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Review

Hazards of Viruses and their Management

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Abstract:
This comprehensive review paper delves deeply into the intricate realm of viruses, investigating their classification, diversity, origins, and pathways of transmission. It sheds light on the significant threats that viruses pose to humanity, including human infectious diseases, outbreaks, pandemics, antibiotic resistance, and their link to cancer. Furthermore, it scrutinizes the challenges presented by the emergence and resurgence of viruses in the contemporary world. In response to these viral threats, the paper explores the range of strategies for managing them. Firstly, it delves into the essential role of vaccination and immunization programs in safeguarding populations against viral infections. Secondly, it critically examines the potential of antiviral therapies for treating viral diseases. Thirdly, it elucidates the importance of vector control methods as pivotal tools in controlling diseases transmitted by vectors. The "One Health" approach is investigated, emphasizing the interconnectedness of human, animal, and environmental health in the context of viral hazard management. Finally, the paper underscores the significance of quarantine and isolation measures in preventing the spread of infectious viruses. This comprehensive review paper furnishes an in-depth overview of the dangers posed by viruses and underscores the critical necessity of implementing effective management strategies to safeguard public health and global well-being.

Keywords: *Virus, Zoonotic viruses, COVID 19, Epidemics and Pandemics, Vaccination.*

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1. Introduction

Eukaryotes, which include fungi and protozoa, and prokaryotes, which include bacteria, chlamydia, mycoplasmas, and rickettsia, can be used to classify unicellular microorganisms in descending order of complexity. Due to their lack of cellular organization, viruses do not properly belong in the category of unicellular microorganisms. The cells that make up even the most basic microbes have a cell wall, RNA as well as DNA, the capacity to synthesize their own macromolecules, and the capacity to divide through binary fission.(1) Viruses exist in a grey area between living and non-living. They never have both DNA and RNA; instead, they only have one form of nucleic acid.(2)

Viruses are intracellular obligate parasites. They are dependent on the host cell's synthesis process for reproduction since they lack the enzymes required for the generation of proteins and nucleic acids. Rather of employing binary fission, they multiply through a complex process. Antibacterial antibiotics have no impact on them.(1) Viruses cannot be spotted under light microscopy, in contrast to bacteria, fungi, and parasites. Moreover, since viruses are exclusively intracellular pathogens, they cannot develop in synthetic culture media.(3)

The word "virus" originates from the Latin word meaning poison, and it was used to describe any kind of infectious agents across the eighteenth and nineteenth centuries. In time, these submicron-sized infectious entities came to be known specifically as viruses. During 1918-influenza outbreak, viruses were only understood to be a strange class of minute creatures that could be filtered, were contagious, and required living cells to replicate. Their structure and function were unknown.(4) Capsid (protein coat) encircles the genetic material (RNA or DNA) in the basic structure of viruses. Some have a lipid sheath on the outside. Host cells are required for reproduction due to a lack of cellular machinery. By adhering to host cells, delivering genetic material, and using host machinery for replication and assembly, this simple structure facilitates infection.(1)

In addition to having a high rate of morbidity and mortality in humans, parasites as viruses also cause epidemics and pandemics.(5)Viral infections account for a substantial number of infectious diseases, which cause about 20% of population mortality. The World Health Organization (WHO) estimates that annually, 37 million individuals globally acquire human immunodeficiency virus, 70 million suffer hepatitis C virus (HCV viral hepatitis), and 3 to 5 million contract influenza, 257 million catch hepatitis B virus (HBV).(6) This review concentrates on the many threats that viruses represent, including those to human health and the world population (epidemics and pandemics) and covers information on vaccination, antiviral research, and public health initiatives, as well as preventive measures, medical advancements, and global responses.

2. Classification of Viruses

Viruses can be classified on the basis of structure (Icosahedral, Helical, Enveloped, Complex), genome (on the basis of Baltimore classification system), and host specificity (Animal, Plant, Bacteria, Fungi). In order to control viral hazards effectively, it is essential to understand viral diversity. Different viruses have different modes of infection, levels of virulence, and resistance to drugs. Broad-spectrum therapies, epidemic prevention, and flexible strategy design are all aided by comprehensive knowledge. This knowledge improves our capacity to manage, stop, and lessen the effects of new viral dangers.(7, 8) Depending on what kind of genetic material they contain, there are two main divisions: Deoxyriboviruses are those that contain DNA, while riboviruses have RNA.(1)

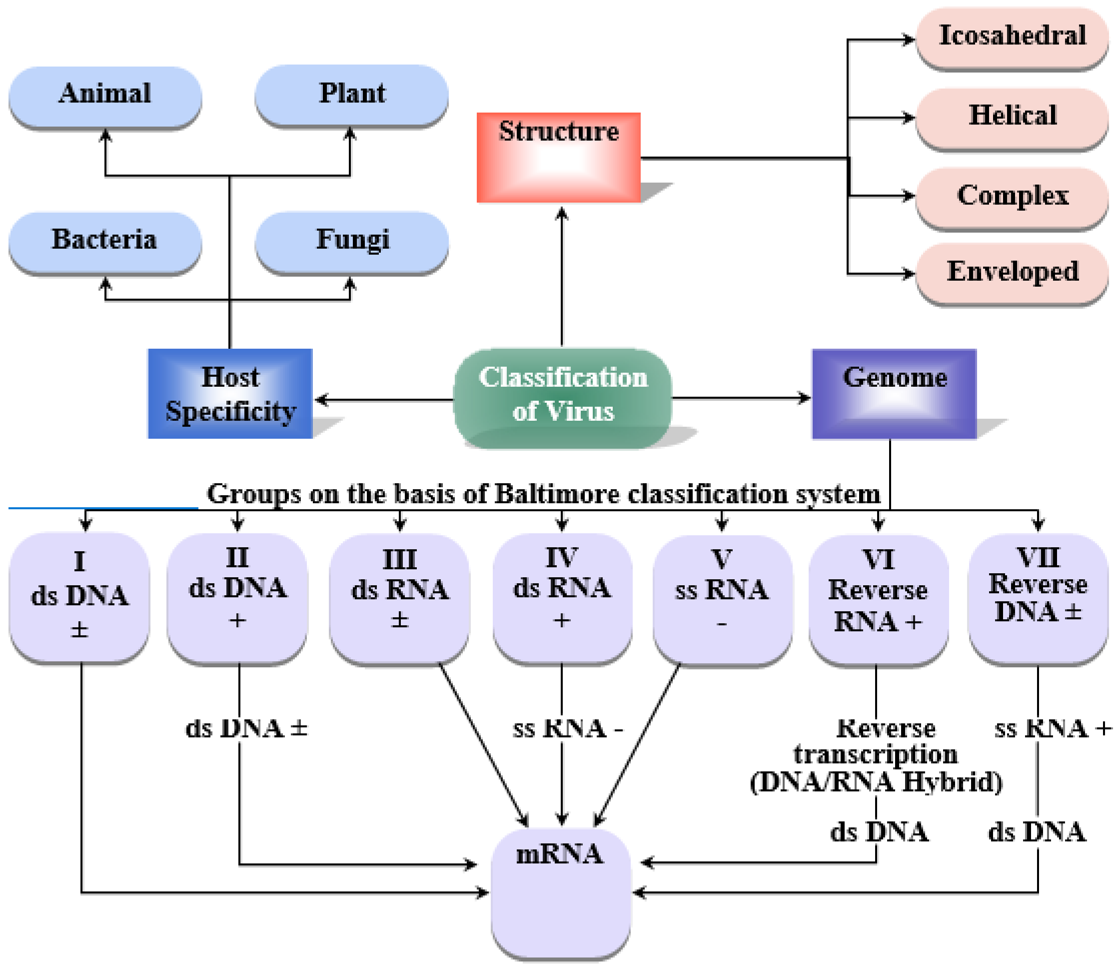

Fig. 1 This flowchart shows classification of viruses on the basis of genome type, their host, and their structure.

3. Origin and Transmission Pathways

The most prevalent biological organisms on earth, viruses are pervasive parasites of cellular life. Although it is generally acknowledged that viruses are polyphyletic, there is still no agreed-upon theory explaining their ultimate genesis.(9) Despite a number of theories have lately been put up to explain the genesis of viruses, the development of virions as a particular mechanism for gene transmission is still unknown.(10)

3.1 Zoonotic Viruses

Zoonotic diseases are pathogenic illnesses that can spread from animals to people. Bacteria, viruses, parasites, and fungi are all potential disease-causing agents. Examples that come to mind right away are rabies, influenza, Ebola, and COVID-19. Zoonotic diseases show how closely linked human and animal health are, and how crucial it is to comprehend and control these diseases to stop outbreaks and safeguard both animal and human populations.(11, 12)

Table 1 List of transmission pathways of zoonotic virus.

Transmission pathway	Description
Direct Contact	Interaction with disease-carrying animals or their bodily fluids, like faeces, blood, saliva, or urine. e.g., Hantavirus
Indirect Contact	Getting in touch with infected surfaces, items, or environments. e.g., Norovirus
Vector-Borne Transmission	Certain zoonotic viruses are spread to people by vectors such fleas, ticks, and mosquitoes. e.g., West Nile virus
Consumption of Infected Animals or Animal Products	Transmission of zoonotic viruses can occur when infected animal’s meat, organs, or other items are consumed raw or undercooked. e.g., Toxoplasmosis
Respiratory Droplets	When infected animals expel respiratory droplets containing the virus, airborne transmission can happen. e.g., Influenza (Flu)
Waterborne Transmission	Zoonotic viruses may be retained in contaminated water sources like lakes or ponds. e.g., Leptospirosis
Fomite Transmission	The virus can be carried and transmitted by inanimate items, also known as fomites. e.g., Methicillin-resistant Staphylococcus aureus (MRSA)
Bites and Scratches	If the virus exists in an animal's saliva or bodily fluids, bites or scratches from infected animals may result in transmission. e.g., Rabies
Vertical Transmission	During pregnancy, childbirth, or breastfeeding, some zoonotic viruses can be passed from mother to foetus. e.g., Zika

According to one tally, 213 viral varieties from 25 viral families had been implicated as the root causes of human illness by the end of 2010. 68 percent of these viruses (more than two thirds) are recognized or suspected zoonoses.(13) The initial descriptions of more than a quarter (28%) were from non-human mammals, birds, or blood-feeding arthropods.(12) As human activities increasingly encroach on animal habitats, it's undeniable that zoonotic viruses will continue to emerge. In order to forecast and prevent the formation of viruses, we need a better understanding of how these viruses function within their animal hosts and how human-driven environmental changes influence their potential to jump to humans.(14)

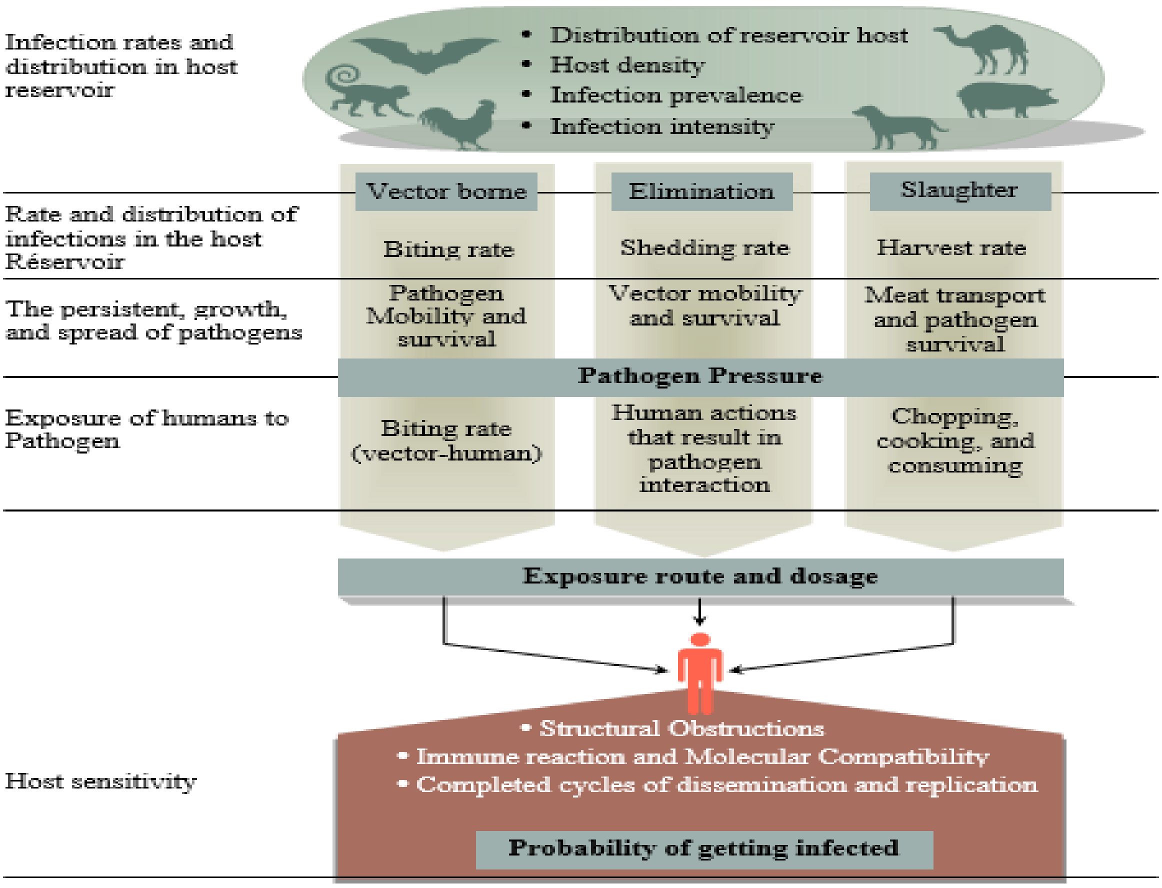

Fig. 2 Showing pathways of transfer of zoonotic viruses.

3.2 Vector-borne Viruses

Diseases transmitted by arthropods such as mosquitoes, triatomine bugs, black flies, tsetse flies, sand flies, lice, and ticks are termed vector-borne diseases (VBDs). These illnesses account for approximately 17% of the total burden of transmissible diseases worldwide, significantly contributing to the global disease burden.(15) Although arthropod-borne viruses have an extensive record of infecting people, they have recently begun to spread more broadly and are now impacting greater populations. (16)

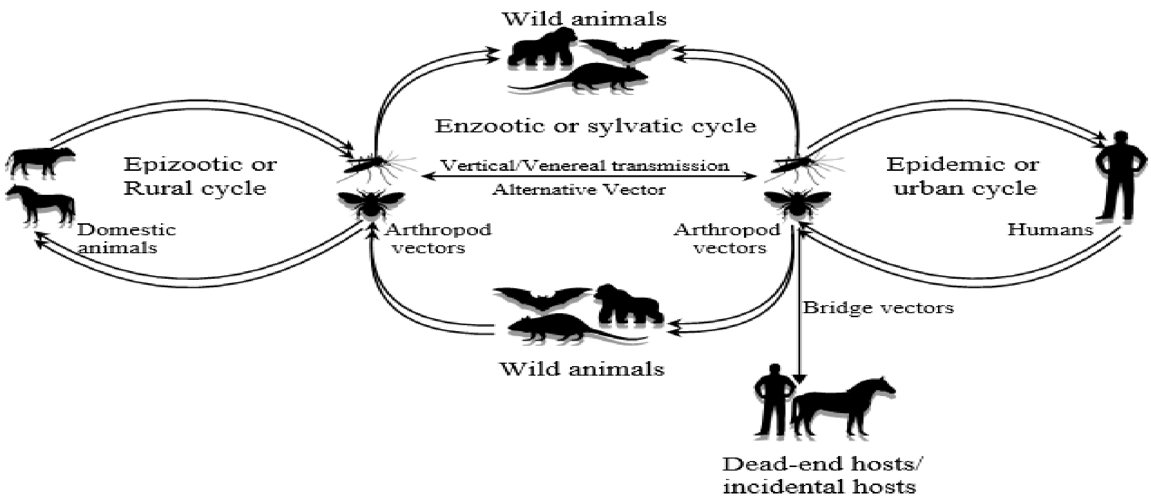

Fig. 3 Transmission and maintenance cycles of vector-borne viruses.

3.3 Waterborne and Food-borne Viruses

Several viruses can be transmitted via food and water. Besides mild diarrhoea, these viruses can also cause severe neural diseases, flaccid paralysis, myocarditis, respiratory disease, and hemorrhagic fever, as well as rare cases of myocarditis, respiratory disease, and hemorrhagic fever. However, gastroenteritis and hepatitis remain among the most common food-borne infection.(17)

Table 2 A list of viruses that are water borne and food borne along with their families, genome, genus and associated disease.

Virus Family	Common name	Genus	Genome	Related condition
Caliciviridae	Norwalk virus	Norovirus	ssRNA (+)	Gastroenteritis
Picornaviridae	Hepatitis A virus	Hepatovirus	ssRNA (+)	Hepatitis
Reoviridae	Rotavirus	Rotavirus	dsRNA	Gastroenteritis
Hepeviridae	Hepatitis E virus	Orthohepeviru	ssRNA (+)	Hepatitis
Caliciviridae	Sapovirus	Sapovirus	ssRNA (+)	Gastroenteritis

3.4 Airborne and respiratory Viruses

In the past, the concept of airborne transmission was focused on the idea of inhaling infectious aerosols or "droplet nuclei" that were smaller than 5 mm in size, typically originating from a distance of more than 1 to 2 meters away from the infected person. This type of transmission was considered noteworthy mainly for uncommon diseases.(18) However, there is now compelling evidence supporting the airborne transmission of various respiratory viruses, including respiratory syncytial virus (RSV), influenza virus, human rhinovirus, and Middle East respiratory syndrome coronavirus (MERS-CoV).(19) Respiratory aerosols, categorized based on their production sites, include alveolar, bronchiolar, bronchial, laryngeal, and oral aerosols.(20)

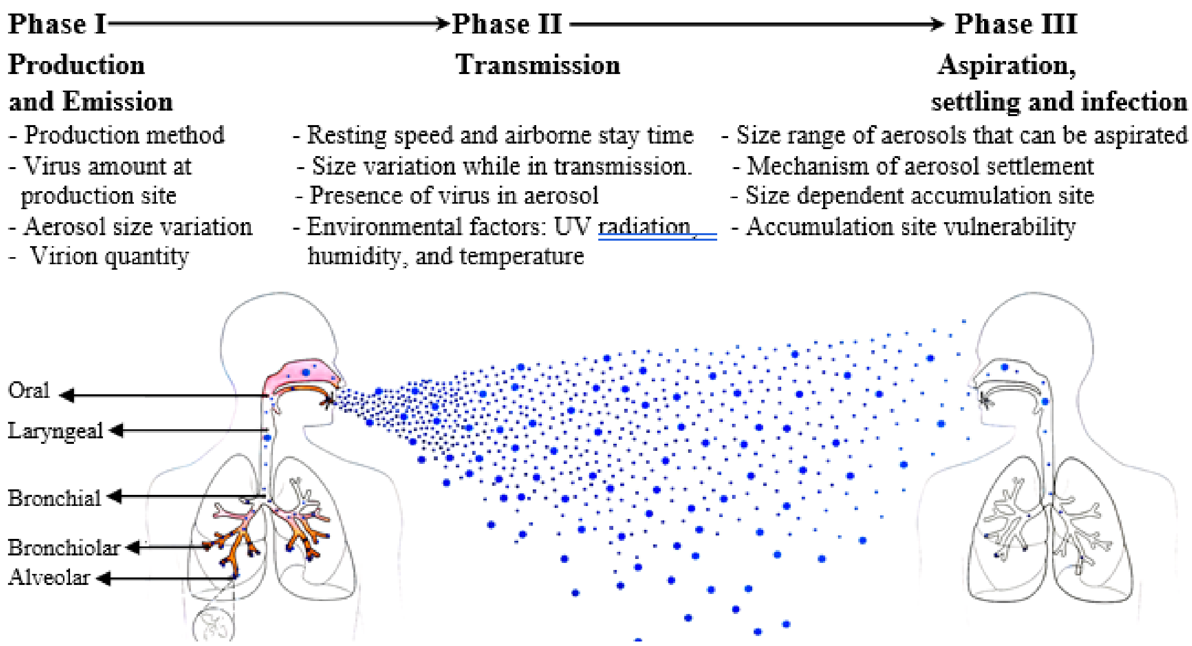

Fig. 4 The airborne transmission of respiratory viruses encompasses a multi-phase sequence, comprising (i) the production and emission, (ii) transmission, and (iii) the subsequent phases involving inhalation, sedimentation, and the potential for infection.

3.5 Nosocomial Transmission

Nosocomial viruses, sometimes called hospital-acquired viruses or healthcare-associated viruses, are spread inside healthcare environments, including hospitals, clinics, nursing homes, and other health care facilities. These viruses may propagate from patient to patient, from medical personnel to patients, or through contaminated surfaces and equipment in the medical industry. These infections can pose a serious threat because of the possibility of greater disease, extended hospital stays, and increased healthcare expenditures.(21)

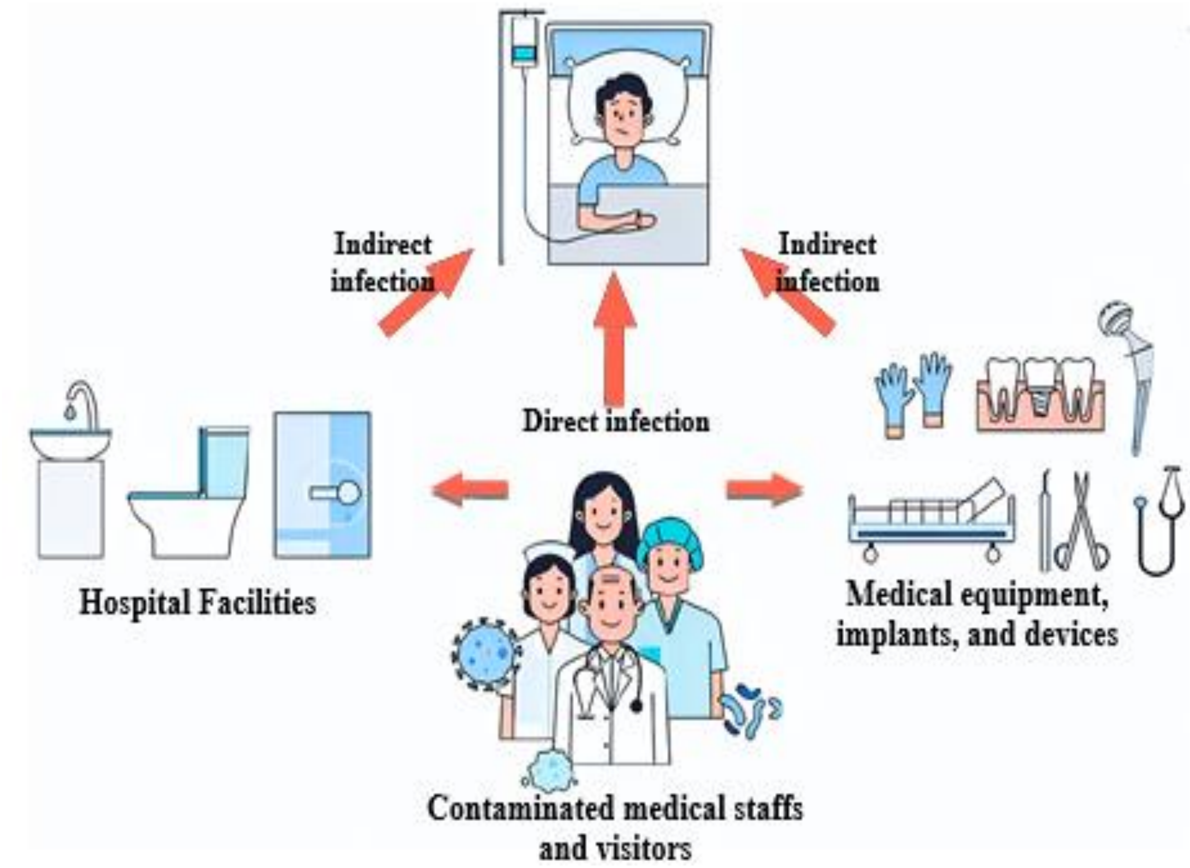

Fig. 5 Diagrammatic representation of the nosocomial infection or hospital-acquired infection (HAI) transmission channels.

4. Hazards of viruses

Viruses provide serious risks to both human health and the health of the planet's ecosystems. They have the potential to bring about large-scale disease epidemics that devastate the healthcare system and inflict sickness and death. Their capacity for fast mutation can produce new, more aggressive strains that complicate medical efforts. Some fatal viral hazards are discussed below.

4.1 Human infectious diseases

Infectious diseases can be transmitted by bodily fluids, respiratory droplets, contaminated food, and insect bites. The most prevalent infectious diseases on a global scale include HIV/AIDS, yellow fever, dengue, viral hepatitis, rabies, ebola virus, nipah virus, small pox, SARS-CoV, zika virus, MERS-CoV.(22-25) Some globally fatal infectious diseases are discussed below.

4.1.1 HIV/AIDS

Acquired immunodeficiency syndrome (AIDS), resulting from a prolonged infection with human immunodeficiency virus-1 (HIV-1), stands as one of the most devastating pandemics in human history.(26) Almost 80 million individuals have been infected by the disease since it was first reported in the United States in 1981, shortly after which HIV-1 was isolated two years later.(27)

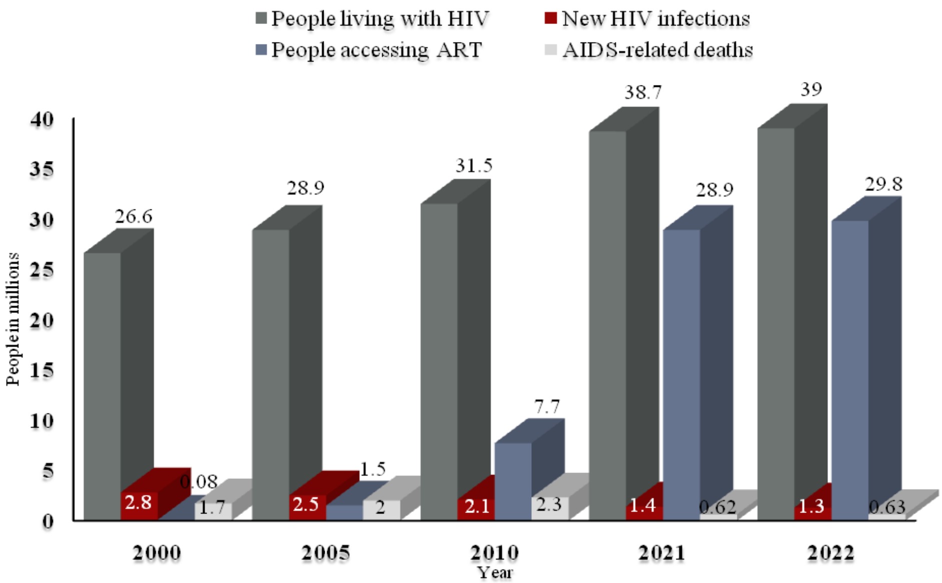

Fig. 6 Trends in HIV Statistics: This graph illustrates the changes in key HIV-related indicators over the years 2000, 2005, 2010, 2021, and 2022. The data includes the number of people living with HIV, new HIV infections, individuals accessing Antiretroviral Therapy (ART), and AIDS-related deaths.

The progression of infection by these viruses is often characterized by an extended latency period between the inception of the initial infection and the emergence of severe symptoms. Upon penetrating the cellular milieu, HIV, along with other retroviruses, harnesses the enzymatic prowess of reverse transcriptase to transmute its viral RNA into DNA, which can then be seamlessly integrated into the host cell's genomic framework.(28) This proviral DNA, akin to endogenous cellular genes, undergoes duplication during instances of cell division. Subsequently, viral RNAs are synthesized, leveraging the provirus as a template. A fraction of these viral RNAs assumes the role of genomic RNA in progeny virions, while others undergo translation to yield viral proteins.(29) For HIV transmission to occur, contact must transpire with bodily fluids containing infectious virions, HIV-infected cells, or a composite of both elements.(30-32).

4.1.2 Rabies

One of the most frequent deadly illnesses globally is rabies, which is caused by rabies virus (RABV) genotype. In Europe, Asia, and Africa, it is mostly linked to dog bites; in the Americas, it is linked to bat bites.(33) Approximately two-thirds of individuals infected with rabies variants found in dogs exhibit the typical symptoms associated with furious rabies. These symptoms include phobic or inspiratory spasms, changes in mental state, and signs of heightened autonomic activity.(34, 35) The most effective method of transmission is by a bite from an animal that is infected with RABV. Aside from inhaling aerosolized RABV, other means of transmission include tissue and organ transplants, handling contaminated corpses, scratching or abrasions, or mucous membranes, and contamination of open wounds with infected saliva or neural tissue.(34) Viral inocula and viral tissue tropism determine how well a virus is transmitted by bites.(36, 37) Between 1988 and 2004 in Thailand, there were 80 cases of furious rabies and 35 cases of paralytic rabies caused by a dog rabies virus variant. These patients, who received limited or no intensive care support, survived for an average of 5 days in the case of furious rabies and 11 days in the case of paralytic rabies from the onset of clinical symptoms until their passing. These survival rates were compared to those reported in India between 1980 and 2007 and were found to be statistically similar.(38, 39) Patients getting intensive care assistance can extend their survival to one month or more.(40)

4.1.3 COVID- 19

Coronaviruses are members of the Coronaviridae family, characterized by their distinctive appearance resembling studded rings as observed through electron microscopy. The virion surface exhibits an array of spikes which serve as crucial elements for cellular attachment and interaction. This viral group encompasses a spectrum of diseases, ranging from mild common colds to severe manifestations including SARS-CoV and MERS-CoV. The origin of these viruses is attributed to animal reservoirs, predominantly bats. (41) Coronaviruses have the capacity to infect the upper gastrointestinal and respiratory tracts of mammals, including humans, as well as avian species. SARS-CoV-2 relies on RNA replication facilitated by the RNA-dependent RNA polymerase enzyme. Its gradual mutational evolution poses challenges for management and containment. The incubation period for COVID-19 symptoms can vary between 2 and 14 days post-infection, occasionally extending up to 27 days, although Chinese researchers noted an average of 5.2 days.(42) The duration of COVID-19 fatalities ranges from 6 to 41 days post-infection, contingent on factors like age, health status, and clinical particulars.(43) Common indications of infection encompass fatigue, myalgia, sneezing, sore throat, dry cough, pyrexia, and respiratory complications, with severe cases potentially progressing to pneumonia, acute respiratory distress syndrome, renal impairment, and fatality.(44-46)

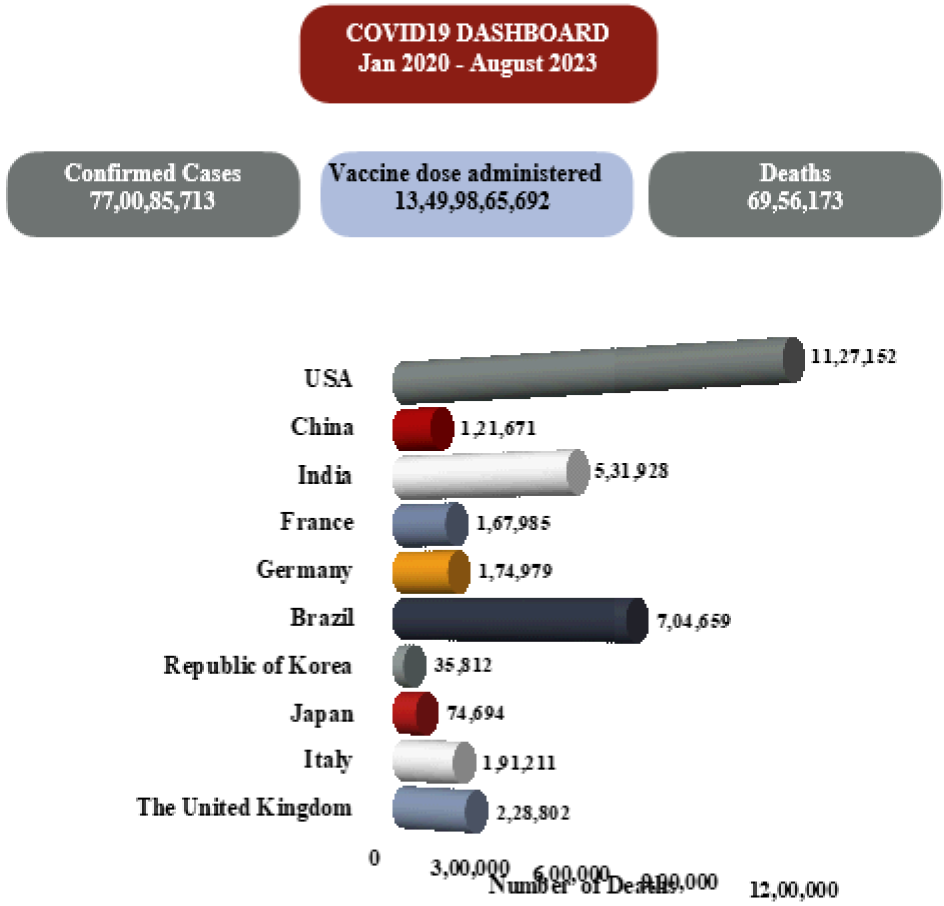

Fig. 7 COVID-19 Deaths by Country (Jan 2020 - Aug 2023).

4.1.4 Hepatitis

Viral hepatitis (or hepatitis caused by viral infections) results from inflammation of the liver. (47) It is primarily attributed to five viruses: hepatitis A virus (HAV), hepatitis B virus (HBV), hepatitis C virus (HCV), hepatitis D virus (HDV), and hepatitis E virus (HEV). A considerable fraction of individuals who have viral hepatitis go on to develop hepatocellular carcinoma (HCC), liver cirrhosis, and die. (48) In the year 2019, the World Health Organization (WHO) reported a global prevalence of hepatitis B, with an estimated 296 million individuals affected, and hepatitis C, affecting approximately 58 million individuals. These infections possess the potential for persistent and lifelong manifestation. The same year saw 1.5 million new cases of chronic hepatitis B and an equivalent number of new cases of chronic hepatitis C. The consequential health implications of these infections encompass severe conditions such as liver cancer, cirrhosis, and other afflictions attributed to chronic viral hepatitis, culminating in 1.1 million recorded fatalities in 2019. It is noteworthy that hepatitis A and hepatitis E, while not establishing persistent infections, can inflict severe liver damage and fatality. Global instances of these infections are exacerbated in regions characterized by suboptimal sanitation conditions.(49)

4.2 Antibiotic Resistance

Antibiotic resistance is a pressing issue that confronts the medical community, stemming from the overuse and misuse of antibiotics. While antibiotics are powerful tools against bacterial infections, they are essentially ineffective against viruses. Viruses and bacteria are fundamentally different in their structures and biological processes.(50) Antibiotics target specific aspects of bacterial physiology, disrupting their growth, reproduction, or other essential functions. However, these mechanisms have no impact on viruses, as viruses lack the cellular machinery that antibiotics typically target.(51) The crucial connection between antibiotic resistance and viral infections lies in the potential consequences of antibiotic misuse. When antibiotics are wrongly prescribed or used inappropriately, such as for viral infections, it can lead to a selective pressure on bacteria present in the body. This selective pressure favours the survival of bacteria that have developed resistance to antibiotics. These bacteria that have developed resistance can subsequently propagate and result in infections that are challenging to manage with conventional antibiotics.(52) Furthermore, the utilization of antibiotics with a wide spectrum of activity, can disrupt the equilibrium of the body's microbiota. This disruption can further contribute to an environment that promotes the growth of antibiotic-resistant bacteria.(53) In essence, while antibiotics are not effective against viruses, their misuse can indirectly impact bacterial resistance. The emergence of antibiotic resistant bacteria poses a serious challenge to healthcare, as these infections become harder to treat and may lead to more severe outcomes.(54)

4.3 Epidemics and Pandemics

An outbreak is characterized by a sudden increase in the number of individuals affected by a specific health condition or the emergence of cases in a previously unaffected area. When such an outbreak extends its reach to a larger geographic region, it is termed an epidemic. And when an epidemic extends its impact to a global scale, it is referred to as a pandemic.(55) Viruses are posing unprecedented challenges to global health in the 21st century.

Table 3 Summary of key virus-induced epidemics and pandemics.

Virus	Year	Cases and Mortality	Geographic Location
Influenza (Spanish flu)	1918-1920	500 million cases And 30 to 100 million deaths	Worldwide
Influenza (Asian flu)	1957-1958	1 to 2 million deaths	Worldwide
Influenza (Hong Kong flu)	1968-1969	500,00 to 2 million deaths	Worldwide
HIV/AIDS	1960- present	78 million cases and 40 million deaths	Worldwide
Smallpox	1974	130.000 cases and 26000 deaths	India
SARS	2002-2003	8098 cases and 774 Deaths	Originated in China and spread to 37 countries
Influenza (Swine flu)	2009	2,84,000	Worldwide

Virus	Year	Cases and Mortality	Geographic Location
Ebola	2014-2016	28,600 cases and 11325 deaths	West Africa, primarily Guinea, Liberia and Sierra
Zika	2015-present	Unknown number of Cases and 0 deaths Reported	The Americas, primarily Brazil
Dengue	2016	100 million cases and 38,000 deaths	Worldwide
COVID 19	2019-present	77,00,85,713 cases and 69,56,173 deaths	Worldwide

4.4 Emerging and Re-emerging viruses

Emerging and re-emerging infectious diseases have surfaced in recent times. An "emerging infection" can be a completely new disease or a known one with a recent increase in prevalence.

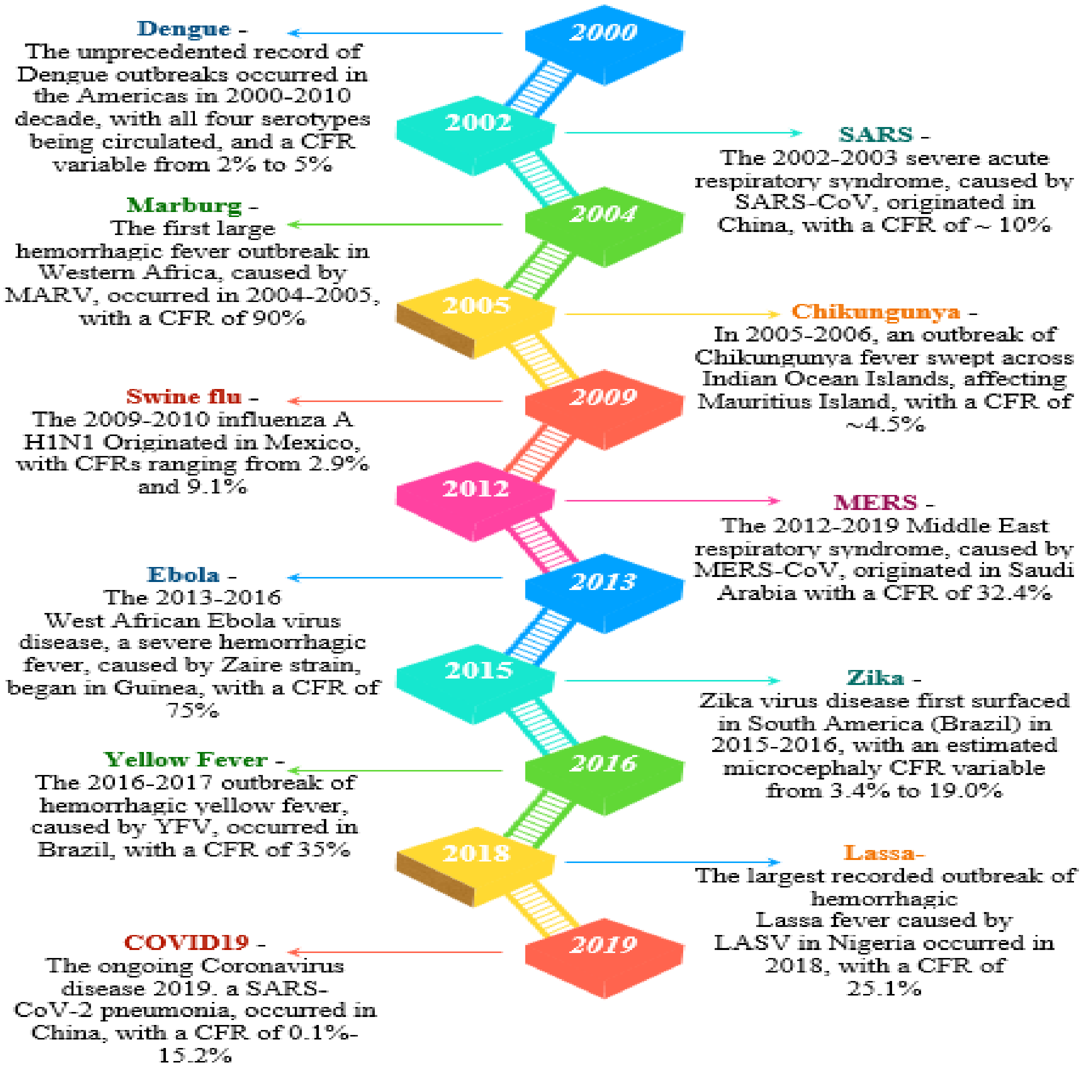

Fig. 8 Emerging and re-emerging viruses (year) and their case fatality rate (CFR).

For instance, the HIV pandemic and the outbreak of severe acute respiratory syndrome (SARS-CoV) are notable examples of newly emerging infectious diseases that the general public encountered in the 1980s and 2003, respectively. A "re-emerging infection," on the other hand, is a familiar disease making a comeback. The influenza pandemics of 1918, 1957, and 1968 are notable examples of re-emerging diseases. These patterns demand consideration within the realms of public health and disease control.(56)

4.5 Cancer

Cancer is a complex and multifaceted group of diseases that can be caused by various factors, including genetic mutations, environmental exposures, and infectious agents. Among the infectious agents, certain viruses have been identified as significant contributors to the development of cancer. These viruses are known as "oncogenic" or "cancer-causing" viruses and have a notable impact on public health worldwide. According to the international agency for research on cancer, viruses are responsible for a significant portion, specifically one out of every five, of cancer cases globally.(57, 58) They also have a significant economic impact, as they cost billions of dollars to treat.(59) The impact of cancer-causing viruses on public health is not evenly distributed. Some countries have higher rates of infection with these viruses than others. For example, HPV infection rates are higher in developing nations compared to developed ones. Similarly, HBV infection is more prevalent in developing countries, particularly in East Asia and Africa. Ongoing research efforts focus on understanding the mechanisms by which these viruses contribute to cancer development and on developing more effective prevention and treatment strategies.(57)

5. Management Approaches for Viral Hazards

Management of viral hazards encompasses strategies and actions aimed at mitigating the impact of viral infections on public health. This includes prevention through vaccination and immunization programs, anti-viral therapies, vector control strategies, and quarantine and isolation measures. Collaboration and global monitoring enhance preparedness for emerging viral threats.

5.1 Vaccination and immunization

The most effective biological strategy for preventing viral pandemic disease has been antiviral vaccinations.(60) By exposing the body to a virus in weakened or inactive form, vaccines assist the body build an immunity to the pathogen. If the person is exposed to the virus again, their immunity may prevent them from becoming infected.

Table 4 Comparative Analysis of Vaccine Impact on Viral Diseases (2010 vs. 2022)

Disease	Year of vaccine development or license	Cases in 2010	Cases in 2022	Percentage vaccine coverage (%)
Measles	1963	3,43,806	2,05,153	83%
Mumps	First strain developed in 1949	6,19,389	3,69,582	59%
Rubella	1969	75,961	17,917	68%
Yellow fever	1936	453,000 deaths per year	89,000	45%
Polio	1950–1956	737	217	84%

The primary outcome of vaccinations has been a decrease in illness and death caused by serious infections, with a particular focus on their impact on children. It is estimated that vaccines will prevent 386 million years of life loss, reduce 96 million years of disability, and prevent over six million deaths annually on a global scale.(61) Many individuals who receive vaccinations often prioritize their own immediate protection as the primary health benefit. However, on a broader scale, vaccinations offer an additional advantage in the form of potentially establishing herd immunity. When a significant portion of the population is vaccinated, it can halt the transmission of the infectious agent, thereby safeguarding those who cannot be immunized due to factors like age, vulnerability, or immune suppression.(62) Immunization plays a vital role in saving lives globally, preventing approximately four million deaths annually through childhood vaccination. Unfortunately, one out of every five children worldwide lack access to crucial immunizations. This absence of vaccine access exposes children to the possibility of death, disability, and illness caused by preventable diseases.(63) The table above (Table 7) shows the importance of vaccines in managing viral hazards.

5.2 Antiviral therapies

One of the most fascinating aspects of virology lies in the field of antiviral therapy, where scientific knowledge has been effectively harnessed to produce highly effective drugs for severe viral infections. By 2015, over 12 million individuals had received life-saving treatment for their human immunodeficiency virus (HIV) infection, illustrating the substantial impact antiviral drugs can have on a lethal, long-lasting infection. This significant progress is expected to be repeated in the treatment of hepatitis C virus (HCV) infection. Ongoing efforts in drug discovery are also targeting filoviruses, coronaviruses, dengue, and other viruses, underscoring the ongoing work to develop new antiviral medications.(64) Inhibition of Viral Replication: In the case of HIV, antiretroviral therapy (ART) has been highly effective in reducing viral replication. According to UNAIDS data, by the end of 2020, 27.4 million people were accessing ART globally, leading to a substantial decrease in AIDS-related deaths.(65) In the context of hepatitis B, antiviral therapy can suppress viral replication, reducing the risk of transmission to others through activities like sexual contact or sharing needles. This has been a crucial strategy in preventing the spread of hepatitis B.(66) The use of antiretroviral therapy in the management of HIV/AIDS has not only extended the lifespan and improved the quality of life for individuals living with HIV but has also contributed to efforts to control and eventually eradicate the virus.(67) During the COVID-19 pandemic, several antiviral drugs, such as remdesivir and monoclonal antibodies, have been authorized for emergency use to treat individuals with COVID-19 or to provide post-exposure prophylaxis to prevent severe disease in high-risk individuals.(64) Data from clinical trials and epidemiological studies continue to support the importance of antiviral therapy in reducing the burden of viral infections.

5.3 Vector control strategies

Historically and presently, the main approach for managing numerous vector-borne diseases is vector control. Moreover, for certain infections like West Nile disease, Chikungunya, Zika, and dengue (where a vaccine exists but isn't widely used due to safety concerns), vector management is the sole viable option.(68) The goal of vector control is to decrease the transmission of infections by minimizing or preventing human contact with the disease-carrying vector. Strategies for vector control, such as the use of insecticide-treated bed nets, indoor residual spraying, and larval control, focus on tackling the vectors that transmit diseases such as dengue, zika, and westnile virus. To illustrate, the extensive adoption of insecticide-treated bed nets has significantly reduced the number of malaria cases in various African nations.(69) Vector control can prevent localized outbreaks and epidemics of vector-borne diseases. In areas where Zika virus outbreaks occurred, aggressive mosquito control efforts led to a decline in reported cases.(15) Sustainable vector control programs can provide long-term protection against vector-borne diseases. These programs include efforts to reduce breeding sites, community education, and the development of vector-resistant crop varieties.(70) As pathogens evolve or new diseases emerge, vector control strategies can be modified accordingly. The rapid response to the Zika virus outbreak in the Americas included the development of new vector control methods and the distribution of information to communities on how to reduce mosquito breeding sites.(71) Vector control is a vital component of virus disease management, and its effectiveness is supported by data from various studies and real-world interventions.

5.4 Quarantine and isolation measures

Isolation (which involves separating symptomatic individuals from the general population) and quarantine (which entails isolating individuals who have been in contact with infected individuals but aren't showing symptoms), are adequate to effectively manage the disease's transmission.(72) During the COVID-19 pandemic, studies have shown that quarantine measures helped reduce transmission rates. For example, a study in China found that quarantine measures contributed to a significant reduction in the spread of the virus. In the context of Ebola outbreaks, quarantine has been effective in preventing further transmission.(73) Data from the years 2014 to 2016 West Africa ebola outbreak showed the importance of isolating and quarantining infected individuals to control the epidemic.(74) During the severe acute respiratory syndrome outbreak in 2003, isolation of confirmed cases played a crucial role in controlling the spread of the virus. Data from that outbreak showed that prompt isolation of cases led to a decline in new infections. In the context of COVID-19, isolation measures have been essential in preventing severe cases and reducing mortality rates. Data from various countries have shown that isolating confirmed cases and providing appropriate medical care have been effective in managing the pandemic.(75)

5.5 One health approach

The One Health approach represents a comprehensive strategy for preventing viral diseases. It acknowledges that viral diseases are not standalone entities but are shaped by the interplay between humans, animals, and the environment. By collaboratively addressing these interactions, we can proactively stop the transmission of viral diseases and safeguard the well-being of people, animals, and the environment.(76) By vaccinating animals against these diseases, we can reduce the risk of them being transmitted to humans.(69)

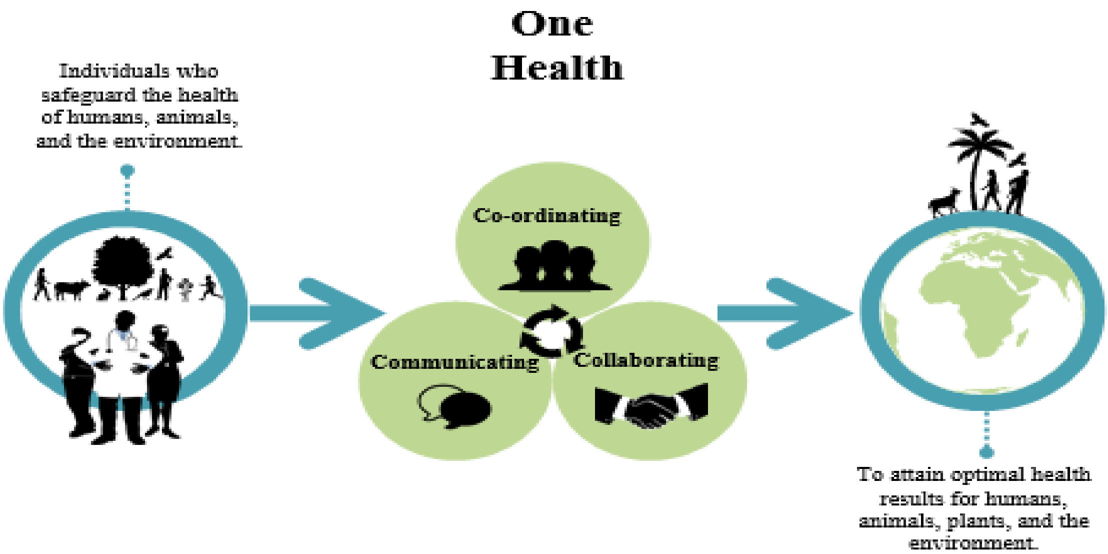

Fig. 9 The One Health Approach - A Holistic Strategy for Safeguarding Public and Environmental Health

Poor sanitation and hygiene practices can increase the risk of exposure to virus diseases.(77) Wildlife can sometimes carry virus diseases that can be transmitted to humans. By protecting wildlife, we can help to prevent these diseases from spreading to humans.(78) Pollution can weaken the immune system and make people more susceptible to virus diseases. By reducing pollution, we can help to protect people from getting sick.(79) We need to invest in research to better understand virus diseases and how to prevent them. This research can help us to develop new vaccines, treatments, and prevention strategies. The World Health Organization (WHO) is using the One Health approach to develop a global strategy to combat antimicrobial resistance.(80) The Centre's for disease control and prevention (CDC) is using the One Health approach to track the spread of zoonotic diseases.(81) The One Health approach is a growing field of research and practice. There is still much to learn about how to best implement the approach, but it is clear that it has the potential to make a significant impact on global health.

Conclusion

In conclusion, our review paper has explored the viruses, covering their categorization, origins, transmission methods, and the diverse risks they pose to both human health and society. Viruses have proven to be formidable adversaries, giving rise to a wide spectrum of ailments, encompassing infectious diseases, epidemics, pandemics, antibiotic resistance, and even cancer. Additionally, the persistent specter of emerging and re-emerging viruses necessitates our unwavering vigilance in the face of continually evolving challenges. However, the realm of science and medicine has equipped us with an array of strategies to effectively counter viral hazards. These encompass comprehensive programs for vaccination and immunization, the advancement of antiviral therapies, strategies for controlling vectors to curtail transmission, the holistic adoption of a "One Health" approach that recognizes the interconnectedness of human, animal, and environmental health, and the enforcement of quarantine and isolation measures during outbreaks. In our collective endeavour to protect public health and global well-being, it is crucial that we continue to invest in research, bolster public health infrastructure, and foster international cooperation. By doing so, we cannot only manage the existing viral threats but also fortify our preparedness to confront potential future challenges. In this enduring battle against viral hazards, collaboration, education, and the application of evidence-based strategies will remain our most potent tools, ensuring a safer and healthier world for future generations.

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