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West Nile Virus

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General Description of Viruses

Viruses are very small agents that can cause many problems in humans and are a huge concern for medical professionals across the world. According to Bauman (2014), viruses are an acellular agent that can cause disease by invading a host's cell. Invasion of a host cell is so crucial for viruses because they cannot reproduce on their own. Viruses rely on the chemical and metabolic pathways of a host cell to grow, reproduce and sustain function. Even though viruses contain their own genetic material, there is a great deal of variety between viruses' genome as compared to genomes of other cells. This along with the invasion of host cell has lead to many obstacles in effectively treating viruses.

This paper will specifically examine the nature of West Nile Virus (WNV) and the problems it poses to humans. Examining the time and location that WNV is most prevalent will provide for a better understanding and scope of the virus. Furthermore, WNV has several distinct characteristics that allow for accurate classification and identification. Along with this, the paper will examine how WNV is spread, replicated (pathophysiology) and which body systems are affected by it. Finally, the paper will examine how to treat and prevent the number of cases of the virus.

Statistics of West Nile Virus

In 2012, 5,674 cases of West Nile Virus (WNV) were reported in the United States alone (CDC, 2014). WNW is also common in many parts of the world and can be found in Africa, Europe, the Middle East and West Asia (World Health Organization [WHO], 2014). According to Bauman (2014), only 20% of those infected will have symptoms associated with WNV and around 1% of infected patients will experience life threatening conditions. These aspects will be examined in greater detail in the disease section of the paper.

Characteristics of West Nile Virus

There are several distinct characteristics that help scientist identify and distinguish WNV from other viruses. One way is by examining which host cell the virus infects. WNV is an example of a generalist virus, meaning it has the ability to infect a wide range of cells in many hosts (Bauman, 2014). According to Pierson (2013), WNV has the ability to infect and target cells such as monoctyes, macrophages, dendritic cells and neurons.

Another distinctive characteristic of WNV is how it is transmitted. WNV is classified as an arbovirus, meaning that it is transmitted by insects such as mosquitoes (New York Times Health, 2013). Mosquitoes are a vital part of the transmission cycle, serving as vectors that carry the virus from birds to dead end hosts such as humans. Although this is the primary way of transmission, WNV has also been shown in rare cases to be transmitted via blood transfusions, organ transplants, and from mother to the new born during pregnancy (CDC, 2014). Cases of WNV increase during the summer months due to the favorable climate conditions for mosquitoes (Mayo Clinic, 2014).

In the extra-cellular state, West Nile virions measure around 50 nanometers in diameter and tend to be spherical in shape (Brinton, 2014). The spherical appearance of the virions indicates the presence of a polyhedral capsid. More, specifically West Nile is an icosahedron, meaning the virion has 20 sides. These protein shells of the capsid allow for attachement to hosts' cells and provide protection of the genetic material (Bauman, 2014).

Finally, West Nile is an enveloped virus, meaning that it acquires part of the phospholipid bilayer of host cell. This allows for easier entry into host cells and disguises virions from the host's immune system. The process of the WNV acquiring an envelope will be explained in greater detail in the pathophysiology section of the paper.

Classification and Identification of West Nile Virus

West Nile Virus is classified in the family *Flaviviridae* and the genus *flavivirus*. Compared to other viruses, members of *Flaviviridae* tend to be smaller and posses a protein matrix between the virus' capsid and envelope (Bauman 2014). Another important aspect of flaviviruses is the location of replication in infected cells. Replication of flaviviruses occurs in the cytoplasm of infected cells and can lead to modification of the cellular environment (Brinton, 2014).

The genome of WNV is classified as positive (+) single-stranded RNA, meaning that the virus' RNA can act directly on mRNA and has the ability to instruct ribosomes in the process of protein synthesis (Lanciotti, et al., 1999).

As mentioned previously, WNV is transmitted via arthropods and is also known as zoonoses. A zoonotic virus is a type of animal disease that is spread to humans via other animal hosts (Bauman, 2014). These classification methods along with the characteristics of West Nile are directly related to the pathophysiology of the virus.

Pathophysiology of West Nile Virus

Replication of West Nile Virus in the host consists of five steps; attachment, entry, synthesis, assembly and release. Each of these steps will be examined in greater detail to understand how WN infects host cells.

According to Bauman (2014), attachment depends on the chemical attraction between proteins on the virion and the protein receptors located on animal cells. Currently, little is known on the specific host cell receptor that serves as a place of attachment for West Nile virions.

West Nile Virus gains entry into an animal cell via endocytosis (Brinton, 2014). This means that the cytoplasmic membrane of the cell engulfs the virus allowing for access inside the

cell. When the virus enters a lysosome after endocytosis, a decrease in pH levels causes the release of the nucleocapsid into the cytoplasm (The Microbial World [TMW], 2014). Once this occurs, West Nile's (+) single-stranded RNA removes the capsid via a process called uncoating. This releases the genetic material into the cytoplasm for the next step, protein synthesis and replication.

The freed (+) single-stranded RNA of West Nile virus can act directly as mRNA inside the cell and is immediately translated into proteins. These shell proteins help assembled new viral capsids in the icosahedral shape (Hofkin, 2014). Replication is contingent on the synthesis of the negative (-) strand RNA template in the cytoplasm of the animal cell. Once this is achieved, the (-) strand RNA template allows for further transcription and creates complementary (+) RNA strands (TMW, 2014).

The next step in the replication process of West Nile Virus is to assemble the components made during synthesis and replication into new virions. New virions are formed from by joining the new complementary (+) RNA strands made from the (-) strand RNA template with the new capsids made after endocytosis (Hofkin, 2014). The new West Nile virions are then ready to be released by animal cells.

West Nile and flaviviruses contain envelops and use a process known as budding to release into the extracellular space. This allows for the virion to acquire a portion of the animal cell's membrane and leads to the formation of new envelopes for virions. Eventually, budding will lead to cell death (lyses cell) but the process allows cells to remain alive for a long time (Bauman, 2014). Once outside the cell, the West Nile virions can repeat the replication process.

Symptoms and Diseases Caused by West Nile

As mentioned previously, only around 20 % of the cases of West Nile Virus produce mild symptoms, while 80% of cases are and asymptomatic (CDC, 2014). Some of the symptoms of patients infected with West Nile include; fever, headache, swollen lymph nodes, and body aches. Generally, these symptoms last only a few days and patients experience a full recovery (Pennsylvania's West Nile Virus Control Program [PWNVCP]. (n.d.).

However, West Nile Virus also has the potential to lead to severe disease and cause permanent damage to patients. These rare cases, which occur in about 1 out 750 human infections, can cause damage to the nervous system and lead to life threatening conditions (Bauman, 2014). The reason for this is due to WNV's ability to be neuroinvasive and cross the blood brain barrier leading to a disease state known as encephalitis, or inflammation of the brain (Cunha, B. A., & Bronze, M. S. (n.d.). Inflammation in the brain and infection of the CNS can lead to several life threatening conditions. Some of the symptoms that accompany severe infection include; coma, tremors, convulsions and paralysis. The symptoms of encephalitis can last for weeks and can cause permanent damage to a patients' nervous system (PWNVCP, n.d.).The most at risk group for developing a serous disease during infection are people with cancers, diabetes, and kidney diseases (CDC, 2014).

Treatment and Prevention

Currently, there are no treatments or vaccines for infected patients with West Nile Virus. Healthcare professionals usually provide supportive therapy that includes; intravenous fluids, respiratory support, pain medication and nursing care (CDC, 2014). As mentioned previously, most patients have a full recovery from infection. However, the ability of WNV to cross the blood-brain barriers makes it difficult to treat severe cases.

The most effective way to decrease the number of occurrences of WNV is by implementing preventive measures to avoid mosquito bites. According CDC (2014), using insect repellants, wearing longer sleeves, and removing standing areas of water outside the house can all decrease the amount of mosquito bites in humans. Along with these, cities can further prevent the amount of mosquitoes by implementing a spraying plan within the city.

Conclusion

In summary, West Nile Virus is a member of the *Flaviviridae* family and of the genus *flavivirus*. West Nile Virus is classified as a (+) single-stranded RNA with a polyhedral capsid to protect the genetic material. The virus also posses several distinctive characteristics that can cause problems in humans. These include the presence of envelopes, transmission by insects, and the ability to infect multiple cells. Another key characteristic of West Nile virions is the ability to cross the blood-brain barrier and cause disease states of the central nervous system. This ability makes WNV difficult to treat in at risk patients. It has been established that effort should be focused on preventative methods to decrease the cases and damages West Nile Virus can cause.

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