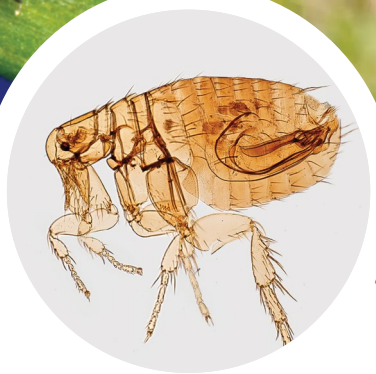
The National Public Health Strategy to

Prevent and Control Vector-Borne Diseases in People



DEPARTMENT OF HEALTH & HUMAN SERVICES USA
CDC

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INTRODUCTION

Almost everyone has been bitten by vectors—mosquitoes, ticks, fleas, or lice that can spread pathogens. Vector-borne diseases (VBDs) are major causes of death and illness worldwide, and the United States continues strengthening its response to these threats. The National Public Health Strategy for the Prevention and Control of Vector-Borne Diseases in People (VBD National Strategy) identifies and describes federal priorities to protect people from diseases and conditions caused by vectors in the United States.

VBDs increasingly threaten the health and well-being of people in the United States, with reported cases doubling over the last two decades.[1] Close to 1,000,000 reported VBD cases in the United States occurred between 2001 and 2023 due to multiple mosquito-borne disease outbreaks and geographic spread of tickborne diseases.[2] Further, as the geographic range of vectors is expanding, the number of pathogens spread by vectors continues to climb, yet only one vaccine is available to protect people against domestic VBD threats.

The rising public health threat of VBDs requires a comprehensive and sustained national effort to protect people.[3–4] In 2020, the U.S. government published a framework responding to this need, titled A National Public Health Framework for the Prevention and Control of Vector-Borne Diseases in Humans[5] (VBD National Public Health Framework). A consortium expanded the VBD National Public Health Framework into this comprehensive VBD National Strategy.

This VBD National Strategy represents the largest formal federal coordination effort focused on VBD prevention and control. This collaborative effort will help:

- Address the significant challenges facing public health related to VBDs.
- Incorporate a One Health approach[6] to enhance coordination and communication across human, animal, and environmental areas.
- Reverse the upward trends in illness, suffering, and death.

Scope

The Kay Hagan Tick Act (codified at 42 U.S.C. §§ 247b-23 and 300hh-32),[7] signed into law in 2019, mandated the U.S. Department of Health and Human Services (DHHS) to develop a VBD National Strategy. This strategy identifies and describes federal priorities to detect, prevent, respond to, and

control diseases and conditions caused by vectors in the United States. The federal government also collaborates with international partners and public health officials in other countries to monitor VBD risks, respond to emerging threats, and ensure national public health security. However, those activities are not included in this domestic VBD National Strategy.

Although critical to public health and wellness, clinical and healthcare services; access to care; legal protections; and reimbursement or payment for clinical services are also outside the scope of this VBD National Strategy.

The VBD National Public Health Framework and the VBD National Strategy align with the October 2022 National Biodefense Strategy,[8] objective 3.1, to promote measures that prevent or reduce the spread of naturally occurring infectious diseases (sub-objective 3.1.2: Strengthen Capacities to Combat Emerging and Zoonotic Disease). The VBD National Strategy also aligns with the National Institutes of Health's (NIH) October 2019 *Strategic Plan for Tickborne Disease Research.*[9]

Participating Federal Departments

Department of Health and Human Services (DHHS)

Centers for Disease Control and Prevention (CDC)

Immediate Office of the Secretary, Office of the Secretary (IOS/OS); Office of the Assistant Secretary for Health (OASH); and Office of the Chief Technology Officer (IOS/CTO)

Administration for Strategic Preparedness and Response (ASPR), Biomedical Advanced Research and Development Authority (BARDA)

Food and Drug Administration (FDA)

National Institutes of Health (NIH)

Department of Defense (DOD)

Armed Forces Pest Management Board (AFPMB)

Defense Health Agency, Public Health Directorate, Armed Forces Health Surveillance Division (AFHSD), Global Emerging Infections Surveillance (GEIS) Branch

Department of Agriculture (USDA)

Agricultural Research Service (ARS)

Animal and Plant Health Inspection Service (APHIS)

Environmental Protection Agency (EPA)

Office of Chemical Safety and Pollution Prevention (Office of Pesticide Programs)

Department of the Interior (DOI)

National Park Service (NPS)

U.S. Geological Survey (USGS)

Department of Commerce (DOC)

National Oceanic and Atmospheric Administration (NOAA)

National Aeronautics and Space Administration (NASA)

Other Participants

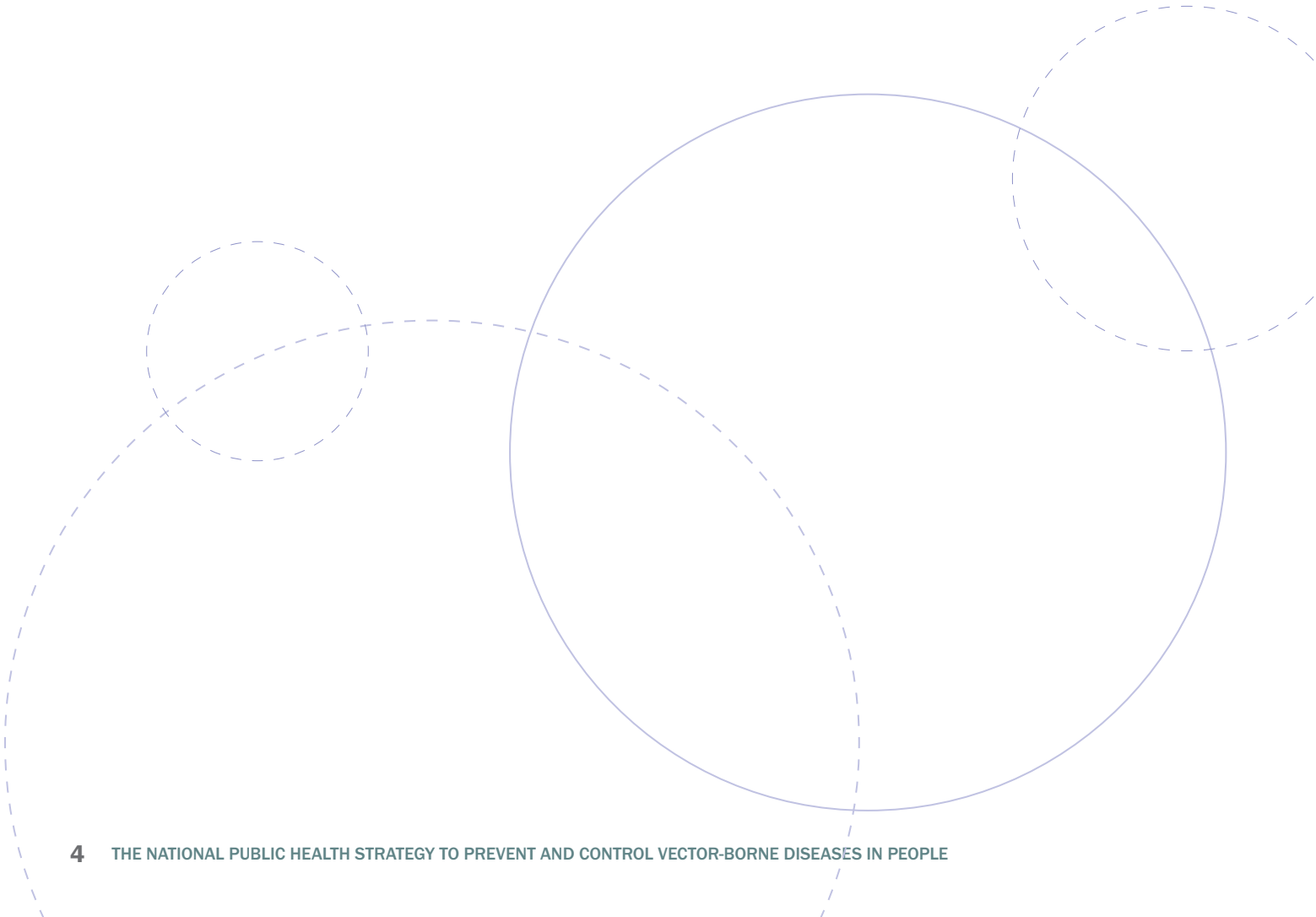
National Invasive Species Council (NISC)

U.S. Global Change Research Program

Consulting Federal Departments

Department of Homeland Security (DHS)

Federal Emergency Management Agency (FEMA)



BACKGROUND

In December 2019, the Kay Hagan Tick Act was signed into law, as part of the fiscal year (FY) 2020 Further Consolidated Appropriations Act, authorizing VBD prevention and control activities. Activities include:

- Continuing CDC's Regional Centers of Excellence (COE) in Vector-Borne Diseases program.[10]
- Providing additional VBD support in jurisdictions through CDC's Epidemiology and Laboratory Capacity cooperative agreement.[11]
- Developing a VBD National Strategy, led by the DHHS Secretary, expanding upon the VBD National Public Health Framework that was in development.

CDC released the VBD National Public Health Framework in September 2020.[12] The framework was developed in collaboration with other departments and offices with direct authority over and responsibility for the prevention and control of VBDs.[13]

DHHS OASH and CDC co-led this VBD National Strategy, released in 2024. It was developed in collaboration with department and federal entities that collaborated on the VBD National Public Health Framework, with additional representation from NASA and NOAA.

The Tick-Borne Disease Working Group (TBDWG) was authorized by Congress in 2016. While no longer active, TBDWG met biannually beginning in 2017 for more than 5 years throughout the development of this strategy to summarize federal tickborne disease activities and develop recommendations for the Secretary of DHHS and Congress. The TBDWG delivered three reports to Congress, with more than 70 recommendations before sunsetting at Congressional direction in December 2022.[14,15]

The TBDWG was consulted during development of the VBD National Strategy, as stipulated in the Kay Hagan Tick Act. Additionally, updates were provided on the development of the VBD National Strategy at public TBDWG meetings. Steps were taken to ensure that the TBDWG recommendations were reflected within the strategic priorities of the VBD National Strategy; the alignment of the content was reflected in a Request of Information that was publicly distributed.[16]

The Problem

Everyone in the United States is at risk from diseases transmitted by ticks, mosquitoes, fleas, and other vectors. VBDs, such as Zika, West Nile virus, dengue, malaria, plague, Lyme disease, and Rocky Mountain spotted fever (RMSF), are serious, life-threatening illnesses. Some communities and people are affected by these diseases more than others due to greater exposure to vectors and increased barriers to health care.

BOX 1.

VBDs REPORTED TO CDC

- Anaplasmosis/ehrlichiosis infections
- Babesiosis
- California serogroup viruses
- Chikungunya virus
- Dengue viruses
- Eastern equine encephalitis virus
- Lyme disease
- Malaria
- Plague
- Powassan virus
- Spotted fever rickettsiosis
- St. Louis encephalitis virus
- Tularemia
- Western equine encephalitis virus
- West Nile virus
- Yellow fever virus
- Zika virus

Currently, states, territories, and freely associated states voluntarily report cases of 17 VBDs to CDC,[17] plus additional cases that are not nationally notifiable but of interest to public health. The reported number of VBD cases have increased significantly since 2004,[18] with more than 1,000,000 cases reported between 2001 and 2023, and annual reported cases of disease from mosquito, tick, and flea bites more than doubling during this period.[19]

However, reported cases tell only a portion of the story. For example, it is estimated that only one in ten West Nile virus cases are reported,[20,21] and the number of treated Lyme disease cases is possibly 10 times higher than the number reported to CDC.[22] The burden of the COVID-19 pandemic further impacted the ability of health departments to investigate and report VBD cases.

In addition, the geographic range of ticks,[23] mosquitoes,[24] and fleas[25] that transmit pathogens and cause disease have expanded within the United States.

Several factors are driving the emergence and increased transmission of VBDs, putting more people at greater risk.[26]

- **Changing land use patterns,** like reforestation, can lead to increased deer populations and suburban growth, exposing more people to more infected tick bites each year.
- **Global travel and trade** play a role in introducing invasive vectors and pathogens throughout the Americas.[27] For example, the movement of pets or livestock into the United States has been implicated in the introduction and establishment of the invasive Asian longhorned tick *(Haemaphysalis longicornis),* an important disease vector in other parts of the world, to the United States.[28] Travelers have inadvertently brought chikungunya and Zika viruses into the United States. Almost every year, travelers have been associated with local transmission of dengue viruses in southern states.
- **A changing climate** influences the geographic distribution and seasonality of VBDs. This includes changing weather patterns and increased frequency of severe and unpredictable weather, such as heat waves and droughts. Longer and warmer summers and shorter and milder winters lengthen vector seasons in the United States. Temperature and precipitation affect disease transmission by impacting the replication, interaction, and survival of pathogens disease vectors, and animals in the environment.

These factors, along with societal factors like housing conditions, occupational exposures, and access to health care, can contribute to worsening the already disproportionate impacts of VBDs in some communities.

Tickborne Disease Threats

Tick bites can result in the transmission of pathogens that cause serious diseases such as Lyme disease,[29] ehrlichiosis,[30] babesiosis,[31] RMSF,[32] and Powassan virus.[33] Some of these diseases can be deadly if not treated promptly.

Tickborne disease cases are on the rise, and ticks are spreading to new geographic areas.

- Scientists have discovered **at least seven** new tickborne pathogens in people in the United States from 2004 to 2023.
- Annual reported tickborne disease cases in the United States **more than doubled** from 2004 through 2019.
- Each year, **approximately 90%** of reported VBD cases are tickborne disease cases (50,865 of the total 56,045 reported cases in 2019).

Lyme disease, caused by *Borrelia burgdorferi,* is the leading cause of tickborne disease, accounting for more than 8 out of 10 reported tickborne disease cases annually. However, reported cases are only a fraction of the diagnosed and treated cases. Recent estimates suggest that approximately 476,000 people are diagnosed and treated for Lyme disease each year in the United States. A June 2022 study estimated the total societal cost—costs incurred by patients, healthcare systems, or third-party payers—of diagnosed Lyme disease ranges from $345 million to $968 million.[35]

BOX 2.
TICKS THAT ARE KNOWN TO BITE PEOPLE IN THE UNITED STATES INCLUDE:[34]

- Lone star tick *(Amblyomma americanum)*
- American dog tick *(Dermacentor variabilis* and *Dermacentor similis)*
- Brown dog tick *(Rhipicephalus sanguineus)*
- Groundhog tick *(Ixodes cookei)*
- Gulf Coast tick *(Amblyomma maculatum)*
- Rocky Mountain wood tick *(Dermacentor andersoni)*
- Soft ticks *(Ornithodoros* species)
- Blacklegged tick *(Ixodes scapularis)*
- Western blacklegged tick *(Ixodes pacificus)*
- Asian longhorned tick *(Haemaphysalis longicornis)*

In addition to causing serious and potentially fatal tickborne diseases, the bite of a tick may result in other health impacts, such as alpha-gal syndrome (AGS, also called red meat allergy). AGS is a serious, potentially life-threatening allergic condition. Evidence suggests that AGS is primarily associated with the bite of a lone star tick in the United States, but other kinds of ticks have not been ruled out. AGS symptoms occur after people eat red meat or are exposed to other products containing the sugar molecule alpha-gal (galactose-α-1,3-galactose). Recent estimates suggest that up to 450,000 people in the United States may have AGS,[36] and yet healthcare provider knowledge regarding this condition is low.[37]

Global travel and trade introduce new ticks to the United States, which threatens the nation's public health if the vector transmits new pathogens or increases the transmission of pathogens. For example, the invasive Asian longhorned tick was identified in 2017 for the first time in the United States.[38,39] By 2022, it was reported in 17 states. While laboratory studies have shown that these ticks cannot transmit *Borrelia burgdorferi,*[40] they can acquire and transmit *Rickettsia rickettsii,* which causes RMSF.[41] In other parts of the world, the Asian longhorned tick can transmit at least one medically relevant human pathogen.[42] Habitat suitability studies suggest that this tick has the potential to expand broadly across the continental United States.[43]

Mosquito-Borne Disease Threats

When mosquitoes bite people, they can transmit pathogens that cause diseases such as West Nile virus infection,[44] dengue,[45] Zika,[46] and malaria.[47] Mosquito-borne diseases cause substantial illness in the United States each year, although the reported number of cases varies by virus and geography and can occur sporadically.[48]

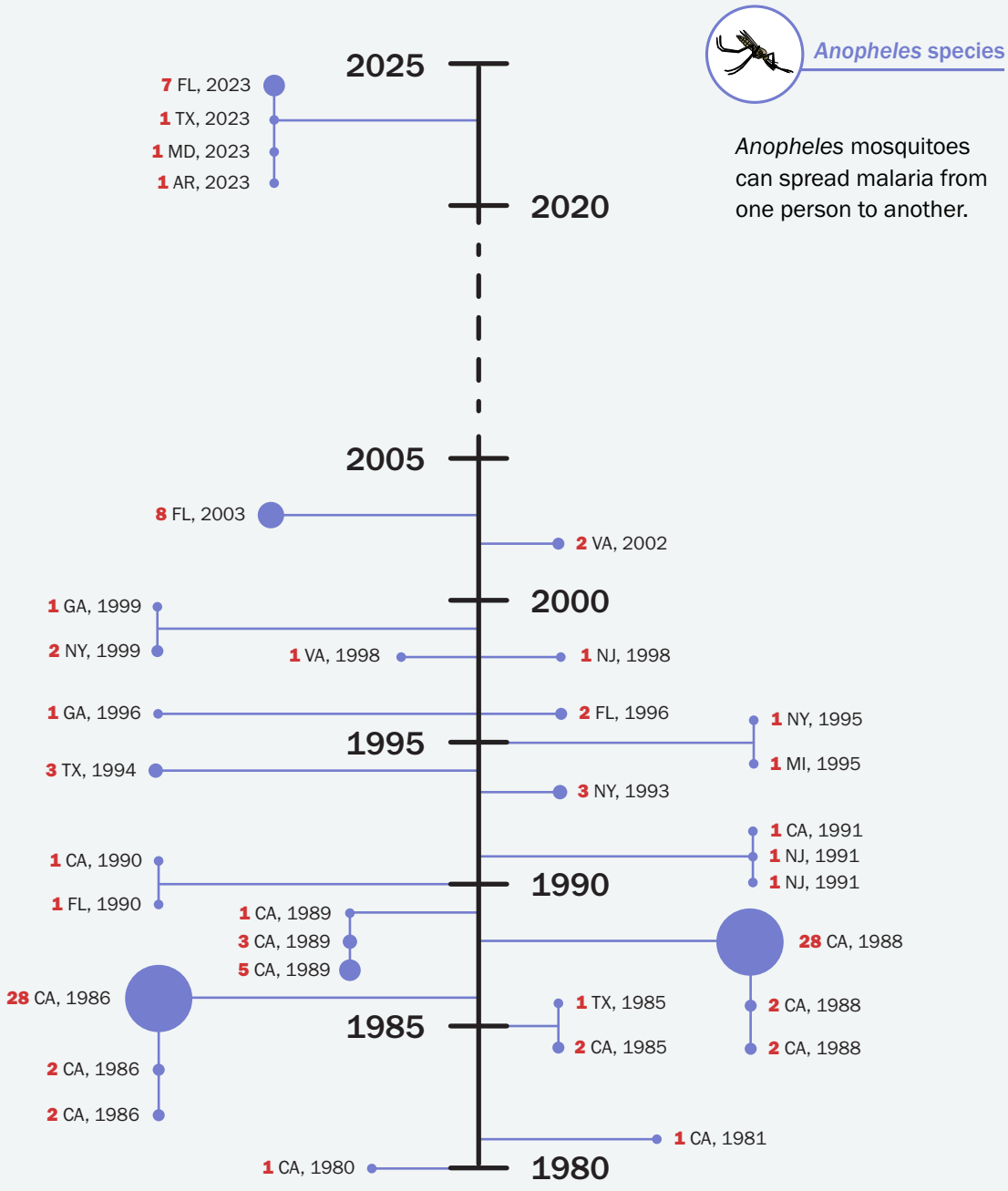
Mosquito vectors in the United States include *Culex, Aedes,* and *Anopheles* species.[49]

As with tickborne pathogens, mosquito-transmitted pathogens have caused an increasing number of outbreaks.

- Chikungunya virus spread to the Americas from Southeast Asia in 2013 and expanded to 40 countries, **causing more than 1 million cases** in the first year alone.[50]
- Zika virus, first isolated in 1947 in Uganda, caused fewer than 20 known human cases until it **caused an outbreak** in the Federated States of Micronesia in 2007, followed by large outbreaks worldwide.[51] The ability of the virus to cause birth defects was not recognized until 2016.[52]
- Malaria was detected in four states across the United States in 2023 in people with no history of travel, suggesting the disease **was transmitted locally.**[53]
- After continued geographic expansion of *Aedes aegypti* mosquitoes, the **first cases of locally transmitted** dengue virus were documented in California in 2023.[54]

Timeline of Locally Acquired Malaria Outbreaks

In the United States, 1980–2023



www.cdc.gov/malaria/about

= Cases

Multiple circles in a given year represent separate cases or outbreaks. Data as of October 1, 2023.

Various factors have and will continue to influence the geographic range of mosquitoes. Weather, vector abundance, animal hosts, and human behavior influence when and where mosquito-borne disease outbreaks occur, making it difficult to predict the emergence and locations of outbreaks. Maintaining surveillance nationwide is important to rapidly identify outbreaks and respond to these threats as early as possible using informed response and prevention strategies.[55]

West Nile virus[56] is the leading cause of mosquito-borne disease in the continental United States. It accounts for 83% of all domestic mosquito-borne disease cases annually.[57] An estimated 70% to 80% of West Nile virus infections are asymptomatic. Around 20% to 30% of infected people develop an acute systemic febrile illness and less than 1% of infected people develop neuroinvasive disease (e.g., meningitis, encephalitis, or myelitis). Among patients with neuroinvasive disease, approximately 10% die. Those surviving the infection often have long-lasting or even life-long neurological symptoms, including depression, memory loss, and motor dysfunction.[58]

In 2021, Arizona experienced the largest local outbreak of West Nile virus since the virus was first detected in the United States in 1999. The outbreak was responsible for 121 deaths and more than 1,100 neuroinvasive disease cases—almost twice the number of cases compared to the next largest localized outbreak in the United States.[59]

Four closely related dengue viruses (DENV-1, -2, -3, -4) can be spread to people through bites of infected *Aedes* mosquitoes *(Aedes aegypti* or *Aedes albopictus)*. Almost half of the world's population, about 4 billion people, live in areas with a risk of dengue virus transmission.[60,61] In areas where dengue virus transmission occurs, it is often a leading cause of illness. Around 1% to 5% of symptomatic dengue cases result in severe disease. Dengue causes sporadic outbreaks in the Caribbean and Pacific territories of the United States. Local cases and limited spread of dengue occur periodically in some states with hot, humid climates and Aedes mosquitoes, including Florida and Texas.

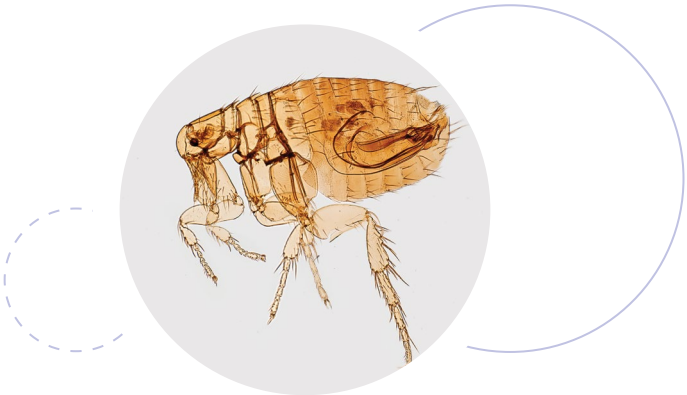
Other sporadic mosquito-borne disease and occasional outbreaks occur in the United States, such as La Crosse virus, Jamestown Canyon virus, eastern equine encephalitis virus, malaria, and St. Louis encephalitis virus. La Crosse virus is the most common cause of neuroinvasive arboviral disease in children. Of particular concern is that more cases of eastern equine encephalitis virus disease were reported in 2019 than any previous year.[62] Eastern equine encephalitis virus remains one of the deadliest arboviral diseases—nearly one-third of patients who develop neurological disease die.[63,64]

Fleaborne and Other VBD Threats

In addition to mosquitoes and ticks, fleas, kissing bugs, lice, deer flies, chiggers, and other vectors can also transmit pathogens. Together, annual cases of VBDs caused by these vectors are few, but they can cause death and long-term disability.

Two of these diseases—plague and tularemia—are caused by bacteria classified as select agents. The pathogens that cause plague[65] and tularemia[66] are designated the highest risk category of biologic agents and toxins with the potential to pose a severe threat to public health and safety (tier 1 select agents).[67] This designation is due in part to the low infectious dose and high case-fatality rate if untreated, and history of use as an agent of bioterrorism.[68,69]

People usually acquire plague, caused by *Yersinia pestis,* after being bitten by a rodent flea carrying *Yersinia pestis* or by handling an animal infected with plague. Plague is an occupational risk for



veterinarians and their technicians. Antibiotics are effective in treating plague, but the disease can cause serious illness or death without prompt treatment. People continue to get plague infections in the western United States, with a national average of seven cases reported each year (a range of 1 to 17 cases per year from 2000–2020). CDC recommendations are used to guide treatment and prophylaxis for naturally acquired plague infections and for bioterrorism response.[70]

Plague is also a priority disease for the U.S. Department of the Interior and natural resource managers because in addition to visitors of managed natural areas being at risk for infection, endangered black-footed ferrets and their prey (prairie dogs) die from this disease. Mitigation tools[71,72] developed by USGS to reduce upstream wildlife disease outbreaks has reduced questing flea abundance in areas used by campers, decreasing the risk for people.[73]

Hundreds of naturally occurring human tularemia cases are reported each year, ranging from 90 to 314 cases between 2000 and 2020. Rabbits, hares, and rodents are especially susceptible to tularemia and often die in large numbers during outbreaks. People can acquire tularemia, caused by *Francisella tularensis,* through:

- Tick and deer fly bites.
- Skin contact with infected animals.
- Drinking contaminated water.
- Inhaling contaminated aerosols or agricultural and landscaping dust.
- Exposure in a laboratory.

Fleaborne (murine) typhus,[74] a disease caused by *Rickettsia typhi,* occurs in tropical and subtropical climates around the world, including areas of the United States (e.g., southern California, Hawaii, and Texas). Fleas become infected when they bite infected animals like rats, cats, or opossums. When an infected flea bites a person or animal, the bite breaks the skin, causing a wound. Fleas defecate when they feed, producing a fecal residue also known as "flea dirt." People can rub the flea dirt into their bite wound or other wounds, which leads to infection. People can also breathe in infected flea dirt or rub it into their eyes.

Although flea-borne typhus is uncommon in the United States, an outbreak occurred in 2018 in Los Angeles County, California, and cases remained higher than expected in subsequent years. The number of people diagnosed with flea-borne typhus in Los Angeles County increased from 31 reported cases in 2010 to 171 reported cases and three deaths in 2022.[75] The outbreak disproportionately affected people experiencing homelessness.

Body lice are also known to transmit less common but clinically important pathogens, such as *Rickettsia prowazekii (*epidemic typhus),[76] *Bartonella quintana,*[77] and louse-borne relapsing fever.[78]

Chagas disease,[79] caused by the parasite *Trypanosoma cruzi,* is transmitted by kissing bugs in the subfamily Triatominae. An estimated 300,000 people living in the United States have Chagas disease. While the kissing bug species are present in the United States, most domestic cases are travel associated.[80] Chagas disease is common throughout parts of South and Central America and Mexico, particularly in rural areas where an estimated 8 million people are infected. However, there is a concern that this situation could change as warmer temperatures could increase habitat suitability in the United States for some of the currently geographically limited triatomine species.

Emerging Vector-Borne Pathogens

More than 100 pathogens are known to spread through vectors and make people sick, and this number is increasing.[81] Since 2004, scientists have identified at least nine new vector-borne pathogens in the United States.

BOX 3.

PATHOGENS DISCOVERED OR FIRST REPORTED IN THE UNITED STATES THAT CAUSE VBDS SINCE 2004

Tick-transmitted

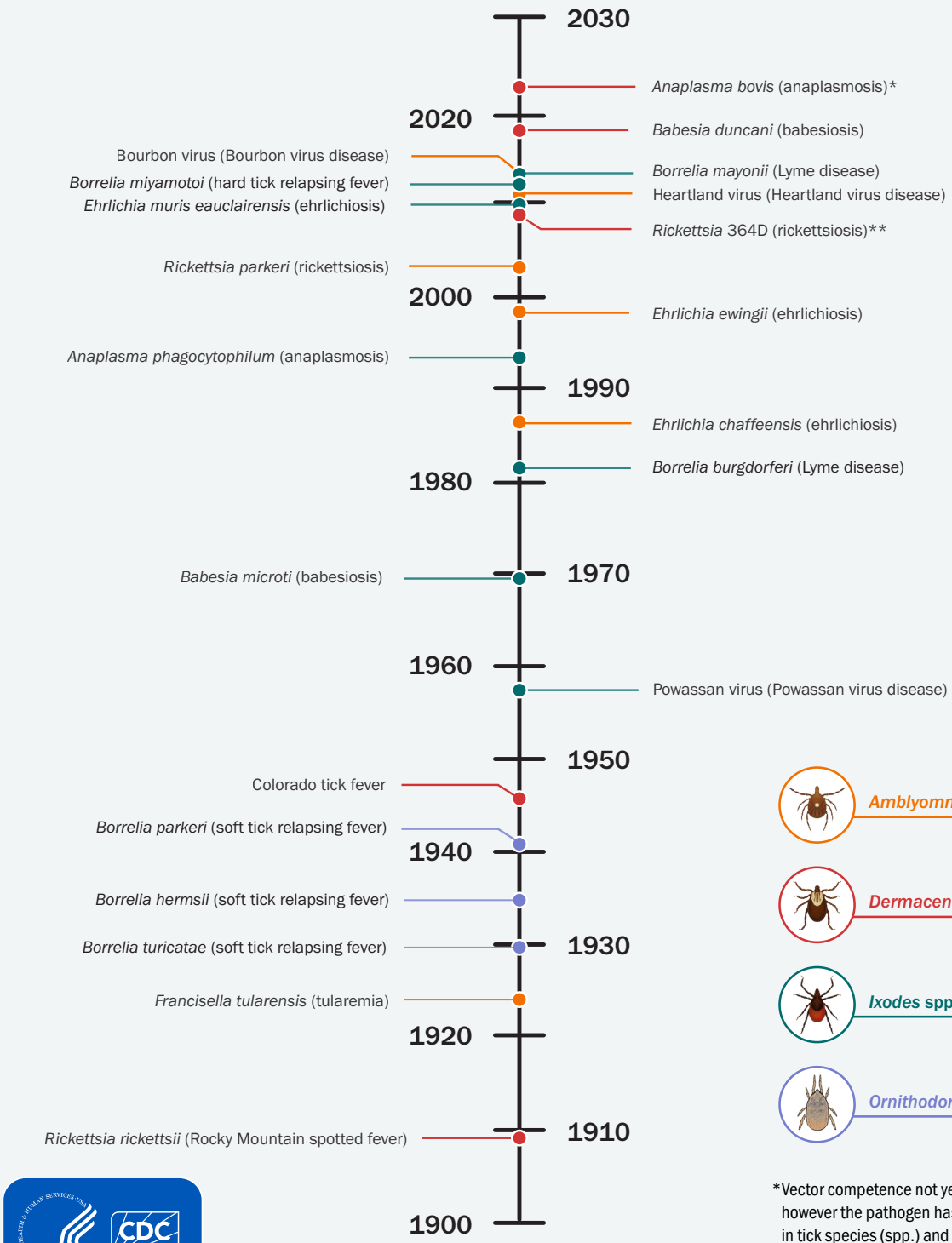
- *Borrelia mayonii*
- *Borrelia miyamotoi*
- Bourbon virus
- *Ehrlichia muris eauclairensis*
- Heartland virus
- *Rickettsia parkeri*
- *Rickettsia* species 364D

Mosquito-transmitted

- Chikungunya virus
- Zika virus

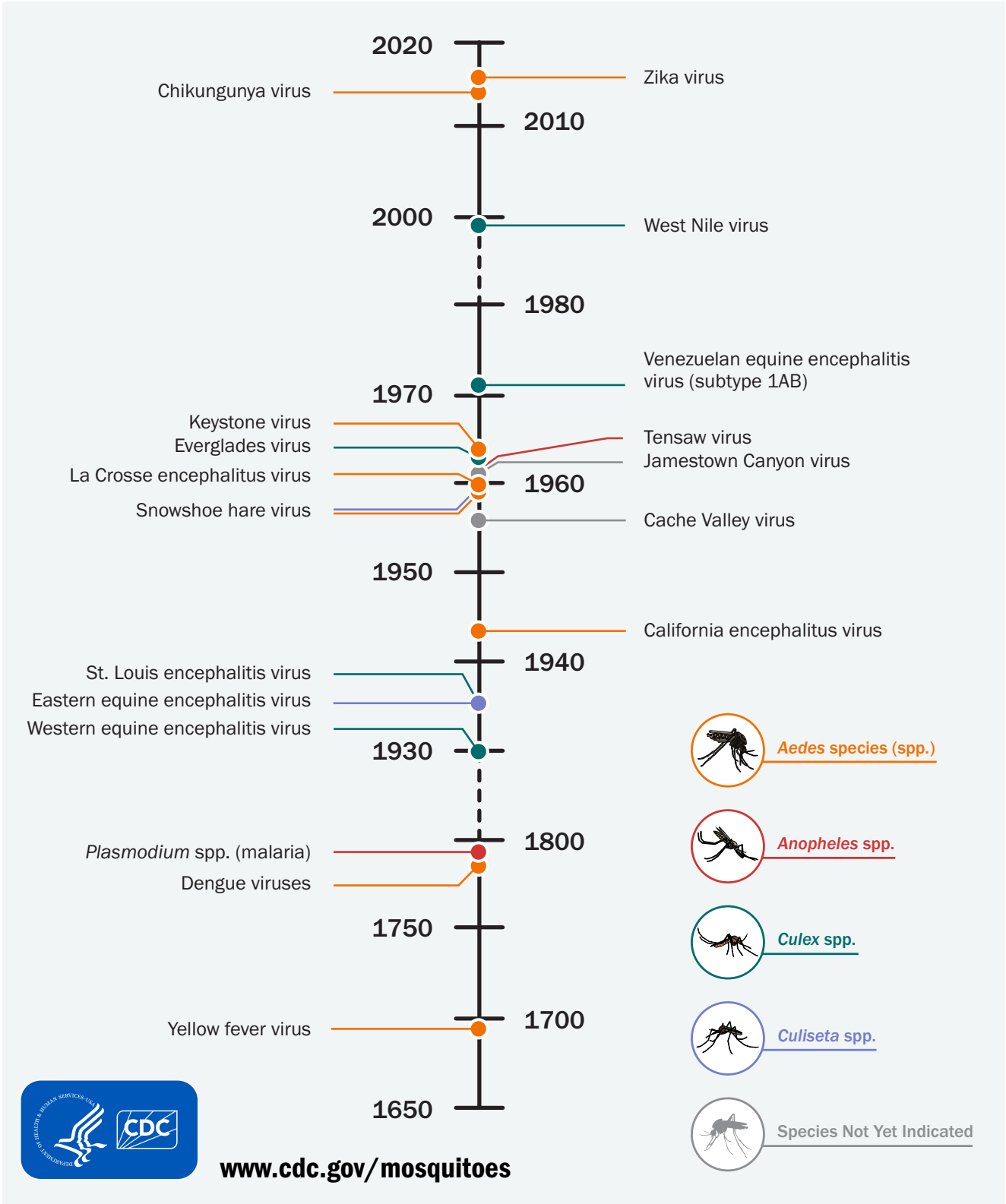
Discovery of Tickborne Pathogens

That Cause Human Disease in the United States, 1900–2023



Mosquito-Borne Pathogens

Identified in the United States That Cause Human Disease, 1650–2023



While some of these pathogens are invasive species, others have been present in the United States for a long time and only recently recognized. Of note, Orientia species bacteria were recently detected in North Carolina among chigger mites that bite people.[82] This pathogen is an important cause of scrub typhus, a disease seen traditionally in Southeast Asia and Oceania but not known to be present in the United States. As new pathogens are discovered and put people at risk, research is needed to determine:

- Where the pathogens are present.
- Which vectors and animals spread the pathogens.
- The type and amount of disease and disability the pathogens can cause, and treatment.
- Who is at risk.

BOX 4.
ABOUT NATIVE AND INVASIVE SPECIES

A native species has developed over hundreds or thousands of years in a particular region or ecosystem.

Invasive species include harmful plants, animals, or pathogens newly introduced to an area, often through global trade, commerce, or travel. Invasive species are harmful because they can introduce new pathogens or transmit existing pathogens.

Concurrent and Competing Public Health Threats

The 2020 VBD National Public Health Framework was released while our nation's public health professionals responded to the multi-year COVID-19 pandemic.

The pandemic hindered the nation's ability to conduct other public health surveillance activities.[83] Public health professionals nationwide were diverted to the pandemic response—72% of state and local public health workers were reassigned to work at least part-time on the COVID-19 response.[84] Additionally, many clinics and healthcare facilities limited services, served fewer patients, or closed their doors entirely in the face of challenges from COVID-19.[85,86,87,88] People had reduced access to care and testing services, affecting health-seeking behaviors and challenging access to diagnosis and treatment.

In 2022, public health professionals were also actively engaged in emergency responses for mpox (formerly known as monkeypox),[89] hurricanes, and polio, alongside numerous local public health emergencies. These competing public health priorities call for steady-state, continuously operational systems to withstand the repeated impacts on the public health system such as that described in the National Biodefense Strategy.[90]

As new pathogens are discovered and put people at risk, research is needed.

Maintaining Global Capacity

The novel introductions of West Nile, chikungunya, and Zika viruses in the Americas illustrate that, in today's globalized society, VBDs are a global threat, with national security, economic, and health implications to the United States. Global health security[91] ensures strong and resilient public health systems that can detect, prevent, respond to, and control infectious disease threats, wherever they occur in the world. Global health security can help prevent the spread of exotic vector-borne pathogens before they reach the United States or, at a minimum, provide early warning and knowledge of potential risks so that public health systems can develop countermeasures.

It is important to maintain complementary international capabilities that can help fight vector-borne global health security risks, including:

- Surveillance systems to quickly detect outbreaks before they spread.
- Laboratory networks to accurately diagnose diseases and identify new pathogens.
- Highly trained frontline staff to identify, track, and contain outbreaks at their source.
- Emergency management systems to coordinate response efforts when they occur.

This VBD National Strategy is domestic in focus. International efforts complement domestic priorities.

PUBLIC HEALTH OUTCOMES

Public Health Outcomes

Collaborating to Address Vector-Borne Diseases and Save Lives

Vector-borne diseases (VBDs) increasingly threaten the health and well-being of people in the United States. This rising public health threat calls for a comprehensive, sustained, and collaborative national effort to address significant challenges, reverse the upward trends, and protect people.

VISION

A nation where **VBDs no longer threaten the health of people.**

MISSION

Protect people from illness, suffering and death due to VBDs.

TARGETED U.S. PUBLIC HEALTH OUTCOMES

Eliminate deaths from **Rocky Mountain Spotted Fever** in Arizona tribal communities by 2025.

Eliminate sustained local spread of **dengue** by 2035.*

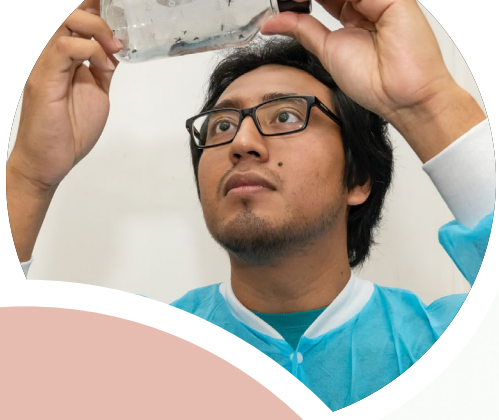
Reduce the number of **Lyme disease cases** (laboratory confirmed) 25% by 2035, compared to 2022.

Reduce the annual number of **West Nile virus neuroinvasive disease cases** to below 500 by 2035.

*Sustained is defined as having more than 10 related cases in one jurisdiction.

Together, more action is needed to protect people from VBDs. The United States must continue to identify challenges, recognize innovative opportunities, and scale effective strategies to meet the nation's vision, mission, and targeted health outcomes.

www.cdc.gov/vbd



CHALLENGES AND SELECT OPPORTUNITIES

to Prevent and Control VBDs

Many challenges hinder the nation's ability to detect, prevent, respond to, and control VBD threats, slowing national progress towards the vision, mission, and public health outcomes. Yet, collaborative innovation offers opportunities to mitigate these challenges.

This strategy identifies 15 challenges to address VBDs and describes at least one opportunity to overcome the challenge. The challenges are listed to align with outlined goals, not ranked by importance.

CHALLENGE	OPPORTUNITY
Surveillance limited by the existing infrastructure of programs and systems	Support expanded surveillance capacity to inform public health action
Lack of interconnected, quality data	Modernize data collection systems to increase learning and make data more readily available to decision-makers and the public
Lack of interconnection of information and activities across VBD-relevant sectors	Take a One Health approach to prevent and control VBDs
Our understanding of how VBD pathogens can be transmitted is still developing	Conduct investigations that expand our knowledge of how VBD pathogens are transmitted
Increasing risk for VBDs due to geographic expansion of vectors	Understand and address the impacts of a changing climate on VBDs
Certain populations experience inequities in the burden of VBDs	Use an equity-centered approach to prevent and control VBDs and eliminate health inequities Leverage DHHS Lyme Innovation initiative—Of the people, by the people, for the people
Ability to diagnose VBDs limited by diagnostic test performance and availability	Create opportunities for open innovation to improve Lyme disease diagnostics
Few VBD prevention and control measures	Evaluate and make available promising technologies in vector control
Few human VBD vaccines are approved for use in the United States	New VBD vaccines are in development
VBD outbreaks can be difficult to predict	Investing in forecasting and outbreak analytics
Need for improved VBD treatment	Optimize existing treatment protocols and develop new therapeutics
Innovation can sometimes outpace regulatory processes	Increase flexibility and coordination in the regulatory processes for novel vector control
Limited capacity to respond to VBD threats	Implement new models that build capacity
Lack of workforce diversity in the field of Entomology	Implement programs to enrich the public health entomology workforce

CHALLENGE: Surveillance limited by the existing infrastructure of programs and systems

It is critical to know where infections occur and when their incidence changes. Knowing where and why changes are occurring inform solutions, such as predicting increased risk and identifying groups of people who could benefit the most from tailored interventions. However, demands on state and local public health systems and programs limit the amount of attention focused on VBD surveillance, which hinders a community's and the nation's ability to accurately monitor human disease incidence and changes in vector populations.

OPPORTUNITY: Support expanded surveillance capacity to inform public health action

Expanding surveillance capacity to monitor where pathogens and vectors are present, where infections occur (human cases), and the changes in incidence over time better informs VBD prevention and control activities.

From 2016 to 2022, CDC doubled the funding that states, tribes, and select large cities (jurisdictions) received to support epidemiology and laboratory capacity for the prevention and control of VBDs. This increased funding resulted in increased VBD program capacity to conduct surveillance, investigate VBD cases, detect pathogens in vectors and diagnose VBDs, and take actions to prevent these diseases. Data from these programs are used by state and local agencies to inform vector control, environmental management, and health communication activities.

Beginning in 2019, CDC dedicated new resources, including additional funding and technical assistance, to states to support tick surveillance and pathogen detection. CDC also developed guidance for the surveillance of Lyme disease vectors *(Ixodes scapularis* and *Ixodes pacificus)* and non-*Ixodes* hard ticks. These resources help public health professionals characterize their local tickborne disease risk and develop prevention and control plans.

Mosquito-based arbovirus surveillance data[92] help track virus activity. The most basic form of mosquito-based surveillance data is the number of positive mosquito pools for a particular mosquito species over a defined period and area.

CDC also encourages capturing virus infection rates (IR) when evaluating local virus activity patterns. Tracking mosquito IR on a weekly basis at the county level or below can provide important predictive indicators of transmission activity levels associated with elevated human risk. Nationwide, jurisdictions use this strategy to inform prevention activities.[93,94,95] CDC developed a new tool for jurisdictions to support calculating the IR and help with decision-making.[96]

CHALLENGE: Lack of interconnected, quality data

Data to address VBDs, including clinical, surveillance, environmental, meteorological, animal (e.g., pets), and wildlife data, exist in a variety of non-standardized sources and formats across the public and private sectors. These data are not easily linked or shared, but instead are housed in siloed systems that restrict data sharing and require multiple points of data transfer. This limits the ability of public health professionals to rapidly analyze data, which can delay the quick response needed to address VBD threats and protect people. Additionally, surveillance data are voluntarily submitted to CDC by states, territories, and freely associated states, with some continuing to use paper-based reporting strategies.

OPPORTUNITY: Modernize data collection systems to increase learning and make data more readily available to decision-makers and the public

Real-time VBD and environmental data inform decision-making. With rapid access to actionable data, federal agencies and state and local public health departments could better understand ongoing and emerging threats and facilitate more effective mitigation.

In 2020, the U.S. government began a national, cross-departmental, multi-year effort to create a modern, integrated, and real-time public health data and surveillance system that can protect the nation from any threat, including VBDs.[97] The data modernization initiative reflects five priority areas:[98]

- Building the correct foundation for data collection.
- Accelerating data into action.
- Developing a state-of-the-art workforce.
- Supporting and extending partnerships with government, health care, and private industry partners.
- Managing and changing data governance.

Another new multi-year collaborative effort between CDC and the U.S. Digital Service (USDS) is the Pandemic-Ready Interoperability Modernization Effort (PRIME). PRIME will help strengthen data quality and information technology systems in state and local health departments.

CHALLENGE: Lack of interconnection of information and activities across VBD-relevant sectors

The health of people is connected to the health of animals and our shared environment. In fact, more than half of all pathogens are spread to people by animals. However, activities and information are not integrated or connected across sectors affected by VBDs.

Sometimes infections in animals can serve as early warnings of potential illness in humans. For example, in 1999, local health officials in New York observed an increased number of fatalities in birds, especially crows. Later, public health professionals reported an unusual cluster of meningoencephalitis cases in humans in New York.[99-100] West Nile virus was later identified in human and bird samples, confirming the first introduction of West Nile virus in the United States. USGS and USDA collaborated with CDC on the now defunct VectorMaps, which was initiated with West Nile virus to integrate human, animal, and mosquito detections. While this data collaboration no longer exists, there is an opportunity for future data integration to support early warning through databases like USGS's national wildlife disease database (whispers.usgs.gov).

OPPORTUNITY: Use a One Health approach to prevent and control VBDs

The federal government recognizes the intricate relationships between the health of people, animals, and the environment, and the need to collaborate across federal agencies to respond to public health outbreaks and emergencies.

In 2017, a workshop between DHHS, USDA, and DOI identified the top eight priority zoonotic diseases—diseases that spread between animals and people—of national concern for the United States.[101] Three priority diseases were vector-borne—West Nile virus, plague, and Lyme disease.[102]

The departments continued to collaborate to address the three VBDs. For example, USGS collaborated with DHHS to investigate plague, contributing to a One Health understanding of flea ecology, management tools, and the impacts of plague on human health. In addition, the USDA awarded grants to more than 23 states to support scientists in developing new practices and tools to control Lyme and other tickborne diseases.[103]

CHALLENGE: Our understanding of how VBD pathogens can be transmitted is still developing

Experts continue to learn how vectors transmit pathogens and cause disease. Understanding transmission dynamics is critical to developing prevention strategies and guidance.

OPPORTUNITY: Conduct investigations that expand our knowledge of how VBD pathogens are transmitted

Conducting investigations, especially in collaboration with jurisdictions, better inform VBDs transmission and guidance to prevent these diseases.

For example, when Zika virus[104] emerged in the Americas, it was known to be a mosquito-borne disease that causes fever, rash, headache, conjunctivitis, and joint and muscle pain, but concerns emerged in 2015 about the impact of Zika on the developing fetus. The U.S. government worked with public health departments to collect information about women exposed to Zika during pregnancy and their babies after birth.

Scientists confirmed that Zika can be passed from a woman who is pregnant to her fetus and that infection during pregnancy can cause certain birth defects. CDC developed recommendations to help women who are pregnant or planning to conceive protect themselves from Zika. Following the Zika outbreaks in the Americas, 5% of babies with confirmed or possible Zika virus infection at birth were presumed infected during pregnancy and had documented Zika-associated birth defects.[105]

CHALLENGE: Our understanding of how VBD pathogens cause disease and how the body's natural defenses combat infection remains incomplete

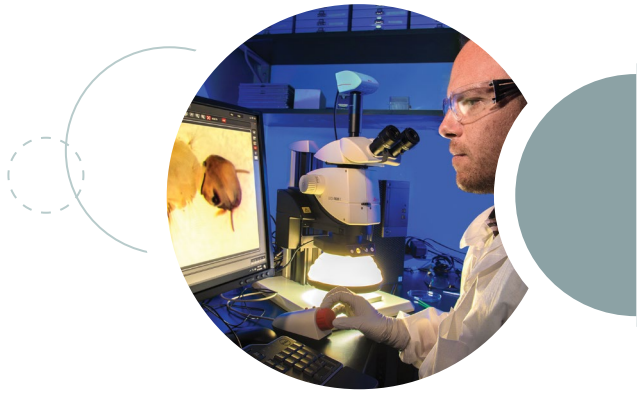
Developing effective countermeasures to combat VBDs requires an understanding of how the pathogens infect, spread, and cause disease within humans. It is already clear that those mechanisms can vary widely among the different VBD pathogens, and thus each pathogen must be studied in detail to gain a comprehensive understanding of VBD biology.

OPPORTUNITY: Support or conduct research on the pathogen and host biology of VBDs using new tools and technology as they become available

New technologies and perspectives are beginning to shed new light on the mechanisms by which VBD pathogens cause disease and avoid immune detection. Those discoveries can be accelerated by a focus on current gaps in our technology and understanding.

For example, NIH-funded research is now underway to create and expand genetic tools for a notoriously difficult to study group of bacteria, the Rickettsiales, responsible for several life-threatening VBDs, including RMSF, ehrlichiosis, and scrub typhus.[106] These tools could greatly expand our ability to understand how the Rickettsiales survive within human cells, evade immune detection, and cause disease. Another research initiative has been used to support fundamental research on viruses that target the immune system, such as West Nile virus and Powassan virus, among others.[107]

In addition, a recent NIH initiative called for research on the underlying causes of persistent symptoms attributed to Lyme disease,[108] and multiple projects are now underway that may begin to unravel the causes of this high-priority issue. By expanding on these studies, researchers may be able to develop new approaches for prevention and treatment.



Developing effective countermeasures to combat VBDs requires an understanding of how the pathogens infect, spread, and cause disease within humans.

CHALLENGE: Increasing risk for VBDs due to geographic expansion of vectors

The expanding geographic range of vectors, influenced by the introduction of invasive species and a changing climate, impacts the health of people.[109]

For example, *Aedes aegypti* was presumably introduced into the United States in the 1600s during the trans-Atlantic slave trade and likely caused yellow fever outbreaks in New York City, Philadelphia, and Boston from the 1690s to the 1820s. Today, the nation is increasingly threatened by invasive, epidemic-prone viruses spread by *Aedes aegypti* mosquitoes, including dengue, chikungunya, and Zika. *Aedes aegypti* mosquitoes have expanded from the southeastern United States as far north as Maryland and Delaware, and north from Mexico to northern California. Since being detected in California in 2013, these mosquitoes have spread throughout much of the state and to neighboring Nevada.[110]

In 1985, the *Aedes albopictus* mosquito, vector of yellow fever, La Crosse encephalitis virus, and 13 other viruses, was introduced into the United States, likely through used tire shipments from Asia. *Aedes albopictus* mosquitoes have rapidly spread throughout the southeastern United States and as far north as New Hampshire.[111–112]

OPPORTUNITY: Understand and address the impacts of a changing climate and environment on VBDs

The U.S. government is using a multidisciplinary, integrated, and cross-sectoral approach to detect, investigate, forecast, track, prevent, and respond to public health threats related to climate change.[113–114] Additionally, changing climate and public health efforts are being integrated, such as:

- Enhancing preparedness and response to climate-related emergencies.
- Improving surveillance of climate-sensitive diseases.
- Sharing effective messages to protect the public from climate-related diseases.
- Addressing inherent health inequity and environmental injustice issues.

CDC works with public health professionals to act within their communities by using CDC's framework of Building Resilience Against Climate Effects (BRACE);[115] implementing CDC's Climate and Health Strategy; [116] and considering new ways to monitor the impact of climate change, such as using habitat suitability and ecological niche models to assess the impact of climate change on vector distributions.[117]

The expanding geographic range of vectors, influenced by the introduction of invasive species and a changing climate, impacts the health of people.

CHALLENGE: Certain populations experience inequities in the burden of VBDs

Everyone should have a fair and just opportunity to attain their highest level of health. Unfortunately, some communities are at disproportionate risk of exposure to VBD pathogens, infection, illness severity, and death. This is due to systemic inequities, including limited access to prevention and control strategies, housing conditions, environmental and occupational exposures, and access to health care.

For example, more than 500 RMSF cases occurred in tribal communities in Arizona from 2002 through 2022. This includes 28 fatalities, approximately half of which were children. The rate of RMSF on the three most highly impacted tribal lands is more than 150 times the national rate. Preventing RMSF requires investments in local training and infrastructure because many impacted communities are in rural locations with limited resources for veterinary care and tick control services; have large free-roaming dog populations that serve as hosts to infected ticks; and have limited large trash removal (ticks can live in trash).

OPPORTUNITY: Use an equity-centered approach to prevent and control VBDs and eliminate health inequities

It is federal policy that the Federal Government should pursue "a comprehensive approach to advancing equity for all, including people of color and others who have been historically underserved, marginalized, and adversely affected by persistent poverty and inequality."[118] A multi-sectoral, innovative, and data-driven approach with health equity principles embedded into the design, implementation, and evaluation of research, data, surveillance, intervention, and evaluation strategies[119] would help address drivers of health inequities and improve health outcomes for all.

For example, in 2018, CDC initiated a One Health collaborative model to develop, implement, and evaluate a prevention strategy to reduce RMSF illness, disability, and death in Arizona tribal communities. CDC, in collaboration with numerous partners including tribal organizations, employed a prevention strategy that includes using long-lasting tick collars on dogs, applying pesticides, and educating communities and healthcare providers.

Thousands of homes were treated with acaracide (a tick-targeted pesticide), thousands of dogs received tick collars, health communication materials were co-developed and disseminated, healthcare providers were educated in early diagnosis and treatment, and trash removal and animal control efforts were expanded.

This collaborative effort has increased the capacity of the tribes to lead the prevention efforts independently, and case counts in participating communities have decreased by more than two-thirds. Further declines in illness and death will rely on sustained efforts that include similar place-based approaches, co-developed with and tailored to meet the needs and leverage assets of the community.

OPPORTUNITY: Leverage DHHS Lyme Innovation initiative

Health equity goals can be advanced by including patients, their caregivers, and patient advocates in the research, policy, and prioritization process. In response to citizen petitions that the U.S. government prioritize Lyme and tickborne diseases and the Fourth Open Government National Action Plan for the United States of America,[120] DHHS launched its patient-centered, data-driven Lyme Innovation initiative.

DHHS Lyme Innovation exemplifies a human-centered design approach originated by, for, and with a community that used the U.S. government's open data,[121] open science,[122] and the international "Open Government" playbooks[123,124] to transform national policy for Lyme and tickborne diseases. Patients are the driving forces of the innovation process, and their lived experience informs the roadmap.[125] DHHS Lyme Innovation uses interdisciplinary collaborations and strategic partnerships to accelerate patient-centered advancements in three priority areas:

- Data-driven, human-centered innovations that improve patient outcomes.
- Innovative ways to collect and share data while raising awareness of tickborne illnesses.
- Discovery of next-generation diagnostic tools and technologies.

CHALLENGE: Ability to diagnose VBDs limited by diagnostic test performance and availability

Rapid, accurate diagnosis is critical to effectively respond to VBD outbreaks. However, diagnosis of VBDs requires that patients seek care, accurate FDA authorized diagnostic tests are available, and healthcare providers are familiar with VBDs and order tests based on diagnostic recommendations. Additionally, highly sensitive diagnostic tests for some VBDs are not available, including early Lyme disease and RMSF.

OPPORTUNITY: Create opportunities for open innovation to improve Lyme disease diagnostics

Health+ is a human-centered design and research model sponsored by DHHS to co-create solutions with people impacted by the most pressing healthcare challenges.[126] The Health+ model positions people as active participants and experts in their own life challenges, listening and learning from their lived experiences, to uncover their needs and understand their challenges. DHHS applied a human-centered design model to Lyme and tickborne diseases, through the DHHS Lyme Innovation initiative.[127]

Early and accurate diagnosis of Lyme disease is needed to help reduce death and disability associated with infection. Federal open innovation activities, such as the DHHS Lyme Innovation initiative, may help identify challenges and solutions through prizes, challenges, crowdsourcing, citizen science, and innovative public-private partnerships. As part of the DHHS Lyme Innovation initiative, DHHS and the Steven & Alexandra Cohen Foundation launched the LymeX Innovation Accelerator (LymeX)[128] to accelerate Lyme Innovation[129] progress and address the growing magnitude of Lyme disease and its serious impact on the American people. The LymeX partnership has bold goals, beginning with Lyme disease diagnostics, and an ambitious tagline: “Together, redefining the Lyme status quo.”[130]

In 2020, the LymeX Diagnostics Prize launched with a $10 million pledge from the Steven & Alexandra Cohen Foundation to incentivize the development of diagnostics that accurately detect active Lyme disease infections in people. One million dollars in cash prizes have already been awarded in Phase 1 of the prize competition. In 2023, Phase 2 was launched with 10 winning teams from Phase 1 of the prize joining the LymeX Diagnostics Prize Virtual Accelerator for mentorship and resources to help the teams progress toward FDA review and move their technologies to market. This challenge is expected to continue until the development of one or more Lyme diagnostics that perform better than currently available diagnostics.

CHALLENGE: Few VBD prevention and control measures exist

Preventing VBDs often depends on controlling the vectors. Yet there are limited vector control options that are cost-effective and socially, culturally, and environmentally acceptable.

A proven scalable tick control method to prevent disease does not exist. Additionally, integrated pest management (IPM)[131] ensures the least amount of chemical control is used for the maximum benefit to effectively control certain mosquito vectors, like the primary mosquito vector of West Nile virus. However, chemical control measures may be considered unacceptable and large-scale IPM may be cost-prohibitive to communities.

Many communities also report varying levels of insecticide resistance—a reduction in the ability of an insecticide to kill mosquitoes. Over time and after repeated use, insecticide resistance can occur in mosquito populations. Even when used as directed, a product may have no or limited efficacy due to variations in the resistance levels within a mosquito population.

When used consistently and correctly, personal protective measures, like using EPA-registered insect repellents, are effective for preventing mosquito, tick, and flea bites. However, most people do not take these precautions.[132] Insect repellents are regularly used by 22% to 42% of the U.S. population, with higher use reported among people at significant risk, such as women who are pregnant and lived in an area at risk for Zika during the outbreaks in 2016.[133,134,135]

OPPORTUNITY: Evaluate and make available promising technologies in vector control

The best way to prevent mosquito-borne disease outbreaks is to control for mosquitoes before an outbreak happens. New control methods being field tested for *Aedes aegypti* mosquitoes offer opportunities for communities to control for and potentially evaluate how well the methods protect people from *Aedes*-transmitted diseases, like dengue, chikungunya, or Zika.

New mosquito control methods include vector replacement and self-limiting techniques. Some of these techniques include the use of *Wolbachia,* a naturally occurring bacteria found in many insects. *Wolbachia* bacteria are not typically found in *Aedes aegypti* mosquitoes; however, when the bacteria are introduced into *Aedes aegypti* mosquitoes, they can be used to reduce the ability of mosquitoes to transmit mosquito-borne viruses, like dengue.

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One method is to replace local *Aedes aegypti* mosquitoes with male and female mosquitoes treated with *Wolbachia.* When *Aedes aegypti* mosquitoes carry *Wolbachia,* the bacteria make it harder for viruses like dengue, Zika, chikungunya, and yellow fever to reproduce inside the mosquitoes. The result is that these mosquitoes are much less likely to spread viruses to people. This method is known as *Wolbachia* replacement and has been used in other countries to reduce transmission of arboviruses.[136]

Another method is to release only male mosquitoes treated with *Wolbachia.* When male *Aedes aegypti* mosquitoes with *Wolbachia* mate with wild female mosquitoes that do not have *Wolbachia,* the resulting eggs do not hatch. Over time, this reduces the number of mosquitoes in an area. This method is known as *Wolbachia* suppression.[137]

Other self-limiting mosquito techniques include releasing genetically modified or irradiated mosquitoes. Exploring these promising technologies will determine if they can be used in community-integrated mosquito management plans to reduce vector populations or reduce the likelihood that targeted vectors can transmit pathogens.

CHALLENGE: Few human VBD vaccines are approved for use in the United States

Vaccinations are a mainstay of the prevention of many infectious diseases, yet few vaccines for VBDs are currently available for use in the United States. Vaccines are approved for international travelers and the military to prevent yellow fever, tickborne encephalitis, Japanese encephalitis, and chikungunya. However, only one vaccine is available to prevent a domestic VBD.[138]

In 2019, a vaccine to prevent dengue was approved by the FDA for use in children 9–16 years old with laboratory confirmed prior dengue virus infection and who live in an area where dengue is common, such as U.S. territories. The first child was vaccinated against dengue in Puerto Rico in September 2022, and the vaccination program is expanding. No other licensed vaccines to prevent VBD in the United States are currently available.

OPPORTUNITY: New VBD vaccines are in development

In 2023, a new vaccine for Lyme disease, the most common bacterial VBD in the United States, underwent late-stage human clinical trials.

Effective vaccines for West Nile virus, the most common arboviral VBD in the United States, have been marketed for horses and have successfully undergone early-stage human clinical trials. However, conducting late-stage trials for human West Nile virus vaccine has proven logistically challenging. A recent call to action suggests that lessons from the development of other vaccines can be applied to move West Nile virus vaccine candidates further through development.[139]

New vaccines for dengue could expand the ages eligible for vaccination and simplify vaccination schedules. A vaccine for Zika virus, which mainly threatens residents of the U.S. territories and international travelers, is undergoing human clinical trials. Numerous vaccines for pets and domesticated animals exist or are under development and may further protect people from VBDs indirectly.

Innovative vaccine strategies being considered or in development include host-targeted vaccines that could potentially reduce transmission of enzootic diseases spread by animals, which could reduce the risk of people getting diseases like Lyme disease and RMSF.

Anti-tick vaccines have the potential to simultaneously reduce transmission of multiple tickborne pathogens. A passive immunization strategy is being developed for Lyme disease. This prevention strategy, called Lyme pre-exposure prophylaxis (Lyme PrEP),[140] prevents infection by delivering a human antibody (or blood protein) directly to a person rather than triggering their immune system to make antibodies as traditional vaccines do. The antibody then kills the bacteria that causes Lyme disease in a tick's gut while the tick is attached, but before the bacteria can infect the person.[141] Lyme PrEP entered Phase 1 clinical trials in 2021.

CHALLENGE: VBD outbreaks can be difficult to predict

The factors that lead to VBD outbreaks are numerous and interrelated, making outbreaks difficult to predict. For example, West Nile virus has caused seasonal (summer) sporadic disease or intermittent outbreaks that vary in size and location since the initial transcontinental spread from its first identification in the United States (New York City) in 1999. Most areas of the United States are at risk of a VBD outbreak.

No vaccine or specific treatment for West Nile virus infection is currently available. Primary forms of prevention are reducing mosquito exposure through vector control and using personal protective behaviors, such as using repellant and wearing loose-fitting, long-sleeved clothing and pants.[142,143] Predicting where and when West Nile virus transmission will occur could help inform public health control efforts, which may include sentinel surveillance data.[144] Considering climate factors in prediction models is also important, given the known relationships between vector proliferation, temperature, and moisture.[145]

OPPORTUNITY: Investing in forecasting and outbreak analytics

In 2014, CDC launched the Epidemic Prediction Initiative to drive innovation in infectious diseases forecasting with a focus on VBDs, including an open and on-going West Nile virus forecasting challenge that began in 2020.[146] The 2020 challenge was to predict the total number of neuroinvasive West Nile virus disease cases for each county in the contiguous United States that will be reported to CDC's ArboNET surveillance system[147] during the 2020 calendar year. In the first 2 years of the challenge, 23 sets of forecasts were submitted by 18 teams comprising academia, government, and public health organizations across the United States. A comparison of each model submitted was published to share the methods and lessons learned.[148]

In addition to open forecasting challenges, establishing organizational infrastructure to support forecasting and outbreak analytics could better support decision-making and program development. In 2021, CDC established a new CDC Center for Forecasting and Outbreak Analytics,[149] with initial funding from the American Rescue Plan.[150] The Center is working to enable timely, effective decision-making to improve outbreak response using data, analytics, and models.

The Center will also develop a program to provide insights about infectious disease, which will help the public make informed individual decisions through three main pillars of predict, inform, and innovate. Forecasts and analyses for outbreak preparedness and response efforts will be generated to respond to needs of decision makers at the federal, state, tribal, local, and territorial levels. These may provide early warnings that allow for coordination of efforts between CDC subject matter experts and other federal agencies. The Center will support research and development among government, academic partners, and private sector partners to create tools and products to inform practice.

Further, NOAA and NASA have supported the use of environmental information in epidemiological modeling for many years. This has created research grant opportunities for climate and health studies, postdoctoral training opportunities, and fostering transdisciplinary collaboration at conferences and workshops. Research funding and collaboration has led to new experimental forecast products such as:

- International Research Institute for Climate and Society (IRI).[151]
- *Aedes*-Borne Disease Monitoring and Forecasting Tool for Decision Makers (AeDES).[152]
- CHIKRisk platform for monitoring global chikungunya activity and creating climate-based risk maps.[153,154]
- Arbovirus Mapping and Prediction (ArboMAP) West Nile virus forecasting system.[155]

CHALLENGE: Need for improved VBD treatment

No antiviral treatment options exist for arboviral VBDs. Many times, people with diseases caused by bacteria, rickettsia, and parasites that have existing treatments still experience ongoing symptoms, severe disease, and death. This particularly occurs when the infection is not promptly recognized and rapidly treated.

Infections can sometimes leave people with symptoms that last for weeks to months or longer, even after appropriate treatment.[156] These infection-associated chronic illnesses are a growing public health problem and can cause disability and death. Infection-associated chronic illness has been well documented for Lyme disease, West Nile virus, dengue virus, and RMSF, yet no clinical guidance is available to guide the treatment of these later-stage VBD outcomes. [157,158]

OPPORTUNITY: Optimize existing treatment protocols and develop new therapeutics

Educating healthcare providers has improved VBD diagnosis and treatment. Treating diseases such as RMSF, dengue, and plague earlier, even by a couple of hours, can dramatically reduce severe outcomes, including death. Developing effective anti-viral medicines for diseases such as West Nile and Powassan viruses could also reduce adverse outcomes and death.

Increased understanding of infection-associated chronic illness could lead to more effective treatments. Increased recognition of these later stage illnesses has resulted in a call for a common research agenda that might leverage understanding and lessons learned across infection-associated chronic illnesses for broader benefit across etiologies.[159]

CHALLENGE: Innovation can sometimes outpace regulatory processes

New tools and products, such as those designed to break resistance cycles and lower risk to people and the environment, do not always fit into existing regulatory structures. When regulatory pathways are unclear, it substantially increases the time it takes for these tools to reach the market, which can postpone benefits to effectiveness and efficiency.

OPPORTUNITY: Increase flexibility and coordination in the regulatory processes for novel vector control

Direct and transparent regulatory pathways encourage the development of products and allow new technologies to efficiently reach the market.[160,161] Over the past several decades, vector control has experienced a period of increased innovation and discovery. New technologies have emerged, and our scientific understanding has improved. The FDA and EPA collaborated on FDA's Guidance for Industry #236 *Clarification of FDA and EPA Jurisdiction Over Mosquito-Related Products.*[162] This guidance clarified the respective roles of these two regulatory agencies regarding the oversight of mosquito-related products, facilitating the planning and regulatory submission, review, and approval of these products. Continued collaboration on the regulatory processes for novel technologies is ongoing and will encourage development of these new, promising technologies.[163]

CHALLENGE: Limited capacity to respond to VBD threats

Most vector control organizations in the United States are locally controlled and funded, and jurisdictions manage vector control activities differently. Many jurisdictions, including some at significant VBD risk, lack critical public health functions like surveillance, health communications, and vector control.

In a recent national survey of more than 480 vector control organizations, 72% reported needing improved core capacities, such as conducting mosquito surveillance and testing for insecticide resistance. Only 24% reported having full core capacity.[164] Despite being central to the One Health approach,[165] communication, collaboration, and coordination among vector control operations and between public health officials is often lacking, as is the capacity to conduct insecticide resistance testing.

OPPORTUNITY: Implement new models that build capacity to respond to VBD threats

In response to Zika virus threatening the U.S. and its territories, CDC established five university-based regional VBD COEs in 2017. From 2017 to 2022, the COE program made substantial gains towards increasing the nation's capacity to prevent and control VBDs.[166] Together, the university partners:

- Trained more than 8,300 local vector control professionals in vector management and more than 600 entomology students.
- Conducted research that contributed to more than 300 peer-reviewed publications.
- Executed more than 200 collaborative projects with local and state public health departments and vector control agencies.

The Kay Hagan Tick Act authorized the appropriated funds that are available for the COE program through FY 2025 to continue building upon the COEs progress.

CDC also established an additional set of Training and Evaluation Centers[167] to support regional capacity building for VBD prevention and control and evaluations of VBD programs, strategies, and tools. This work will continue to:

- Conduct applied research.
- Train the next generation of VBD prevention and control professionals.
- Strengthen community partnerships and collaborations to develop, evaluate, and implement VBD prevention and control strategies.

CHALLENGE: Lack of workforce diversity

A diverse, skilled workforce is critical to develop and implement successful prevention and control programs. However, the workforce of numerous science and technology disciplines lack diversity. For example, the field of entomology lacks diversity, which limits the ability of the field to address social, cultural, racial, ethnic, environmental, and community-based inequities and barriers around VBD prevention and control.

A recent assessment by the National Science Foundation (NSF) suggests that graduate students in entomology and parasitology are dramatically under-represented (2.3% Black and 4.9% Hispanic/Latinx)[168] as compared to the general population (13.8% Black and 17.3% Hispanic/Latinx; Census, 2016). Our public health workforce must reflect the communities we serve to be effective and responsive.[169]

OPPORTUNITY: Implement programs to enrich the public health entomology workforce

Diversity, equity, inclusion, belonging, and accessibility within a workforce drives innovation, improves performance, and strengthens work to:

- Promote public health.
- Reduce health and healthcare inequities in underserved communities that have been placed at increased risk.
- Enhance work in VBD prevention and control.

Federal agencies can establish and develop programs designed to build and maintain diversity, equity, inclusion, belonging, and acceptance into workforce development programs.

For example, in collaboration with the Entomological Society of America (ESA), CDC co-created the Public Health Entomology for All (PHEFA) internship and fellowship program, which implements strategies to expand the diversity of entomologists and help meet public health entomology workforce needs.[170] Strategies aim to expand racial, ethnic, cultural, demographic, and experiential diversity in the field of public health entomology through outreach, mentorship, training, service, and promoting networks among current and future entomologists.

The program collaborates with minority-serving institutions to recruit college students and graduate students for internships and research fellows. Cohorts are recruited and placed within CDC's entomology and ecology teams. Graduating interns and fellows demonstrate increased awareness of careers in entomology and build skills in applied public health entomological surveillance, research, and public health practice to prevent and control VBDs.

GOALS

VISION	MISSION
A nation where VBDs no longer threaten the health of people.	**Protect people from illness, suffering, and death due to VBDs.**

GOALS

1. Better understand when, where, and how people are exposed to and get sick or die from VBDs.
2. Develop, evaluate, and improve tools, methods, and guidance to detect vector-borne pathogens and diagnose VBDs.*
3. Develop, evaluate, and improve tools, methods, and guidance to prevent and control VBDs.
4. Develop and assess drugs and treatment strategies for VBDs.
5. Disseminate and implement public health tools, programs, and collaborations to prevent, detect, diagnose, and respond to VBD threats.

*Update as of 3/29/2024.

Goal 1:
Better understand when, where, and how people are exposed to and get sick or die from VBDs

Strategic Priority 1:
Better understand vectors, the pathogens they transmit, and the potential effects of a changing climate

OBJECTIVE 1:
Determine how vector-borne pathogens are transmitted to and survive within people

Sub-objectives

1. Develop and refine animal and vector models for VBD research.
2. Identify key animal reservoirs for vector-borne pathogens.
3. Identify factors associated with the ability of vectors to effectively transmit pathogens to people.
4. Determine if co-infections with other vector-borne pathogens within vectors and animal reservoirs impact transmission to people.
5. Identify and characterize the factors of vector-borne pathogen biology that allow them to survive within people.

Relevant Federal Entities

DHHS (CDC, NIH)
DOD
DOI
USDA (APHIS, VS)

OBJECTIVE 2:
Identify the environmental factors associated with vector and animal reservoir populations

Sub-objectives

1. Identify attributable factors associated with the distribution and abundance of vectors and animal reservoirs, such as climate and ecological factors.
2. Identify main factors associated with the seasonality of vectors and animal reservoirs, such as climate and ecological factors.

Relevant Federal Entities

DHHS (CDC, NIH)
DOD
DOI
NASA
NOAA
USDA (APHIS)

OBJECTIVE 3:
Determine which vectors found outside the United States and its territories pose the greatest near-term risk of invading and becoming established in the United States, including its territories

Sub-objectives

1. Conduct assessments to develop a list of vectors that pose the highest risk for establishment.
2. Identify routes and determine how invasive species are introduced to the United States, including its territories.
3. Develop habitat suitability models for the potential distribution of vectors within the United States and its territories based on their global distribution.

Relevant Federal Entities

DHHS (CDC)
DOD
DOI (NISC, NPS, USGS)
NOAA
USDA (APHIS)

Strategic Priority 2:
Modernize[171] and maintain surveillance systems for vectors, reservoirs, and VBDs

OBJECTIVE 1:
Evaluate, improve, and maintain surveillance systems for vectors, reservoirs, pathogens, and VBDs in people and animals

Sub-objectives

1. Identify existing, complementary public and private surveillance systems.
2. Evaluate existing surveillance systems to identify gaps within and across systems.
3. Address surveillance gaps within and across existing human and animal surveillance systems to improve interoperability and efficiency.
4. Increase usability of surveillance data by expanding data access, improving timeliness, and enhancing visualizations of data from VBD systems.
5. Evaluate alternative data sources and tools (e.g., artificial intelligence, citizen science, crowdsourcing, patient registries) to further inform surveillance and integrate usable alternative data into relevant systems.

Relevant Federal Entities

DHHS (CDC, NIH)
DOI (NPS, USGS)
USDA

OBJECTIVE 2:
Increase integration of and data sharing across surveillance systems and sectors

Sub-objectives

1. Identify opportunities and challenges to increasing data integration and sharing across surveillance systems.
2. Implement steps to increase data integration and compatibility across systems to allow interoperability of surveillance systems, as identified in the previous sub-objective.

Relevant Federal Entities

DHHS (CDC, NIH)
DOD
USDA
USGS

Strategic Priority 3:
Better understand the risk factors for and effects of VBDs on people

OBJECTIVE 1:
Determine the social, behavioral, and environmental factors of VBD exposure to people

Sub-objectives	*Relevant Federal Entities*
1. Identify the social determinants of health[172,173,174] associated with VBD pathogen exposure to people.	DHHS (CDC, NIH) NASA NOAA
2. Identify the environmental factors, including the built environment,[175] associated with VBD pathogen exposure to people.	
3. Determine the knowledge, attitudes, and behaviors that influence human exposure to VBDs, including differences among communities.	
4. Identify, monitor, and evaluate policies and laws aimed at reducing the risk of VBD pathogens exposure to people.	

OBJECTIVE 2:
Determine the disease processes, progression, and clinical outcomes of VBDs

Sub-objectives	*Relevant Federal Entities*
1. Describe the disease processes, progression, clinical presentations and outcomes associated with VBDs of concern, including symptom persistence.	DHHS (CDC, NIH) USDA
2. Describe the frequency of VBD co-infections and their effects on diagnosis, treatment, and clinical outcomes.	
3. Identify differences in the clinical presentation, disease processes, progression, and clinical outcomes of VBDs associated with specific demographic factors, co-morbidities, and social determinants of health, particularly as they relate to differences across communities.	

OBJECTIVE 3:
Determine the burden of VBDs in the United States and its territories, including identifying differences in disease burden across population groups for VBDs of concern

Sub-objectives

1. Describe the epidemiology of VBDs, including social determinants of health.[176]
2. Describe the burden of VBDs, including societal costs and impacts on quality of life.

Relevant Federal Entities

DHHS (CDC)
USDA (APHIS)

Goal 2:
Develop, evaluate, and improve tools, methods, and guidance to detect vector-borne pathogens and diagnose VBDs*

Strategic Priority 1:
Identify and characterize novel VBD pathogens and their clinical manifestations

OBJECTIVE 1: Determine strategies for detecting novel pathogens and variants that may be transmitted by vectors

Sub-objectives

1. Develop and disseminate strategies to detect novel VBD pathogens and apply strategies to detect novel VBD pathogens, including using new technology.[177]
2. Publish a list of those novel VBDs that pose a potential risk to public health.
3. Identify and describe knowledge gaps related to novel pathogens that pose a risk to public health.
4. Collaborate with agricultural and other non-health sector partners to detect novel VBD pathogens in vectors and animals that may pose risk to public health.

Relevant Federal Entities

DHHS (CDC, NIH)
USDA (APHIS, ARS)
DOI
DOD

*Update as of 3/29/2024.

OBJECTIVE 2:
Conduct studies to address knowledge gaps related to novel pathogens that may be transmitted by vectors

Sub-objectives	*Relevant Federal Entities*
1. Investigate potential VBD transmission in people and animals with illness of unknown origin. 2. Address knowledge gaps to inform preparedness and response to novel VBD emergence events.	DHHS (CDC, FDA, NIH) DOD DOI USDA (APHIS, ARS)

Strategic Priority 2:
Develop, evaluate, and improve diagnostic tests for VBDs and VBD pathogens

OBJECTIVE 1:
Develop tests for novel pathogens

Sub-objectives	*Relevant Federal Entities*
1. Determine the biologic specimen types collected from people that perform optimally for diagnostics. 2. Develop pathogen-detection tests, including rapid tests, within 1 year of identifying a novel pathogen. 3. Develop serologic tests and biomarker tests within 1 year of identifying a novel pathogen. 4. Investigate new methods for pathogen detection as new technologies advance. 5. Make new tests for novel pathogens available for expanded use and commercialization, as public health needs arise.	DHHS (CDC, FDA, NIH) DOD USDA (APHIS, FADS, NVSL)

OBJECTIVE 2:
Develop and make improved tests available for known VBD pathogens

Sub-objectives

1. Develop pathogen-detection tests with significantly reduced cost and improved accuracy, precision, efficiency, performance, and speed of results.
2. Develop serologic tests with significantly reduced cost and improved accuracy, precision, efficiency, performance, and speed of results.
3. Investigate new methods for detecting existing vector-borne pathogens (e.g., for detecting biomarkers) as new technologies advance.
4. Make new tests available for expanded use and commercialization as public health needs arise.

Relevant Federal Entities

DHHS (CDC, FDA, NIH, OASH)
DOD

OBJECTIVE 3:
Compare the performance of new and existing tests for pathogens in people, vectors, animals, and animal reservoirs

Sub-objectives

1. Develop, maintain, and disseminate a set of standardized specimens for use in evaluations of tests for pathogens.
2. Compare the characteristics and performance of tests to inform test guidance.

Relevant Federal Entities

DHHS (CDC, FDA)
USDA (APHIS, NVSL; ARS)

Strategic Priority 3:
Develop and evaluate recommendations and guidance on VBD diagnosis in people

OBJECTIVE 1:
For novel pathogens, collaborate with non-federal partners to develop guidance, recommendations, or guidelines on clinical and laboratory diagnosis

Sub-objectives

1. Establish a surveillance case definition for each VBD caused by a novel pathogen within one year of pathogen identification.
2. Develop and disseminate guidance, recommendations, or guidelines on effective diagnostic test methods and procedures, including for interpretation of test results (e.g., laboratory and clinical parameters) and methods to reduce disparities in diagnosis.

Relevant Federal Entities

DHHS (CDC, NIH)
DOD
USDA (APHIS)

OBJECTIVE 2:
Review and update diagnostic guidance, recommendations, or guidelines to incorporate new knowledge as it becomes available

Sub-objectives

1. Continuously monitor emerging science that may inform the diagnosis of VBDs.
2. Update and disseminate guidance, recommendations, and guidelines for diagnosis of VBDs, to include methods for reducing disparities in diagnosis.

Relevant Federal Entities

DHHS (CDC)
DOD
USDA (APHIS, NVSL)

Strategic Priority 4:
Develop, maintain, and distribute relevant non-commercial resources to facilitate VBD diagnosis

OBJECTIVE 1:
Ensure resources are available to identify VBD pathogens and facilitate research and surveillance

Sub-objectives

1. Identify reagents that need to be developed.
2. Identify reagents that require additional production to supplement commercial resources.
3. Inventory national supplies of diagnostic resources (e.g., reagents and biospecimens) available for VBD pathogens of concern.
4. Generate and disseminate sufficient resources to facilitate research, development, surveillance, and diagnostic testing capacity for VBD pathogens of concern.

Relevant Federal Entities

DHHS (CDC, NIH)
USDA (APHIS, NVSL; CVB)

Goal 3:
Develop, evaluate, and improve tools, methods, and guidance to prevent and control VBDs

Strategic Priority 1:
Develop, evaluate, and improve safe and effective VBD prevention tools, methods, and approaches, including vaccines, vector control strategies, and health communications tailored to communities that are disproportionately affected

OBJECTIVE 1:
Prioritize, develop, evaluate, and refine vaccines against VBD pathogens of concern

Sub-objectives

1. Design and implement a process to prioritize VBDs for vaccine development.
2. Identify key challenges and opportunities to developing successful vaccines.
3. Facilitate partnerships across sectors, including disproportionately affected communities, to develop vaccines and reduce health disparities.
4. Prioritize, develop, evaluate, and refine vaccines.

Relevant Federal Entities

DHHS (CDC, FDA, NIH)
USDA (APHIS CVB)

OBJECTIVE 2:
Prioritize, develop, evaluate, and refine vector control tools and approaches

Sub-objectives	*Relevant Federal Entities*
1. Identify the factors that make vectors susceptible to vector control tools.	DHHS (CDC, NIH, OASH) DOD USDA (ARS)
2. Design and implement a process to prioritize vector control tools and approach development.	
3. Identify potential challenges and opportunities to developing successful vector control tools and approaches.	
4. Facilitate partnerships across sectors, including disproportionately affected communities, to develop vector control tools and reduce health disparities.	
5. Prioritize, develop, evaluate, and refine vector control tools and approaches.	

OBJECTIVE 3:
Develop and evaluate public health communication tools, messages, and approaches for encouraging public acceptance and adoption of prevention and control guidance

Sub-objectives	*Relevant Federal Entities*
1. Conduct research, including with disproportionately affected communities, to inform the development of effective public health communication tools, messages, and approaches.	DHHS (CDC, NIH) EPA (OPP) USDA (APHIS)
2. Develop complementary dissemination and implementation strategies for communication tools, messages, and approaches.	
3. Evaluate public health communication tools, messages, and approaches to ensure effectiveness among intended audiences.	

Strategic Priority 2:
Develop, evaluate, and refine data-driven and adaptive predictive models and decision support tools for VBD prevention and control

OBJECTIVE 1:
Develop predictive models and decision support tools to guide prevention and control activities

Sub-objectives

1. Elicit and prioritize decision-maker needs and requirements for decision-support tools.
2. Prioritize VBDs for the development of predictive models and decision support tools.
3. Develop VBD predictive models and other forecasting tools to provide decision support.

Relevant Federal Entities

DHHS (CDC, NIH)
DOD
NOAA (NCAR)
USDA (APHIS, ARS, ERS, NIFA)

OBJECTIVE 2:
Evaluate and refine predictive models and decision support tools

Sub-objectives

1. Evaluate the accuracy and utility of predictive models and decision support tools.
2. Refine predictive models and decision support tools based on evaluation.

Relevant Federal Entities

DHHS (CDC, NIH)
NOAA (NCAR)

Strategic Priority 3:
Develop and evaluate recommendations and guidelines on VBD prevention and control[179]

OBJECTIVE 1:
Develop and update VBD prevention and control recommendations and guidelines

Sub-objectives

1. Regularly update guidelines based on science.
2. Identify and prioritize VBDs to develop new recommendations and guidelines.
3. Collaborate with partners to develop new guidelines for VBDs of concern, ensuring specific population needs are considered, addressed, and that outcomes are geared towards reduction in health disparities.
4. Monitor and evaluate the implementation and effectiveness of recommendations and guidelines

Relevant Federal Entities

DHHS (CDC, NIH, OASH)
EPA (OPP)
USDA (APHIS)

Strategic Priority 4:
Develop and evaluate tools, methods, and approaches to respond to VBD public health emergencies

OBJECTIVE 1:
Promote national preparedness through the development of national, state, tribal, and territorial preparedness and emergency response plans, including partner engagement strategies, for VBD outbreaks

Sub-objectives

1. Develop, maintain, and exercise VBD preparedness and emergency response plans.
2. Ensure equitable access to medical countermeasures and VBD prevention and control tools, consistent with preparedness and emergency response plans.

Relevant Federal Entities

DHHS (CDC, NIH)
EPA (OPP)
FEMA
USDA (APHIS)

OBJECTIVE 2:
Develop inclusive public health communication plans including tools, messages, and approaches to respond to VBD outbreaks and integrate them into preparedness and emergency response plans

Sub-objectives

1. Develop inclusive messages, tools, and approaches to effectively communicate health information to all communities.
2. Identify and address challenges to effectively implement VBD response communication plans to ensure equitable access to information.

Relevant Federal Entities

DHHS (CDC)
EPA (OPP)
FEMA
USDA (APHIS, ARS)

OBJECTIVE 3:
Evaluate tools, methods, and approaches to respond to VBD emergencies and reduce associated health inequities

Sub-objectives

1. Engage multiple sectors and community partners in VBD emergency response exercises.
2. Conduct after-action reviews of emergency responses.
3. Evaluate the implementation and effectiveness of public health communication tools.

Relevant Federal Entities

DHHS (CDC)
EPA (OPP)
FEMA

Goal 4:
Develop and assess drugs and treatment strategies for VBDs

Strategic Priority 1:
Identify, develop, and evaluate safe and effective drug regimens and treatment strategies for VBDs

OBJECTIVE 1:
Develop new safe and effective drugs, including immunotherapies

Sub-objectives	*Relevant Federal Entities*
1. Identify and characterize new molecular targets for therapeutics for VBDs of concern.	DHHS (FDA, NIH) DOD USDA (CVB)
2. Develop effective drugs from newly identified molecular targets including evaluating/comparing clinical efficacy.	

OBJECTIVE 2:
Evaluate existing therapeutic strategies to benefit the treatment and management of VBDs

Sub-objectives	*Relevant Federal Entities*
1. Conduct and disseminate comparative effectiveness studies of existing VBD treatments.	DHHS (FDA, NIH)
2. Optimize existing therapeutic strategies for VBDs.	
3. Optimize therapeutic strategies repurposed for VBDs.	
4. Evaluate complementary and integrative health therapies for safety and efficacy.	

OBJECTIVE 3:
Advance research on treatment for persistent symptoms associated with VBDs

Sub-objectives	*Relevant Federal Entities*
1. Assess treatment strategies for persistent symptoms associated with VBDs.	DHHS (NIH)
2. Collaborate across fields of medicine to learn about promising therapeutic strategies for persistent symptoms following VBD infections.	

Strategic Priority 2:
Develop evidence-based recommendations and guidelines on the treatment and management of VBDs

OBJECTIVE 1:
Periodically review the scientific evidence supporting federal recommendations and guidelines to treat and manage VBDs and update as appropriate

Sub-objectives	*Relevant Federal Entities*
1. Coordinate systematic review of the evidence to inform revisions of federally developed recommendations and guidelines.	DHHS (CDC, NIH) USDA (APHIS, ARS)
2. Update and disseminate existing federally developed recommendations or guidelines on VBD treatment and management.	

OBJECTIVE 2:
Develop new guidance for the treatment and management of VBDs when peer-reviewed recommendations or guidelines do not currently exist

Sub-objectives	*Relevant Federal Entities*
1. Coordinate systematic review of the evidence to inform the development of new federally developed recommendations and guidelines.	DHHS (CDC, NIH) USDA (APHIS, CVB; ARS; NVSL)
2. Disseminate new federally developed recommendations or guidelines on VBD treatment and management.	

Strategic Priority 3:
Evaluate treatment and management use patterns of VBDs

OBJECTIVE 1:
Describe patterns of treatment and management of VBDs

Sub-objectives	*Relevant Federal Entities*
1. Conduct and disseminate studies of drug use and treatment use patterns, as well as clinical VBD management, including surveys and analysis of administrative claims data collected for surveillance purposes.	DHHS (CDC, FDA)

OBJECTIVE 2:
Develop clinician and public advisories pertaining to the treatment and management of VBDs

Sub-objectives	*Relevant Federal Entities*
1. Disseminate advisories for clinicians and the public pertaining to the treatment and management of VBDs.	DHHS (CDC, FDA)

Goal 5:
Disseminate and implement public health tools, programs, and collaborations to prevent, detect, diagnose, and respond to VBD threats

Strategic Priority 1:
Disseminate VBD prevention and control guidelines to partners and the public

OBJECTIVE 1:
Disseminate recommendations and guidelines to key audiences (e.g., healthcare providers, health departments, veterinarians, and professional societies)

Sub-objectives

1. Tailor dissemination of products and tools based on audience needs.
2. Develop and implement a dissemination plan to distribute evidence-based recommendations and guidelines.

Relevant Federal Entities

DHHS (CDC, FDA, OASH)
USDA (APHIS, ARS)

OBJECTIVE 2:
Disseminate health communication products and tools tailored for specific communities and partners

Sub-objectives	*Relevant Federal Entities*
1. Collaborate with impacted populations, multi-sectoral partners, and diverse communities to create dissemination plans that are evidence-based and integrate traditional and innovative strategies to reach communities of focus.	DHHS (CDC, OASH) USDA (APHIS, ARS)
2. Implement plans to disseminate VBD prevention and control and health-protective tools and products.	

Strategic Priority 2:
Ensure current and future capacity to implement and scale safe, effective, and equitable VBD prevention and control programs

OBJECTIVE 1:
Support state, tribal, territorial, and collaborating partners to implement VBD programs including surveillance, diagnosis and detection, prevention, and control

Sub-objectives	*Relevant Federal Entities*
1. Provide support, including for sufficient staff, to states, tribes, and partners to implement effective VBD programs.	DHHS (CDC) USDA (APHIS, CFTEP; ARS)
2. Provide technical assistance to implementing jurisdictions, tribes, and partners in their selection, planning, and implementation of programs, tools, collaborations, and innovations.	
3. Ensure that support is distributed equitably across implementing state, tribal, territorial and collaborating partners.	

OBJECTIVE 2:
Collaborate with partners to build and sustain implementation capacity

Sub-objectives	*Relevant Federal Entities*
1. Assess and monitor training needs on evidence-based information, guidelines, and recommendations.	DHHS (CDC) USDA (APHIS)
2. Provide trainings on evidence-based information, guidelines, and recommendations.	
3. Provide funding and technical assistance to partners to build, expand, and diversify the public health workforce.	

Strategic Priority 3:
Monitor and evaluate evidence-based public health programs and tools

OBJECTIVE 1:
Monitor and evaluate public health implementation efforts related to VBDs in affected communities

Sub-objectives	*Relevant Federal Entities*
1. Monitor the implementation of programs and tools over time and across communities, including assessment of efforts to reduce health disparities.	DHHS (CDC)
2. Collaborate with implementers to evaluate acceptability, suitability, effectiveness, and sustainability of public health programs and tools.	
3. Broadly disseminate evaluation findings to implementers, the scientific field, and the public.	

OBJECTIVE 2:
Adapt and optimize public health efforts to support VBD prevention, detection, diagnosis, and response

Sub-objectives

1. Regularly review and update public health products, tools, and guidance based on findings from program evaluations.
2. Disseminate updated public health products, tools, and guidance as needed.
3. Synthesize the state of the field and share lessons learned, promising and best practices, technologies, and opportunities for continuous improvement, including for the reduction of VBD-related health disparities.

Relevant Federal Entities

DHHS (CDC)

Strategic Priority 4:
Respond to public health emergencies from VBD threats

OBJECTIVE 1:
Respond directly to public health emergencies

Sub-objectives

1. Provide laboratory testing for state, tribal, local, and territorial jurisdictions.
2. Deploy staff to support local response efforts (e.g., vector surveillance and control) when requested by jurisdictions and tribes.
3. Disseminate public health messaging to support local response efforts.
4. Disseminate data that identify populations disproportionately affected by VBDs.
5. Facilitate the process for emergency use of VBD tools during public health emergencies.
6. Partner with populations disproportionately affected by VBDs to respond to emerging threats.

Relevant Federal Entities

DHHS (CDC, NIH)
EPA (OPP)
FEMA
USDA (APHIS)

OBJECTIVE 2:
Support local responses to public health emergencies, including addressing the needs of disproportionately affected populations

Sub-objectives	*Relevant Federal Entities*
1. Support implementation of local preparedness and emergency response plans.	DHHS (CDC, NIH) EPA (OPP)
2. Provide direct technical assistance to state, tribal, local, and territorial jurisdictions in the implementation of their emergency response plans.	
3. Make medical countermeasures and VBD prevention and control tools available to optimize equitable access and reduce health disparities.	
4. Ensure the collection and public access of quality data to inform public health actions.	

Strategic Priority 5:
Clarify, facilitate, and improve regulatory and commercial processes to bring diagnostic tests, treatment strategies, vaccines, and vector control products to market

OBJECTIVE 1:
Clarify and facilitate the regulatory process for vector control and VBD products, tools, and guidelines

Sub-objectives	*Relevant Federal Entities*
1. Develop communication strategies that clearly articulate the regulatory process.	DHHS (FDA) EPA (OPP) USDA (ARS)
2. Provide direction to applicants in their submission and response to regulatory process requirements.	
3. Clarify jurisdiction of federal agencies in their regulatory responsibilities for new and innovative products.	

OBJECTIVE 2:
Develop innovative strategies to identify and address challenges in bringing vector control and VBD products and tools to market

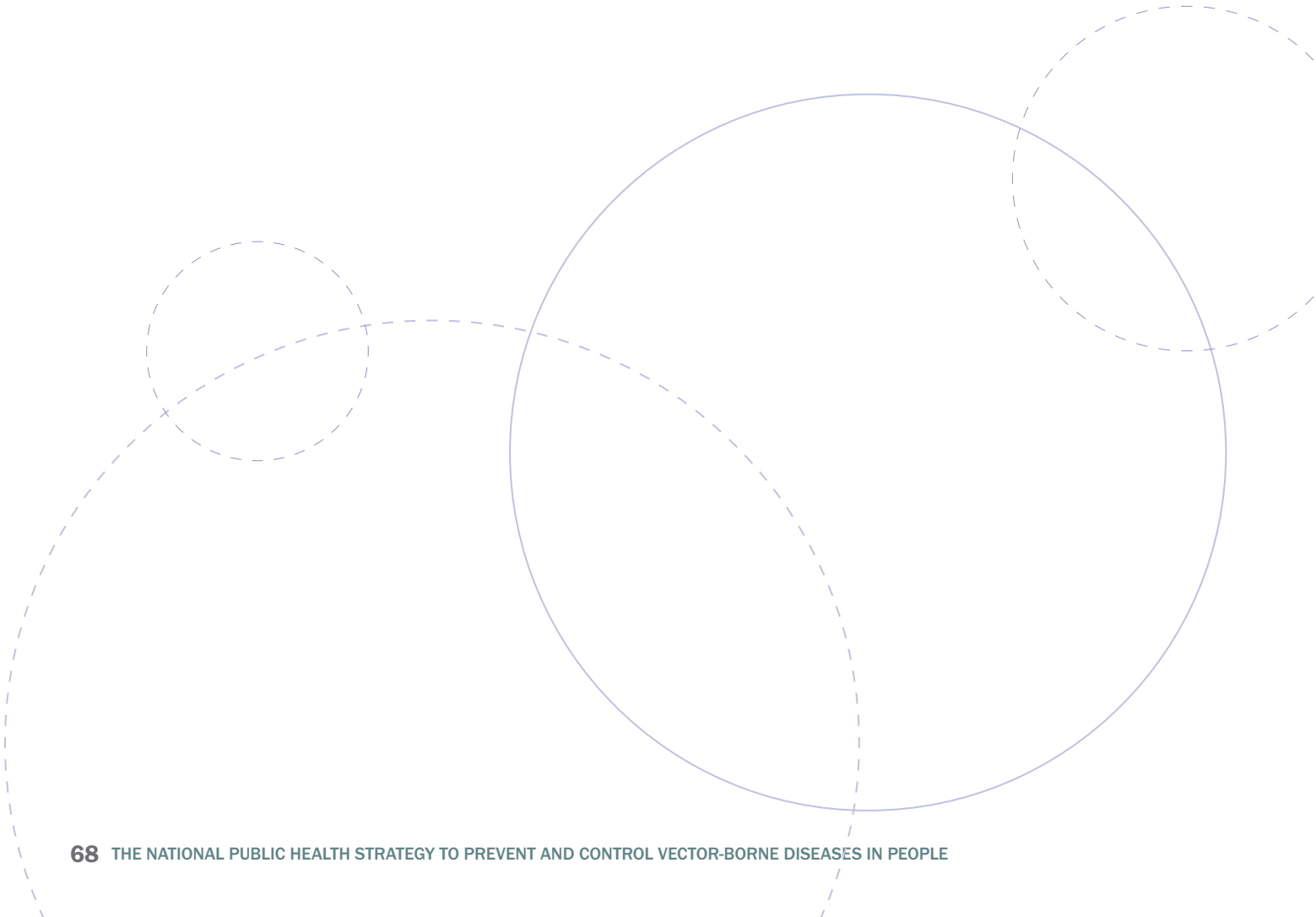
Sub-objectives

1. Ensure that regulatory knowledge gaps are identified for new and emerging technologies.
2. Use scientific approaches (including regulatory science as per FDA) to address the knowledge gaps for bringing new tools and products to market.

Relevant Federal Entities

DHHS (FDA)
EPA (OPP)
USDA (APHIS, ARS)

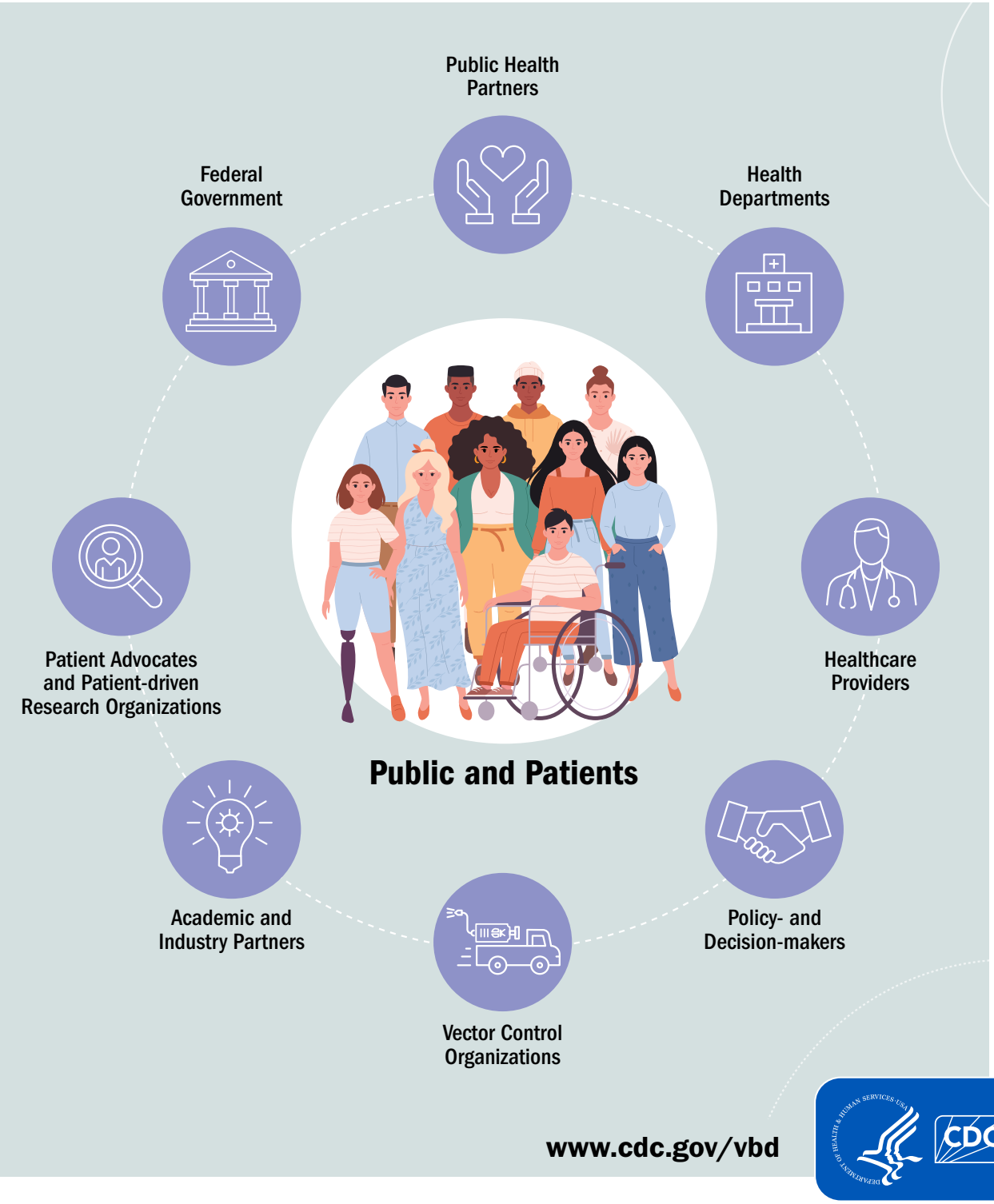
LOOKING FORWARD



Looking Forward

Protecting People from Vector-Borne Diseases (VBDs)

Successfully implementing the VBD National Strategy depends on continued collaboration, support, leadership, and excellence in innovation and program implementation. Collaboration within and outside of the federal government is necessary to protect the nation and save lives.



FEEDBACK AND PARTNER ENGAGEMENT

The VBD National Strategy was developed by a group of federal representatives. Individual feedback and individual opinions were solicited and collected from interested parties and the public through two requests for information.[184,185] Consensus views from the public were not solicited nor received. Consultations were scheduled with public health and partner organizations where technical guidance was needed. The individual responses guided the development of this report and will inform future updates, as appropriate.

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  - Department of Defense
  - Department of Agriculture
  - Environmental Protection Agency
  - Department of the Interior
  - Department of Commerce
  - National Aeronautics and Space Administration
  - National Invasive Species Council
  - U.S. Global Change Research Program

ACRONYMS

AFHSD: Defense Health Agency, Public Health Directorate, Armed Forces Health Surveillance Division

AFPMB: Armed Forces Pest Management Board

AGS: Alpha-gal syndrome, also called red meat allergy

APHIS: Animal and Plant Health Inspection Service

ARS: Agricultural Research Service

ASPR: Administration for Strategic Preparedness and Response (ASPR)

BARDA: Biomedical Advanced Research and Development Authority

BRACE: Building Resilience Against Climate Effects

CDC: Centers for Disease Control and Prevention

COE: Centers of Excellence

DHHS: Department of Health and Human Services

DOC: Department of Commerce

DOD: Department of Defense

DOI: Department of the Interior

EPA: Environmental Protection Agency

ESA: Entomological Society of America

FDA: Food and Drug Administration

FEMA: Federal Emergency Management Agency

FY: Fiscal year

GEIS: Global Emerging Infections Surveillance Branch

IOS/CTO: Office of the Chief Technology Officer

IOS/OS: Immediate Office of the Secretary; Office of the Secretary

IPM: Integrated pest management

IR: Infection rate

Lyme PrEP: Lyme pre-exposure prophylaxis

NASA: National Aeronautics and Space Administration

NIH: National Institutes of Health

NISC: National Invasive Species Council

NOAA: National Oceanic and Atmospheric Administration

NPS: National Park Service

NSF: National Science Foundation

OASH: Office of the Assistant Secretary for Health

PHEFA: Public Health Entomology for All

PRIME: Pandemic-Ready Interoperability Modernization Effort

RMSF: Rocky Mountain spotted fever

TBDWG: Tick-Borne Disease Working Group

UDSA: U.S. Department of Agriculture

USDS: U.S. Digital Service

USGS: U.S. Geological Survey

VBD: Vector-borne disease

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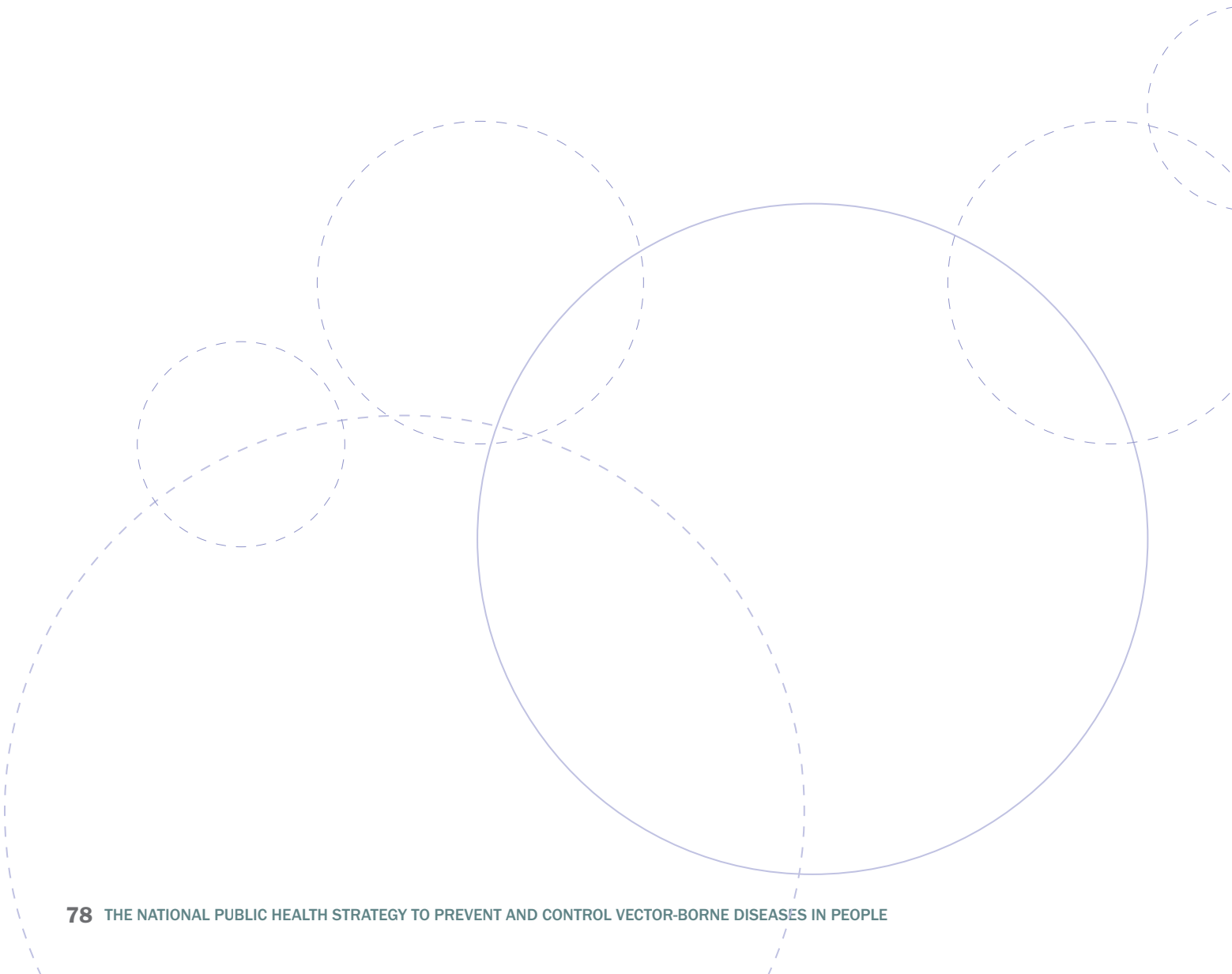

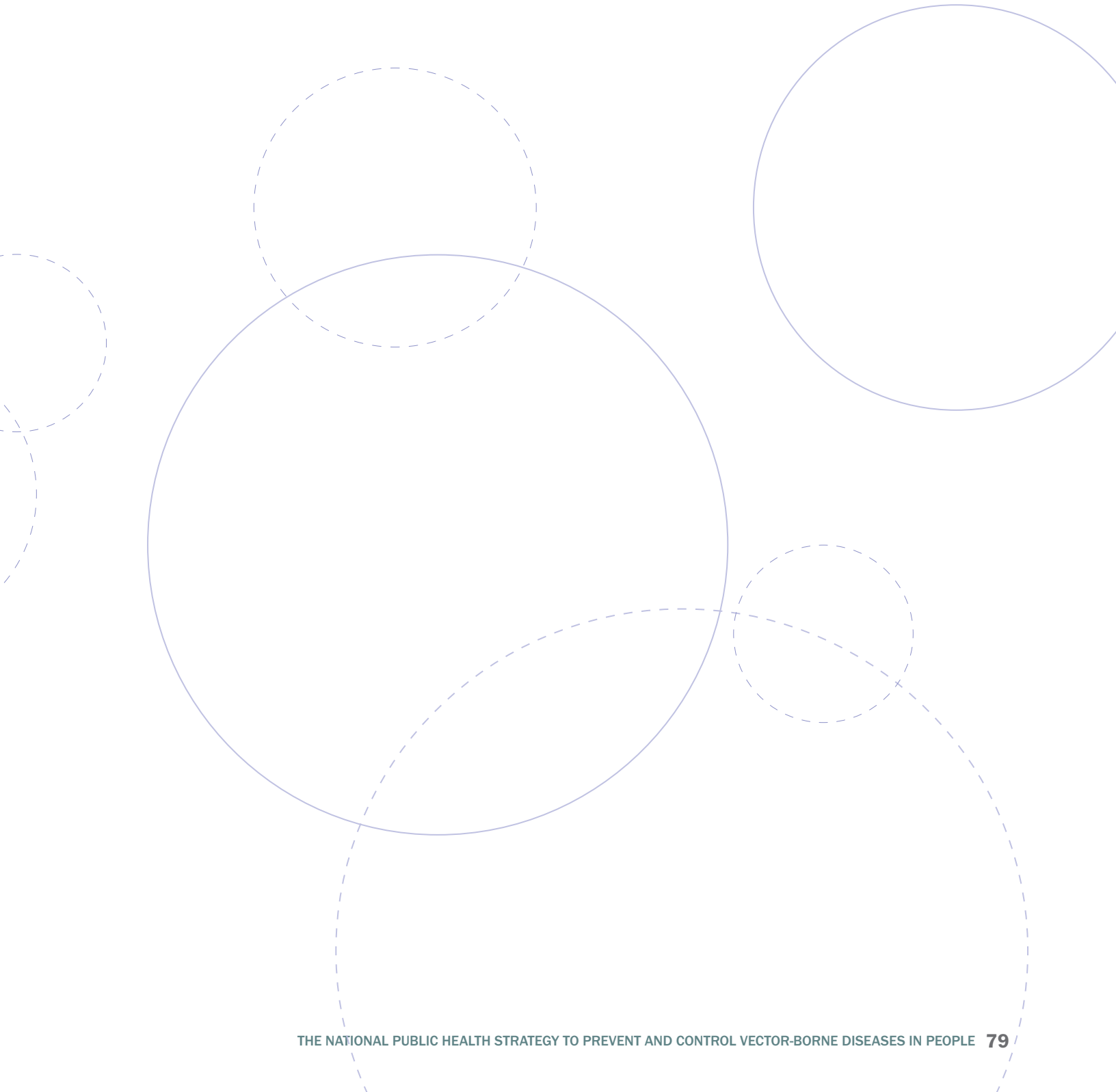

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