Mini Review
Open Access
CrossMark

Emerging and re-emerging infectious diseases – past, present and beyond

Abstract

Surge in infectious diseases either emerging or re-emerging can be seen almost every year. The emergence can occur in different forms such as an adaptation of the organism to provide resistance against an antibiotic or mutation in an existing non-pathogenic strain making it virulent strain or spread of a zoonotic agent to the humans. The advancement in infection only goes on to continue without any hindrance due to the various factors including increased population, intense inter globe travelling, climate change, and loss of habitat. The control of emerging or re-emerging diseases is quite difficult but not impossible, this review underlines the factors responsible for the emergence and possible precautionary measures that can be taken, along-with the detailed mention of various pandemics faced by human kind.

Keywords: emerging, infectious disease, COVID-19, SARS, pandemic, epidemic

Volume 6 Issue 1 - 2021

Jyoti Oswalia,[1] Kavita Vasdev[2]
[1]School of Biotechnology (SBT), Jawaharlal Nehru University, India
[2]Department of microbiology, Gargi College, University of Delhi, India

Correspondence: Kavita Vasdev, Associate Professor, Department of microbiology, Gargi college, (University of Delhi), Siri Fort Road, 110049, New Delhi, India, Tel 91-9811873144, Email atikav@gmail.com

Received: December 12, 2020 | **Published:** January 11, 2021

Introduction

One of the most concerning transitions we encounter due to the modernization of the world is, the emergence and re-emergence of infectious diseases. During the course of time, world has faced some deadly, uncontainable pandemics and epidemics. The very first such disease outbreak ever recorded dates back to CIRCA 3000 BC, "Hamin Mangha" a best-preserved prehistoric -archaeological site in north-eastern China showed the evidence about the origin of an epidemic. The findings of the archaeological studies done at the Hamin Mangha published in the *Cell* magazine in 2015 which revealed the presence of *Yersinia pestis* sequences in the DNA of Bronze age skeleton indicating the plaque provenance by 3000 years.[1]

Next was the ancient pandemic, the Plague of Galen or Antonine Plague (165 AD) the disease was carried by the soldiers who returned to Rome which devastated the population and caused the death of 5 million souls. The next epidemic recorded and faced by the humankind occurred during the war between Athens and Sparta (430-426 BC), the infected individuals suffered eye inflammation with reddening, foul smell with bloody tongue and throat and heat in the head. As time flew, centuries passed, new diseases emerged, generating the fear of death, and agitating the lives, however, with the evolution of civilization of mankind, and the advancement of technologies, the death toll due to infectious disease has declined. During earlier times, there was no existing literature, no information about causative agents, fewer facilities were available for identifying the cause and development of a cure was not possible. Even at the time of writing this review, the world has been facing the adversity of highly disseminating infectious disease caused by the SARS-CoV2, COVID-19.

Timeline of the various epidemics and pandemics

The archaeological study of the Hamin Mangha provided the strong evidence that the humankind is battling with the catastrophe of novel diseases from the early times. Although at that time of pre- historical era or ancient times, the adversity of the disease was constraint to a geographical area as then the travelling between the continents was not as convenient as it is now. So, the widespread of the infection was restricted but the severity of the infection was unmeasurable, as it spread vastly between the populations at the site of origin of the infection. If we peruse the timeline of various pandemics and epidemics, we will recognize a pattern that shows that as the humans step up in civilization and modernization, the emergence of novel infectious diseases also escalated, as in 16th century there was emergence of only 2 pandemics and in 21th century 7 disease calamities have been recorded so far.

Major Global pandemics occurred over the time[1–8]

Sl.no	Name of epidemic/ pandemic	Year	Spread of disease/ infection sites	Cause	Death toll	Mode of transmission
1	Pre-historic epidemic/ Hamim Manga epidemic	3000 BC	China	Yersinia pestis	50 Million	Personal Contact
2	Plague of Athens	430-426 BC	Greece and eastern Mediterranean	measles, Ebola, typhoid fever? Unknown	Upto 100,000	Personal contact/ Rats
3	Antonine Plague /Plague of Galen	165-180 AD	Rome (origin- China)	Smallpox or Measles Unknown	5 Million	Rodents

Table Continued...

Sl.no	Name of epidemic/ pandemic	Year	Spread of disease/ infection sites	Cause	Death toll	Mode of transmission
4	Plague of Cyprian	250-271 A.D.	Rome, Greece, Syria	Small pox, Bubonic plague?	5000 deaths/day	Personal contact/
				unknown		Rodents
5	Plague of Justinian	541-542 A.D	Europe,	Yersinia pestis	30-50 Million	Rodents
	1st Pandemic of Bubonic Plaque		Eastern Mediterranean			
6	Japanese smallpox epidemic	753-737 A.D	Japan	Pox virus (variola)	1 milion	Personal contact
7	The Black Death	1347-1351	Asia to Europe	Yersinia pestis	200 Million	Rodents
	2nd Pandemic of Bubonic plaque					
8	Smallpox	1492-1980	Europe, Africa, America, Austraia, Asia	Pox virus	56 Million	Personal contact
	(11th, 15th to 18th century)					
9	Cocoliztili epidemic	1545-1448	Mexico	Viral hemorrhagic fever (VHF) – Salmonella paratyphi C	15 Million	Personal contact
10	American Plaques	16th Century	Europe to America	One of the illes was Smallpox	-	-
11	The Italian Plaque	1629-1631	Italy	Bubonic plaque- Yersinia pestis	280 Thousand	rodents
12	Great Plague of London	1665-1666	London	Bubonic plaque- Yersinia pestis	100 Thousand	Rodents/Fleas
13	Great Plague of	1720 to 1723	Marseille/ western Europe	Bubonic plague / Yersinia pestis	100 Thousand	Rodents/ Fleas
	Marseille					
14	Russian Plague	1770 to1772	Moscow	Bubonic plague / Yersinia pestis	100 Thousand	Rodents/flea?
15	Philadelphia yellow fever epidemic	1793	United States of America	Yellow Plague	5,000	Mosquitoes
16	CHOLERA PANDEMICs	1817-1923	1st – India	Vibrio cholerae	1 Million	Contaminated water/ Rodents
	1817	(6 outbreaks of Cholera)	2nd – Europe, America			
	1829		3rd - Asia, Europe, North America and Africa			
	1852-1859		4th-Europe			
	1863–1875		5th- Germany			
	1881–1896		6th- India, Russia, the Middle East and northern Africa			
	1899–1923					
17	Third Bubonic plague pandemic	1855-1960	China, India	Yersinia pestis	15 Million	Rat flea bites
18	Flu Pandemic	1889 to 1890	Asia and Russia	Influenza virus	1 Million	-
	Asiatic / Russian Flu			H2N2		
19	American Polio epidemic	1916	USA	Polio Virus	6000	-
			New York city			
20	Spanish Flu	1918-1920	Spain	Influenza virus	40-50 million	Avian
				H1N1		

Citation: Oswalia J, Vasdev K. Emerging and re-emerging infectious diseases – past, present and beyond. *MOJ Biol Med.* 2021;6(1):5–8. DOI: 10.15406/mojbm.2021.06.00121

Table Continued...

Sl.no	Name of epidemic/ pandemic	Year	Spread of disease/ infection sites	Cause	Death toll	Mode of transmission
21	Asian Flu - Pandemic	1957-1958	China	Influenza virus H2N2	1.1 Million	Avian
22	Hong-Kong Flu	1968-1970	Hong Kong	Influenza virus H3N2	1 Million	Avain
23	AIDS pandemic Epidemic	1981-Present (Peak years 2005-2012)	Global Originated in Democratic Republic of the Congo	chimpanzee virus- HIV	25-35 Million	Sexual contacts
24	SARS	2002 -Present day	China	SARS -CoV	770 Thousands	Bats
25	Swine Flu pandemic	2009-2010	Global Originated in Mexico	Influenza virus H1N1	2,00,000	Swine
26	MERS	2012- Present	Arabian peninsula	MERS-CoV	850 Thousands	Camels
27	West African Ebola epidemic	2014 - 2016	West Africa First case - Sudan and the Democratic Republic of Congo	Ebola virus	11.3 thousands	Bats
28	Zika Virus epidemic	2015- Present	South Africa and Central America	Zika virus	Variable no definite data	Spread through Mosquitoes & Sexual contacts
29	COVID-19	2019 Present day	Global Started in China	SARS-CoV-2	Bats/ Civet Cats/ Pangolin	1.09 Millions(as on 15/10/2020) On going

What accounts for emergence and reemergence of infectious diseases?

In the last 20 years, we have seen the emergence and re-emergence of both bacterial, viral diseases, and vector transmitted viral diseases at the global level including on-going COVID-19, Severe Acute Respiratory Syndrome **(**SARS**)** originated from China, Middle East respiratory syndrome coronavirus (MERS-CoV) in the Middle East, Ebola virus disease in Africa, Zika virus disease, chikungunya, yellow fever and dengue in the Americas, West Nile fever, and Japanese encephalitis.[9] Our environment harbors a diversity of microorganisms including both pathogenic and non-pathogenic to humankind.

The emergence and re-emergence of infections involve both viral and bacterial diseases. Emerging infectious diseases are the diseases which are novel or unknown and have not been recognized, whereas remerging infections are the disease caused by the known causative agent which once has occurred and declined to a level that the disease was perceived to be ceased and some variant of the causative agent or any mutation in their genome caused their re-emergence.

Many factors account for the emergence and re-emergence of infectious diseases, however, the most crucial reasons which can be said to be the source of other factors is the increased population or enhanced movement of humans all over the globe and environmental changes. Over-population and the rapid spread of human contributes to the spread of infectious diseases, this can be said due to the following grounds. Overpopulation leads to higher demands of lands, overcrowding with poor sanitation, increased travel around the world.[10] To fulfil the surged demands forests are wiped out, deforestation is frequent that causes the loss of the natural habitat of animals and microorganisms.

Changes in human behaviour also have a part to play in contracting the pathogen. One such behavioural notion is "Experimentation with food" which motivates the people to eat far-reached, forbidden, or hard to get food products. In curiosity, we tend to try new things including poisonous/dangerous fruits or animals which are the natural reservoir of zoonotic microorganisms. Animals are the natural reservoir of Zoonotic agents which are not harmful to their host but can cause disease in human via direct contact, scratch or consumption of the animal meat [11] and the best example of this such scenario is none other than the COVID-19 pandemic, resulted from a single person eating the bat soup.Globalization and intense traveling around the globe also provided the opportunity to the pathogens for their easy dissemination. Easy access to the exotic location again enhanced the exposure between the host and novel pathogen.

Another crucial factor is environmental alterations, Our environment is the reservoir of infinite kinds of organisms whether pathogenic or non-pathogenic. Change in natural habitat provides the coercion to mutate to survive resulting in the conversion of a human non-pathogenic organism into a disease-causing agent.[12] Destruction of the natural ecosystem exposes us to all kinds of potentially pathogenic species, disease vectors, or vice versa. Another factor that causes the emergence of pathogenic strains is the evolution of

Citation: Oswalia J, Vasdev K. Emerging and re-emerging infectious diseases – past, present and beyond. *MOJ Biol Med.* 2021;6(1):5–8.
DOI: 10.15406/mojbm.2021.06.00121

established pathogens trying the bypass the drugs used to treat them[13] resulting in generation of multidrug resistant strains multidrug-resistant or extensively resistant tuberculosis, extended-spectrum β-lactamase E. coli and vancomycin-resistant enterococci.

Climate change also leads to an increase in vector-borne diseases such as chikungunya and dengue due to the changes in vector biology, their persistence, and expansion to new areas with better and easy transport systems.[14] An excellent example of this is provided by the spread of ongoing COVID-19, which originated in the city Wuhan, China got spread around the globe by the travellers who flew from there in different locations and acted as the carrier of the virus. Similarly, global warming aids in growth of algal blooms which seems to be associated with growth and epidemic of cholera.[15]

Control of emerging infectious diseases

Vaccination, chemotherapy, and prophylaxis can be said to be the three major pillars for the containment of any disease. These three norms should be accompanied by the quarantine, isolation of the infected person and, social distancing. However, with EIDs, it is very difficult as they are caused by the novel, undocumented and untreated pathogen which may not have vaccines or drugs at our disposal at the time of the emergence. A scrutinized investigation is required to find even a single therapeutic molecule to reduce the burden of illness without having any adverse effects.

For EIDs, the most significant action will be the active surveillance and proper documentation of the cases which together with the help of social networks media, epicenters of infection can be determined.[16] An effective disease surveillance system will provide the information about the most common symptoms, susceptible age groups, meaningful interventions and, the possible cause of the outbreak.[17]

A scientifically validated message should be delivered(Infomation dissemination) to the population about the risks of emerging diseases and people need to be encouraged to seek medical care after exposure and comply with general preventivemeasures[11] Lastly, the ecosystem needs to be maintained rather than destroying it for personal use and pleasure. Deforestation needs to be controlled, the loss of the natural habitat of the organism should be avoided and efforts should be made to save the environment.

Conclusion

Ongoing pandemic made us realize that we are still not ready or equipped to face global adversity. The situation with the emergent disease is complex as we do not have the vaccine at our hands to combat the disease. The first requirement for the protection against infection is the implementation of an effective disease surveillance system even in remote areas with amicable health practices. This will require co-ordinated efforts among, clinicians, para-medical staff, patients and communities in diagnosis, sharing of information about symptoms, therapy as well as maintainence of data about prevalence and spread of disease. Unique skill sets, of paramedical staff and nurses brought to health care settings can enhance the ability to assess patients for EID as well as promote health in the community.[18]

Targeted screening for migrants arriving from or moving to different areas can be frontline defense. Being knowledgeable about emerging infections increases the ability to include these in differential diagnoses in clinical practice as well as recognizing best practices in care through evidence-based resources. Personal protective measures include regular hand washing and proper drying of hands, respiratory hygiene, early self-isolation, and avoid the touching of the eyes, nose, or mouth. All health care providers must use airborne precautions 18 Adequate Personal Protection Equipment (PPE) should be manufactured and present all the time for the health workers.

Establishment of well- equipped laboratories, with level 4 safety biosafety cabinets and trained technicians to carry out sensitive tests like RT-PCR for the diagnosis and identification. International collaboration with inter-institutional and inter-continental will help in sharing in-conclusive results, which will benefit in the development of a vaccine. Last but not the least management of infectious diseases involves providing Antiviral drugs like Neuraminidase can reduce the onset and duration of spread if provided within 48 hrs.

Acknowledgments

None.

Conflicts of interest

The authors declare that there is no conflict of interest.

Funding

None.

References

1. Bronze Age Skeletons Were the Earliest Plague Victims - Scientific American. 2020.
2. Infographic: The History of Pandemics, by Death Toll. 2020.
3. History of Smallpox. Smallpox. CDC. 2020.
4. Cholera - HISTORY. 2020.
5. MPHonline. Outbreak: 10 of the Worst Pandemics in History. Masters Public Heal Online. 2020.
6. 20 of the worst epidemics and pandemics in history. Live Science. 2020.
7. The World's Deadliest Plagues and Pandemics. 2020.
8. Lakshman M, Rachana M. Global Epidemics and Pandemics in the Light of Civilization, Colonization and Globalization Its Impact on Environmental Health To Contain COVID -19 One Heath Approach is Mandate: A. 2020.
9. Ogden N, Gachon P. Climate change and infectious diseases: What can we expect? *Canada Commun Dis Rep*. 2019;45(4):76–80.
10. Bloom DE, Black S, Rappuoli R. Emerging infectious diseases: A proactive approach. *Proc Natl Acad Sci USA*. 2017;114(16):4055–4059.
11. Vouga M, Greub G. Emerging bacterial pathogens: The past and beyond. Clin Microbiol Infect. 2016;22(1):12–21.
12. Lessler J, Orenstein WA. The Many Faces of Emerging and Reemerging Infectious Disease. *Epidemiol Rev*. 2019;41(1):1–5.
13. Marston HD, Dixon DM, Knisely JM, et al. Antimicrobial resistance. JAMA - J Am Med Assoc. 2016;316(11):1193–1204.
14. Paixão ES, Teixeira MG, Rodrigues LC. Zika, chikungunya and dengue: The causes and threats of new and reemerging arboviral diseases. *BMJ Glob Health*. 2018;3:1–6.
15. Epstein PR. Algal blooms in the spread and persistence of cholera. *BioSystems*. 1993;31(2-3):209–221.
16. Chunara R, Andrews JR, Brownstein JS. Social and news media enable estimation of epidemiological patterns early in the 2010 Haitian cholera outbreak. *Am J Trop Med Hyg*. 2012;86(1):39–45.
17. Low N, Bender N, Nartey L, et al. Effectiveness of chlamydia screening: Systematic review. *Int J Epidemiol*. 2009;38(2):435–448.
18. CDC Seasonal flu vs. pandemic flu. 2018.