

## Yellow Fever

*Yellow Fever is a Class A Disease. Any case must be reported immediately to the state by calling the phone number listed on the website.*

Yellow fever (YF) is caused by a Flavivirus (this family includes dengue, West Nile and Saint Louis encephalitis, and Japanese encephalitis)

### Epidemiology

Yellow fever is transmitted by *Aedes aegypti* and other mosquitoes. It is naturally occurring in Africa and South America but the anthroponotic (vector-borne person-to-person) transmission of the virus may occur wherever a suitable vector is present. In the southern United States where *A. aegypti* is present, epidemics of urban YF have occurred. Yellow fever was transmitted by *A. aegypti* mosquitoes that were infected after feeding on viremic humans and then spread the infection in subsequent feeding attempts.

#### Urban cycle

The urban cycle involves human hosts and *Aedes aegypti* vector. For over 200 years YF was a major killer in U.S. port cities (1,000 deaths in the last major epidemic in New Orleans in 1905).

Elimination efforts undertaken in the early 1900s led to the complete elimination of YF as an urban epidemic in the Americas in 1934. (The last urban American cases occurred in north-eastern Brazil.) This was one of the most successful eradication campaigns in public health.

#### Sylvatic cycle

The sylvatic cycle involves forest primates, principally monkeys and forest canopy mosquitoes. Human infections occur when humans get into the forest. In the Americas the canopy mosquitoes responsible for transmission are mostly *Haemagogus* spp. The vast majority of human cases are adult males with occupational exposure in the forest. The number of cases vary from year to year (up to 500 cases per year). In West Africa, massive immunization programs against YF carried out from 1945 to 1960 had led to the disappearance of epidemic YF. In the early 1960s, this approach was abandoned for outbreak control measures. Due to the sylvatic cycle, worldwide eradication is not possible. In some environments a vector-primate cycle is possible, in some other places the presence of virus is maintained by transovarial transmission in mosquitoes.

#### The risk of importation remains

During interepidemic periods, the incidence of overt disease is below the threshold of detection by existing surveillance. Such interepidemic conditions may last years or even decades in certain countries or regions. This “epidemiologic silence” may provide a sense of false security and lead to travel without the benefit of vaccination. Surveys in rural West Africa during “silent” periods indicate that the incidence of YF illness is 1.1 to 2.4 cases per 1,000 persons and that the incidence of death due to YF is 0.2 to 0.5 deaths per 1,000 persons; both these ranges are less than the threshold of detection of the existing means of surveillance.

## Clinical picture

Yellow fever starts as a flu like illness with fever, chills, headache and backache, myalgias, nausea, vomiting, facial flushing, and conjunctival injection. In the majority of cases, resolution of this period of infection concludes the illness, but in others, the remission of fever for a few hours to several days is followed by renewed symptoms. The disease progressively affects liver (from the jaundice came the old name “Yellow Jack” or “Bronze John”), and kidney. A severe hemorrhagic syndrome with gum bleeding, epistaxis, hematemesis, melena, petechiae and ecchymoses may develop (hence the name “Black Vomit”). Ultimately, the patient will die from hypotension, shock compounded by heart dysfunction, acute renal failure, confusion, seizures, and coma.

## Yellow Fever in Louisiana

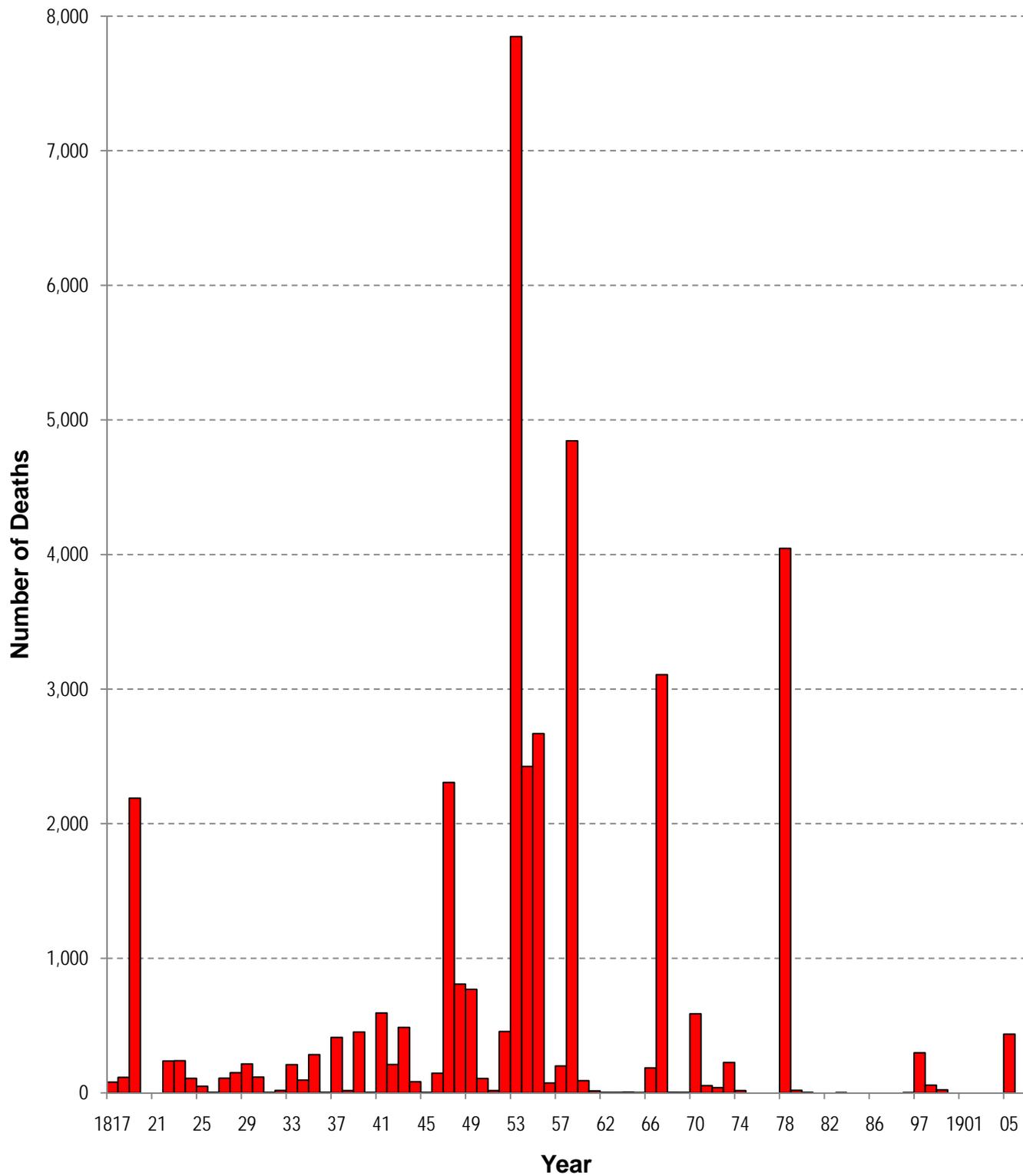
The most deadly diseases to strike Louisiana during the antebellum period (pre-Civil War) were cholera, smallpox, malaria, and YF.

More than 41,000 people died from YF in New Orleans between the years 1817 (the first year that reliable statistics are available; deaths in earlier times – not being recorded), and 1905 (New Orleans - last epidemic). The number of fatalities ranged from none in years that YF spared New Orleans to more than 1,000 in nine of the 88 years of the fever's activity.

Yellow fever helped shape the future of the new republic of the United States. Yellow fever had destroyed nine-tenths of Napoleon’s expeditionary force in Saint Domingue (now Haiti) in 1802. Facing another war with Great Britain and in need of funds, Napoleon Bonaparte reversed his thoughts of a new French Empire in the Americas and sold the entire colony.

In an epidemic year the mortality rate could reach as high as 60% of those who contracted a disease. The death rate in New Orleans ranged from a low of 36 per 1,000 in the late 1820s to a high of one in 15 during the summer of 1853. It is estimated that 8,000 to 12,000 people died of YF in New Orleans that year, with still more deaths in rural areas in south Louisiana, marking the single highest annual death rate of any state during the entire nineteenth century. Because people died faster than graves could be dug, the popular saying was that “pretty soon people would have to dig their own graves” (Figure 1).

**Figure 1: Number of deaths from Yellow Fever – Louisiana, 1817-1907**



Death rates were highest in urban areas like New Orleans, where large numbers of people packed into small areas spread disease quickly.

Primary victims of disease were immigrants, children, laborers, and the poor. Wealthy residents could escape the plague by leaving the city during the most dangerous months, June to November, or afford good health care and clean surroundings. Many native Louisianians who had been exposed to mild attacks during childhood, were immune to YF, malaria and cholera, and were accustomed to their frequent visitations.

## **Two theories about the causation of disease**

### 1-The ‘Importation’ theory

Many felt that YF was imported by sailors and steamboat workers as they passed through the port and had made the connections between epidemics in the Caribbeans and the surges in YF in New Orleans. They felt that strong quarantine laws would be effective in preventing YF in Louisiana.

### 2-The ‘Miasma’ theory

In the 1790s, influential doctors Benjamin Rush and Noah Webster first believed that the disease came from contagion, but eventually denounced this idea. In addition, they denounced that it was imported, finding quarantine methods unproductive. They determined that YF came from local miasmas spawned by decaying plants and animals, especially when exposed to heat and water. Sanitation was deemed the best way to rid the infected area of the disease.

Many physicians felt that YF came from harmful fumes, known as noxious effluvia, which spread the disease. By the early 1800s, travelers in New Orleans pronounced the vapors rising from garbage that was exposed to heat as the direct cause of the disease. When an outbreak occurred, many fled the area, but some were unable to do so. Several of those who stayed behind believed that breathing through cloth that had been soaked in garlic juice, camphor, or vinegar would help protect them from the disease.

### 3-The ‘Personal Contact’ and other theories

Few believed the disease to be contagious from personal contact and through clothing and other articles. Eating too much opossum was even cited as a possible cause.

### 4-Alternance between promoters of one theory versus the other have profoundly influenced public health in New Orleans and Louisiana

Believers in these theories had been instrumental in promoting sanitation in the New Orleans area. Thus following a major epidemic of YF in the years 1803 to 1804, Governor Claiborne on July 9, 1804 commissioned a Permanent Health Committee (Board of Health #1), including two physicians who met weekly and issued ordinances to clean slaughterhouses and cemetery dumps, establish exams for physicians, surgeons and apothecaries without diplomas, and maintain sanitary conditions at Charity Hospital. By 1817, the New Orleans Sanitary Code included 24 ordinances addressing the cleaning of streets, sidewalks, gutter, location of privies (at least three feet from a house with a minimum of seven feet depth), moratorium of hog raising, slaughterhouses and tanneries, requirements to bury the dead in cemeteries and prohibition against selling oysters during the summer.

Following the increase of YF in the late 1810s, the State Legislature passed an ‘Act to establish a Board of Health and Health Office to Prevent the Introduction of Malignant Pestilential and Infectious Diseases in the City of New Orleans’ (Board of Health #2) whose main function was to administer new quarantine laws. Businessmen and politicians who wanted goods and people to keep coming to Louisiana ignored, or purposefully covered up the problem of disease and death. To maintain a wide-open port free of quarantines, business interests tried to convince newspapers not to publish negative news or publicize the large number of deaths in New Orleans.

The second Board of Health was short-lived but was revived when the Louisiana legislature introduced an “Act against the Introduction of Infectious Diseases” (Board of Health #3) containing a provision for quarantine aboard ship with YF patients (10 days for healthy people, 15 days for sick ones). This period of time is when the Epidemiology Section started to track daily accounts of deaths in New Orleans.

In 1819, a large epidemic of YF fueled anti-quarantine fire. The quarantine had not prevented the epidemic which was followed by several years of lower level epidemics from 1823 to 1825. Thus in 1825, the third Board of Health was abolished, and quarantine stopped.

Doctors and state officials tried to improve the quality of medical care and their understanding of diseases. After the 1830s, Louisiana was the only southern state to require medical licenses for physicians. In response to the 1817 YF epidemic, French speaking physicians in New Orleans formed their first professional organization, La Société Médicale de la Nouvelle-Orléans, and English-speaking physicians created the Physico-Medical Society in 1820. Members of both groups devoted their talents and resources to study the recurring pestilence of YF.

During the 1830s there was a series of yearly YF outbreaks. These lead the Société Médicale de Nouvelle Orleans to promote another Board of Health (#4) with sanitary and quarantine regulations and emphasis on the epidemiology’s mortality list. The early 1840’s saw a decrease of YF and the Board declined.

In 1844, the State Legislature declared that ‘YF is infectious and transmissible, and in most, if not all instances, has been introduced in vessels from other ports into this city’ thus was created on July 16, 1845, a renewed Board of Health (Board of Health #5) which was to keep meteorological and mortality records, advance warning of YF, and re-enforce the sanitary condition of New Orleans with more power than before with a Health Warden in each ward. However, in 1847 a very large epidemic of YF with over 2,000 deaths, undermined confidence in quarantine as a preventive measure and the fifth Board of Health was discharged.

In 1852, a Board of Health (Board of Health #6) was renewed with vague powers. However, 1853 saw the highest mortality ever in an epidemic with over 8,000 deaths in New Orleans, and 1,600 cases in Baton Rouge. The passive board sprung into action and reported cases weekly. The press was extremely slow and reluctant to acknowledge this epidemic, reporting a ‘fancied existence of YF in the city’ (Picayune). Canon-firing (400 discharges), and tar-burning were used to try to purify the city’s air.

The concept that YF was imported from West Indies was making progress. Quarantine stations were set up at Fort Jackson (70 miles south of New Orleans on the Mississippi River),

and the Rigolets (strait between Lakes Pontchartrain and St. Catherine to Lake Borgne). Many understood that sanitation and quarantine were not opposing measures. The press supported the quarantine for the first time.

Finally in 1855, an Act to establish quarantine for the protection of the state led to the creation of the State Board of Health composed of nine citizens: three appointed by the New Orleans City Council; six by the Governor. The President of the Board (State Health Officer) was to live in New Orleans. Quarantine was the major component of the activities to be carried out, but also included were sanitation activities.

During the Civil War there was very little YF, but in 1867, the disease returned with over 3,000 cases. In 1870, the Board's authority was reinforced. The importation theory became widely accepted. Strong quarantine and disinfection of ships were in place. But there was still some resistance against quarantine. The Great Banana controversy erupted when merchants complained that disinfectants used at the quarantine stations were discolorizing the bananas. Challenges to the constitutionality of quarantine laws went up to the U.S. Supreme Court leading to a 1886 decision upholding the legality of quarantine laws.

YF was not always confined to New Orleans. For example in Shreveport in mid-August of 1873, "men dropped dead on Texas Street for unknown reasons". Then at least five people died each day, until the disease claimed 759 people after more than 80 days. Officials ignored the calls for action and tried to calm the panic-stricken city, but Shreveporters packed up their belongings and headed west to Texas and north to Arkansas. The population of the city shrank to about 4,500. (A census from 1870 shows Caddo parish with a population of 21,714.) East Texas communities set an embargo on traffic arriving from Shreveport, intercity commerce was halted, and all trains to the city stopped running.

Sanitation was a big problem in Shreveport. The city had unpaved streets, no sewage system, and inadequate drinking water. People in tenant houses on the edges of St. Paul's Bottoms lived near the stagnant swamps of Silver Lake with water flowing beneath their stilt-raised homes. Water usually came in the form of uncovered cypress cisterns behind homes since wells were impossible so close to the river; drinking water came from Currie's Spring.

However, in 1873, Shreveporters believed that heavy rainfall or humidity caused the outbreak of yellow fever; some believed it came from a circus that had traveled through the area. Still others believed it came from the steamboat cargo and passengers that had made their way up the rivers. Dr. Henry Smith, who cared for the sick first-hand, believed that the disease came from the miasmatic vapors from downtown's Silver Lake. He also saw the city garbage, which baked in the streets under the afternoon sun, to be a cause. By November 15, the epidemic had reached its end as cool weather moved into the city.

The last large outbreak of YF was in New Orleans in 1878 with some 4,000 deaths.

Once the role of mosquitoes was understood, controlling the YF epidemics became much easier.

#### 5-Role of mosquitoes

In 1848, Dr. Josiah C. Nott of Mobile, Alabama published his hypothesis. Dr. Nott noticed that the disease traveled along the rivers and the coast and that it was most frequent in cities

visited by ships and trains. He stated that insects, such as the mosquito, were the most likely culprits.

It was not until 1881 that Dr. Carlos Juan Finlay of Cuba began experimenting with mosquitoes and human volunteers. He felt that it was possible that the mosquitoes could bite infected people and spread it to others through their lancet. He chose to work with the culex species, which was later known as the stegomyia, and is presently referred to as the *Aedes aegypti*. One problem with Dr. Finlay's work was that he was unsure if his volunteers were immune to the disease. With the Spanish-American War in 1898, the United States took over Cuba and began combating the YF problem. In 1900, bacteriologist Walter Reed headed the U. S. Army Medical Commission and began testing Dr. Finlay's research, except that they made sure their volunteers were non-immunes. By February of 1901, they had determined that the mosquito required ten to twelve days after it had bitten an infected person before it was able to transmit the disease to another.

#### 6-YF last stance

1905 saw the last YF epidemic. On May 2, cases were imported from Belize. There were 3,402 cases and 452 deaths. Mosquito control was fully implemented but the epidemic lasted until the winter broke it.