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# Pretravel Considerations for Non-vaccine-Preventable Travel Infections

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## KEY POINTS

- Pretravel advice should be tailored to the individual following a thorough review of his or her itinerary, planned activities, and host characteristics.
- The pretravel consultation should include preventive advice for regionally endemic non-vaccine-preventable infections that can cause severe illness or chronic morbidity.
- Special consideration should be given to common or emerging arboviral infections (including dengue, chikungunya, and Zika) and regionally endemic severe respiratory infections such as Middle East respiratory syndrome (MERS) and certain strains of avian influenza.
- Preventive advice for other infections associated with specific exposures or activities should be provided where relevant.
- Understanding the epidemiology and prevention of these infections is crucial to providing a comprehensive pretravel consultation.

## INTRODUCTION

To provide optimal advice, travel health providers should be able to educate the traveler on preventive measures against key travel-related infections, including those for which no vaccine is available. Tailoring this advice for an individual requires a thorough review of the travelers' itinerary and planned activities, consideration of the travelers' host characteristics, and a working knowledge of the epidemiology of relevant diseases. Travelers play an important role in the global epidemiology of infectious diseases; therefore ensuring that travelers are aware of specific preventive measures not only protects the health of the individual but has the potential to protect the health of their communities. In this chapter, pretravel considerations for major non-vaccine-preventable infectious diseases are covered, including specific advice for dengue, chikungunya, Zika, Middle East respiratory syndrome coronavirus (MERS-CoV), and avian influenza.

## DENGUE, CHIKUNGUNYA, AND ZIKA

### Overview

Dengue virus (DENV), chikungunya virus (CHIKV), and Zika virus (ZIKV) are globally important mosquito-borne viruses spread via *Aedes aegypti* and *A. albopictus*. The public health impact of these viruses has increased dramatically over the last 50 years, with epidemics of increasing size, geographic reach, and severity recorded. With factors such as population growth, urbanization, globalization, travel, and climate change facilitating increased transmission, travel medicine practitioners in temperate countries are increasingly likely to see returned travelers with these infections. Furthermore, since the ranges of *Aedes* vectors extend into temperate areas, infected returned travelers can precipitate outbreaks of these viruses in nonendemic regions.

### The Mosquito Vectors: *Aedes aegypti* and *A. albopictus*

*Aedes* mosquitoes are typically daytime biters and have a preference for the morning and late afternoon hours (crepuscular periods).<sup>1</sup> *A. aegypti*, the primary mosquito vector for dengue, chikungunya, and Zika, is found in tropical, subtropical, and some temperate climates and has adapted to cohabit with humans in both urban and rural environments.<sup>2</sup> *A. aegypti* typically lays eggs in manmade or artificial containers in or around the home and can bite indoors.<sup>2</sup> *A. albopictus* (the Asian tiger mosquito) can live in a broader temperature range and at cooler temperatures than *A. aegypti* and thus has a wider geographic distribution, extending into temperate regions. *A. albopictus* feeds on animals as well as humans, prefers natural habitats, usually bites outdoors, and is generally considered a less efficient vector of human disease than *A. aegypti*.<sup>1</sup> *Aedes* mosquitoes can be found in temperate areas, including southern Europe (*A. albopictus*), northern Queensland in Australia (*A. aegypti*), and southeastern regions of the United States (both species)<sup>2,3</sup> (Fig. 7.1).

### Dengue

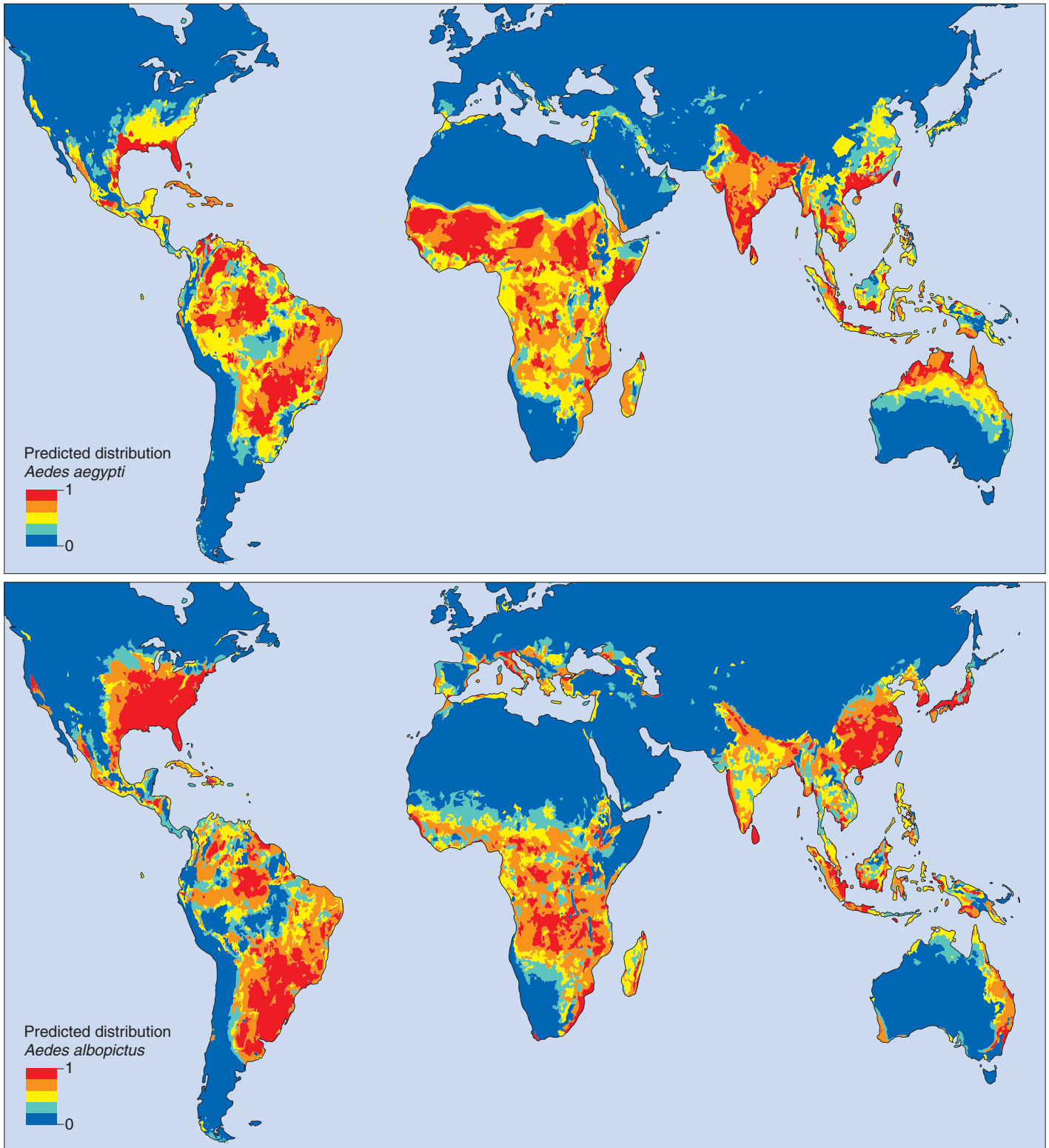
DENV is a flavivirus that is the most common and arguably most important arbovirus globally. Originating in Africa, DENV is now endemic in more than 100 countries across Africa, Southeast Asia, the Americas, the western Pacific, and the eastern Mediterranean regions.<sup>4,5</sup> Estimates suggest 390 million infections occur worldwide annually, with 70% of cases occurring in Asia.<sup>6</sup> DENV has four distinct serotypes (DENV 1–4), with most endemic countries reporting circulation of all four serotypes.<sup>7</sup> Primary infection provides lifelong serotype-specific protection but only short-lived cross-protection to other serotypes.<sup>4,8</sup> Broadly neutralizing antibodies are produced following a second dengue infection, and symptomatic disease is rarely seen with subsequent infections.<sup>9</sup>

**Abstract**

Pretravel advice should be tailored to the individual following a thorough review of his or her itinerary, planned activities, and host characteristics. In addition to vaccinations and malaria chemoprophylaxis, a pretravel consultation should include advice on regionally endemic or emerging non-vaccine-preventable infections that can cause severe illness or chronic morbidity. These include mosquito-borne infections such as dengue, chikungunya, and Zika, and regionally endemic severe respiratory infections such as Middle East respiratory syndrome (MERS) and some strains of avian influenza. Zika virus is notable given its capacity for sexual transmission and association with congenital birth defects. Preventive advice for other potentially relevant infections associated with specific exposures or activities (e.g., schistosomiasis and leptospirosis from freshwater exposure) should be provided where relevant. Understanding the epidemiology and prevention of these infections is crucial to providing a comprehensive pretravel consultation.

**Keywords**

*Aedes*  
Arbovirus  
Avian influenza  
Chikungunya  
Congenital Zika syndrome  
Dengue  
Middle East respiratory syndrome (MERS)  
Pretravel  
Prevention  
Severe acute respiratory syndrome (SARS)  
Zika



**FIG. 7.1** Predicted global distribution of *Aedes* mosquitoes. (Reproduced from Kraemer MUG, Sinka ME, Duda KA, et al. The global distribution of the arbovirus vectors *Aedes aegypti* and *Ae. albopictus*. eLife 2015;4:e09347. Licensed CC0 1.0 <https://creativecommons.org/publicdomain/zero/1.0/legalcode>.)

Following a short incubation period, with symptoms typically beginning 4–7 days (range 3–14 days) after exposure, dengue can present with a wide spectrum of illnesses, from asymptomatic infection to severe and fatal disease.<sup>5</sup> Most infections are asymptomatic or subclinical; symptomatic infections occur in approximately one-third of cases.<sup>4</sup> Patients who recover after a self-limited febrile illness, typically characterized by fever, headache, retroorbital pain, arthralgia, and myalgia, are classified as having dengue.<sup>5</sup> The small proportion who progress to capillary (plasma) leakage with or without bleeding, circulatory collapse, or severe end organ impairment are designated as having severe dengue.<sup>5</sup> Epidemiologic risk factors for severe dengue include young age, secondary infection with a different serotype, and infection with a more virulent strain of virus.<sup>4,10</sup> Severe dengue occurs in approximately 1%–3% of dengue cases, with case fatality rates ranging from <1%–5%; the greatest burden of severe dengue occurs in children and infants in endemic countries.<sup>11</sup>

Dengue is a common diagnosis in travelers, accounting for >3% of presentations to GeoSentinel surveillance clinics. Most infections are acquired in Asia, followed by the Americas, with only a small proportion acquired in Africa.<sup>12</sup> The incidence of dengue infection in travelers ranges from 10.2–30 infections per 1000 person months, and varies according to travel destination, duration, and season of travel.<sup>11</sup> Region-specific peaks of travel-related dengue infections have been demonstrated for Southeast Asia (June and September), South Central Asia (October), and South America (March).<sup>13</sup> Viraemic travelers can introduce dengue into new areas, with autochthonous transmission documented in the continental United States, Europe, and Australia.<sup>11,12</sup> Some travelers with dengue may require hospitalization or even evacuation.<sup>10</sup> Studies of dengue in travelers have reported a dengue hemorrhagic fever prevalence of 0.9%–3%, though this is likely an overestimate as patients experiencing more severe symptoms are more likely to seek medical attention.<sup>11</sup> Epidemiologic studies in endemic settings have shown that the risk of severe disease is significantly higher during a second DENV infection than during a primary infection.<sup>5</sup> However, a lack of consensus exists regarding risk factors for severe disease in travelers.<sup>11</sup> Results of one study in travelers suggest that severe dengue may occur at similar rates among cases with primary and secondary infections.<sup>9</sup> Given that most dengue infections are asymptomatic, and that severe dengue in travelers is rare, travelers with a history of dengue infection need not avoid known dengue areas but rather should be advised to use the personal protection strategies outlined in [Box 7.1](#) to prevent subsequent infection.

### Chikungunya

CHIKV is a mosquito-borne alphavirus first isolated in Tanzania in 1952.<sup>14</sup> In Africa, CHIKV exists in an enzootic sylvatic transmission cycle

between nonhuman primates, small mammals, and *Aedes* mosquitoes.<sup>14</sup> However, in outbreaks CHIKV can spread without the need for animal reservoirs.<sup>14</sup> Among populations with no prior immunity, CHIKV outbreaks can be explosive, and attack rates as high as 70% have been documented.<sup>15</sup> Introduction of CHIKV into Asia occurred during or before the 1950s and led to outbreaks in India and Southeast Asia.<sup>16</sup> Reemergence of CHIKV from Africa in 2004 resulted in major outbreaks involving millions of people across the islands of the Indian Ocean in 2005 (including the Comoros Islands, La Reunion, and Mauritius) and India in 2005–2006.<sup>16</sup> Furthermore, introduction of CHIKV to temperate areas in this period resulted in autochthonous transmission in Italy and France.<sup>17,18</sup> The first report of local transmission of CHIKV in the Americas occurred in 2013 in Saint Martin, with subsequent spread to >40 countries and territories across North, Central, and South America.<sup>15</sup> The unprecedented magnitude of CHIKV outbreaks in recent years is probably attributable to several factors including increased urbanization, global travel, and a series of adaptive mutations in the virus which have resulted in enhanced transmission by *A. albopictus*.<sup>16</sup>

The incubation period of chikungunya is typically 2–4 days (range 1–14 days).<sup>14</sup> Most chikungunya infections are symptomatic, with more than 85% of people with serologic evidence of infection reporting a history of symptoms.<sup>16</sup> Chikungunya infection is characterized by sudden onset of fever and severe, potentially disabling arthralgia. Notably, the name chikungunya is derived from a Makonde word describing the bent posture that can be seen with severe arthralgia.<sup>16</sup> The arthralgia/arthritis is usually symmetric and affects multiple joints, with fingers, wrists, ankles, elbows, toes, and knees the most often affected.<sup>14</sup> Additional symptoms include headache, myalgia, conjunctivitis, and rash. The case fatality rate of chikungunya is <1%, but disease can be associated with significant acute and long-term morbidity secondary to debilitating polyarthralgia/arthritis.<sup>15</sup> Although self-limiting in most individuals, some of those affected develop chronic joint pain that may last for months to years, with older people (>35–45 years) more predisposed.<sup>14,18</sup> Unlike Dengue, in which nonsteroidal anti-inflammatory drugs (NSAIDs) are contraindicated, anti-inflammatory drugs are indicated for symptomatic management of chikungunya infections.

### Zika

ZIKV is a flavivirus that was first isolated in 1947 from a rhesus monkey in the Zika Forest of Uganda, with the first human cases detected in Uganda and Tanzania in 1952.<sup>19,19a</sup> Following its discovery, the virus remained in relative obscurity for over 50 years, with only 14 cases reported until 2007, when an explosive outbreak infected approximately three-quarters of the population of Yap, Federated States of Micronesia.<sup>20</sup> Subsequent outbreaks occurred across the Pacific Islands from 2013 to 2016; spread of the virus to Brazil in March 2015 preceded subsequent transmission throughout Latin America, the Caribbean, Mexico, and Florida and Texas in the United States.<sup>21,22</sup> As of February 2018, 86 countries, territories, or subnational areas have reported evidence of vectorborne ZIKV transmission.<sup>23</sup>

Unlike DENV and CHIKV, there is now substantial evidence that direct person-to-person transmission of ZIKV is possible—both horizontally through sexual transmission, and vertically from the mother to the fetus during pregnancy.<sup>22</sup> Transmission through blood transfusion has been reported,<sup>22</sup> as well as a single case report of transmission probably resulting from close contact with bodily fluids from an infected patient.<sup>24</sup> The incubation period is thought to be similar to other mosquito-borne flaviviruses<sup>21</sup> with an estimated range from 3–14 days.<sup>25</sup> Male-to-female, male-to-male, and female-to-male transmission to unprotected sexual contacts of returning

#### BOX 7.1 Personal Protection Strategies Against *Aedes* Mosquitoes

- Wear an insect repellent containing an active ingredient such as DEET or picaridin, particularly during daylight hours when the mosquitoes are most active.
- Wear long-sleeved shirts and long pants to help protect yourself from bites. Light-colored clothes are best.
- Treat clothes and shoes with an insecticide such as permethrin or purchase pretreated clothing.
- Use mosquito coils, plug-in mosquito repellent devices, or insecticide surface sprays inside your accommodation; or stay in screened or air-conditioned accommodation.

travelers has been reported with the former felt to be most prominent. Sexual transmission from patients with both symptomatic and asymptomatic disease has been described.<sup>22</sup> Currently it appears that Zika can remain in semen longer than in other body fluids (including cervical mucus, vaginal fluids, urine, and blood).<sup>26</sup> In semen, ZIKV RNA has been detected as long as 188 days after the onset of symptoms, and infectious virus has been cultured up to 69 days after symptom onset.<sup>22</sup>

Most ZIKV infections are asymptomatic, with serosurvey studies indicating that only 19% of those infected report clinical illness.<sup>20</sup> In symptomatic cases, illness is generally mild and self-limiting with symptoms including fever, rash, pruritus, arthralgia, myalgia, conjunctivitis, and headache.<sup>21</sup> ZIKV has been associated with neurologic complications including Guillain-Barré syndrome (GBS) and adverse fetal outcomes including congenital microcephaly. An association with GBS was first reported in 2013–2014 during the French Polynesian outbreak. More than 20 countries have now reported an increased incidence of GBS and/or laboratory confirmation of a ZIKV infection among GBS cases.<sup>23</sup> In February 2016, following reports from Brazil of microcephaly in babies whose mothers had been exposed to Zika during pregnancy, the World Health Organization (WHO) declared that Zika constituted a Public Health Emergency of International Concern (PHEIC).<sup>19</sup> Microcephaly is one of several neurologic and musculoskeletal birth defects described in congenital infection; this constellation of findings is now known as congenital Zika syndrome.<sup>27</sup>

### Prevention of Dengue, Chikungunya, and Zika

Although a live attenuated tetravalent dengue vaccine (CYD-TDV; Dengvaxia) has been registered in several countries, and several other dengue vaccine candidates are in clinical development,<sup>8</sup> at this time no dengue vaccine is licensed for travelers.

Likewise no vaccines are licensed for chikungunya or Zika; therefore prevention of these viruses largely relies on personal protection strategies that limit contact between humans and *Aedes* mosquitoes (see [Box 7.1](#) and Chapter 6; Insect Protection) as well as avoidance of travel during peak transmission or outbreak periods. Travelers returning to nonendemic areas with *Aedes* mosquitos (see [Fig. 7.1](#)) should also be advised to avoid mosquito bites on their return to prevent local transmission. Symptomatic travellers should seek medical evaluation immediately.

Infection with CHIKV is thought to result in lifelong protective immunity.<sup>14</sup> Duration of ZIKV immunity following infection is currently unknown. In contrast, due to the multiple serotypes, individuals can be infected with dengue up to four times, and travelers with a history of infection should be educated about the potential risks of subsequent infections.

### Additional Considerations for the Prevention of Congenital Zika Infection

Due to the high prevalence of asymptomatic infections and the risk of sexual and vertical transmission, Zika-specific preventative advice is important for those traveling to Zika affected areas. Pregnant women who do not reside in Zika transmission risk areas should be advised not to travel to areas with risk; if travel cannot be avoided, advice to prevent mosquito bites and sexual transmission should be given.<sup>28</sup> Measures to prevent sexual transmission include abstaining from sexual activity or use of condoms during sexual activity (including vaginal, anal, and oral sex, and sharing of sex toys) during the entire pregnancy.<sup>28</sup>

Pregnant women possibly exposed to ZIKV due to travel or sexual contact should discuss the potential exposure with their

**TABLE 7.1 Web Resources for Updated Disease and Vector Information**

- *Aedes* Vector ranges in United States: <https://www.cdc.gov/Zika/vector/range.html>
- European Centre for Disease Prevention and Control mosquito maps: [http://ecdc.europa.eu/en/healthtopics/vectors/vector-maps/Pages/VBORNET\\_maps.aspx](http://ecdc.europa.eu/en/healthtopics/vectors/vector-maps/Pages/VBORNET_maps.aspx)
- Dengue health map: <http://www.healthmap.org/dengue/en/> (recent reports of local or imported dengue cases from official, newspaper, and other media sources)
- World Health Organisation International Travel and Health (ITH) interactive map: <http://apps.who.int/ithmap/>
- Zika
  - <https://www.cdc.gov/zika/index.html>
  - <http://www.who.int/emergencies/zika-virus/en/>
- Middle East respiratory syndrome coronavirus (MERS-CoV)
  - <https://www.cdc.gov/coronavirus/mers/index.html>
  - <http://www.who.int/emergencies/mers-cov/en/>
- Avian influenza
  - <https://www.cdc.gov/flu/avianflu/index.htm>
  - [http://www.who.int/influenza/human\\_animal\\_interface/en/](http://www.who.int/influenza/human_animal_interface/en/)

health care provider. Those with symptoms of Zika infection or fetal ultrasound findings consistent with congenital Zika virus syndrome should be tested for ZIKV.<sup>29</sup> Testing may also be considered in asymptomatic potentially exposed pregnant women after considering risk of infection, patient preferences, and clinical judgment.<sup>29</sup>

Nonpregnant individuals and couples traveling to Zika-affected areas should also be counseled on measures to prevent sexual transmission and congenital infection. Due to the risk of prolonged viral shedding in semen, public health authorities advise men with risk of Zika exposure to wait 3 months from the last possible exposure to Zika (or after onset of symptoms following symptomatic infection) before attempting procreation.<sup>22</sup> Most authorities advise women to wait 8 weeks from the last possible exposure to Zika (or after onset of symptoms following symptomatic infection) before attempting to conceive<sup>22</sup>; one exception is the WHO, which advises women to wait 6 months before attempting conception.<sup>30</sup> Because many pregnancies are unplanned, all sexually active travelers and female partners of travelers should also practice measures to prevent congenital Zika infection. Readers are encouraged to review the most updated recommendations for prevention of sexual transmission of ZIKV and congenital Zika infection from public health authorities including WHO and the US Centers for Disease Control and Prevention (CDC) ([Table 7.1](#)).

### SEVERE RESPIRATORY INFECTIONS WITH REGIONAL ENDEMICITY

The 2003 severe acute respiratory syndrome (SARS) outbreak highlighted the potential for travelers to introduce novel respiratory infections into their home countries. More recently, concern has focused most on the emergence of Middle Eastern respiratory syndrome (MERS) and certain strains of avian influenza.

## Middle Eastern Respiratory Syndrome

MERS is a respiratory infection caused by MERS coronavirus (MERS-CoV). First described in 2012,<sup>31</sup> MERS is an endemic infection in the Arabian Peninsula with epidemic potential in health care and travel settings. Following an incubation period of 2–14 days, initial symptoms of MERS are similar to many common viral respiratory infections and include fever, rhinorrhea, sore throat, and muscle aches. Rapid progression to acute respiratory distress syndrome may follow, but mild and asymptomatic infections have also been described.<sup>32,33</sup> Nausea, vomiting, or diarrhea, and acute kidney injury can also occur.<sup>32</sup> Risk factors for severe MERS include age >50 years and comorbid conditions such as hypertension, diabetes, heart disease, end stage renal disease, chronic lung disease, cancer, or those receiving immunosuppressive therapy.<sup>32</sup> Among confirmed cases reported to WHO up to July 2017, 35% have been fatal.<sup>33a</sup>

Seroepidemiologic studies indicate that MERS-CoV circulates in dromedary camels in the Middle East and Africa, and direct contact with camels has been described in 33% of primary cases without known exposure to MERS cases or health care settings.<sup>34</sup> The route of transmission from dromedaries to humans is unclear, but contact with infectious bodily secretions and fluids are suspect, and consumption of raw dromedary products has also raised some concern.<sup>32</sup> Person-to-person transmission is primarily described in health care settings, although transmission among household close contacts has been described.<sup>35</sup> All cases of MERS reported outside of the Arabian Peninsula have occurred in returned travelers, or as a result of secondary transmission from a patient with recent travel to the Arabian Peninsula, as was the case for the 2015 health care–associated outbreak in South Korea that resulted in 186 cases and 36 deaths.<sup>32,36,37</sup> In this outbreak, delayed MERS diagnoses and inadequate infection control precautions led to multiple generations of infections affecting other patients, visitors, and health care workers.<sup>37,38</sup>

The risk of traveler-initiated health care–associated outbreaks with MERS mirrors the global experience of SARS. Like MERS, the viral agent of SARS is a coronavirus that emerged in southern China in 2002 and subsequently caused over 8000 infections and 774 deaths in more than 20 countries.<sup>38,39</sup> The reservoir of SARS coronavirus (SARS-CoV) is unknown, but some cases appear to have resulted from contact with animals used for human consumption such as civet cats.<sup>40</sup> Although no cases of SARS have been reported since 2004, the potential for reemergence is possible.<sup>39</sup>

## Avian Influenza

While seasonal influenza is a common infection among travelers, other influenza types including certain strains of avian influenza can also pose a risk to travelers. Although avian influenza typically affects birds, human cases and outbreaks occur sporadically. Avian influenza strains associated with severe respiratory infections with high mortality rates in humans include the highly pathogenic avian influenza A H5N1,<sup>41</sup> and more recently, novel avian influenza A H7N9.<sup>42</sup> Although the majority of human infections caused by avian influenza are linked to direct contact with infected birds (primarily poultry), unsustained person-to-person transmission has been reported for H5N1 and H7N9.<sup>41,43</sup> Furthermore cocirculation of different influenza A viruses in humans and animals raises the concern of reassortment leading to new strains that spread more readily from person to person.<sup>42</sup>

H5N1, first described in southern China in 1996, has since been documented in over 60 countries in Asia and Africa.<sup>41</sup> A review of human cases reported over an 18-year period found 907 cases reported from 16 countries with a case fatality rate of 53.5%.<sup>41</sup> Countries and

## BOX 7.2 Recommendations to Prevent Severe Respiratory Infections

- General hygiene practices that may reduce respiratory infection risk:
  - Hand-washing
  - Cough etiquette
  - Avoiding contact with eyes, nose, and mouth
  - Avoiding contact with sick individuals
- Avoidance of activities that increase risk of exposure to avian influenza, including contact with live or dead poultry, wild birds, or environments contaminated with bird droppings or fluids
- Avoidance of markets where live poultry and animals are kept and slaughtered in close proximity
- Travelers to the Arabian peninsula and other areas with evidence of MERS-CoV (Middle East and Africa):
  - Practice hygiene measures around camels and areas with camels
  - Do not consume raw camel products
  - Travelers with risk factors for severe MERS-CoV infection (including diabetes, renal failure, chronic lung disease, and immunosuppression) should avoid any contact with camels

Adapted from CDC. Human infection with H5N1: advice for travelers, 2017; WHO (WHO, 2014) and Ma T, Heywood A, MacIntyre CR. Chinese travellers visiting friends and relatives—a review of infectious risks. *Travel Med Infect Dis.* 2015 Jul–Aug;13(4):285–94.

territories reporting the most cases were (in descending order): Egypt, Indonesia, Vietnam, Cambodia, China, Thailand, Hong Kong, and Turkey.<sup>41</sup> Travel-related cases have been reported, including a case in a Canadian traveler.<sup>44</sup> H7N9 emerged in China in 2013, and has since caused over 1200 human cases with a case fatality rate of 40% during yearly winter-spring epidemics in China.<sup>42</sup> While 20 of 31 provinces in China have reported H7N9 cases, most cases have been reported in the Yangtze River Delta in Eastern China and Guangdong province in southern China.<sup>42</sup> Travel-associated cases of H7N9 have been reported in Hong Kong, Macao, Taiwan, and Canada.<sup>43,45</sup>

## Preventative Advice for Severe Respiratory Infections

Although no vaccines are available at this time for prevention of MERS and avian influenza (H5N1 and H7N9) in travelers, providers should routinely review the most recent epidemiology of severe respiratory infections reported by authorities such as the WHO and CDC (see [Table 7.1](#)) and promote general hygiene and other preventative measures to travelers to these areas ([Box 7.2](#)). While seasonal influenza vaccination does not protect against avian influenza or MERS, vaccine-related prevention of seasonal influenza may reduce the chance of coinfections and overall risk of respiratory infections. Travelers should also be advised to inform their health care providers of their travel history whenever seeking medical care for respiratory (and other illnesses) acquired during or soon after travel (see chapter 59).

## OTHER REGIONALLY IMPORTANT INFECTIONS IN TRAVELERS

Travel medicine providers should also be familiar with risk areas and specific preventive advice for other non-vaccine-preventable infectious diseases with regional distributions. Some of the more important of these infections are presented in [Table 7.2](#), along with specific preventive advice, such as insect bite avoidance (e.g., for prevention of African trypanosomiasis) or freshwater contact avoidance (e.g., for prevention of schistosomiasis or leptospirosis).

**TABLE 7.2 Epidemiology and Preventive Strategies for Other Diseases With Regional Distribution**

Disease (Pathogen)	Mode(s) of Transmission	Geographic Distribution	Risk Activities/At-Risk Groups	Preventive Strategies
African trypanosomiasis (sleeping sickness) ( <i>Trypanosoma brucei</i> ) <sup>46</sup>	Vectorborne: tsetse fly ( <i>Glossina</i> spp.)	Focal areas of central Africa, West Africa, eastern and southeastern Africa	Rural travel with outdoor exposure	<ul style="list-style-type: none"> <li>Wear long clothing of medium-weight material in neutral colours (tsetse flies are attracted to bright or dark colors, especially blue, and can bite through lightweight clothing)</li> <li>Use insect repellent</li> </ul>
Cutaneous larva migrans ( <i>Ancylostoma</i> spp.)	Direct contact with soil or sand contaminated with dog or cat hookworm larvae	Widespread in tropical areas, especially the Caribbean	Walking barefoot	<ul style="list-style-type: none"> <li>Wear shoes when walking on sand or soil</li> <li>Use barriers such as towels or mats when seated on the ground</li> </ul>
Cutaneous (or mucocutaneous) leishmaniasis <sup>47</sup> ( <i>Leishmania</i> spp.)	Vectorborne: Sandflies (genus <i>Phlebotomus</i> )	Africa, Asia, the Middle East, Mediterranean countries, Central and South America	Adventure travelers, military personnel, researchers	<ul style="list-style-type: none"> <li>Personal protective measures against sandfly bites (especially between dusk and dawn)</li> </ul>
Histoplasmosis <sup>48</sup> ( <i>Histoplasma</i> spp.)	Inhalation of contaminated dust/soil	United States, Central and South America, Africa, Asia	Visiting bat caves, spelunking, activities that disturb soil Immunosuppressed travelers	<ul style="list-style-type: none"> <li>Those with risk factors (immunosuppression) should avoid contact with bird or bat droppings, avoid exploring caves, and avoid activities that generate dust</li> </ul>
Leptospirosis <sup>49</sup>	Direct contact with infected animals Ingestion of or direct contact with water, mud, soil, or vegetation that has been contaminated with animal urine	Worldwide, particularly in tropical or subtropical regions	Freshwater swimming, rafting, kayaking, canoeing, fishing, hunting, caving, hiking, trail biking, contact with floodwater	<ul style="list-style-type: none"> <li>Avoid swimming or wading in water that may be contaminated</li> <li>Cover all cuts or abrasions with waterproof dressings</li> <li>Doxycycline chemoprophylaxis may be considered in some cases</li> </ul>
Melioidosis <sup>50</sup>	Contact with contaminated soil (direct contact or inhalation of aerosolized particles)	Southeast Asia, northern Australia	Outdoor activities during periods of wind and rain, activities involving direct contact with soil	<ul style="list-style-type: none"> <li>Avoid direct contact with soil</li> <li>Those with risk factors (diabetes, chronic lung disease, chronic kidney disease, chronic alcoholism) should stay indoors during periods of heavy wind and rain</li> </ul>
Murine typhus <sup>51</sup>	Vectorborne: fleas (carried by rats and mice)	Worldwide, particularly in tropical or subtropical regions	Outdoor activities, contact with rats or mice	<ul style="list-style-type: none"> <li>Personal protective measures against fleas</li> </ul>
Myiasis ( <i>Cochliomyia hominivorax</i> , <i>Dermatobia hominis</i> , others) <sup>52</sup>	Penetration of skin by fly larvae (may be deposited on clothing or carried to humans by a biting mosquito)	Tropical areas in Africa and Latin America	Outdoor activities	<ul style="list-style-type: none"> <li>Iron clothing after line drying</li> <li>Cover skin with clothing and use insect repellent</li> <li>Stay in screened accommodation and use mosquito nets</li> </ul>
Schistosomiasis <sup>53</sup>	Contact with contaminated fresh water	Sub-Saharan Africa (majority of exposures), Southern Africa and some areas of North Africa, the Middle East, South America, the Caribbean, and Southeast Asia (Mekong River region)	Swimming, bathing, or wading in rivers, lakes, ponds, or seasonally flooded areas	<ul style="list-style-type: none"> <li>Avoid swimming or wading in fresh water</li> </ul>
Scrub typhus <sup>54</sup> ( <i>Orientia tsutsugamushi</i> )	Vectorborne: mites (chiggers)	South and Southeast Asia and the Pacific (including northern Australia)	Campers, trekkers, visitors to rice paddies	<ul style="list-style-type: none"> <li>Personal protective measures against mites (e.g., long pants and long sleeves, tucking pant legs into socks or boots, insect repellents)</li> </ul>



**TABLE 7.2 Epidemiology and Preventive Strategies for Other Diseases With Regional Distribution—cont'd**

Disease (Pathogen)	Mode(s) of Transmission	Geographic Distribution	Risk Activities/At-Risk Groups	Preventive Strategies
Spotted fever group rickettsiosis <sup>54</sup> NB: >10 species including <i>Rickettsia africae</i> (African tickbite fever) and <i>R. rickettsii</i> (Rocky Mountain spotted fever)	Vectorborne: Ticks	Worldwide, but with species-specific distributions Majority of exposures in sub-Saharan Africa	Travel to game parks, outdoor activities, late summer season travel	<ul style="list-style-type: none"> <li>Personal protective measures against ticks (e.g., long pants and long sleeves, tucking pant legs into socks or boots, insect repellents)</li> <li>Tick check of skin at the end of the day</li> </ul>

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