Chapter 2

Overview of West Nile Virus Transmission and Epidemiology

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Abstract

West Nile virus (WNV) is a mosquito-borne flavivirus that can cause mild-to-severe disease in humans and horses. WNV was first documented in Uganda in 1937 and passed through the majority of Africa, West Asia, and Europe before arriving in the USA (with infections in New York City in 1999). After the spread of the virus on the US east coast, it traveled westward, northward, and southward through the USA and into Central and South America. WNV can cause fever, rashes, nausea, vomiting, and potentially neuroinvasive disease or death. The virus is sustained through a mosquito-bird-mosquito cycle and there are many species that are competent vectors. Unfortunately, there are no vaccines and the only treatment is supportive care. This chapter highlights the epidemiology and transmission of WNV and provides insight into some of the challenges of controlling WNV disease.

Key words West Nile virus, Transmission, Epidemiology, Mosquitoes, *Culex* sp.

1 Introduction

West Nile virus (WNV) is a mosquito-borne flavivirus that was first identified in Uganda in 1937. It now can be found in Africa, Europe, West Asia, North America, and Australia [1–3]. In 1999, WNV made its first appearance in North America by the way of New York City causing an epidemic of encephalitis. By 2002, the disease was reported in 39 states with ~4000 cases and almost 300 deaths (Fig. 1; [5]). Most human WNV infections are asymptomatic but a small percentage of people present with symptoms such as fever, rash, nausea, and vomiting [1, 5]. Less than 1% of infected people may develop severe disease, which can include headaches, disorientation, coma, paralysis, and potentially death. Individuals over the age of 50 have a higher incidence of severe neuroinvasive disease [3, 5]. The only available vaccines are for horses and there is no specific treatment other than supportive care.

Birds are the natural reservoir and *Culex* sp. are the natural vectors of transmission, and WNV is maintained in nature in this

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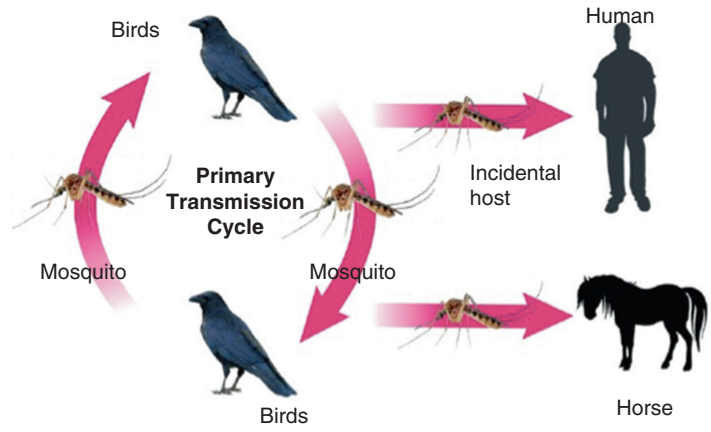

Fig. 1 Incidence of West Nile virus in the USA from 1999 to 2004 [4]

mosquito-bird-mosquito transmission cycle (Fig. 2). WNV is primarily transmitted by *Culex* sp. mosquitoes but other mosquito genera can be involved if they favor people and their dwellings. In North America alone, 59 mosquito species have been identified that can become infected with WNV; however, only 10 out of the 59 are competent transmission vectors [1, 4]. The dominant vector species for WNV varies across the USA. For example, the northern house mosquito, *Culex pipiens*, an efficient transmission vector, made up at least half of the WNV-positive mosquitoes in the northern region of North America during initial viral spread [1, 4]. In 2002, *Culex pipiens* still made up a large portion of confirmed WNV-positive mosquitoes though *Culex quinquefasciatus*, also known as the southern house mosquito, emerged as the leading WNV transmission vector in the southern USA. *Culex tarsalis* is an efficient laboratory vector but it has also been found to be the principal vector west of the Mississippi River [4].

Birds are the natural reservoir, or amplifying hosts, for WNV, and in North America over 100 bird species are capable of becoming infected. Most bird hosts are able to survive the disease and develop permanent immunity [1, 4]. Infected birds have transient high viremic titers consequently allowing transmission of WNV to ornithophilic mosquito species. In North America, crows and jays from the family Corvidae do not usually survive WNV infection and are useful in tracking virus spread through dead-bird surveillance programs [1, 3, 4]. WNV can be transported through different regions by viremic migratory birds along established flyways [1].

Unfortunately, humans and horses can become incidentally infected and develop a mild-to-severe disease. As incidental or "dead-end" hosts, both humans and horses are unable to transmit the virus to other mammals or mosquitoes during infection.

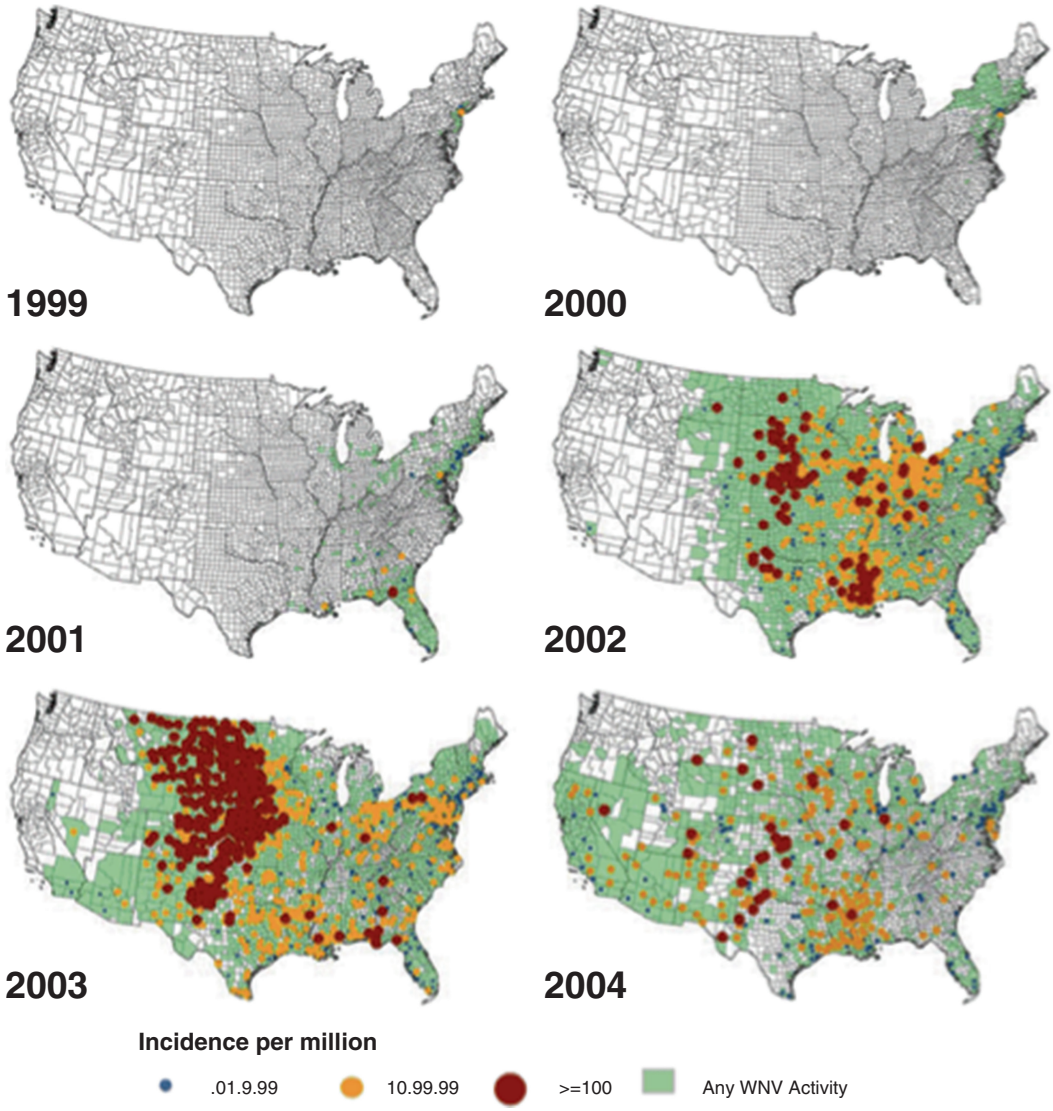

Fig. 2 West Nile transmission cycle [6]

Interestingly, eight other animal species including cats, rabbits, skunks, squirrels, chipmunks, alligators, lake frogs of Russia, and some bats may become infected with WNV but these are usually asymptomatic [1, 3, 4]. The role that these animals play in the transmission cycle is unknown, but it is highly unlikely that they are natural reservoirs as viremia titers are quite low [4].

Little was known about WNV upon its detection in 1937 but the virus has become the primary cause of arboviral neuroinvasive disease on every continent excluding Antarctica [2]. In 2002, reports of transmission pathways through blood transfusions, organ donations, and from mother to neonate during childbirth

or breastfeeding were discovered [2, 3]. The virus is able to overwinter year after year, indicating that it has an efficient "hibernation" method. Reducing the risk of WNV transmission will require intense emphasis on sustained mosquito control and public education [1, 3]. Providing bed nets, applying insect repellant, and encouraging people to remain inside during peak mosquito biting times are crucial community programs [3]. In addition, environmental modifications to destroy mosquito-breeding sites will lower transmission rates. Sadly, the risk of outbreaks remains high in cities with unsanitary conditions and poor economic environments [1]. Many of these cities lack the infrastructure for proper surveillance or vector control programs creating a higher risk of disease and thus continuing the transmission cycle and incidental human infections.

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