

EMERGING OF RNA VIRUSES: A THREAT OF EPIDEMICS AROUND-THE-CLOCK

Jagtar Singh and Shweta Sinha

Department of Biotechnology, Panjab University, Chandigarh, India.

Corresponding author: jagtar72@gmail.com

ABSTRACT

Viral infections are global public health concern and RNA viruses are the major cause of morbidity and mortality across the world due to their high error rate of replication and better adaptability inside the host cell. Some of the recent viral outbreaks around the globe are mainly hepatitis and its subtypes, influenza and its subtypes, Japanese encephalitis, dengue, ebola and the chikungunya. Vaccines are available only for some of these diseases. Therefore, organisation comprising WHO in accordance with the International Health Regulations of 2005 keeps on to track the evolving infectious diseases and the Global Outbreak Alert and Response Network, establishes the human and technical resources to diagnose these outbreaks and thereby check the virus growth. In this review article, we are discussing the outbreaks, precautions along with the appropriate preparedness of individual as well as the government for dealing with these viral diseases.

Key words: Ebola, hepatitis, influenza, outbreaks, RNA viruses

INTRODUCTION

The small infectious organisms, viruses were first introduced by Martinus Willem Beijerinck in 1898 and he was awarded the Nobel Prize for it. He described the mosaic disease of tobacco as a *contagium vivum fluidum* that now a days is well known as Tobacco mosaic virus (TMV). He also observed that the virus could diffuse through agar and could not be cultured except in living and growing plants (Scholthof, 1898). Wendall Stanley had isolated the TMV crystals in 1946 and was also awarded the Nobel Prize for the same (Scholthof, 2000). TMV was the first virus to be purified in pure crystal form thereby first to be passed through filter candles, and the first virus to be identified having an infectious nucleic acid. This revolutionised the research on genetic information and biological role of virus encoded protein and gave the concept of virology.

Viral infections are a global public health concern as they are a major cause of morbidity and mortality across the world. Currently, due to changes in the global landscapes and local environments, these microbes are also undergoing evolution. The causative agents of the most of the viral outbreaks are the RNA viruses that can quickly modify themselves to these varying conditions. These modifications are due to the high error rates of the virus polymerases that replicate their genomes. However, a complex interplay of genetic variations (mutation, recombination) as well as environmental factors (ecological, social, and behavioural influences) can also play important roles in their evolution. Furthermore, the advancement in the global transportation of biohazard materials and their accidental spills combine to increase the opportunity for emergence and re-emergence of viral diseases (Nichol *et al.*, 2000). Almost all the viral infections have asymptomatic or subclinical manifestations but may become fatal in the severely immunocompromised recipients (Lin and Liu, 2013). Therefore, to circumvent the viral infections an effective innate immune response is required in order to trigger an efficient antiviral defence. Fortunately, active participation of organisations such as World Health Organisation (WHO), keeps a track on the evolving infectious diseases, arouse global alert, share knowledge and skill and organise the quick response that needed to protect populations from the consequences of epidemics. The International Health Regulations (IHR, 2005), substructure the WHO epidemic alert and also assist them to strengthen international public health security and the Global Outbreak Alert and Response Network (GOARN) establishes the human and technical resources for the rapid identification, confirmation and response to these outbreaks, *etc.* (www.who.int). The advancements in molecular biology techniques have led to the discovery of various sophisticated instruments for detecting virus, such as polymerase chain reaction (PCR) and reverse transcriptase PCR which facilitate the early diagnosis of viral infections (Sahin *et al.*, 2013). In this article, we are going to review some RNA viral diseases (influenza, hepatitis, Japanese encephalitis, dengue, ebola and chikungunya) in brief.

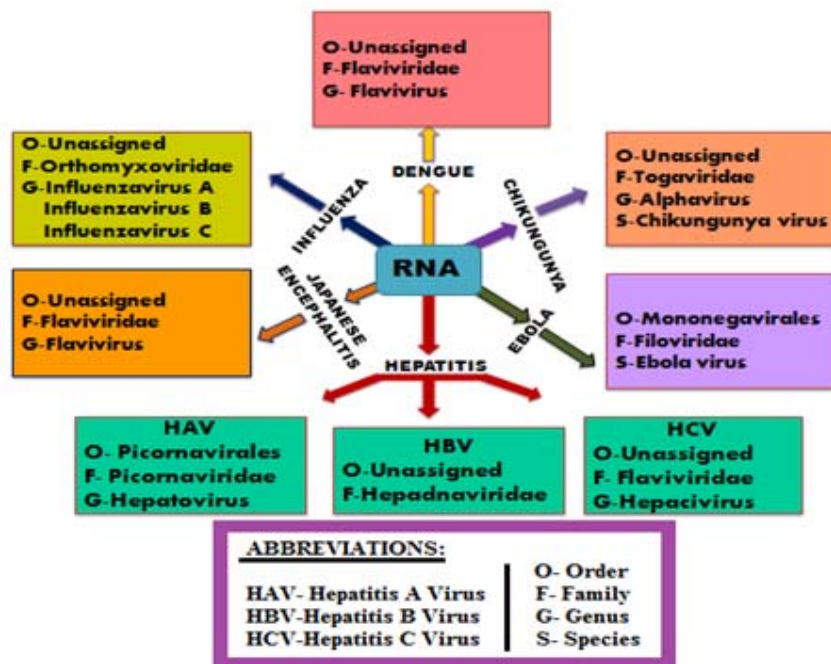


Fig 1: Classification of RNA viruses.

Influenza Virus

Charles-Jules-Henri Nicolle (1866–1936) first isolated human influenza virus and got the Nobel Prize for the same (Schultz and Morens, 2009). The Influenza word is originated from the Italian language meaning "influence" and was first used in English in 1703 by Jon Hugger (www.influenzavirusnet.com). Influenza (flu) is a contagious viral infection (Table 2) that affects mainly the nose, throat, bronchi and occasionally the lungs. Infection usually lasts for about a week, and is characterized by sudden onset of high fever, muscles ache, headache and severe malaise, dry cough, sore throat and rhinitis (www.who.int). The incubation period of virus lasts for 1-4 days (www.cdc.gov). Influenza epidemics affect almost all the populations, but the children (≥ 2 years), adults (≤ 65 years), pregnant women, sick person are at the highest risk of complications. Classification of some RNA viruses has given in fig. 1.

Virus structure

Human influenza viruses are ssRNA viruses and are composed of 8 ssRNA segments having a diameter range between 80-120 nm (Clancy, 2008). They consists of the genera labelled A, B, and C (Fig 2).

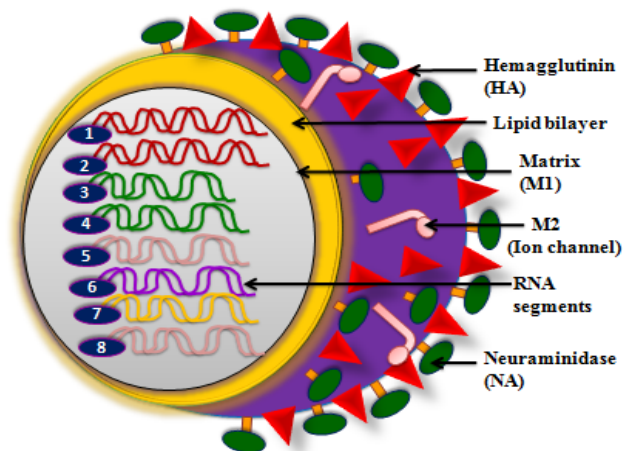


Fig 2: Structure of Influenza virus.

Further, Type A influenza viruses are divided into subtypes on the basis of the presence of two surface proteins mainly the hemagglutinin or “H” protein and the neuraminidase or “N” protein. Type C influenza cases occur much less frequently than A and B, therefore only type A and B are included in seasonal influenza (Khanna *et al.*, 2014).

In humans, A(H3N2) and A(H1N1) viruses are found. In USA, 2009 influenza pandemic was first detected as A(H1N1) virus (Table 1). Over the past decades, multiple instances of sporadic transmission of influenza viruses between animals and humans such as avian influenza virus subtypes A(H5N1) and A(H9N2), swine influenza virus subtypes A(H1N1) and A(H3N2) have been reported. These changes may be due to “antigenic drift and antigenic shift”. Antigenic drift are small changes in the genes of influenza viruses that occur continually after each virus replication whereas antigenic shift is an abrupt or major change in the viruses, resulting in new H or N proteins that infect humans (www.cdc.gov). In 2011, A(H3N2) began circulating from swine to human in the USA, they were labelled “variant” to distinguish them from human virus. Other animal viruses infecting humans are, avian influenza A(H5N1), A(H7N7), A(H7N9) and A(H9N2) and simply called “avian influenza” or “zoonotic influenza” viruses.

Globally, around 3-5 million cases of severe illness and about 2,50,000 to 5,00,000 deaths occur because of these annual epidemics. In 1918-1919, the most notorious pandemic from H1N1 was the “Spanish Flu” which caused an estimated 20-50 million deaths worldwide. In India, the first case of influenza A(H1N1) was reported in Hyderabad on May 16, 2009 and WHO declared the post pandemic phase on August 10, 2010 (www.mohfw.nic.in). In 2014, out of 32 positive cases, only one death due to swine flu (H1N1) has been reported in Delhi. Time line of outbreaks of viral diseases is given in table 1.

Avian influenza

The first chronicle of avian influenza dates back to 1878 in Northern Italy (Lupiani and Reddy, 2009). The highly pathogenic avian influenza (HPAI) H5N1 first emerged in 1996 in Eastern Asia. In India, the first H5N1 outbreak was reported in January 2006 in the Navapur District (Maharashtra) and in December 2014, it was identified near Sukhna Lake, Chandigarh. The samples were tested at the National Institute of High Security Animal Diseases, Bhopal and the virus had been confirmed to be H5N1. The H5N1 has also spread to 8 different states including Gujarat, Madhya Pradesh, Manipur, West Bengal, Tripura, Sikkim and Assam (Chakrabarti *et al.*, 2009; Pawar *et al.*, 2012). In West Bengal, fifty four H5N1 outbreaks in poultry were reported between January 2006 and August 2010 making it the highest incidence state in India. Currently, H5N1 outbreaks are only restricted to poultry except for outbreaks in Jungle Crow (*Corvus macrorhynchos*) in February 2012 (www.oie.int). This indicates that wild and migratory birds can introduce HPAI to domestic poultry that shared common habitat but the likelihood of HPAI outbreaks can be greatly reduced by the process of swift culling within a kilometre radius of the outbreak spot (Pandit *et al.*, 2013). The Department of Animal Husbandry, Dairying & Fisheries has also proposed the Standard Operating Procedures (SOPs) to curb the disease outbreak that includes isolation, quarantine, restricted access for new birds along with cleaning, sanitation, personnel hygiene, poultry manure disposal, dead bird’s disposal by rendering burial or incineration, *etc.*

Present swine flu outbreak in India

The total number of H1N1 deaths was 1,587 out of 27,889 lab confirmed cases upto 13 March 2015. A study done by Massachusetts Institute of Technology (MIT), USA, has declared mutation in H1N1 strain from those of 2009 outbreak, however it was rejected by the National Institute of Virology (NIV), Pune, by analysing six full genomes of the virus (www.nihfw.org). Most of the cases were reported from Delhi, Gujarat, Rajasthan, Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu and Telangana while the death toll was high in Maharashtra, Madhya Pradesh, Gujarat, Rajasthan and Telangana, as reported by the Ministry of Health & Family Welfare (MOHFW). Integrated Disease Surveillance Programme (IDSP) assisting 12 laboratories and ICMR facilitate 9 labs to test for H1N1 cases. In addition, NCDC (National Centre for Disease Control) provided the diagnostic kits and viral transport medium kits to the States Governments to circumvent the viral outbreak. Oseltamivir (Tamiflu) or Zanamivir (Relenza) drug recommended by WHO was made available free of cost to the public health system (mohfw.gov.in). The H1N1 vaccines testing was undertaken by the Central Drug Laboratory, Kasauli (National Control Laboratory) and declared to be of standard quality. The vaccine included VaxiFlu S, manufactured by Zydus Cadila Health Care Limited; inactivated and live attenuated H1N1 vaccine Nasovac manufactured by Serum Institute of India Limited, Pune (pib.nic.in).

Vaccination is the most effective way to prevent the disease, can be egg based or cell-line based vaccine. Another advanced and alternative method of influenza vaccine production is the recombinant DNA technology in which virus hemagglutinin (HA) is produced in insect cells by a recombinant baculovirus. This is an efficient protein expression method which is under the control of the baculovirus polyhedron promoter that facilitates the use of high doses of HA in the vaccine (Lakey *et al.*, 1996; Powers *et al.*, 1997). Several studies have also found various methods for the production of influenza virus-like particles (VLP). VLPs are non-replicating particles that spontaneously self-assemble from expressed influenza virus proteins that can be used as vaccine candidates for both seasonal and pandemic influenza (Schmeisser *et al.*, 2012). Other methods of diagnosis, remedies and preventions are provided in table 3b.

Table 1: Timeline of outbreaks of viral diseases.

S.N.	Viral diseases	Year/ Period (Strain)	Places	Death toll	References
1	Influenza	1918 (H1N1)	United States (Spanish flu)	≈675,000	www.flu.gov
		1957-58 (H2N2)	United States (Asian flu)	≈70,000	
		1968-69 (H3N2)	United States (Hong Kong flu)	≈34,000	
		1997 (H5N1)	Hong Kong	6	www.niaid.nih.gov
		2004 (H5N1)	Thailand and Vietnam	34	
		2005 (H5N1)	Cambodia	4	
			Worldwide	74	
		2006 (H5N1)	Sub-Saharan Africa.	79	
		2007 (H5N1)	Indonesia, Cambodia, China, Lao People's Democratic Republic, Myanmar, Nigeria, Pakistan and Vietnam	59	
		2009-2010 (H1N1)	United States	8,870 and 18,300	
2014-2015 (H1N1)	India	1,587	www.nihfw.org		
2	Hepatitis E	1983	Namibia	7*	Isaacson <i>et al.</i> , 2000
		2007-2009	Uganda	160	Teshale <i>et al.</i> , 2010
		2012-2013	Sudan	111	CDC, 2013
	Hepatitis D	1988	India (South Kashmir)	7	Khuroo <i>et al.</i> , 1988
	Hepatitis B	1997	India (Gujrat)	15*	Singh <i>et al.</i> , 1998
	Hepatitis B and C	1998–2008	United States	448*	Thompson <i>et al.</i> , 2009
		2009	India (Gujrat)	49	Patel <i>et al.</i> , 2012
Hepatitis A	2013	United States	165*	Collier <i>et al.</i> , 2014	
3	Japanese encephalitis	1978-2001	Nepal	5,381	Bista and Shrestha, 2005
		1995	Australia	110*	Hanna <i>et al.</i> , 1995
		2005	India (Gorakhpur, U.P.)	1,344	Parida <i>et al.</i> , 2006
4	Dengue	2014	Malasia	190	www.dengue.info
5	Ebola	2014	West Africa	6346	www.cdc.gov
6	Chikungunya	2006	India	≈70000*	www.nvbdc.gov.in
		2013	Caribbean, Central and South America	795,000*	www.cdc.gov

*-cases ; ≈ approximately equal

Hepatitis Virus

The word *hepatitis* comes from the ancient Greek word *hepar* meaning 'liver', and Latin word *itis* meaning 'inflammation'. There are mainly five types of hepatitis (A,B,C,D,E) caused by different viruses. Hepatitis G is also found in the population but very rarely. In 1963, hepatitis B virus was detected by Baruch Blumberg in the blood sample by using an antigen (www.cevhap.org). Hepatitis A virus was detected in 1973 by Steven M. Feinstone (www.who.int), hepatitis C virus was isolated in 1989, hepatitis E virus in 1990 by Mohammad Sultan Khuroo (2011) and hepatitis G virus in 1965.

Virus structure

HAV is the smallest, unenveloped symmetrical RNA viruses with a diameter of 27-32 nm, composed entirely of viral protein and RNA (Hollinger and Ticehurst, 1996). The hepatitis B virus has core antigen viral genome (HBcAg) of approximately 3.2 kb in length surrounded by an outer lipoprotein coat containing the HBsAg (Ganem and Schneider, 2001; Gitlin, 1997) (Fig 3). The genome of HCV comprises around 10,000 nucleotides of sense RNA and lacks a 3' polyA tail. The HDV genome is a 1679 nucleotides closed circular RNA molecule and resembles those of the satellite viroids and virusoids of plants. Hepatitis E virus was found to be 7.5 kb in length and that was cloned in 1991 (Zuckerman, 1996).

Table 2: Mode of transmission of viral diseases.

S.N.	Viral Diseases	Mode of Transmission
1	Influenza	Direct contact with infected individuals, fomites and inhalation of virus-laden aerosols (Mubareka <i>et al.</i> , 2009).
2	Hepatitis A	Contaminated food and water
	Hepatitis B	Contaminated blood, needles, sex and from pregnant mothers to their offspring.
	Hepatitis C	Contaminated blood and needles.
	Hepatitis D	Must already have hepatitis B and from pregnant mother to their offspring. Infected blood, body fluids, sex, and needles.
	Hepatitis E	Contaminated water (www.cdc.gov).
3	Japanese encephalitis	Infected mosquito (mainly <i>Culex tritaeniorhynchus</i> , <i>C. vishnui</i> and <i>C. pseudovishnui</i>) transmits the virus (JEV) to humans and animals during biting at night (Hills <i>et al.</i> , 2014).
4	Dengue	Infected mosquito (mainly <i>Aedes aegypti</i> and <i>Aedes albopictus</i>) transmits the virus (DENV) to humans and animals during biting at daytime (Staples and Fischer, 2014).
5	Ebola	The natural reservoir host of ebola viruses has not identified yet, although as per scientists, the infection may first transfer to the patient that are in contact with an infected animal (fruit bat or primate), which is called a spillover event (www.cdc.gov).
6	Chikungunya	Infected mosquito (mainly <i>Aedes aegypti</i> and <i>Aedes albopictus</i>) transmits the virus (CHIKV) to humans and animals during biting at daytime (Staples and Fischer, 2014).

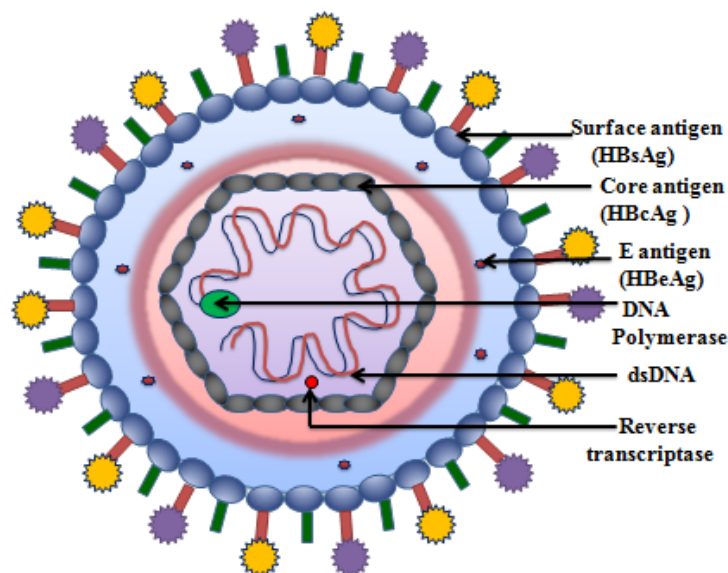


Fig 3: Structure of Hepatitis B virus.

Globally, around 250 million people are affected by hepatitis C and 300 million people are hepatitis B carrier along with 1.4 million cases of hepatitis A every year (www.who.int). Hepatitis A and E are caused by hepatitis A Virus (HAV) and HEV (Table 2). Epidemic in Shanghai in 1988 estimated to affected about 3,00,000 people. Hepatitis B, C and D spread by HBV, HCV and HDV. In the early 2009, hepatitis B epidemic spread in Modasa, Northern Gujarat (Table 1), India in which over 125 people were infected and up to 49 people were died (Patel *et al.*, 2012). Furthermore, hepatitis B surface antigen (HBsAg) prevalence ranges from 2- 8% of the population that ranked India in the intermediate HBV endemic zone and 50 million people are HBV carriers that place India to second position after East Asia in chronic HBV infections (Gupta *et al.*, 2008). HEV is also an important cause of large epidemics of acute hepatitis E in the subcontinent of India, Central and Southeast Asia, the Middle East, parts of Africa and elsewhere.

According to the IDSP of the NCDC, about 1,19,000 cases in 2012 and 2,90,000 cases of acute viral hepatitis in 2013 were reported in India (NCDC Newsletter, 2014). All types of hepatitis having common symptoms including fatigue, flu-like symptoms, dark urine, light-colored stools, fever, and jaundice. The incubation period of HAV is about 15-45 days, HBV from 45-160 days, and HCV from about 2 weeks to 6 months (www.cdc.gov). The methods of diagnosis, remedies and preventions are provided in table 3a.

Table 3a: Diagnosis, remedies and preventions of hepatitis.

Viral Disease	Diagnosis	Remedies	Precautions
Hepatitis	Serologic tests comprises immunoelectron microscopy, complement-fixation, immune adherence hemagglutination, radioimmunoassay and enzyme immunoassay (Gelderblom, 1996)	Vaccine available only for hepatitis A and B.	Depends upon the type of hepatitis.
Hepatitis A	HAV cultured in hepatocarcinoma cell line (Huh7 cells) (Konduru and Kaplan, 2006)	Avaxim (Aventis Pasteur India Ltd.) and Havrix (Glaxo Smithkline Pharmaceuticals Ltd.) (www.medindia.net)	Safe drinking water, proper sewage disposal, personal hygiene practices.
Hepatitis B	HBV cultured in primary human hepatocytes that are fused with HepG2 cells to establish hybrid HepCHLine-4 cell line (Jiang <i>et al.</i> , 2009)	yeast-derived, recombinant DNA vaccine, Shanvac-B® for hepatitis B (Chakma <i>et al.</i> , 2011).	For HBV, HCV and HDV prevention, sharing of personal items (razors or toothbrushes), needles or other drug equipment should be avoided.
Hepatitis C	HCV cultured in Huh7 cells (Kato <i>et al.</i> , 2006)	NA	
Hepatitis D	HDV cultured in hepatocytes from chimpanzee liver (Sureau <i>et al.</i> , 1991)	NA	
Hepatitis E	HEV cultured in Alexander hepatoma cells PLC/PRF/5 and A549 cell line (Okamoto, 2011)	NA	Safe drinking water, proper sewage disposal, personal hygiene practices.

NA- not available

Japanese Encephalitis Virus

It is a brain inflammation caused by encephalitis virus (EV) that was first described in Japan from the 1870s onwards and first isolated in 1935 in Asian countries (Solomon *et al.*, 2003). JEV is widely distributed in Japan, South Korea, China, Taiwan, Vietnam, Philippines, India, Nepal, Sri Lanka (Mackenzie *et al.*, 2005). In 2005, Japanese encephalitis outbreaks in Gorakhpur (U.P.) killed around 1,344 people among which children being in higher numbers (Table 1) (Parida *et al.*, 2006).

It is primarily a childhood disease (age \geq 15), as they are yet to acquire partial immunity against this virus (Table 2). Other vertebrates like birds and pigs can also get infected by this virus (Hennessy *et al.*, 1996). The central nervous system gets severely infected after viral contact and causes death in 10,000 out of 35,000 infected people each year. Only about 30% of the people survive after infection but they develop paralysis, brain damage or other permanent deformity (Solomon *et al.*, 1998). The methods of diagnosis, remedies and preventions are provided in table 3b.

Dengue Virus

The dengue fever is a very old disease, has re-emerged in the past 20 years with an expanded geographic distribution (Gubler, 1998). In 1943, Ren Kimura and Susumu Hotta first isolated the dengue virus from blood samples of patients during dengue epidemic in Nagasaki, Japan (www.nature.com). The dengue word originated from the Swahili phrase 'Ka dinga pepo', that has been supposed to be transferred from Africa to the Caribbean in 1827. In Cuba, 'dinga' in Spanish called dengue, meaning fastidious or careful (Rigau-Perez, 1998).

The Dengue Hemorrhagic Fever (DHF) is the first known epidemic that occurred in Manila, Philippines, in 1953 to 1954, but within 20 years the disease in epidemic form had spread throughout Southeast Asia and in 1970s, dengue was reintroduced to the Pacific Islands (Gubler, 1998). The data provided by NVBDCP (www.nhp.gov.in) and by NIV (Cecilia, 2004) shows that dengue has been endemic in 16 states since the beginning and during 2010-2012, it spreads to the remaining states.

The infections are caused by four closely related viruses named DEN-1, DEN-2, DEN-3, and DEN-4 sharing same geographical and ecological niche (Muruganathi and Ramyachitra, 2014). The blood of infected individual was sucked by mosquito (Table 2) and virus travels from the mosquito's stomach to its salivary glands where they multiply. These viruses then enter into another person after its bite. The mosquito remains able to transmit dengue for its entire life (Kautner *et al.*, 1997). The disease is more prone to the low-lying and flooded region which provides a breeding ground for mosquitoes. The majority of deaths are due to the development of DHF and Dengue Shock Syndrome (DSS). People who develop DHF have a 5% chance of death but if they develop DSS then the mortality rate can rise as high as 40%. According to WHO, the DHF include fever or history of acute fever lasting for 2-7 days, bleeding (haemorrhagic tendencies), thrombocytopenia (1,00,000 cells per mm³ or less), evidence of plasma leakage due to increased vascular permeability. The DSS symptoms in addition to these four criteria must have evidence of circulatory failure together with rapid and weak pulse, hypotension, cold clammy skin and restlessness (www.who.int). The methods of diagnosis, remedies and preventions are provided in table 3b.

Ebola Virus

The ongoing ebola outbreak of West Africa is one of the largest ebola outbreaks in the history. Peter Piot and his colleagues from Belgium were the first ones known to identify ebola in 1976 from human blood that had been taking a toll on people's lives in the forests of Zaire (www.nature.com). The origin of word '*Ebola*' comes from the Ebola River in Zaire/Democratic Republic of the Congo. The outbreak began in Guinea in December 2013, but was not detected until March 2014 and now it is affecting four countries in West Africa: Guinea (2,412), Liberia (4,806), Nigeria (8), and Sierra Leone (3,907). There are total 26,999 case count and about 14,973 people has confirmed laboratory tests (www.cdc.gov). The outbreak is caused by the Zaire ebolavirus, also known as the Ebola Virus (EBOV) (Table 2). CDC owns a patent on a particular strain of ebola known as 'EboBun' having patent No. CA2741523A1 in 2010.

Types of ebola virus

There are five antigenically distinct ebolaviruses that cause hemorrhagic fever in humans or non-human primates namely ebola virus (1976), Sudan virus (1977), Reston virus (1989), Tai Forest virus (1994) and Bundibugyo virus (2007). Ebola virus has continuous filamentous structure of 970 nm long having 80nm diameter. The -ve RNA strand is about 18-19 kb in size and encodes for seven proteins (viralzone.expasy.org). During a research in Canada, the vaccines against this family were prepared on the basis of recombinant vesicular stomatitis virus (rVSV) that expresses a single filovirus glycoprotein (GP) in place of the VSV glycoprotein (G) (Geisbert and Feldmann, 2011). Moreover, a single injection of blended rVSV-based filovirus vaccine was shown to completely protect nonhuman primates. They are also shown to be important in postexposure treatment against filovirus infections. Recently, they were used to treat an accidental biosafety level 4 laboratory exposure of EBOV in Germany (Gunther *et al.*, 2011).

Isolation and quarantine can play a major role in protecting the public from exposure to this contagious disease. Isolation mainly separates sick people with healthy person while quarantine separates and restricts the movement of disease exposed people. In USA, about 20 Quarantine Stations has responsibility to quarantine at all ports of entry within its assigned area of jurisdiction (www.cdc.gov). In India, a 26 year old person coming from Liberia was quarantined at Airport Health Organization Quarantine Centre, New Delhi. Other methods of diagnosis, remedies and preventions are provided in table 3b.

Decontamination of ebola infected zone

According to Occupational Safety and Health Administration (OSHA), decontamination of ebola infected surface should be done by using EPA List of selected registered antimicrobial products such as Maquat 128-PD, Sunburst No-Bac, *etc.* that meet the CDC criteria (www.epa.gov/oppad001/list-l-ebola-virus.html). Manufacturer instructions should be followed for using proper concentration, application method and contact time for each disinfectant. If EPA-registered disinfectants are unavailable, a 10% solution of common household bleach in water may be an effective alternative. Disposal of waste from surface cleanup of blood borne pathogens standard, 29 CFR 1910.1030; CDC guidelines, www.cdc.gov/vhf/ebola/hcp should be followed (www.osha.gov).

Chikungunya Virus

Recently, chikungunya fever has been reported in almost 31 countries and territories in the Caribbean, Central America, South America and North America on 5th Sept 2014 (Table 1). Approximately 6, 51,344 people were found to be suspected and 9,182 have confirmed cases of chikungunya from these areas (www.cdc.gov).

The disease was first discovered by Marion Robinson and Lumsden in 1955 after an outbreak in 1952 on Makonde Plateau, along the border between Tanzania and Mozambique (Africa) and in Kimakonde language of Makonde "chikungunya" means that "*which bends up*" and the stooped appearance of sufferers with joint pain (Singh *et al.*, 2008). Chikungunya virus (CHIKV) expresses itself as an acute and painful syndrome with strong fever, asthenia, skin rash, polyarthritis, and lethal cases of encephalitis (Sourisseau *et al.*, 2007) and disease ranges from 2-12 days. The diagnosis, remedies and preventions of CHIKV is provided in table 3b.

Table 3b: List of viral diseases and their diagnosis, remedies and preventions.

S.N.	Viral Diseases	Diagnosis	Remedies	Precautions
1	Influenza	Serological tests include rapid antigen testing, PCR, immuno-fluorescence assays, and rapid molecular assays (Kumar and Henrickson, 2012). Virus culture in MDCK cells (Perez-Ruiz <i>et al.</i> , 2007).	The first FDA approved vaccine is Fluzone® Intradermal (Icardi <i>et al.</i> , 2012).	Personal hygiene practices.
2	Japanese Encephalitis	Capture radioimmunoassay (Burke <i>et al.</i> , 1982) ELISAs (Bundo and Igarashi, 1985; Innis <i>et al.</i> , 1989). The immunoglobulin M (MAC ELISA) (Innis, 1995).	Live-attenuated vaccine from PHK cells using the SA14-14-2 viral strain in 1988. JE-VC (Ixiaro, Intercell) (www.fda.gov) in USA, JENVAC in India (Indian Academy of Pediatrics, 2013)	Use of mosquito repellents with N,N-Diethyl-meta-toluamide (DEET), insecticides, larva-killing agents (www.cdc.gov)
3	Dengue	Hemagglutination-inhibition, complement fixation, neutralization test, MAC-ELISA and indirect IgG ELISA (Gubler and Sather, 1988; Guzman and Kouri, 1996; Vorndam and Kuno, 1997), RT-PCR (Deubel, 1997).	No specific treatment. Medicine such as acetaminophen, codeine and good oral hydration preferred. Aqueous extracts of <i>Carica papaya</i> leaves was found to be effective (Ahmad <i>et al.</i> , 2011).	Mosquitoes and their larvae should be avoided (www.cdc.gov).
4	Ebola	Antigen-capture ELISA testing, IgM ELISA, PCR, virus isolation, IgM and IgG antibodies testing after recovery (Zaki <i>et al.</i> , 1999; Leroy <i>et al.</i> , 2000; Towner <i>et al.</i> , 2004).	No FDA-approved vaccine or medicine. However, intravenous fluids and balancing electrolytes should be provided.	Avoiding contact from infected person, wild animal meat, use personal protective equipment (PPE) in case of person working in hospitals (www.cdc.gov).
5	Chikungunya	RT-PCR using nested primers (Tamura <i>et al.</i> , 2007), virus culture and serological tests using IgM and IgG specific ELISA (Schuffenecker <i>et al.</i> , 2006).	No approved vaccine available. However, a phase-II vaccine trial used a live, attenuated virus (Edelman <i>et al.</i> , 2000).	Mosquitoes and their larvae should be avoided Also, rest and plenty water should be taken to avoid dehydration (www.cdc.gov).

CONCLUSIONS

With the environment undergoing tremendous changes, some RNA viruses are evolving to adapt in the host cell. Although the quick diagnostic techniques and the personal hygiene practices have improved immune responses, rapid population growth and incursion for both economic and leisure activities into natural habitats, is likely to put humans at risk. Viral outbreaks are spreading worldwide, so there is a need of proper surveillance and swift culling to avoid the contact from infected persons and animals. There should be proper isolation and quarantine facilities along with the disease diagnostic kits in every country. Treating clinicians should be trained and should make a concerted effort to collect and publish detailed, repeated, and systematic clinical observations to facilitate the research. Clinical observations should be systematically recorded in order to evaluate the treatment efficacy. Until controlled efficacy data is not available, it is not logically and ethically possible to explore the use of herbal compounds in treatment of patients. The government should have permanent allocations so that any outbreak that may last for years could be used to develop proper preparedness and response activities.

Conflict of Interest: None

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