023).

2.1.1 SARS-CoV-2 Variants

- **Alpha (B.1.1.7 lineage)**

In late December 2020, the Alpha variant, also known as GRY (formerly GR/501Y.V1), was announced in the UK after whole-genome sequencing of patient samples that tested positive

for SARS-CoV-2. It was also recognized using a commercial assay that uncovered the variant by removing the S gene from PCR samples. The B.1.1.7 variant's viral genome has 17 mutations. Eight of these mutations are present in the spike (S) protein: the Δ69–70 deletion, the Δ144 deletion, N501Y, A570D, P681H, T716I, S982A, and D1118H. The spike protein of N501Y exhibits a greater affinity for ACE 2 receptors, thereby promoting the virus's attachment to host cells and subsequent entry. According to reports, the SARS-CoV-2 alpha variant is 43% to 82% more transmissible than earlier versions, and it went on to become the predominant SARS-CoV-2 variant in the UK (Cascella et al., 2023).

- **Beta (B.1.351 lineage)**

GH501Y.V2, a beta variant of COVID-19, was first discovered in October 2020 in South Africa and was the cause of the second wave of infections. The spike protein contains nine mutations that increase its binding affinity for ACE receptors: L18F, D80A, D215G, R246I, K417N, E484K, N501Y, D614G, and A701V. Neutralization and transmission risk were increased by this variant (Cascella et al., 2023).

- **Gamma (P.1 lineage)**

The Gamma variant, also known as GR/501Y.V3, was found in Brazil in December 2020 after it was first identified in the US in January 2021. The ten spike protein mutations that are present in this B.1.1.28 variant are as follows L18F, T20N, P26S, D138Y, R190S, H655Y, T1027I V1176, K417T, E484K, and N501Y. In addition to the B.1.351 variation, three mutations located in the RBD are L18F, K417N, and E484K (Cascella et al., 2023).

- **Delta (B.1.617.2 lineage)**

It was the Delta variant, initially identified in December 2020, that caused the second wave of COVID-19 infections in India in April 2021. This variant was discovered for the first time in the US in March 2021. Ten mutations are found in the spike protein of the B.1.617.2 variant,

including T19R, (G142D*), 156del, 157del, R158G, L452R, T478K, D614G, P681R, and D950N (Cascella et al., 2023).

- **Omicron (B.1.1.529 lineage)**

On November 23, 2021, the Omicron variant was first identified in South Africa subsequent to a surge in COVID-19 cases. Omicron was quickly identified as a volatile organic compound (VOC) due to over thirty modifications to the virus's spike protein and a noticeable increase in the number of cases reported in South Africa. T91 in the envelope, P13L, E31del, R32del, S33del, R203K, G204R in the nucleocapsid protein, D3G, Q19E, A63T in the matrix, N211del/L212I, Y145del, Y144del, Y143del, G142D, T95I, V70del, H69del, A67V in the N-terminal domain of the spike, G339D in the receptor-binding domain of the spike; L981F, N969K, and Q954H in the spike's heptad repeat 1, D796Y in the spike's fusion peptide, and several other mutations in the non-structural proteins and spike protein are also present. Among Omicron's many subvariants is BA.1, BA.2, BA.3, BA.4, and BA.5 (Cascella et al., 2023).

2.2 Characteristics of Ebola virus

The family Filoviridae incorporates the Ebola virus (EBOV). Filoviruses are filamentous viruses that are membrane-enveloped and have a negative sense of single-stranded RNA. The virus has an extraordinarily diverse shape, consisting of long tubes and multiple twists and branches. From a morphological perspective, the virus particles look like long, stretched filaments under an electron microscope. Some of them even have a tendency to curve into the shape of the number '6'. The elongated filaments are 80 nm in diameter and 800–1000 nm long. Only one percent of the virus's mass is made up of RNA.1. The nucleocapsid, matrix space, and envelope comprise the three compartments that make up the large virus structure. EBOV codes for eight proteins with just seven genes, an impressive given its small size. The seven genes encode the following proteins: L (polymerase), VP24-VP30-VP35-VP40, the

glycoprotein (GP), and the nucleoprotein (NP). The surface glycoprotein (GP); GP1 and GP2, which are the two molecular forms of expression produced by the GP gene via an RNA editing mechanism. In both viral infection and pathogenesis, the surface glycoprotein is essential, and during viral replication, its expression is tightly regulated. Studies conducted recently have demonstrated that the expression levels of GP1 and 2 regulate the production and release of viruses.3. Upon embedding the genetic material, the NP forms the large complex of proteins VP30 and VP35, which is involved in the synthesis of virus RNAs (Falasca et al., 2015).

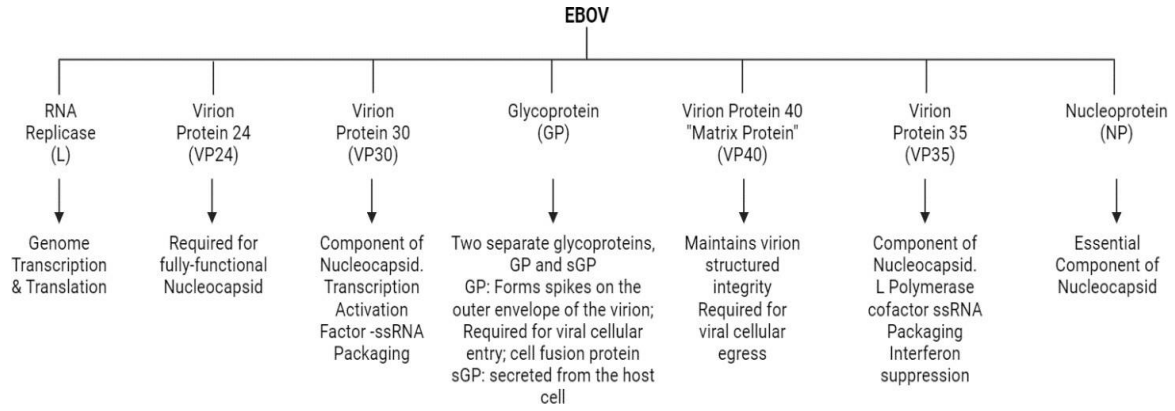

Figure 5: Ebola Virus Gene Products Function.

2.3 Characteristics of Dengue Virus

To aid in the replication of their genome, DENV uses their non-structural protein NS4A to start the formation of invaginated vesicles. Strong evidence that it serves as the replication site can be found in the direct visualization of double-stranded RNA, a key replication marker of DENV, inside DENV-induced ER-derived structures. Fatty acid synthase must build up at the RO site for DENV to replicate. DENV may have an effect on the lipid biosynthesis machinery, which is positioned in close proximity to the ER membrane and plays a role in shaping the dynamic morphology of the ER. Invaginated vesicles, measuring between 80 and 150 nm in diameter, are another way that viruses like DENV, tick-borne encephalitis virus, Langat virus,

Murray Valley encephalitis virus, Japanese encephalitis virus, and yellow fever virus replicate their genomes (Zhang et al., 2023).

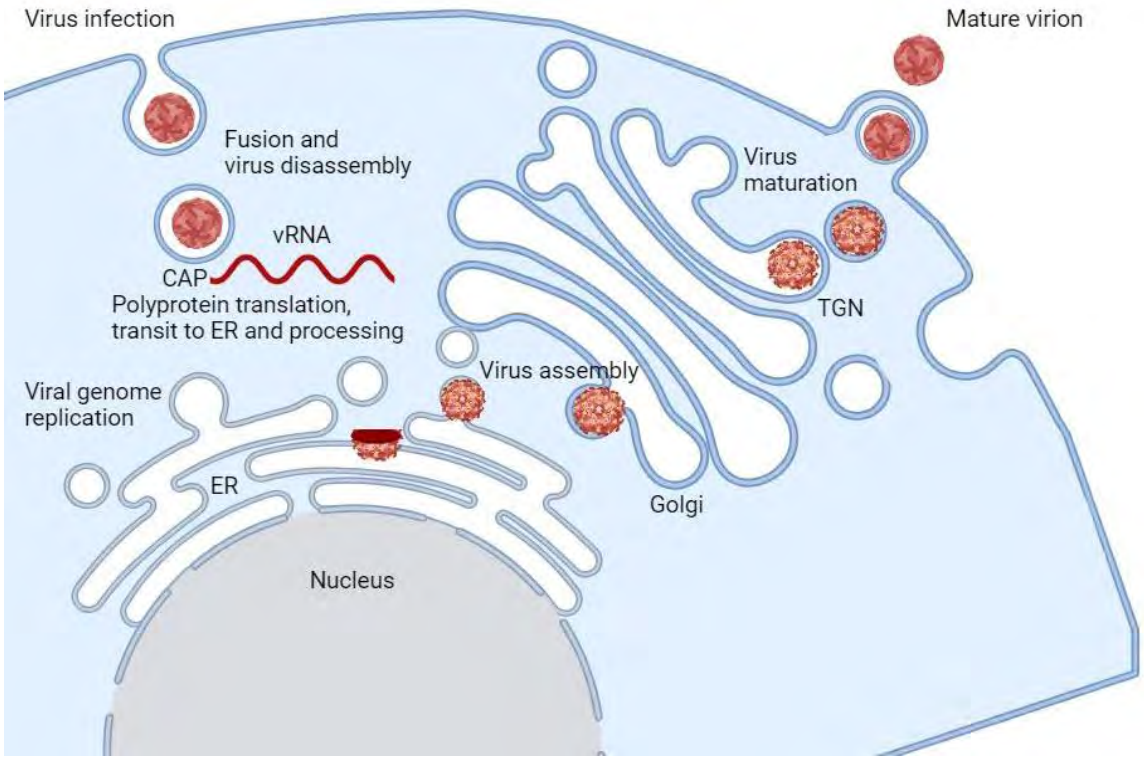

Figure 6: Characteristics of Dengue Virus.

2.4 Characteristics of Nipah Virus

The Nipah virus has several species. Henipavirions is among them. It is somewhat pleomorphic and lacks a distinct shape. Its diameter is between 40 and 600 nm in length. The enveloped RNA virus is single-stranded, non-segmented, and has helical symmetry. As seen in the figure below, the six basic genes that make up the RNA genome are nucleocapsid, phosphoprotein, matrix, fusion glycoprotein, attachment glycoprotein, and long polymerase. They are covered in a lipid membrane on top of their viral matrix protein shell. The phosphoprotein and nucleocapsid proteins are firmly linked to the core's genomic RNA. A spike consists of G (attachment) protein, which is a tetramer embedded in the lipid membrane, and F (fusion) protein trimers. By interacting with the retained mammalian protein family, ephrin b1, b2, or b3, the G protein aids in the virus's attachment to the surface of host cells. To enable the virus

to release the virions into the host cell, the fusion protein assists in the fusion of the virus's and the host cell's membranes. Additionally, it triggers the fusion of enlarged cells with nearby cells to create massive syncytia (Talukder et al., 2023). The primary means of infection between humans and animals is the NiV, which is spread by the droplets of vulnerable hosts other than bats.

2.5 Factors contributing to the emergence of infectious diseases

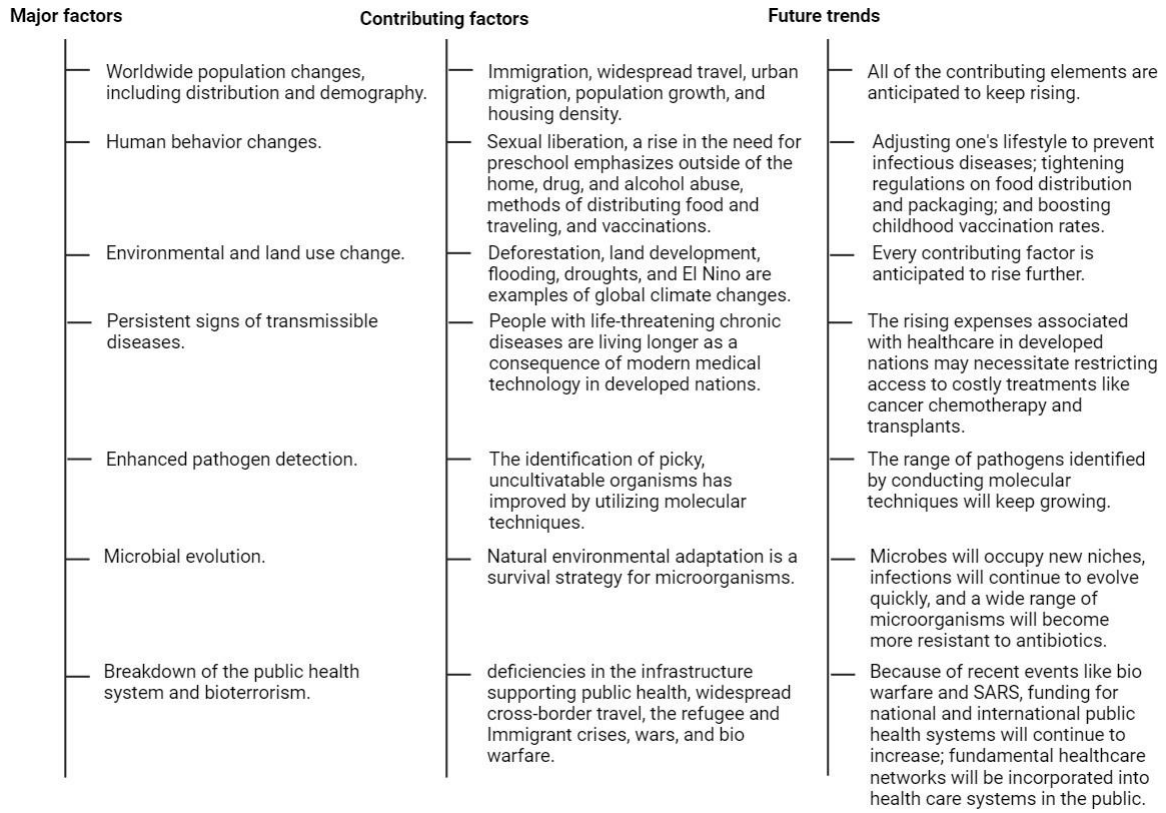

Figure 7: Characteristics of Dengue Virus.

2.6 Global Impact on EIDs

Human activity both locally and globally causes global change. Anthropogenic disturbances of the environment, mainly from land-use change, urbanization, climate change, and transnational movement of people, goods, and other organisms, have an impact on ecosystems and societies that promote the emergence of new infectious diseases in human populations, the spread or

relocation of existing diseases to new geographic areas, or the resurgence of existing diseases in different locations (Nova et al., 2022).

First, although predicting those changes and the ultimate effects of diseases on human populations is still very difficult, climate changes probably going to alter, and it may have already changed, the geographic distribution of zoonotic and vector-borne diseases. Second, changes in land use often contribute to the emergence of novel human diseases by creating more channels for diseases to spread from wildlife to human populations, particularly from disease reservoirs such as bats and rodents. Third, diseases with a sylvatic or rural origin should be suppressed while disease vectors and pathogens adapted to urban settings are expected to flourish; however, the effects of urbanization vary significantly between urban and peri-urban areas. Fourth, there is growing evidence that the migration of people, goods, domestic and wild animals, and plants around the world has contributed to the emergence (Nova et al., 2022).

Chapter 3

Role of Pharmacy Professionals on EIDs

3.1 Patient Education on Prevention and Treatment

As readily available medical professionals, pharmacists have continued to uphold their professional responsibilities to safeguard the public [National Community Pharmacists Association (NCPA), 2020; National Alliance of State Pharmacy Associations (NASPA), 2020b]. Preventative screening and confirmation of appropriate drug indication, dosage, frequency of administration, precautions, contraindications, and drug interactions between patients' current drug therapy and new prescriptions are carried out by community pharmacists using patient medication profiles (Earl et al., 2021).

3.2 Collaborative Efforts in Public Health

Pharmacists are medical professionals who give vaccinations, advise on self-care, dispense prescription drugs, and offer advice on both prescription and over-the-counter medication to their communities. Pharmacies that are independently owned, part of food and beverage stores or general merchandise stores, or chains that operate on a regional or national scale provide healthcare services to the community. During a pandemic, pharmacists can effectively prioritize patients based on best practices and are readily available as healthcare professionals. According to the National Community Pharmacists Association (NCPA), 2020, patients who are considered to be at high risk may be referred to an emergency room, a doctor, or another provider. For instance, pharmacists prescribe and counsel patients on COVID-19-specific treatments, such as medications for symptomatic conditions, glucocorticoid anti-inflammatory drugs (prednisone) after recuperation from sudden lung conditions, and bronchodilator inhalers for dyspnea. Opioids were among the restricted drugs that were prescribed to patients as analgesics. Additionally, chemists kept giving prescriptions and helping patients with both

chronic and acute self-limiting illnesses. In order to calm patients and prevent panic, pharmacists are available by phone and in person to debunk myths and rumors. There were resources from FEMA and WHO available to refute rumors and false information. There were a lot of organizations on the Internet that offered trustworthy information (Earl et al., 2021).

Chapter 4

Individual Preparedness Measures

4.1 Understanding personal risk

Involves the preparedness of the vulnerable population, their age, health conditions, and geographical considerations.

4.1.1 Groups Most Vulnerable to COVID-19

Vulnerable populations are more likely to present themselves with more severe illnesses through previous pandemics. Even with these lessons learned, COVID-19 still exhibits the same disparities. Racial/ethnic minorities, children, the elderly, immigrants/refugees, people from rural communities who are impoverished, disabled, have inadequate insurance, are facing domestic abuse, are incarcerated, or have specific medical conditions such as profound psychological illness are just a few of the many vulnerable groups. Furthermore, even though COVID-19 affects African Americans deliberately (Kuy et al., 2020). The COVID-19 pandemic has highlighted the pressing need to protect marginalized communities. We should apply the lessons learned from previous crises, such as Hurricane Katrina, to this one. Healthcare and social care should work together to provide vulnerable populations with the resources they need. Interventions include distributing educational materials, offering food delivery services, partnering with the public and private sectors to provide free services, setting up a hotline for community assistance, and utilizing technology to pinpoint intervention hotspots (Kuy et al., 2020).

4.1.2 Groups Most Vulnerable to Ebola Virus

It is unknown if eating contaminated food can spread the Ebola virus. Nonetheless, handling and ingestion of wild animal meat or hunted wild animals carrying the Ebola virus can transmit

the disease in some regions of the world. There is no proof that other insects, such as mosquitoes, can spread ebolaviruses.

Those who provide care to patients with suspected or confirmed Ebola disease and their family members are the ones most at risk of contracting the disease. When people encounter infected blood or bodily fluids, ebolaviruses can spread. Travelers and the local population who have not cared for or encountered an Ebola patient are not at significant risk from Ebola viruses. The Ebola virus epidemic that has killed thousands of people in Guinea, Sierra Leone, and Liberia, three West African countries, serves as a stark reminder of post-conflict nations' limited capacity for adaptation. These populations are especially vulnerable to multiple interacting stressors such as food insecurity, climate change, and the cascading effects of disease epidemics like EVD because of the lack of access to health services. It is unknown, nevertheless, how vulnerable rural populations are distributed geographically and what specific stresses make them more vulnerable. Districts in the north and west of Liberia, in the counties of Lofa, Bong, Grand Cape Mount, and Bomi, are classified as exhibiting the greatest susceptibility to social harm. The highest percentage was experienced by three of these counties, the capital Monrovia, and the surrounding counties of Margibi and Montserrado in Liberia (Stanturf et al., 2015).

4.1.3 Groups Most Vulnerable to Dengue Virus

An overview of Southeast Asia's dengue situation can show how the rapidly spreading illness is having a significant negative impact on the region's economy and society, particularly in Bangladesh and Southeast Asia. The dengue outbreak in Bangladesh is having a financial impact on the healthcare sector, similar to other low- and middle-income nations, as annual spending on healthcare is gradually decreasing. Results from the Bangladesh National Health Accounts study show that at the same time, out-of-pocket spending is increasing - it is the highest in South and East Asia. Since the rainy season provides the ideal conditions for the

Aedes aegypti mosquito, dengue transmission is at its highest from August to October (Mahmood et al., 2021). Contrary to a different study conducted in Cameroon, the proportion of dengue fever in men was estimated to be higher in this study than in women. At work or on their commute, men are more likely than women to come into contact with mosquitoes that carry viruses. This could help to explain the differences between the sexes. The age range of 20–40 years old accounted for 49.8% of dengue cases. In contrast, M. Rahman et al., [25] reported that the age group of 18 to 33 years in Bangladesh had the highest proportion of cases. Conversely, younger children (less than ten years old) had a lower incidence of dengue fever (12.7%) (Mahmood et al., 2021).

4.1.4 Groups Most Vulnerable to Nipah Virus

Despite being a pathogenic illness, date palm sap and contaminated food can both spread NiV. NiV can be discovered in bat secretions. Furthermore, bodily secretions like saliva and respiratory droplets from an infected person can spread it. People who climb trees in Bangladesh may be more prone to infection, according to a Goalondo survey. The WHO estimates that between 40% and 75% of deaths are related to NiV infection. According to estimates from Bangladesh's 2 Institute of Epidemiology, Disease Control and Research, 73% of local deaths are thought to be caused by NiV infection. The death rate is alarming enough to raise concerns around the world, even though it depends on the clinical and epidemiological knowledge of the outbreak region (Nazmunnahar et al., 2023). The state of affairs at the moment suggests that the NiV could result in a worldwide public health emergency. As we previously noted, India was affected by the viral outbreak that originated in Bangladesh. As a result, the virus is able to cross national boundaries and travel to nearby countries. The confirmed cases of transmission from person to person serve as a serious alert to everyone on the planet. Saliva and respiratory droplets are two ways that it can spread. Therefore, a case of secondary transmission will unavoidably occur. Acute respiratory infections and lethal

encephalitis are just two of the clinical manifestations that humans infected with the Nipah virus can cause. Across Bangladesh, India, Malaysia, and Singapore, case-fatality rates from outbreaks usually vary from 40–100%. Neither effective treatments nor vaccines are currently available for the disease (*Item*, 2023).

4.2 Basics of Infection Prevention

Preparedness measures for preventing Emerging Infectious Diseases (EIDs) such as hand hygiene, respiratory etiquette, and immunization are crucial components of public health strategies. These measures aim to minimize the transmission of infectious agents and reduce the risk of outbreaks.

4.2.1 Hand Hygiene

Hand hygiene, following WHO, includes regular handwashing with soap and water or the use of alcohol-based hand sanitizers, which is fundamental in preventing the spread of infectious diseases. Proper hand hygiene disrupts the transmission of pathogens from contaminated surfaces to individuals' mucous membranes, thereby reducing the risk of infection.

4.2.2 Respiratory Etiquette

Post notices at doors advising people who exhibit respiratory infection symptoms to: Cover their mouth and nose when sneezing or coughing, take out tissues after using them, each time you touch your mouth or nose, wash your hands, or use hand sanitizer. Provide tissues and no-touch containers to dispose of them. Offer hand hygiene resources in or close to waiting areas. Patients with symptoms should be given space and encouraged to sit as far away from other people as they can. If a separate area is available while patients wait for care, facilities may want to place these patients there. When assessing and treating patients who exhibit symptoms of a respiratory infection, teach DHCP the value of taking preventative measures.

This procedure lowers the possibility of diseases like COVID-19 and influenza spreading through the air.

4.2.3 Immunizations

The process of making someone resistant to a disease is known as immunization, and it usually involves giving them a vaccine. Vaccines boost an individual's immune system, shielding them from future infections or disorders. Immunization reduces the risk of contracting diseases, impairments, and vaccine-preventable diseases (VPDs). Through the development of immunity against particular pathogens, are vital in stopping the spread of infectious diseases. The goals of vaccination campaigns are to protect susceptible groups, create herd immunity, and stop the spread of diseases that can be prevented by vaccination. To lessen the effects of emerging infectious diseases and protect public health, these readiness measures must be put into action in addition to other infection control procedures.

4.3 Medication management for pre-existing conditions

Especially during infectious disease outbreaks, requires careful planning to ensure patients have continued access to necessary medications while minimizing exposure risks. Measures such as ensuring adequate supply chains, implementing telehealth services, and facilitating remote medication access are essential components of this strategy.

4.3.1 Ensuring adequate Supply chains

During infectious disease outbreaks, disruptions in the pharmaceutical supply chain can occur due to various factors, including transportation restrictions and increased demand for certain medications. To mitigate these challenges, it is crucial to establish robust supply chain management systems. This involves maintaining adequate stockpiles of essential medications, diversifying suppliers to reduce dependence on specific regions, and implementing contingency plans for alternative sourcing.

4.3.2 Telehealth and Remote Medication Access

The management of communicable diseases is best served by telehealth. "Social distancing," or reducing interpersonal contact, is a crucial component in slowing the spread of a virus. In particular, for those who are more likely to be affected (such as older adults with pre-existing medical conditions), telehealth can facilitate convenient access to routine care without the risk of exposure in crowded hospital or physician office waiting rooms. For patients with COVID-19 or those who are worried that they might be infected, telehealth can assist with remote assessment and the provision of care. In the event of environmental or biological hazards, telehealth's many important advantages can improve emergency response times. Telehealth can help with remote care triage and fast access to information during infectious disease outbreaks. An example of this is the use of chatbots in Singapore during COVID-19. In addition, video consultations with medical professionals can help with disease diagnosis through telehealth. However, we need to make sure that telehealth is properly integrated into our health service and seen as a "business as usual" modality if we want it to be effective during future events (Smith et al., 2020). In the end, telehealth adoption helps health systems and physician practices focus more on managing persistent conditions, enhancing patient wellness, improving efficiency, providing higher-quality care, and increasing patient satisfaction. It also helps providers increase continuity of care, extend access beyond regular clinic hours, reduce patient travel burdens, and help overcome clinician shortages, especially in rural and other underserved populations (American Medical Association & American Medical Association, 2021).

Chapter 5

Pharmacist Contribution to Community Education

Regarding the current policy environment in the pharmacy field, it has been suggested that, albeit to varying degrees, pharmacy practice and education have evolved from their original, limited product-centered focus to the current patient-centered focus in many nations worldwide. But public health-focused healthcare practice and education are now in high demand from the medical community and from different governments. This is because it equips today's healthcare professionals, including pharmacists, to look beyond the individual patient to the community and society. This is significant because it has the potential to lower medical expenses while simultaneously improving patient experience and safety. Pharmacists perform micro-level public health webinars such as disease management, health and wellness screening, immunizations, medication therapy management, and so on, whereas macro-level public health functions include assessment, policy development, and population-based assurance. Nonetheless, creditors and healthcare providers should anticipate that pharmacists will assess public health initiatives for efficacy and cost-effectiveness and will work with government organizations to develop public health initiatives (Agomo et al., 2020).

Through a variety of initiatives, such as organizing health workshops and webinars, creating educational materials, working with public health organizations, and utilizing social media and technology to raise awareness and prevent emerging infections, pharmacists play a pivotal part in community education and public health outreach.

- **Hosting health workshops and webinars:** Workshops and webinars on a range of community-relevant health topics are frequently planned and led by chemists. These gatherings may address topics like managing medications, preventing illnesses, adopting healthy lifestyles, and more. Pharmacists enable members of the community

to make knowledgeable decisions about their health by giving accurate information and responding to inquiries.

- **Developing informational materials:** Pharmacy professionals produce educational resources to inform the public about topics associated with health, such as booklets, posters, and brochures. The information in these materials might cover aspects like vaccinations, hand hygiene, medicine safety, and methods for preventing illness. Informational materials with clarity and conciseness aid in reaching a broad audience with fundamental health messages.
- **Collaborating with Public Health Agencies:** To support community health initiatives, pharmacists work in partnership with public health agencies. This partnership could entail taking part in immunization drives, supplying tools for disease tracking and reporting, and lending knowledge to public health initiatives. Pharmacists contribute to better community health outcomes and the strengthening of the public health system by collaborating closely with these organizations.
- **Leveraging social media and technology:** To effectively reach a wider audience and distribute health information, pharmacists use social media platforms and technology. They could address followers' health concerns by making informative posts, sharing articles and videos, and interacting with them. To further improve community accessibility to healthcare, particularly for those living in underprivileged areas, pharmacists can use telehealth services to conduct remote consultations and medication counseling.

By teaching the public about infection prevention techniques and immunization programs, pharmacists play an integral part in stopping the spread of newly emerging infections. They maintain current knowledge of the most recent advancements in infectious disease research and propagate factual information to counteract falsehoods and raise public awareness. Pharmacists

assist in preventing infectious diseases and advancing general health by proactively addressing new health risks. Thereby rendering these efforts, pharmacists encourage people to take responsibility for their health and improve the general health and well-being of the community.

Chapter 6

Importance of Continual Education for Pharmacy Students

Incorporating Emerging Infectious Disease (EID) preparedness in the pharmacy curriculum, providing training on effective communication during health crises, and promoting interprofessional education are crucial aspects that make continual education for pharmacists important.

6.1 Incorporating EID Preparedness in Pharmacy Curriculum

The swift emergence of resistant pathogens, the striking lack of high-level evidence in clinical practice guidelines, the stagnant antimicrobial pipeline, and the growing role of pharmacists in determining the best course of treatment and prevention for infectious diseases all underscore the significance of teaching pharmacy students about the prudent and reasonable use of antimicrobial agents. In order to optimize antibiotic selection, dosage, route, and duration to maximize therapeutic effect while limiting unintended consequences, such as adverse effects and the development of antimicrobial resistance, pharmacy students should receive training in the application of evidence-based medicine. In order to effectively care for patients, pharmacy students should also be able to collect data based on evidence, assess the clinical implications, and apply the knowledge (Hidayat et al., 2012). Including EID preparedness in pharmacy education ensures that pharmacists are equipped with the necessary knowledge and skills to respond effectively to emerging health threats. Integrating topics related to infectious disease management, epidemiology, and public health into pharmacy curricula enhances pharmacists' ability to recognize and respond to outbreaks, thereby contributing to public health preparedness.

6.2 Training of Effective Communication During Health Crisis

Community pharmacies see a lot of patients every day, and pharmacists are thought to be the most approachable medical professionals. In pharmaceutical care, where the pharmacist assumes a leadership role, the patient-centered communication concept is applicable. A pharmacist who is committed to his work must possess the following abilities: improved self-confidence, the ability to think positively, the ability to communicate, resistance to stress, generosity with patients, and assistance skills. When evaluating the communication between a pharmacist and a patient, the patient's viewpoint is crucial. Accuracy, effective application of scientific knowledge, diplomacy, communication, management, multitasking, computer literacy, mathematical and analytical abilities, mentoring, integrity, and ethics are critical competencies for pharmacists. Having empathy is essential when speaking with the patient. In his book, Simon Baron-Cohen, a British clinical psychologist and developmental psychopathology professor at the University of Cambridge, stated that *"Empathy is like a universal solvent. Any problem immersed in empathy becomes soluble".* Empathy among chemists in the physical or virtual pharmacy is directly associated with better patient treatment outcomes, adherence, and satisfaction. A strong correlation exists between empathy and job satisfaction (Rusu et al., 2022). Empathy levels among pharmacy students were assessed in a Midwestern University study. Female students exhibited a significantly higher level of empathy than their male counterparts. The findings align with previous research, which indicates that women outperformed men in terms of empathy (Tamayo et al., 2016). This self-assessment of empathy level might be more based on opinion than reality. Pharmacists must receive training on effective communication during health crises in order to provide accurate information, address concerns, and promote cooperation between the community and healthcare professionals. Superior outcomes can be achieved by pharmacists who are skilled communicators because they can foster trust, allay anxieties, and encourage adherence to

public health guidelines during outbreaks. Being infected with a newly emerged infectious disease, patients are mostly affected mentally rather than physically. It has also been repeatedly demonstrated that pharmacists improve their patients' perceptions of their progress, beliefs, and understanding of psychotropics. These results highlight the influence that pharmacists have over the care, attitudes, and beliefs of their patients who suffer from mental health disorders. Medication adherence in patients may be enhanced by such an influence. Pharmacy employees with the necessary mental health skills are equipped to change the negative beliefs that people with mental health needs and illnesses have about themselves and their conditions. Such pharmacy assistance can significantly lower a care barrier. Staff members at pharmacies who are educated about the telltale signs and symptoms of mental health disorders can also assist in identifying patients who might require a referral to a clinician for assistance and follow-up. The personnel at pharmacies can also be very helpful in providing information about mental health issues and in promoting different forms of self-help and other techniques (Rickles et al., 2019).

6.3 Promoting Interpersonal Education

Pharmacy students require appropriate training to develop their own effective communication styles because interprofessional communication skills are vital in the practice of pharmacy. Experiences gained from clinical rotations include valuable practice of these skills. At best, learners ought to be able to emulate the attitudes and methods that their mentors employ. Because of this, pharmacist preceptors must be adequately equipped to give students these kinds of experiences during their community-applied practical experience (McDonough & Bennett, 2006). The community pharmacy provides a wealth of opportunities for students to improve their interprofessional communication abilities. Preceptors are accountable for fostering a practice-oriented atmosphere for clerkship students, offering prompt and helpful feedback, and highlighting the value of multiple communication channels. This isn't always

simple in a busy neighborhood drugstore. To integrate precepting into workflow and give students effective and efficient teaching opportunities, preceptors must have a well-thought-out plan in place (McDonough & Bennett, 2006). Developing interprofessional communication in the workplace, and responsibility toward patients demonstrate the pharmacists from the beginning of their pharmacy education. Consequently, it is significant for students to acquire and apply interprofessional communication skills in the workplace. Respect for fellow employees and a desire to work as a team are the foundations of effective communication in the workplace. Regular staff meetings should be arranged to discuss workplace concerns in a non-confrontational or non-blaming manner as a means to help guarantee that employees are interacting with one another. It is important to remind all staff members that personal attacks are inappropriate during staff meetings. All employees, including technicians, pharmacists, and other support staff, should be encouraged to participate in staff meetings. When evaluating students, one can show that one has the ability to give critical feedback to employees. It takes continual feedback to students and staff, respectively, for successful practices and clerkships. Supervisory or preceptor feedback ought to be helpful and instructive. Together with discussing how to get better in order to satisfy the evaluator, it ought to assist people in identifying their strengths and shortcomings. Feedback of this kind is not always simple to provide or receive. It can be utilized to boost performance, though, if done correctly. Additionally, placing a strong emphasis on interprofessional education promotes cooperation between pharmacists and other medical specialists, which improves the efficiency of public health measures taken to combat infectious diseases. During health emergencies like pandemics, interprofessional collaboration promotes teamwork, enhances communication, and guarantees comprehensive patient care.

Chapter 7

Challenges in EID preparedness

A number of infectious viruses have resurfaced or emerged from wildlife in recent decades. These include the Nipah virus, the Ebola virus, the Dengue virus, the Coronavirus, and others that have spread around the world and had such a severe effect on public health that the scientific community has been urged to act quickly to treat and prevent these infections (Trovato et al., 2020). For a number of reasons, access to medicine and vaccinations, regulatory obstacles, and vaccine reluctance and misinformation present serious obstacles to emerging infectious disease preparedness. In order to ensure fair access to drugs and vaccines, fight misinformation, and expedite regulatory procedures to improve readiness for emerging infectious diseases, addressing these issues calls for cooperation between governments, healthcare providers, pharmaceutical companies, and communities.

7.1 Access to medication and vaccination

The capacity to contain and lessen the spread of newly emerging infectious diseases can also be hampered by restricted access to medicine and vaccines. The issue may be made worse by insufficient distribution networks, especially in underdeveloped areas or those with inadequate access to healthcare. In order to reduce the risk of disease transmission and widen health disparities, people may be prevented from getting necessary vaccinations or medications due to cost barriers.

There are several distinct challenges in evaluating the effectiveness of a vaccine against a newly emerging pathogen that has the potential to become a pandemic and that could result in substantial morbidity and death. Although vaccination can lessen the burden of newly emerging infectious diseases, creating a vaccine in a pandemic presents special difficulties. It usually takes ten to fifteen years to develop and approve a vaccine, which emphasizes the need for

speedier licensing procedures. The average cost of creating a new vaccine candidate for an infectious disease ranges from $319 to $469 million, including the total cost of failed vaccine candidates, and includes preclinical trials through the end of a Phase 2a trial. Because of the delay between pathogen discovery, vaccine approval, and widespread vaccination campaigns, a highly transmissible pathogen could be able to spread globally. Rapid vaccine development is also hampered by issues with determining the ideal dosage, correlates of protection, cross-reactivity with closely related pathogens, short- and long-term side effects, antibody-dependent disease enhancement, and the lack of animal disease models for testing. Although inactivated vaccines might not be highly effective in slowing the outbreak, live attenuated vaccines are probably too dangerous for a pathogen with a high potential for pandemics. But in the COVID-19 pandemic, this issue was avoided by using a swift development cycle for mRNA and viral vector/mRNA constructs. For highly contagious pathogens that cause serious symptoms, high-standard biosafety precautions may also be required in the laboratories used to produce vaccines. The unpredictable nature of emerging infectious diseases presents a unique challenge for researchers organizing vaccine efficacy trials against these diseases. The trial has to be conducted in an area where there is active transmission in order to gather sufficient primary endpoints to accurately determine protective efficacy. Trials examining the effectiveness of vaccines against endemic diseases may depend on a historically stable background incidence level of disease transmission, even though the number of cases in these trials must be high or the duration of the trial must be long to achieve the required statistical power for the hypothesis test. A standard trial, however, might not be feasible if, on the other hand, there are no sites with consistent incidence for a recently emerging infectious disease and no possibility of future transmission in any pre-specified location (Madewell et al., 2021).

7.2 Misinformation and vaccine hesitancy

Building vaccine confidence and encouraging vaccination uptake requires a combination of factors, including vaccination history, trust in the government, and medical advice. VH is everywhere. Immunization reluctance is widespread across nations, states, and subgroups including family members and healthcare professionals. It is also influenced by a number of factors, including perceived illness or outbreak severity, infection risk, vaccine safety, and the need to vaccinate children (Tagliaferro & Glauser, 2022).

Decisions about one's medical care are undoubtedly personal ones. It is noteworthy that psychological factors have an impact on vaccine resistance. Psychological characteristics are common among populations, despite differences in the social, economic, cultural, political, and geographic factors influencing vaccination hesitancy or resistance. These traits distinguished COVID-19 vaccine-hesitant/resistant individuals from those who accepted the vaccine. These traits included being more egocentric, mistrusting experts and authority figures like scientists, doctors, and the government, being more likely to have strong religious beliefs - possibly because these beliefs are connected to a mistrust of the scientific method and being more likely to harbor conspiratorial and paranoid beliefs - for example, that there are government conspiracies, conspiracy theories, and the government, which reflect a lack of trust in the motives of others. Likewise, they thought more impulsively than the average person and their personalities were characterized by unpleasantness, emotional instability, and lack of conscientiousness. Health care providers may or may not be able to identify these psychological problems. By using the comparison analyses, we can gain insight into the significance of framing and phrasing decisions. This knowledge can then be applied to inform the development of a national vaccine campaign that is urgently needed and to improve the design of future studies that will support ongoing surveillance of vaccine hesitancy. The fact that VH is still active must be communicated to the national vaccine campaign. It is important

to concentrate on spreading messages about the safety and efficacy of vaccines as well as the necessity of vaccinations with the goal to change people's beliefs (Tagliaferro & Glauser, 2022). Nevertheless, in an effort to comprehend patients' concerns, medical personnel ought to make an effort to have direct talks with each patient. Minorities' prejudice or resistance to medical research and the healthcare system is a result of historical events, such as the unfair trials conducted on African Americans in the Tuskegee Syphilis Study, as well as current views of prejudice in medical settings and care (Tagliaferro & Glauser, 2022).

A lack of trust in vaccines and medications can be caused by misinformation, which spreads quickly, particularly in the social media age. When vaccination rates are below ideal levels due to vaccine hesitancy stoked by false information, populations become more susceptible to infectious illnesses. Effective public health campaigns, educational initiatives, and transparent communication are necessary to combat vaccine hesitancy, dispel myths, and foster confidence in vaccinations and pharmaceuticals.

7.3 Regulatory barriers in Emergencies

The prompt distribution of drugs and vaccines can be hampered by regulatory obstacles during pandemics of newly emerging infectious diseases. The availability of treatments and preventive measures that can save lives may be slowed down by delays in the regulatory approval processes. To ensure that safety and efficacy standards are met while also facilitating the approval and distribution of drugs and vaccines in emergencies involving public health, regulatory frameworks must be flexible. Improving readiness for newly emerging infectious diseases requires streamlining the regulatory procedures.

Firm review procedures and data requirements may make it difficult for regulatory bodies to expedite EUAs for novel coronavirus diagnostic tests, treatments, and vaccines. Similarly, import/export restrictions and transportation laws may make it difficult to obtain and distribute

vital medical supplies on time, like ventilators and personal protective equipment (PPE). Lengthy clinical trial approval processes may also cause delays in the development and testing of potential treatments and vaccines.

The complex coordination among regulatory agencies across national borders might trigger delays in the cross-border deployment of medical personnel, equipment, and experimental treatments. Compact regulatory requirements for experimental drug approval could prevent impacted populations, especially in resource-constrained environments, from accessing potentially life-saving treatments. Regulatory obstacles to vaccine approval and distribution may make it more difficult to quickly immunize populations that are at risk, which would accelerate the spread of the Ebola virus.

Attempts to stop the spread of dengue could be slowed down by legislation pertaining to environmental and vector control strategies, such as the use of insecticides and genetically modified mosquitoes. Additionally, Dengue diagnostic test approval delays may prevent prompt diagnosis and surveillance, impeding efficient disease control and outbreak response. Furthermore, Dengue vaccine availability may be delayed as a result of regulatory requirements for vaccine development and approval that may present difficulties for scientists and pharmaceutical companies.

Robust biosecurity regulations have the potential to impede the prompt diagnosis and surveillance of Nipah virus outbreaks by adding complexity to sample handling and transportation. Secondly, the investigation of the virus and the creation of animal models for the testing of prospective cures and vaccinations may be slowed down by animal welfare regulations, such as ethical and regulatory issues on animal research. Transmission Between Species Regulations related to research could limit our awareness of the epidemiological research and preventive strategies of the Nipah virus by impeding research into the mechanisms of cross-species transmission.

Chapter 8

Future Directions and Innovation

8.1 Advances in Vaccine Development

It has long been acknowledged that the best method for controlling and preventing infectious diseases is vaccination. They have significantly decreased the burden of disease worldwide. Understanding the immune system and creating innovative vaccines and delivery systems have advanced significantly over time. Furthermore, vaccine accessibility and efficacy are being improved by research into cutting-edge adjuvants and delivery methods. Concerning combating infectious diseases and enhancing public health worldwide, these state-of-the-art technologies and developments in vaccine research have enormous promise. Comprehending the cellular reactions that ensue after vaccination is essential for evaluating the effectiveness and safety of these shots as well as for creating more effective vaccination plans.

The field of disease prevention is changing as a result of the advances made in vaccine research. Advances in mRNA vaccines, adjuvants, and delivery systems, as well as unique antigenic targets, present fresh opportunities for addressing infectious disease outbreaks and enhancing worldwide public health. Priorities also include addressing vaccine hesitancy and guaranteeing fair access to vaccinations. To foster innovation and overcome obstacles, there must be ongoing investments made in R&D, collaboration, and research. The collaborative effort showcases the creative approaches, cutting-edge technologies, and state-of-the-art research in vaccine formulation, delivery systems, and technology that have transformed the vaccine development process. With these developments, we are getting closer to a time when the prevalence of diseases that can be prevented will be much lower, opening the door to a more secure and healthier world.

8.2 Telemedicine and Pharmacy Services

Telemedicine has the ability to evaluate and treat patient conditions, eliminate distance-based barriers, and enhance service accessibility in isolated locations or situations where patient-physician contact is difficult. For the best and most efficient patient care, interdisciplinary interactions are frequently necessary for diagnosis and treatment. With telemedicine, several key professionals can communicate with one another even though they are geographically separated, helping to accomplish this goal. Especially in the event of an infectious disease pandemic affecting the healthcare system, this issue can help with better illness management. Telemedicine is used in many different contexts in the following health systems and has shown promise in terms of reduced expenses, decreased patient mortality, decreased hospital admissions, and enhanced patient well-being. In addition to improved patient-physician communication and simplified processes, higher consult rates are necessary for the long-distance practice process to produce these beneficial effects. The importance of multiple professionals intervening and monitoring during drug prescription can result in lower drug errors and higher prescription accuracy and authenticity when pharmacologists are more involved in tele-pharmacy. However, when patients or professionals are not present, telemedicine is the best option for treating and managing conditions (Shokri et al., 2023). Telemedicine, therefore, can significantly contribute to the decrease of medical errors in health systems by promoting comprehensive interaction between patients and other medical professionals, such as pharmacists. Here's to the telemedicine and pharmacy services in Covid-19 pandemic and emergency infectious situations have been illustrated respectively.

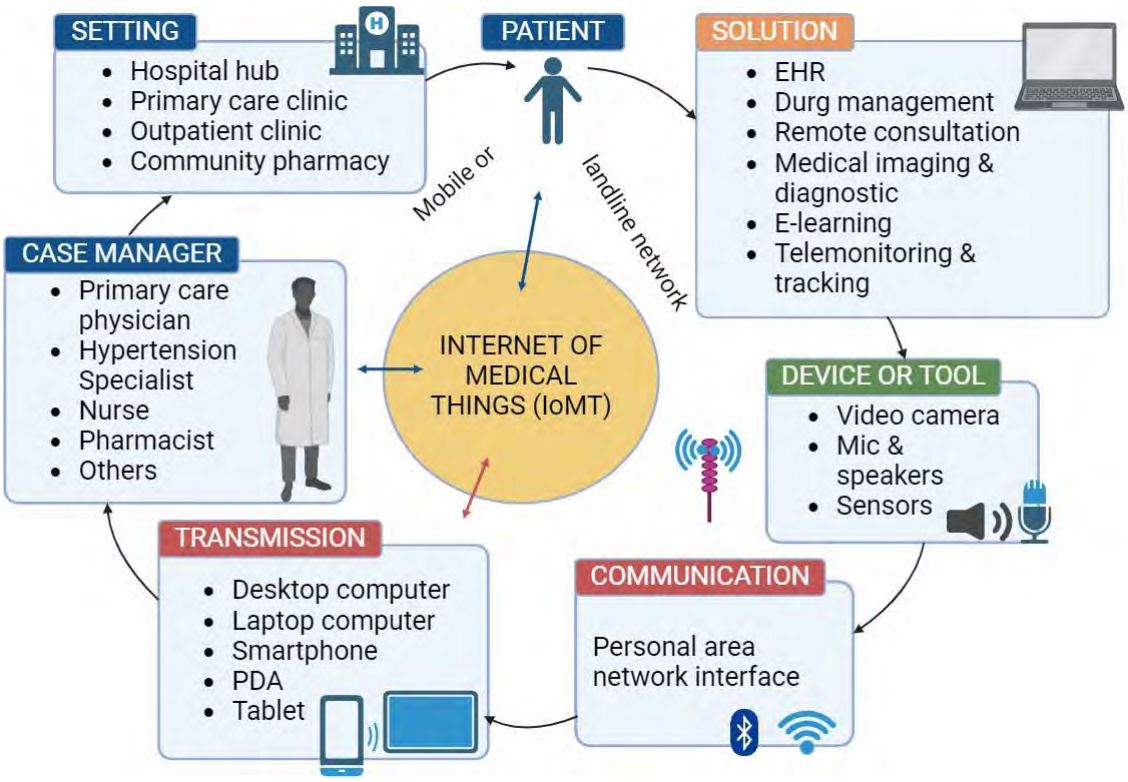

Figure 8: Telemedicine & Pharmacy Services.

8.3 Integration of Technology in EID Surveillance

Through the analysis of multiple data sources, including social media, search trends, electronic health records, and syndromic surveillance systems, technology facilitates the early detection and monitoring of emerging infectious diseases. It is possible to create algorithms that can recognize odd symptom patterns or spikes and assist in spotting possible outbreaks before they become serious emergencies. Geographic Information System (GIS) mapping and remote sensing technologies allow for the visualization and tracking of disease spread patterns. This helps public health authorities pinpoint hotspots, identify vulnerable populations, and allocate resources more effectively for targeted interventions and containment measures. Developments in genomic sequencing technologies allow infectious pathogens to be accurately and quickly characterized. Understanding the dynamics of transmission, spotting new variations, and creating targeted interventions like vaccinations and antiviral medications that are suited to particular pathogen strains all depend on this knowledge.

Moreover, Technology can be integrated with syndromic surveillance systems, which analyze non-specific indicators of illness, like fever or respiratory symptoms, to provide early warning signals of possible disease outbreaks. These systems can track information from a variety of sources, such as pharmacies, emergency medical services, and healthcare facilities, in order to identify unusual patterns and trends that may point to new dangers.

Furthermore, Large volumes of data can be analyzed by artificial intelligence (AI) and machine learning algorithms to find trends and forecast illness. By predicting the spread of disease, evaluating the efficacy of interventions, and assisting with emergency decision-making, these tools can enhance the overall response to infectious disease outbreaks. International collaboration and information sharing would be globally essential for global infectious disease surveillance. Technology facilitates the establishment of global surveillance networks and data-sharing platforms, allowing countries to exchange information, coordinate responses, and mobilize resources collectively to address emerging threats on a global scale.

Chapter 9

Conclusion

As far as healthcare is concerned, the constant threat that infectious diseases present to the world's health emphasizes how critical personal readiness is. This review has shed light on important aspects of the complicated terrain of emerging infectious diseases (EIDs) by examining a number of noteworthy pathogens, such as COVID-19, the Ebola virus, the Dengue virus, and the Nipah virus.

- **Call to action for pharmacy professionals:** The COVID-19 pandemic is a sobering reminder of the necessity of proactive preparedness and quick response due to its rapid global spread and profound societal impact. Similarly, the reappearance of Ebola virus outbreaks, the highly prevalent Dengue virus, and the sporadic Nipah virus infection all demonstrate the variety of EID manifestations and the necessity of specialized containment and mitigation strategies. Pharmacy experts become essential first responders in this ever-changing environment, taking on crucial responsibilities in patient education, medication management, and community outreach. Pharmacists help people manage infectious diseases by using their knowledge of public health and pharmacotherapy to help them take preventive action, follow treatment plans, and manage complicated infectious disease cases. Notwithstanding, specific hurdles continue to exist, such as vaccine reluctance, unequal access, misinformation, and regulatory barriers. It will take cross-sector collaboration, evidence-based tactics, and a dedication to equity and inclusivity to address these issues.
- **Encouraging a Proactive Approach to EID Preparedness:** Within the global health community, a large number of researchers and policymakers are working hard to pinpoint our gaps in emergency preparedness and devise strategies to improve our

ability to address threats from infectious diseases on multiple fronts. For instance, Sands and colleagues have presented a thorough strategy that calls for data collection and analysis to be carried out by numerous organizations at multiple levels in order to improve our understanding of the global economy's susceptibility to emerging infectious disease crises. Furthermore, the creation of novel vaccines is particularly necessary to offer a first line of defense against the spread of disease. Newly emerging infectious diseases typically spark a worldwide panic driven by the media, which then be followed by a surge in funding for research and a drive to develop vaccines. Attracted by the new challenge and funding, a large number of scientists from academia and biotechnology companies rush into the field. Big vaccine companies enter the race despite the high chance that they won't turn a profit or even cover their costs because they are primarily driven by social responsibility and pressure from the public sector. In the meantime, regulatory bodies become more approachable and adaptable with the goal of speeding up the creation and dissemination of vaccines (Bloom et al., 2017).

In order to oversee and promote global pandemic preparedness, the global health community should collaborate to establish, finance, and support an organization. Discourse currently revolves around a number of institutional innovations that aim to close the gap between technological viability and field-ready (or almost field-ready) treatments. Initially, three distinguished vaccine experts suggested raising $2 billion to create the Global Vaccine Development Fund (GVDF), which would fund the development of several vaccines up to the proof-of-concept stage, which is something the private sector avoids doing because they are not profitable. The second is the Coalition for Epidemic Preparedness Innovations (CEPI), which began as an idea for the GVDF and is being led by the Welcome Trust, the Bill & Melinda Gates Foundation, the governments of Norway, Japan, Germany, and India, among others. The development of at least four vaccine candidates for two to three priority pathogens

is the specific objective for which CEPI has set a $1 billion fundraising target for the first five years of its preliminary business plan. To increase these candidates' preparedness for scale-up in the event of an outbreak, the goal is to assist them in advancing through the proof-of-concept phase and up to the point at which complete clinical efficacy testing is feasible. The third concept, which was first put forth by GSK, is setting up a special bio preparedness organization (BPO). Working on two or three vaccines continuously, the BPO would be a nonprofit organization with its own legal status. It would employ committed personnel and utilize resources like adjuvants, platform technologies, and intellectual property. Long-term funding for the BPO would come from public and charitable organizations, along with governance that encourages accountability and observation. The majority of the emerging and reemerging threats could be the target of vaccine and antibody development if cutting-edge global capacity and funding could be accessed and coordinated (Bloom et al., 2017).

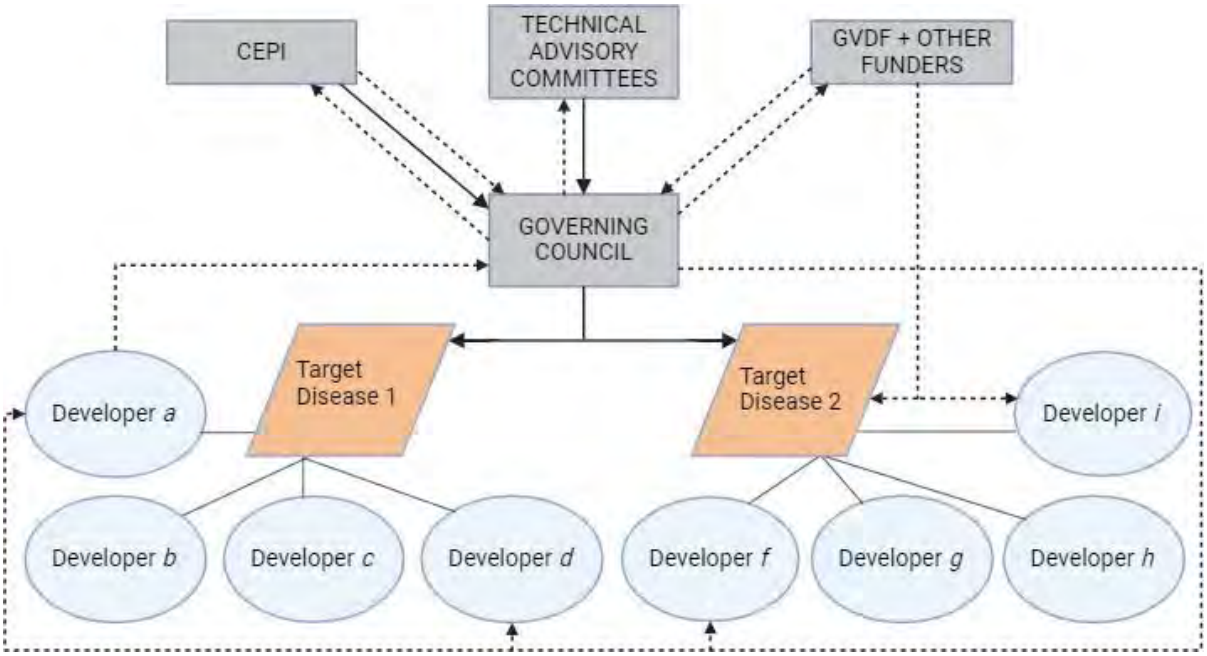

Figure 9: Coalition for Epidemic Preparedness Innovations.

In the future, interdisciplinary cooperation, scientific discoveries, and technological innovation may all work together to improve EID readiness. The field of infectious disease management

has a bright future ahead of it, one that includes everything from the creation of innovative treatments and vaccines to the application of digital health tools and community-based interventions. To sum up, the way we respond to newly discovered infectious diseases depends on being proactive, making educated decisions, and having a common goal of preserving public health. We are at the forefront of this effort as pharmacy professionals, educators, legislators, and advocates, driven by the values of excellence, compassion, and resilience. We can pave the way for a future where everyone is healthier and more resilient by working together.

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