American Journal of Biology and Natural Sciences
https://biojournals.us/index.php/AJBNS
ISSN: 2997-7185

Emerging Viral Infections in Humans: a Review of Recent and Most Notable Cases

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Received: 2024, 04, Jan
Accepted: 2025, 05, Feb
Published: 2025, 04, Mar

Abstract: Emerging viral infections pose a significant threat to global health, often resulting in widespread epidemics and pandemics. This review identifies key knowledge gaps regarding the mechanisms of viral emergence, transmission dynamics, and control strategies. A systematic literature review was conducted, analyzing past and recent outbreaks, including Ebola, Zika, and COVID-19. Findings reveal that environmental changes, globalization, and zoonotic spillovers contribute to the increasing frequency of emerging viruses. The results underscore the necessity for robust surveillance systems, early detection, and rapid response strategies to mitigate future outbreaks. The study highlights the importance of interdisciplinary collaboration and proactive measures in strengthening global preparedness for viral threats.

Keywords: Emerging viruses, zoonotic diseases, pandemic preparedness, viral transmission, epidemiology, public health response, outbreak control.

1. Introduction

Emerging viral infections are an important issue for the recognition of tropical diseases in the game, with a significant number of infections caused primarily by zoonotic viruses, which invade human populations during the rural / urban / township workshop. In recent years, many animal and zoonotic disease experts, particularly virologists and economists, have emphasized the key role that such viral infections play in public health. In the global scale, this is due to many factors, but changes in human behavior, population movements, urbanization, and globalized travels have been particularly involved as they increase transactions of goods and people worldwide, enabling rapid viral propagation. The concern is increased by the fact that, historically, many of the most dramatic viral epidemics in human populations have been caused by emerging viruses, particularly microscopic ones. Emerging diseases are, therefore, often feared, but not, unfortunately, as a public health problem to be addressed by a relatively well-prepared system as a result of the experiences of the past localized epidemics. From an epidemiological perspective, an emerging infection may be defined as a new infectious disease that has suddenly increased pathogen incidence and may be about to become a public health problem [1]. From a virological perspective, emerging pathogens include newly identified viral species and isolates associated with hitherto unrecognized infections, including those responsible for new clinical syndromes or having distinctive epidemiological, genetic, immunological, or pathogenic properties [2]. [3][4][5] [3][4]

2. Overview of Emerging Viral Infections

A broad understanding of emerging viral infections will lay relevancy to these cases and is important for framing the discussion. An emerging viral infection can be newly identified as pathogenic, e.g., human metapneumovirus; newly identified in a new geographic location; newly identified as spreading to a new host, e.g., rabbits from myxoma virus; antecede known cases, e.g., Kentucky poxvirus before smallpox; or re-emerging pathogen, perhaps due to changing resistance or registration. Emerging infections can be slow or sudden in onset and either rare or epidemic in occurrence. Factors contributing to their emergence are diverse and often intertwined with each other. Technological developments often contribute inadvertently to viral emergence, e.g., eclosion of Lassa virus in the 1960s from pediatric patient blood sampling in Nigeria. Ebola's development required the combination of multiple aspects of medical interventions like injections, unsanitary conditions, inadequate barrier protection, and variable reuse of medical devices. The rapid settlement and rapid decay of the disease in the 1980s gouged out a niche for a new strain. Out-of-control healthcare epidemiology and a number of medical setbacks played a part in amplifying an ongoing, although stabilized, disease [6]. Modern transportation significantly alters the epidemiological landscape of a given region and of global disease epidemiology in general. Variances in modern and historical behaviors, customs, and lifestyles can significantly alter infectious disease dynamics such as Waardenburg's description of an influenza epidemic. Mind infrastructures can play a dynamic role in human health. A similar fate may await the 70% of the world's population that live in malaria-endemic areas, should there be a substantial contraction of the vibrant socio-political, economic, and public health infrastructures. Malaria may have been brought to historical India by the trade caravans of Persian ships and Arabian horses. Climate can also exert major influences on infectious disease, regarding not only susceptibility but also

response. Major analysis on the role of climate in Ebola bio-shedding in tropical Africa. Preliminary results suggest an important role for wind in aiding bush meat trade and for viral transfer from degraded rainforest remnants. Finally, the relationships between non-specific antiviral usage and diseases emergence were explored [7]. The multifaceted nature of viral emergence is cut closer to the bone in what may frequently be the resultant interplay of these various vectors.

2.1. Definition and Characteristics

Emerging viral infections are defined as those that have recently appeared within a population, or those that have existed previously but are rapidly increasing in their incidence or spreading geographically. As these new infections or re-emergence of older infections are unexpected in a population, they are not well prepared to cope with the threat posed by these infections. Many viral diseases of man appear to have wild animal reservoirs or intermediate hosts and can be transmitted by arthropods or other invertebrates. As most of the newly emerging infections or re-emerging (resurging) infections are zoonotic in nature, there is also a need for increased surveillance of viral infections in animal populations. Factors like genetic drift and reassortment in viruses, certain changes in the socio-environmental conditions, altering ecological and environmental conditions, global warming and human activities like deforestation, wetland drainage and increased urbanization, settlement in environment polluted with organic wastes, might have played an important role in the increasing emergence of viral infections. Emerging or re-emerging viral infections often show the rapid ability to change/alter their conditions to survive in new/virgin environments or in new hosts by changing their ecological and biological characters.

Given the unprecedented threats to human health posed by newly emerging infectious diseases, a comprehensive emphasis on pathogen surveillance and on mechanisms to enhance immediate detection are required. It is important to be sufficiently informed about the common characteristics of emerging infections, to be able to rapidly recognize and contain the next SARS incursion [7]. Rapid recognition of severe acute respiratory syndrome (SARS) clearly illustrates human vulnerability to emerging infections - including both naturally evolving microbes and those emerging through deliberate events. Efforts to rapidly identify and contain emerging infections then depend on surveillance systems for their detection and a range of interventions for prevention and control. [8][9][10]

2.2. Factors Contributing to Emergence

There have been a number of factors attributed to the increasing frequency with which emerging viral infections are causing epidemics or pandemics. Environmental changes such as habitat destruction and climate change create further opportunities for viruses to spread or establish residence in new habitats. Globalization, proximity, and encroachment on natural habitats have increased chances of cross infection between humans, livestock, and wildlife [11]. Urbanization, population density and other socioeconomic factors provide enlarging niches for virus circulation, including overcrowded living conditions, unsanitary practices, food security issues, and other poor living conditions that foster disease outbreaks. Additionally, with the unprecedented advancements in travel technology and intercontinental commerce, infected individuals can travel to cities around the globe in a few hours, seeding other outbreaks. The increasing demand for wildlife for foods, pets, ornaments, leisure, and tradition also contributes to potential for spillover events for many pathogens. These, coupled with the rapid genetic changes viruses can make and their vast expansion into new potential host and vector species make zoonotic spillovers all the more probable. Moreover, with the development of rapid and sensitive laboratory analysis in efficiently and cost effective set ups, the number of cases identified as novel or ascribed to a specific virus has increased. The interconnected, incessant, and escalating interactions between these factors are enhancing viral emergence, causing sequential and overlapping outbreaks on a global scale. There is a profound need to better monitor, prepare, prevent, and control these shifting threats to public health by addressing factors of zoonotic spillovers rather than falling into

the trap of responding to each event individually. Understanding these underlying dynamics allows a more proactive approach that can help prevent future diseases from transforming into major uncontrolled outbreaks, saving a considerable amount of resources, mitigating much suffering, and alleviate further burdens to health systems. [12][13][14]

3. Notable Cases of Emerging Viral Infections

Emerging infectious diseases are considered an ever-increasing global threat due to the complex interplay between people and their respective environments. Since the beginning of the 21st century, viruses have played a pivotal role in emerging diseases acquiring pandemic potential. Various instances of cross-species transmission of viruses to humans have led to numerous emerging viral infections. Some of these are of remarkable public health importance making them worth analyzing in detail within a short span of time.

The period 2012-2017 was marked by a surge in the number of emerging viral infections. Among these pathogens, agents like the Middle East respiratory syndrome coronavirus, the influenza A/H7N9 virus and the Zika virus have acquired international concern. Beforehand events like the severe acute respiratory syndrome epidemic (SARS) of 2003 had also caused global panic. Moreover the re-emergence of older viruses in new avatars-like the massive epidemics of chikungunya and dengue in unforeseen regions of the globe, the hitherto unexplained sudden outbreaks of infections due to Nipah virus in far apart places and the wide dispersal of Ebola virus to non-traditional regions had widened the interests in the newly emerging and less familiar pathogens. Prior to these more familiar cases of emerging viral infections like the bovine spongiform encephalopathy, the human acquired immune deficiency syndrome, and the highly pathogenic avian influenza had forced changes in global public health policies [2].

Individual bouts of viral epidemics represent more than just an upsurge in arbitrary infections-it illustrates the intertwine of various factors like the perturbation leading to more intensified contact between the pathogen and the host, the ease of international spread and the decisive societal vulnerability of the host. Thanks to the explosive growth in international transport links and the proximity of several new contenders to the human–animal interface, individual outbreaks have multiple consequences, sometimes residing in mixed results. On the optimistic front each viral entity brings home a set of lessons aiding the better preparedness of the public health authorities to effectively anticipate or tackle subsequent outbreaks. A more cautious signal embedded in each event involves the series of errors and fallacies committed in understanding the transmission dynamics of the infection precluding effective public health intervention culminating in serious economic ramification. Broadly viewed, the consequences of individual ‘emerging events’ are manifested in two indispensable interfaces the first interaction happening to be between the well-heeled nations and the rest of the globe and the other-the often ignored and largely unpredicted socio-economic impact of the epidemic in the vulnerable countries [7]. [15][16][17]

3.1. Ebola Virus Disease

This subsection focusses specifically on a review of the Ebola Virus Disease (EVD) in humans. EVD is a viral haemorrhagic fever of humans and other primates caused by Ebola virus, a filovirus. There are five species of Ebola virus with varying pathogenicity in humans: Zaire, Sudan, Reston, Tai Forest, and Bundibugyo. EVD is the deadliest clinical manifestation of infection with Ebola virus with case fatality rates as high as 90%. The natural reservoir of Ebola virus is not completely understood, but it is believed to be fruit bats ([18]). EVD was first recognized in Zaire (now Democratic Republic of Congo) in 1976 and the largest and deadliest outbreaks have historically occurred in Central Africa. Though the case fatality rate of EVD has been lower than 50% in some outbreak settings, the 2014–16 outbreak in West Africa recorded case fatality rates close to 50%. This outbreak grew to eclipse all previous outbreaks combined, striking primarily Guinea, but quickly spreading to Sierra Leone, Liberia, and seven other countries. Reported tolls from the disease indicate 28,652 died of EVD and 11,325 survived infection in this outbreak. In many respects, this outbreak was groundbreaking. The 2014–16

outbreak prompted public health efforts never seen before for EVD, such as ring vaccination trials, and it resulted in a large knowledge base regarding the natural history of EVD in humans. This section will briefly review EVD and discuss significant outbreaks, primarily in West Africa, and responses to contain them especially in light of their implications for future responses. Finally, challenges and difficulties surrounding care, or lack thereof, of EVD will be discussed with an eye toward the present difficulties facing the DRC in managing an ongoing outbreak in the East of the nation ([19]). The hope that lessons learned from past responses can be used to contain the current and future outbreaks of EVD is addressed in depth.

3.2. Zika Virus Infection

Zika (ZIKV) Virus, first identified in 1947, is a single-stranded, neurotropic, arthropod-borne RNA virus of the family Flaviviridae, genus Flavivirus [20]. ZIKV disease is vector-borne, mainly transmitted by mosquitoes such as Aedes aegypti, the primary vector responsible for disease in humans. Aedes albopictus has also adapted to transmit ZIKV in both urban and rural areas. Phylogenetic analysis classifies ZIKV into two major lineages – African and Asian. The ZIKV strain from the ongoing American epidemic is more closely related to the Asian lineage. The first recognized outbreak of ZIKV (Uganda, 1951) involved sporadic cases among humans, with limited clinical symptoms used to differentiate ZIKV from the closely related Dengue Virus. From the earliest isolate until 2007, only 14 reported cases of ZIKV infection in humans were documented. The first well-documented outbreak, involving 108 confirmed cases in the Federated States of Micronesia, was identified in 2007 by laboratory testing [21]. ZIKV spread to other nearby Pacific Island countries from 2007 to 2014. Subsequent local ZIKV outbreaks in autonomous New Caledonia, microcephaly-case detection in Latin America, and WHO Zika burden calls for vigilance led to worldwide concern. Prior to the explosive Latin American and Caribbean outbreaks, scientific knowledge of ZIKV was limited compared to Chikungunya and Dengue Virus. In late 2015, Brazil reported the sustained transmission of ZIKV infection, representing the first outbreaks of illness caused by ZIKV in the western hemisphere. Dissemination quickly spread to the Americas. As of 2016, cases were reported in 33 countries and territories, 10 of which resulted in Guillain-Barré Syndrome (GBS, 0.5%) among those affected. Due to ongoing disease outbreaks, the WHO declared a Public Health Emergency of International Concern (February 1, 2016). Unequivocal causality has since been established, linking infection during pregnancy and severe birth defects such as microcephaly and other abnormal central nervous system (CNS) growth. To curb further spread, countries and territories affected by ZIKV increased vector control activities. Moreover, the public health response to ZIKV also included intensive research efforts to develop fast diagnostics and a better understanding of the virus, as well as evidence-based public health messaging.

3.3. COVID-19 Pandemic

The rapid spread of the new coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), led to the COVID-19 outbreak, which was declared a pandemic on March 11, 2020. As of May 21, 2021, more than 166 million COVID-19 cases had been identified, with nearly 3.5 million confirmed deaths in more than 220 countries, territories, or areas of the world. COVID-19 transmission continues at an alarming rate; however, for the first time in 12 weeks, there is a decrease in new cases. The leading three countries by number of confirmed cases are the United States of America, India, followed by Brazil. The emergence of COVID-19 caused many fears and concerns worldwide because both its origin and nature were not well understood. Global scientific efforts have been made to understand and counter COVID-19. Comprehensive studies have explored the virology, epidemiology, and pathogenesis of SARS-CoV-2. This review contains a systematic and thorough examination of COVID-19. The integrated findings will provide the most up-to-date knowledge of COVID-19, including the origin of the pathogen, clinical manifestations, epidemiological investigation, diagnostic approaches, treatment options, and public health measures. Through a systematic review and integrated analysis, the goal is to provide a more comprehensive understanding of COVID-19 and insightful perspectives. This comprehensive

review is distinct from previous narrative reviews conducted for assessing the rapid development of COVID-19 knowledge. The systematic approach was used to extract and evaluate data rigorously. This comprehensive review of data corresponding to scientific studies and public reports is expected to provide the most up-to-date understanding of COVID-19. The description and discussion of the origin and nature of the pathogen, clinical presentations, epidemiological observations, the detection of the pathogen and serology responses, treatment methods, and measures by public health are included. The concurrence of COVID-19 will undoubtedly provide an in-depth and global perspective on epidemiology and health service safety issues. It is suggested that individualized prevention and control plans be established in conjunction with worldwide health organizations and strategies to achieve better protection against COVID-19 through multi-level cooperation. [22][23][24]

4. Public Health Responses and Preparedness

Introduction. Awareness and Timely Response Are Paramount. After the unprecedented 2014-2016 Ebola outbreak in West Africa, several acute flaccid myelitis cases were detected in the US, molecular tests confirmed the presence of enterovirus D68 and other viruses. A SARS-like outcome traced back to a 47-year-old man in Saudi Arabia marked the beginning of the MERS outbreak. In 2015, a large outbreak of Middle East respiratory syndrome was recorded in Korea, likely triggered by a 68-year-old man who returned from a Bahrain visit. A 60-year-old man exposed in a South African monkey farm developed fever, unsteady gait and mental confusion over a one-week period; analysis revealed a new arenaviridae. In May 2015, a man caring for sick animals in Zambia suddenly got sick and died; he was diagnosed with a new type of rhabdovirus. The disturbing reports above may largely convince us that viral innovations represent a lurking danger, and a tight net of knowledge acquisition and rapid reaction is prime for humankind survival [1].

Public health responses and preparedness. Different strategies can be considered to prevent and cope with viral epidemics and pandemics. Many health authorities worldwide run a risk assessment and preparedness plan, a framework to timely implement preventive or containment measures when a dangerous threat is recognized. Transparent and timely communication is a cornerstone of intervention success. Health recommendations addressed to the public must be clear-cut, and the rationale must be easily understood. Vaccination campaigns may represent a very effective strategy. Once cases of rare and groundbreaking diseases are identified, the immediate implementation of an exhaustive contact tracing is essential. Finally, adequate and comprehensive health education measures can represent an essential component of a successful intervention. Troubles then appear. Emerging viral outbreaks are inherently unexpected, and routine is poorly prepared. This is critical since, as a general concern, health resources are limited. Early responses can only rely on the preparedness plans, and a proper net of responders must be set up in a timely and clear way. A great deal of knowledge is needed to implement a straightforward preparedness framework, and much misinformation is still out and about. It is noted, finally, that in most instances the emerging virus will not be confined within a limited area, nor it can be eradicated. This is to say that international collaboration is of the essence, in conjunction with communities mobilization.

Syndromic Evaluation on Practices, Ongoing Developments and Future Perspectives. To increase knowledge on the evolution of virus epidemics, this article has reviewed 11 recent events about people from different countries who were found to be affected by emerging viral infections with mostly fatal outcome. The review provides a single brief picture of how the emergent diseases have evolved from a range of different viruses chronologically over the years (from 2012 to 2017) and what was the global distribution of the events. Based on the tragic outcomes of the patients, a brief description on pharmacological countermeasures is also provided, while in-depth economic, social and psychological repercussions are not considered. This article ends by summarizing lessons learned on practices and quickly pointing at possible ongoing developments and future perspectives which should be pushed forward in order to increase preparedness with rapid

outbreak reactions. [25][26][27]

5. Conclusion and Future Directions

In conclusion, the identification and recognition of emerging viral infections is a dynamic challenge; new etiological agents continue to threaten human health, and common viruses may acquire infection potential through the process of re-emergence. Expanding research activities, observational skills, and diagnostic potentials is crucial in order to identify new viral agents in humans. Continuous surveillance activities in animals with the aim of identifying potential new zonotic viruses characterize a small starting point. An intensified effort is mandatory in order to identify new agents with particularly high epidemicity and lethality. The outbreak of some well-known viruses suggests revisiting the role of drugs in existing viral infections. In the light of new etiological insights, patients can be appropriately treated and contact persons adequately diagnosed and followed up. New information on molecular and pathogenetic features can counteract the unjustified fear of less known infections. As the risk of emerging and re-emerging infections persists, it is imperative to keep with this argumentation, and scientific advancement in this field is expected in the near future.

Future research activities are expected to focus on the characteristics of the etiological agent, the wild fauna and ecosystems involved in the transmission of zoonoses, and host factors contributing to the particular susceptibility of sporadic patients. Public health policies must be vigilant towards the new risk of contagious diseases, and extremely rapid in adopting effective containment measures. The dramatic appearance of new viral diseases in humans is a call to re-establish international collaboration and communication that, in the past, has proven successful in the conquest of terrible afflictions. Research on viral diseases in low-resource and post-conflict countries should be seen from their potential to pose an international threat. However, a part of the actions adopted should be specifically addressed to strengthening local research facilities.

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