Antigenic shift and drift of influenza virus biology essay

Influenza A virus is known in the worldwide as an acute contagious viral infectious disease and respiratory tract disease that occur as a result of infection. Flu can cause mild to severe sickness, and can be lethal. Certain people, such as elder people and people with health conditions, are at a high risk for serious problems from the flu virus. The influenza or the flu is caused by RNA viruses which belong to Orthomyxoviridae family of viruses. There are three types of flu viruses infect humans are influenza A, influenza B and Influenza C. Influenza A viruses only infect nonhuman hosts, and a reassortment of genes can happen between those subtypes. Influenza is greatly contagious respiratory disease that spreads from person to person by sneezing and coughing. By compare to the most viral respiratory infections, it is found that the symptoms of influenza infection are extremely severe. It is a seasonal infection; the spread of infection is generally in the winter (Richman et al., 2009).

Influenza A infects humans, horses, goats, pigs, birds and some other animals. Based on studies conducted on flu pandemics that hit people in the past, all of these pandemics were caused by influenza A (Taubenberger and Morens, 2006).

However, the history of the great epidemic which occurred in 1918 to 1919 and killed more than 40 million people around the world has encouraged scientists to conduct more studies and research on these viral infections (Greenwood et al., 2002).

Causative Agent:

Influenza infection is caused by a member of viruses which belong to the family Orthomyxoviride, (orthos in Greek means straight and myxa in Greek means mucus). There are three main types: Influenza virus A, Influenza virus B, Influenza virus C. Influenza A is considered here which is also known as avian influenza (Collier et al., 2006).

Classification:

Group: Group V (-)ssRNA

Family: Myxoviridae

Sub-Family: Orthomyxoviridae

Genus: Influenza A

The classification of influenza virus A based on variations on two proteins found on the virus surface. Hemagglutinin, a glycoprotein present on the viral surface as rod-shaped projections, abbreviated HA and has 16 types. It has the ability to agglutinate erythrocytes and enhance the attachment and penetration of the virus to the receptor of the cells, the other type of glycoprotein is Neuraminidase, abbreviated NA and has 9 subtypes. About 80% of them are HA and the ratio of HA to NA is about 4-5 to 1. The most significant subtypes that can cause extensive outbreaks in human are H1N1, H1N2, and H3N2 viruses (Richman et al., 2009)

Subtypes:

The sub-types of viruses that cause avian influenza, which has infected human pandemic deaths:

1 – 1918 (H1N1), which caused the Spanish flu.

2 – 1957 (H2N2), which has caused the Asian influenza.

3 – 1968 (H3N2), flu, which has caused Hong Kong.

4 – 1976 (H1N1), swine flu episode

5 – 1977 (H1N1), Russian flu

6 – 1997 (H5N1), South-East Asia, died tens of millions of birds caused by this strain.

7 – 1999 (H9N2), bird flu in Hong Kong.

8 – 2003 (H7N7), bird flu in Netherland

9 – 2004 (H5N1), bird flu in South-East Asia

10 – 2009 (H1N1) virus, which is a pandemic in our times (H1) derived from the swine flu of 1930 (and related to the H1 of the great 1918 Spanish flu) and (N1) from a virus that had been circulating in the pigs of Europe and Asia since 1979 along with the M gene from that virus (Riel et al., 2007).

The normal hosts for influenza A virus are the birds that live in water or they are called aquatic birds and the different mammals can be hosts for this virus like as humans, horses and pigs.

Structure (Virion):

The influenza virion is roughly spherical and enveloped virus; the outer cover is prepared from the lipid membrane which is occupied from the host cell in which the viruses multiply. Then inserted into the lipid membrane are ‘ spikes’, which are proteins known as glycoprotein spikes, because they contain of protein linked to sugars called as:

HA (hemagglutinin) and NA (neuraminidase) Figur 1: show Schematic of an influenza A virus

Haemagglutinin (HA): which plays a vital role in the ability of the virus to infect the cells of the respiratory tract by integration with cell’s receptors and multiply in the cell. This molecule is more parts of the virus’s ability to stimulate the immune system, and the ability of body resistance measured by the level of Haemagglutinin resistance.

Neuraminidase (NA): works to spread out the virus after replication in respiratory system throughout the body (Gubarea et al., 2008).

Replication:

The influenza A virus contains eight-segmented, negative (-) RNA as its hereditary materials. It replicates by entering the host cells (adsorption) and using this cells as resources to produce hundreds copies of viral RNA.

After attachment to the specific receptors on the surface of the host cells, the hemagglutinin (HA) binds to the sialic acid on the receptors surface and the virions enter into the cells by endocytosis. The neuraminidase plays a vital role in viral replication by removing sialic acid which also known as neuraminic acid from the surface of cell.

The mRNA synthesis and replication take place in the nucleus with assistance of the viral RNA-dependent RNA polymerase. The viral RNA polymerase uses the nucleocapsids as a template and it does not need a fully uncoated nucleocapsids. Since this virus is a negative-strand RNA, RNA modification enzymes and RNA polymerase are packaged in the virion. So the viral genes are transcribed and translated (to give viral proteins) by the cell's enzymes and ribosome, that makes the viruses take over the cell productivity and instead of producing the cellular materials only, the cell will produce hundreds copies of viruses. These viruses will be released out from the host cell and they start invading a new host cell by their own (Korteweg et al., 2008).

Antigenic shift and drift

Influenza type A viruses go through two kinds of changes. One is a sequence of mutations that occur over time and causes a slow development of the virus. This is known as Antigenic Drift. The other type of change is a sudden change in the hemagglutinin and/or the neuraminidase proteins. This is known as Antigenic Shift. In this case, a new subtype of the virus suddenly emerges. Type A viruses go through both kinds of changes (Schweiger et al., 2002).

Transmission:

Influenza virus type A spread among the many animals, including ducks, chickens, pigs, whales, and horses. Somehow, some minor species of the virus strains are limited to animals alone, but in the offspring of birds and subjected to infection with all kinds of influenza virus A (Richman et al.,

2009). Avian influenza type A can be transmitted to humans in two ways: Directly from birds or contaminated environments to humans and through an intermediary host such as pigs (Collier et al., 2006).

Most transmission occurs in a short time before or after the appearance of flu symptoms on an infected person. Moreover, individuals can be infected by inhalation of virus-laden aerosols. However, it can spread rapidly by sneezing and coughing especially in medical settings, classrooms and airports. Whereas, nasal discharges (droplets) are the most common source of virus transmission by contaminated materials or direct contact (Brankston et al., 2007)

Epidemiology:

Three pandemics of influenza occurred in the last century. In 1918, " Spanish" influenza (H1N1) caused an estimated 40 million deaths in less than a year (Nicholson et al., 2001). While, In 1957, " Asian" influenza (H2N2) caused an estimated 70, 000 deaths in the US alone and in 1968 more than 30, 000 people were killed in the US by new subtypes of influenza A virus (H3N2).

According to The World Health Organization, the H1N1 virus affects younger age compared with seasonal influenza in all categories- those who are most frequently infected, requiring intensive care, hospitalized and dying (WHO, 2009). It has been estimated that, 3-5 million of people worldwide are infected by influenza and 250 000 to 500 000 deaths yearly due to influenza (WHO, 2009). According to study published in December 30, 2009 by The New England Journal of Medicine, young people who are under 18 years are

more likely to catch influenza from an infected person in their household than adults (ScienceDaily, 2009).

Pathogenesis:

Virus is spread by contact from person to person through small particles aerosols that can get in respiratory tract or through fomites. The incubation time is short, approximately 18 to 72 hours. Whereas, virus concentration in nasal and tracheal secretions stay long for 24 to 48 hours after symptoms begin.

Influenza A virus infects the epithelial cells of the respiratory tract and leading cells die. Cell death at later times may also result from the action of cytotoxic T-cells. So, the efficiency of ciliary clearance is reduced, due to impaired function of the mucus elevator.

The virulence and pathogencity of the influenza virus can be identified by two major factors which are host and viral factors.

Host factors:

Enzymes should be available in the cell host in order to help the viral entry and replication.

The target receptors must be present on the surface of the host cell.

Immunocompetence State of each host.

Specific immunity against certain viral epitopes in the host.

Ability of the immune system to control the viral replication effectively without causing serious damage for the host by its inflammatory response (Nagata et al., 2008).

Symptoms:

Symptoms continue from 3-7 days, but in some cases, symptoms have persisted to 3 weeks:

Headache

Fever (38 -40 C)

Sore throat

Tiredness

Aches

Dry coughing

Nasal discharge

Vomiting

Diarrhoea

Complications of influenza A virus:

Pneumonia

Otitis

Toxic shock syndrome

Diagnosis:

Normally, clinician will diagnosis influenza based on patients symptoms, but other respiratory infections might have similar symptoms. So, diagnostic is necessary by doing multiple laboratory investigation as show

in this table 1:

Treatment:

In fact there is no effective treatment for influenza A because, the antibiotics (antiviral) do not kill the viruses, but it may make the disease less severe. There are four antiviral medications have been approved for treating influenza A virus infections: Amantadine, Rimantadine, Zanamivir, and Oseltamivir (Jefferson et al., 2006).

Prevention and control:

There are three possible ways to control or prevent influenza infection: vaccination, anti-viral and non-medical interventions. The single best way to protect against influenza is to get vaccination. Also infection can be prevented by disease control steps that to be followed by everyone during pandemic influenza or seasonal influenza (Collier et al., 2006).

DISEASE CONTROL:

Washing hands by using water and soap or alcohol swap.

Covering nose and mouth while coughing.

Discard the tissue after use in dust pin and wash hands.

Avoid close contact with people with influenza symptoms.

Avoid being in poorly ventilated and crowded places for long time.

In order to reduce the spread of influenza from animals:

Quarantine the infected animals, and then kill it after that.

Separation of animal species during the breeding each species in isolation from the other type.

Encourage the people to inform about infected animals as soon as possible.

Conclusion and future outlook

It could be concluded that, influenza A virus is one of the most infectious diseases that affecting humans and a number of animals. However, influenza A virus has led to several pandemics in the last century. Since the influenza virus is able to change each time, so it requires a new vaccine in each time of mutation. Novel influenza virus strains appear periodically to which humans have little immunity, follow-on disturbing pandemics. There have been many achievements in the progress of influenza vaccines and antiviral medications to prevent and treat influenza, and there are systems in place to give early warning for the incidence of pandemic viruses.

There are lot improvements, based on recombinant DNA techniques and novel adjuvant promise to change the vaccine therapy landscape against influenza and other infectious diseases as well.

In addition to that, improving immunization protection will require other healthcare professionals to educate their clients and peers about their susceptibility to influenza and the severity of illness that influenza can cause. World health organization need to assess their clients’ beliefs, perceptions and attitudes about influenza and the vaccine and plan interventions to make the vaccine and delivery of the influenza vaccine attractive so the mortality and morbidity associated with influenza can be decreased.