

EMERGING AND RE-EMERGING INFECTIOUS DISEASES: A PERSISTENT GLOBAL HEALTH CHALLENGE

Abstract

Emerging and re-emerging infectious diseases persist as a pressing global health challenges, transcending borders and eras. Despite medical advancements, these diseases continue to threaten public health, economies, and societies. This chapter surveys the landscape of emerging infections, exploring their origins, drivers, and the urgent need for a coordinated worldwide response.

The 21st century has seen the rapid emergence of novel pathogens and resurgences of familiar diseases. Zoonotic transmission highlights the interconnectedness of human, animal, and ecological health. Globalization accelerates disease spread, necessitating international co-operation. Urbanization, climate change, and antimicrobial resistance compound these challenges.

Noteworthy recent infections like SARS, Ebola, Zika, and COVID-19 underscore the importance of a proactive approach to disease surveillance, readiness, and containment. The abstract emphasizes the enduring relevance of the 1997 World Health Organization slogan, "Emerging Infectious Diseases: Global Alert, Global Response."

In conclusion, these diseases demand constant vigilance, interdisciplinary collaboration, and innovation. A fortified defense against infectious diseases is essential for safeguarding global health and well-being.

Keywords: emerging infectious diseases, re-emerging infections, global health, zoonotic transmission.

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I. OVERVIEW

Throughout the 20th century, medical sciences and advancements in healthcare achieved remarkable successes in combating various diseases, significantly improving global health outcomes. However, amidst these triumphs, infectious diseases continue to persist as a formidable threat, remaining the leading cause of death worldwide [1-3]. The emergence and re-emergence of infectious diseases have posed significant challenges to public health systems, necessitating urgent global attention and collective action.

On World Health Day, April 7, 1997, the World Health Organization (WHO) adopted the slogan "Emerging Infectious Diseases: Global Alert, Global Response," signifying the growing concern among health authorities regarding the rise of new and re-emerging infectious diseases [4]. The relentless emergence of such diseases has led to a fundamental shift in how the global community perceives and responds to health crises.

In its 2007 report, the WHO issued a stern warning, alerting the world to the unprecedented rate at which infectious diseases were surfacing [5]. The phenomenon of infectious agents evolving and adapting at an accelerated pace has raised alarms, demanding proactive measures and greater international cooperation to safeguard global health.

Over the last few decades, approximately 40 infectious diseases have surfaced, some of which have resulted in major outbreaks and pandemics. Notable examples include SARS, Ebola, Avian Influenza, Swine Flu, Zika Virus Disease, Nipah Virus Disease, and, most recently, COVID-19. Each of these outbreaks has revealed vulnerabilities in our public health systems, underscoring the need for agile and robust strategies to counter the unpredictable nature of emerging infectious diseases.

This paper delves into the complexities surrounding the emergence and spread of infectious diseases, exploring the contributing factors, consequences of global inaction, and the imperative for a coordinated and multifaceted response. Drawing insights from past outbreaks and the latest scientific research, we aim to shed light on the ever-evolving landscape of infectious diseases and the critical role played by international collaboration in mitigating their impact on human health.

II. DEFINITIONS

Emerging infectious diseases represent a persistent and evolving global health challenges. They are characterized by the appearance of new diseases or the re-emergence of existing ones in novel forms, presenting "new threats" to public health [6]. The term "emerging" refers to diseases caused by newly discovered infectious agents or newly identified pathogens whose incidence in humans has been on the rise over the past two decades, with a potential to escalate further in the near future [7].

These diseases know no national boundaries and have the capacity to rapidly spread across regions and continents, posing significant risks to human populations worldwide. The emergence of infectious diseases can be attributed to various factors, including the changes or evolution of existing organisms, the spread of known infections to new geographic areas or

populations, and the appearance of previously unrecognized infections in areas undergoing ecologic transformation.

III. NEW INFECTIONS RESULTING FROM CHANGES OR EVOLUTION OF EXISTING ORGANISMS

As infectious agents interact with their hosts and the environment, they may undergo genetic mutations or adaptations, leading to the emergence of new strains or subtypes. These changes can enhance the pathogen's ability to infect humans or evade immune responses, giving rise to novel infectious diseases [8].

Known infections spreading to new geographic areas or populations: Globalization, increased international travel, and trade facilitate the rapid movement of people and goods across borders. This movement can lead to the introduction of infectious agents to new regions where susceptible populations may not have prior exposure or immunity, resulting in outbreaks.

Previously unrecognized infections appearing in areas undergoing ecologic transformation: Environmental changes, such as deforestation, urbanization, and climate shifts, can disrupt ecosystems and bring humans into closer contact with previously unknown infectious agents. This contact can lead to spillover events, where pathogens jump from animals to humans, causing new and potentially severe infections.

The impact of emerging infectious diseases is multifaceted and can strain healthcare systems, disrupt economies, and lead to significant human suffering and mortality [9]. Recent examples of emerging infectious diseases include SARS, Ebola, Avian Influenza, Swine Flu, Zika Virus Disease, Nipah Virus Disease, and the ongoing COVID-19 pandemic.

Given the potential for these diseases to rapidly spread and affect global populations, international cooperation and surveillance efforts are vital to detect and respond to outbreaks in a timely manner [10]. Public health authorities, researchers, and policy makers must work collaboratively to develop effective strategies for prevention, early detection, and control of emerging infectious diseases. Understanding the complex interplay of factors that contribute to their emergence is critical for preparing and adapting to the ever-changing landscape of infectious diseases. Only through a coordinated global response can humanity effectively combat these "new problems" and protect public health on a worldwide scale.

IV. EXAMPLES OF EMERGING INFECTIOUS DISEASES

Emerging Bacterial Infections	Emerging Viral Diseases
<ul style="list-style-type: none"> • Toxic Shock Syndrome • Hemolytic uremic syndrome and hemorrhagic colitis • Lyme disease • Epidemic cholera • Cat-scratch disease and 	<ul style="list-style-type: none"> • Hemorrhagic Fever • Hanta Virus Pulmonary Syndrome • Kaposi's Sarcoma • Avian Flu • Severe Acute Respiratory Syndrome (SARS)

bacillary angiomatosis <ul style="list-style-type: none"> • Pseudomembranous colitis • Legionnaire's disease 	<ul style="list-style-type: none"> • Swine Flu • Crimean Congo Hemorrhagic Fever • Zika virus disease • Nipah Virus Infection • Covid 19
Emerging Parasites <ul style="list-style-type: none"> • Cryptosporidium • Drug resistant plasmodium • Cyclospora • Acanthamoeba • Gnathostoma 	Emerging Fungi <ul style="list-style-type: none"> • Non albicans Candida • Penicillium marneffeii • Fusarium • Trichosporon • Curvularia • Alternaria

V. RE-EMERGING INFECTIOUS DISEASES

Also known as Resurging diseases/infections. Re-emerging infectious diseases present a renewed and concerning global health challenge, often referred to as "old diseases, new problems." These diseases were previously under control or had significantly reduced incidence but have resurfaced to pose significant health threats once again. The term "re-emerging" applies to infectious agents that were once well-known but had declined to such low levels that they were no longer considered public health problems and have come back in a different form or a different location [11]. However, these diseases are now showing upward trends in incidence or prevalence worldwide, warranting renewed attention and response.

The re-emergence of infectious diseases can occur due to various factors, but two primary causes are:

- 1. Antimicrobial Resistance in known Agents:** Overuse and misuse of antimicrobial drugs, such as antibiotics, can lead to the development of resistant strains of infectious agents. These drug-resistant pathogens render conventional treatments ineffective, making it challenging to control and treat infections, leading to their resurgence.
- 2. Breakdown in Public Health Measures:** Previously successful public health measures that kept certain infectious diseases in check might weaken over time due to various reasons, such as complacency, resource limitations, or changes in healthcare systems. This breakdown in preventive measures can create favorable conditions for the resurgence of diseases that were once controlled.

An essential characteristic of re-emerging infectious diseases is their tendency to expand their geographic distribution. Diseases that were once confined to specific regions can now spread to new areas, posing risks to populations with little prior exposure or immunity.

An illustrative example of re-emerging infectious diseases is the Chikungunya virus outbreak in 2005. The virus, previously dormant and limited to specific regions,

experienced a resurgence and rapidly spread to various parts of the world, causing significant outbreaks and challenging healthcare systems [12].

The consequences of re-emerging infectious diseases can be severe, as they catch healthcare systems off-guard and strain resources. Consequently, public health authorities must remain vigilant and adapt their strategies to address the changing dynamics of infectious diseases. Strengthening surveillance systems, promoting responsible antimicrobial use, and ensuring robust public health measures are crucial to effectively combat these resurgent diseases [13].

Addressing re-emerging infectious diseases requires a comprehensive and collaborative approach, involving international cooperation, research, and targeted public health interventions. By learning from past experiences and staying proactive in our response, we can better safeguard global health and minimize the impact of these "old diseases" as they resurface as "new problems."

<p>Re-emerging Bacterial Diseases- Tuberculosis Typhoid Fever Leptospirosis Anthrax Plague</p>	<p>Re-emerging Viral Diseases- Ebola Marburg Dengue Yellow Fever Chikungunya West Nile Virus Rift Valley Fever Human Monkey Pox</p>
<p>Re-emerging Parasites Diseases- Amoebiasis Schistosomiasis Cysticercosis/Taeniasis Hydatid Disease</p>	<p>Re-emerging Fungal Diseases- Zygomycosis Aspergillosis Penicilliosis Histoplasmosis</p>

VI. FACTORS CONTRIBUTING TO THE EMERGENCE OF INFECTIOUS DISEASES

The emergence of infectious diseases is a complex process influenced by various interconnected factors. These factors can create favorable conditions for infectious agents to spread and cause disease [14]. Here are the key factors contributing to the emergence of infectious diseases:

- 1. Human Demographics and Behavior:** Changes in population size, density, and movement can affect the transmission of infectious diseases. Urbanization, migration, and population growth can lead to increased contact between individuals, facilitating the spread of pathogens.

- 2. Technology and Industry:** Advances in technology and industrial practices can alter the environment and human interactions with animals, potentially leading to the spillover of pathogens from animals to humans.
- 3. Economic Development and Land Use:** Economic activities, including agriculture, mining, and deforestation, can alter ecosystems and disrupt wildlife habitats, increasing the likelihood of contact between humans and zoonotic pathogens.
- 4. International Travel and Commerce:** Global travel and trade can rapidly disseminate infectious agents across borders, allowing diseases to reach new geographic areas and vulnerable populations.
- 5. Microbial Adaptation and Change:** Infectious agents have the ability to evolve and adapt, leading to the emergence of new strains or variants with enhanced transmission or virulence.
- 6. Breakdown of Public Health Measures:** Weak public health infrastructure, inadequate surveillance, or a lack of resources for disease control can hinder early detection and response to outbreaks.
- 7. Human susceptibility to infection:** Changes in human immune status, such as immune-suppression due to diseases or treatments, can increase susceptibility to infectious diseases.
- 8. Climate and Weather:** Climate change and extreme weather events can influence the distribution and abundance of disease vectors (e.g., mosquitoes and ticks), affecting the transmission of vector-borne diseases.
- 9. Changing Ecosystems:** Environmental changes, such as deforestation, urbanization, and land use changes, can bring humans into closer contact with wildlife, increasing the risk of zoonotic spillover events.
- 10. Poverty and Social Inequality:** Disadvantaged populations may face challenges accessing healthcare, sanitation, and education, making them more vulnerable to infectious diseases.
- 11. War and Famine:** Armed conflicts and humanitarian crises can disrupt healthcare systems, lead to displacement of populations, and exacerbate food insecurity, creating conditions conducive to disease outbreaks.
- 12. Lack of Political Will:** Inadequate investment in healthcare infrastructure and disease surveillance can hinder effective response and control measures.
- 13. Intent to Harm:** Deliberate release of infectious agents or bioterrorism can lead to the emergence of infectious diseases as a result of malicious intent.

VII. ECOLOGICAL FACTORS

Ecological factors play a significant role in the emergence and spread of infectious diseases, involving the complex interplay between infectious agents, hosts, and the environment. These factors can create conditions that facilitate the transmission and evolution of pathogens, leading to the emergence of new diseases or the re-emergence of existing ones. Here are the ecological factors that contribute to the spread of infectious diseases:

1. Agent Related Ecological Factors

- Evolution of pathogenic infectious agents (microbial adaptation and change): Pathogens can undergo genetic changes, such as antigenic shift and drift in influenza viruses, leading to the emergence of new strains with altered virulence or transmission characteristics.
- Development of resistance to drugs: The inappropriate use of antimicrobial drugs in humans and animals can promote the development of drug-resistant pathogens, making treatments less effective.
- Resistance of vectors to pesticides: Vector-borne diseases, such as malaria and dengue fever, can become more challenging to control when disease-carrying vectors develop resistance to the pesticides used for their control.

2. Host-Related Ecological Factors

- Human demographic change: Human migration and inhabiting new areas can introduce individuals to new pathogens and ecosystems, leading to potential disease transmission.
- Human behavior: Risky behaviors, such as unsafe sexual practices, can contribute to the spread of sexually transmitted infections like HIV, gonorrhea, and syphilis. Changes in agricultural and food production patterns can also lead to food-borne infectious agents like E. coli.
- Increased international travel: Global travel can facilitate the rapid spread of infectious diseases across different regions and continents, as seen with influenza outbreaks.
- Human susceptibility to infection: Immuno-suppression due to factors like medical conditions or treatments can increase individuals' vulnerability to various infectious agents.
- Poverty and social inequality: Disadvantaged populations may lack access to adequate healthcare and sanitation, making them more susceptible to infectious diseases.

3. Environment Related Ecological Factors

- Climate change and changing ecosystems: Deforestation and changes in ecosystems can force animals into closer contact with humans, increasing the potential for zoonotic spillover events.
- Natural disasters and outbreaks: Climate-related events like El-Niño can trigger natural disasters and related outbreaks of infectious diseases, such as malaria and cholera.

- Economic development and land use: Urbanization and deforestation can disrupt ecosystems and bring humans into contact with new pathogens.
- Technology and industry: Food processing and handling practices can contribute to the transmission of food-borne pathogens.
- International travel and commerce: Globalization can lead to the introduction and spread of infectious agents to new geographic areas.
- Deterioration in surveillance systems: Inadequate surveillance and lack of political will can hinder early detection and response to outbreaks, allowing diseases to spread unchecked.

VIII. ANTIBIOTIC RESISTANCE

Antibiotic resistance has become a critical issue in modern healthcare and is a major contributing factor to the re-emergence of infectious diseases [15]. It occurs when bacteria evolve and develop mechanisms to withstand the effects of antibiotics, rendering these drugs ineffective in treating infections. The misuse and overuse of antibiotics, both in human medicine and agriculture, have accelerated the development of antibiotic-resistant pathogens [16]. Here are the main causes and consequences of antibiotic resistance:

- 1. Wrong Prescribing Practices:** Over-prescribing or inappropriately prescribing antibiotics for viral infections or using broad-spectrum antibiotics unnecessarily can promote the development of resistance.
- 2. Non-Adherence by Patients:** Failure to complete the full course of antibiotics as prescribed can lead to the survival of resistant bacteria, potentially causing treatment failure.
- 3. Counterfeit Drugs:** The use of substandard or counterfeit antibiotics may contain inadequate doses or ineffective ingredients, leading to treatment failure and the development of resistance.
- 4. Consequences of Antibiotic Resistance:**
 - Prolonged hospital admissions: Infections caused by antibiotic-resistant bacteria may require longer hospital stays for patients, leading to increased healthcare costs.
 - Higher death rates from infections: Antibiotic-resistant infections can be more challenging to treat effectively, leading to higher mortality rates.
 - Requires more expensive, more toxic drugs: As first-line antibiotics become ineffective, healthcare providers may need to resort to more expensive and potentially more toxic drugs to combat infections.
 - Higher healthcare costs: Antibiotic-resistant infections increase healthcare costs due to the need for extended hospital stays, specialized treatments, and the use of costly antibiotics.

5. Examples of Multi-Resistant Pathogens:

- Methicillin/oxacillin-resistant *Staphylococcus aureus* (MRSA): A common cause of hospital-acquired infections that has developed resistance to multiple antibiotics.
- Vancomycin-resistant enterococci (VRE): Enterococci bacteria that are resistant to the antibiotic vancomycin.
- Extended-spectrum beta-lactamases (ESBLs): Enzymes produced by certain bacteria that render them resistant to cephalosporins and monobactams, two classes of antibiotics.
- Multi-drug resistant tuberculosis (MDR-TB): *Mycobacterium tuberculosis* strains resistant to two or more of the most effective anti-TB drugs.
- Antibiotic resistance is not the sole factor contributing to the re-emergence of infectious diseases. Other factors also play a significant role:
 - Breakdown of public health measures: Wars, unrest, and overcrowding can disrupt public health systems, leading to the re-emergence of infections.
 - Poor populations as major reservoirs: Poor and marginalized communities may serve as reservoirs for infectious agents, leading to continued transmission.
 - Poverty and malnutrition: These factors create a cycle of severe infectious diseases in vulnerable populations.
 - Lack of funding and inadequate health delivery systems: Limited resources and inadequate prioritization of health funds can hinder disease surveillance and control efforts.
 - Uncontrolled urbanization and population displacement: Rapid urbanization and migration can create conditions conducive to disease transmission.
 - International travel and commerce: Global travel and trade can contribute to the spread of infectious agents across borders.

IX. TRANSMISSION OF INFECTIOUS AGENT FROM ANIMALS TO HUMANS

The transmission of infectious agents from animals to humans, known as zoonotic diseases or zoonoses, is a significant public health concern. Zoonotic diseases account for more than two-thirds of emerging infectious diseases, highlighting the critical role of animals, both wild and domestic, in the emergence of new infections in humans. Here are some important aspects of zoonotic disease transmission:

1. **Zoonotic Origins of Emerging Infections:** Many of the emerging infections that have appeared in humans are believed to have originated in animals. Wild animals, such as bats and other wildlife, as well as domestic animals like poultry, pigs, and cattle, can serve as reservoirs for infectious agents that can cross the species barrier and infect humans.
2. **Emerging Influenza Infections:** Influenza viruses are well-known for their zoonotic potential. Avian influenza strains, for example, are associated with birds such as geese, chickens, and ducks. Additionally, swine flu is linked to pigs. When these animal viruses undergo genetic changes or reassortment, they can infect humans and potentially cause pandemics.

- 3. Deforestation and Zoonotic Spillover:** Environmental changes, such as deforestation and habitat loss, can lead to the displacement of wild animals, forcing them into closer contact with humans in search of food or shelter. This increased interaction between humans and wildlife creates a higher risk of zoonotic spillover events, where pathogens jump from animals to humans. One example is Lassa fever, a viral hemorrhagic fever transmitted to humans from rodents.
- 4. Reservoir Hosts:** Some animals can carry infectious agents without getting sick, acting as reservoir hosts for these pathogens. When humans come into contact with these infected animals or their bodily fluids, they can contract the disease. For instance, certain rodents are reservoir hosts for hantaviruses, and ticks can carry Lyme disease-causing bacteria.
- 5. Wildlife Trade and Interaction:** The global wildlife trade, both legal and illegal, can facilitate the spread of zoonotic diseases. Human interactions with wildlife in markets, zoos, and ecotourism settings also pose risks for disease transmission.
- 6. Agricultural Practices:** Intensive agricultural practices, particularly in animal husbandry and food production, can increase the likelihood of zoonotic diseases spreading from animals to humans. Close contact with livestock, poultry, and other farm animals can lead to disease transmission.

X. CONTROL OF EMERGING AND RE-EMERGING DISEASES

Controlling both emerging and re-emerging infectious diseases requires a comprehensive and multi-dimensional approach that addresses the various stages of disease transmission and the underlying factors contributing to their emergence. Here are key strategies for controlling these diseases:

- 1. Controlling the Reservoir:** Identifying and controlling the sources or reservoirs of infectious agents is vital to prevent their spread to humans. This involves monitoring and managing both animal and human reservoirs of the disease to reduce the risk of transmission.
- 2. Interrupting the Transmission:** Breaking the chain of transmission is critical to containing infectious diseases. Implementing infection control measures, such as proper hygiene practices, isolation of infected individuals, and vector control (e.g., mosquito control for vector-borne diseases), can help interrupt disease transmission.
- 3. Protecting the Susceptible Host:** Strengthening the immunity of susceptible individuals through vaccination and providing prompt and appropriate treatment can reduce the severity of the disease and prevent its spread to others.
- 4. Strengthening the Disease Surveillance System:** Early detection and surveillance are crucial for rapid response and containment of outbreaks. Developing and maintaining robust disease surveillance systems, including real-time data reporting and analysis, can enable timely interventions.

- 5. Encouraging Research Initiatives for Treatment Regimens and Diagnostics:** Investing in research to develop new and effective treatment regimens and diagnostic tools is essential for managing emerging and re-emerging diseases. Research can also help understand the mechanisms of resistance and identify potential targets for new therapies.
- 6. Encouraging Research for New Methods of Control Measures:** Innovating and implementing novel control measures can be crucial for addressing the challenges posed by emerging and re-emerging diseases. This may involve new approaches to vector control, therapeutics, and prevention strategies.
- 7. Establishment of Drug Resistance:** Monitoring and understanding the development of drug resistance in pathogens are essential for guiding treatment practices and preventing the further spread of resistant strains. Strategies to combat drug resistance should include rational antimicrobial use, antimicrobial stewardship programs, and research into new drug classes.
- 8. International Collaboration and Coordination:** Infectious diseases know no boundaries, and effective control requires collaboration among countries and international organizations. Sharing information, resources, and expertise can aid in early detection, rapid response, and effective containment.
- 9. One Health Approach:** Recognizing the interconnectedness of human, animal, and environmental health, the One Health approach encourages collaboration among human health, veterinary, and environmental experts to address zoonotic diseases and other health threats holistically.
- 10. Public Education and Awareness:** Raising public awareness about infectious diseases, their transmission, and preventive measures can empower individuals and communities to take appropriate actions, reducing the risk of disease spread.

By implementing these control measures and collaborating at local, national, and global levels, we can better prepare for and respond to emerging and re-emerging infectious diseases, ultimately protecting global health.

XI. GLOBAL OUTBREAK ALERT AND RESPONSE NETWORK (GOARN)[17-18]

The Global Outbreak Alert and Response Network (GOARN) is a collaborative network of diverse institutions, including technical and public health organizations, laboratories, non-governmental organizations (NGOs), and other relevant entities. The primary objective of GOARN is to monitor, detect, and respond swiftly to threatening epidemics and public health emergencies of international significance.

1. Key Features of GOARN Include:

- **Rapid Response to Outbreaks:** GOARN facilitates the rapid deployment of human and technical resources to areas experiencing outbreaks or potential epidemics. By coordinating international outbreak responses, GOARN ensures that the right expertise and tools are deployed where and when they are needed the most.
- **Pooling of Resources:** The network leverages the combined capabilities of its member organizations to provide a comprehensive and effective response to health emergencies. It pools resources, expertise, and knowledge to support countries facing outbreaks.
- **Identification and Confirmation of Outbreaks:** GOARN assists in the timely identification and confirmation of outbreaks through the collective efforts of its member institutions. Early detection is crucial for containing and controlling the spread of infectious diseases.
- **Coordination by WHO:** The World Health Organization (WHO) serves as the coordinating body for GOARN. It plays a central role in mobilizing resources from the network and ensuring the timely and effective deployment of technical assistance during disease outbreaks.
- **Capacity Building and Epidemic Preparedness:** GOARN contributes to long-term epidemic preparedness and capacity building in countries and regions at risk of infectious disease outbreaks. This includes providing training, technical support, and strengthening public health systems.
- **International Collaboration:** GOARN fosters international collaboration and cooperation among various stakeholders, promoting the exchange of information, expertise, and best practices in outbreak response and control.
- **Response to Diverse Health Threats:** While GOARN is particularly focused on infectious disease outbreaks, it is also equipped to respond to other health emergencies and public health threats of global concern.

XII. PREVENTIVE STRATEGY IN INDIA

India, being a diverse and populous country, faces significant challenges in preventing and controlling infectious diseases. The preventive strategy in India involves various surveillance measures aimed at early detection, response, and containment of disease outbreaks. Here are some key preventive strategies implemented in India:

1. **Vector Surveillance:** Vector-borne diseases pose a considerable threat to public health in India. The country conducts extensive vector surveillance to monitor the presence, density, and distribution of disease-carrying vectors such as mosquitoes and ticks. This helps in predicting and responding to vector-borne outbreaks, including diseases like Japanese Encephalitis (JE), Dengue, Plague, Kala Azar (Visceral Leishmaniasis), and Rickettsial diseases.
2. **Early Warning Signals:** By monitoring changes in vector density and breeding sites, health authorities can identify early warning signals indicating an increased risk of disease transmission. Timely detection allows for the implementation of targeted preventive measures to control vector populations and prevent outbreaks.

3. Insecticide Susceptibility Status: Regular assessments of insecticide susceptibility in vector populations help determine the effectiveness of insecticides used for vector control. This data informs the selection of appropriate insecticides and ensures their continued efficacy in controlling disease vectors.

4. Laboratory Surveillance:

- **Serological Surveillance:** Serological surveillance involves collecting and testing blood samples from different populations to identify the prevalence of specific diseases. This data helps identify high-risk areas and age groups, providing an early warning signal for potential outbreaks.
- **Microbial Surveillance:** Microbial surveillance involves monitoring changes in the genetic makeup of infectious agents, such as viruses and bacteria. It helps in detecting changes in the genotype, mutations, and development of antimicrobial resistance in pathogens, such as Salmonella, Cholera, Plague, and Anthrax.
- **Laboratory Network:** India has established a network of laboratories at various levels to strengthen disease surveillance. This includes international collaborating centers like CDC Atlanta, National Reference Laboratories like NICD Delhi, NIV Pune, NICE Kolkata, State Laboratories, Intermediate level Laboratories at district/provincial/medical college levels, and peripheral laboratories at Primary Health Centers (PHCs) and Community Health Centers (CHCs).
- **Immunization Programs:** India has robust immunization programs aimed at preventing vaccine-preventable diseases. These programs target infants, children, and high-risk groups to ensure widespread vaccination coverage.
- **Health Education and Public Awareness:** Health education and public awareness campaigns are crucial in informing the public about disease prevention measures, recognizing early symptoms, and seeking prompt medical attention.
- **One Health Approach:** India recognizes the importance of a One Health approach, emphasizing collaboration among human health, animal health, and environmental health sectors to address zoonotic diseases and other health threats.

5. Recommended Laboratory Testing in Emerging Infections: Molecular testing, such as Polymerase Chain Reaction (PCR), is a powerful tool in the diagnosis and surveillance of infectious diseases. It offers high sensitivity and specificity, allowing for the detection of very small amounts of genetic material from pathogens [19]. Here are some applications of molecular testing in infectious disease management:

- **PCR for Pathogen Detection:** PCR is commonly used to detect the presence of specific pathogens in clinical samples, such as blood, sputum, or swabs. It can rapidly and accurately identify viruses, bacteria, parasites, and fungi responsible for various infectious diseases.
- **Rapid Testing for Influenza:** Rapid diagnostic tests, including antigen-based tests, can provide quick results for the diagnosis of influenza. However, these tests may have lower sensitivity compared to PCR. Therefore, when a rapid test is positive for influenza, confirmation with PCR is recommended.

- **Dengue NS1 Antigen Test:** The NS1 antigen test is a rapid test used for the early diagnosis of dengue fever. It detects the presence of the dengue virus NS1 antigen in the blood of infected individuals, particularly during the first five days of illness.
- **Antimicrobial Resistance Testing:** Molecular testing, such as PCR, is utilized to determine the antimicrobial resistance profile of bacterial pathogens. This enables healthcare providers to select appropriate antibiotics for effective treatment.
- **Gene Detection by PCR:** PCR can be used to detect specific genes associated with antimicrobial resistance, virulence factors, or other traits that influence the pathogenicity of infectious agents. This information aids in understanding the characteristics of the circulating pathogens.
- **Molecular Surveillance:** Molecular testing is crucial for conducting surveillance of infectious diseases and monitoring the emergence of new strains or variants. This information helps in tracking disease trends and guiding public health interventions.
- **Point-of-Care Testing:** Advancements in molecular testing technology have enabled the development of point-of-care molecular tests. These tests provide rapid and accurate results at the patient's bedside, facilitating timely diagnosis and treatment.
- **Tracking Outbreaks:** PCR and other molecular methods are invaluable in tracking and characterizing outbreaks of infectious diseases. They help in identifying the source of the outbreak, determining transmission routes, and implementing appropriate control measures.
- **Viral Load Monitoring:** In the context of managing viral infections such as HIV and Hepatitis B and C, PCR-based viral load testing is used to monitor the effectiveness of antiviral therapy and to guide treatment decisions.

Molecular testing has revolutionized the field of infectious disease diagnosis and management, providing healthcare professionals with essential tools for accurate and timely detection, surveillance, and control of infectious diseases. It plays a crucial role in guiding appropriate treatment decisions and implementing effective public health measures.

Peripheral laboratories, district laboratories, state laboratories, and national laboratories play different roles in the surveillance and management of infectious diseases in India. Here are the functions of each level of laboratory:

6. Peripheral Laboratories:

- **Collection of Specimens:** Peripheral laboratories are responsible for collecting various clinical specimens, such as blood, urine, and swabs, from patients.
- **Preliminary Processing, Storage, and Transport:** They handle the initial processing, storage, and transport of collected specimens to ensure their integrity and suitability for testing.
- **Reporting of Results:** Peripheral laboratories report the results of simple tests to healthcare providers to aid in patient management.
- **Undertaking Simple Tests:** They perform basic tests such as microscopy for diseases like malaria, tuberculosis (TB), meningitis, and dysentery/cholera.
- **Rapid Tests:** They conduct rapid tests like Typhi Dot for enteric fever and latex tests for detecting HBsAg (Hepatitis B surface antigen).

- **Water Quality Monitoring:** Peripheral laboratories may conduct rapid H₂S tests for monitoring water quality.

7. District Laboratories:

- **Microscopy:** District laboratories perform microscopy for diseases like diphtheria, kala-azar, and cholera.
- **Bacterial Cultures:** They culture and identify common bacteria, including enteropathogens and those causing enteric fever.
- **Antimicrobial Susceptibility Testing:** District labs carry out antimicrobial susceptibility testing for common bacteria, including mycobacteria.
- **Serological Tests:** They conduct serological tests like the Widal test, latex test for meningitis in cerebrospinal fluid (CSF), and ELISA-based tests.
- **Bacteriological Examination of Water:** District laboratories assess water quality through rapid H₂S tests and coliform counts.
- **Coordination:** They coordinate with state/national laboratories and disease surveillance units for data reporting and management.

8. State Laboratories:

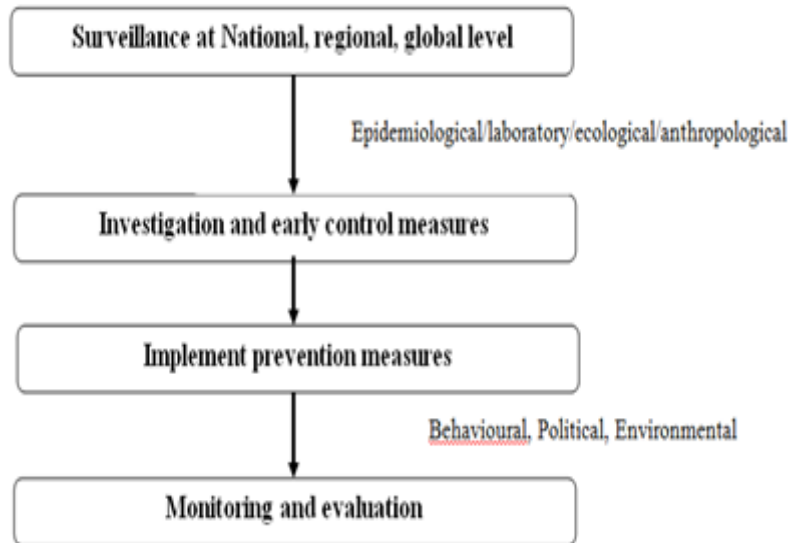
- **Specialized Microscopy:** State laboratories conduct specialized microscopy techniques like dark ground and fluorescent microscopy.
- **Bacterial Cultures and Identification:** They culture and identify all common bacteria, including mycobacteria, and may perform serotyping when applicable.
- **Antimicrobial Susceptibility Testing:** State labs conduct antimicrobial susceptibility testing for common bacteria, including mycobacteria.
- **Serological Tests:** They perform serological tests for viral hepatitis markers, dengue, Japanese encephalitis, measles, leptospirosis, etc.
- **Viral Cultures (Possibly):** State labs may also conduct viral cultures.
- **Quality Assurance:** State labs ensure quality control through Internal Quality Control (IQC) and External Quality Assessment Schemes (EQAS).

9. National Laboratories:

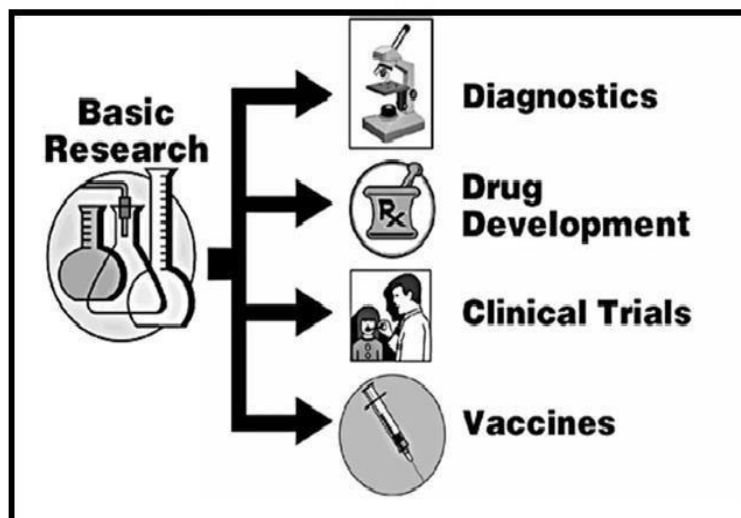
- **Specialized Tests:** National laboratories handle specialized tests for diseases like Plague, Anthrax, and other potential agents of bioterrorism.
- **High Containment Laboratory:** They operate high containment laboratories (P3/BSL-3) for handling highly infectious or dangerous pathogens.
- **Outbreak Investigation:** National labs assist in outbreak investigations, providing expertise and resources.
- **Confirm New Isolates:** They confirm new and unusual isolates that require further characterization.
- **Lab-Based Epidemiological Markers:** National labs contribute to the generation of lab-based epidemiological markers for tracking disease patterns.
- **Training and Preparation:** They prepare teaching material, reagents, and antisera, and provide training for laboratory personnel.

- **External Quality Assessment Schemes:** National labs organize external quality assessment schemes for other laboratories to ensure accurate testing.
- **Collation of National Data:** They collate and analyze national data for disease surveillance and reporting purposes.

Key Tasks in Dealing with Emerging/Re-emerging Diseases



Emerging Infectious Diseases: A Research Approach



Emerging Infections in the World Since 2000 [20]

Year	Organism
2002	SARS coronavirus (Severe acute respiratory syndrome coronavirus)
2003	Influenza-A (H5N1)
2004	Plasmodium knowlesi
2009	Influenza-A (H1N1), Candida auris
2012	Novel coronavirus or MERS-CoV (Middle East respiratory coronavirus) syndrome coronavirus)
2013	Severe fever with thrombocytopenia syndrome (SFTS)
2019-20	COVID-19 pandemic (Coronavirus disease 2019) due to SARS coronavirus-2

Emerging Infections in the India Since 2000[20]

Year	Organism	Place
2000	Diphtheria	Delhi
2001	Nipah virus	Siliguri
2002	Plague	Shimla
2004	Plague	Uttarakhand
2003	Chandipura	Andhra Pradesh
2004	Chandipura	Gujarat
2005	Chikungunya	Hyderabad
2007	Chandipura	Maharashtra
2009	Influenza A (H1N1), Candida auris	Almost all states
2011	Crimean-Congo hemorrhagic fever	Gujarat
2018	Nipah virus	Calicut (Kerala)
2019-20	COVID-19 Pandemic	All over India

XIII. WHO'S TOP 8 EMERGING DISEASES[21]

Crimean Congo hemorrhagic fever
Ebola virus disease
Marburg virus disease
Lassa fever
MERS coronavirus disease
SARS coronavirus disease
Nipah virus disease
Rift Valley fever

Three other diseases - designated as 'serious', requiring action by WHO to promote R&D as soon as possible; these were:

Chikungunya

Severe fever with thrombocytopenia syndrome (SFTS)

Zika virus disease.

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