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Infectious Disease

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Foreword

One of my high school friends lives in Puerto Rico. Last summer, I received an e-mail from his wife, who said she had been sick with a chikungunya virus infection. I acknowledged that while I had heard of it, I did not know anything about it. After working on this edition, I do know about it and many other infectious diseases.

We all see common bacterial and viral infections every day in clinical practice. However, there are many other infections that most of us rarely see but which are increasingly important and in the media. Key among the mosquito-borne viruses that cause these infections are Zika, dengue, chikungunya, and others. These infections are all reviewed in *Section One.*

There also are other common infections we often do not think about, such as those caused by ectoparasites, a term that refers to bedbugs, lice, and mites. Infestations of these creatures are more common than I realized. These infections are reviewed in *Section Two*.

In *Section Three*, the authors review what we need to know about how communities and individual clinicians should respond to emerging infectious diseases. This issue was on everyone's mind several years ago when Ebola threatened to spread around the world. Although concerns about Ebola have faded, it is only a matter of time before some other infection—perhaps a lethal influenza outbreak—brings the issue back to our attention.

Finally, the authors cover an issue that is an everyday concern—health care-associated infections (HAIs). These affect 2 million patients and cause 90,000 deaths every year. In *Section Four*, the authors provide guidance on what we, as individual clinicians, can do to prevent HAIs from affecting our patients.

I hope you will find this edition of *FP Essentials*™ to be as interesting and informative as I did.

Barry D. Weiss, MD, FAAFP, Medical Editor
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Learning Objectives

1. Identify the mosquito-borne viral infections most likely to occur in the United States.
2. Recognize the typical presentation of patients with these mosquito-borne viral infections and obtain appropriate laboratory tests for diagnosis.
3. Distinguish skin lesions attributable to bedbugs from those attributable to scabies.
4. Prescribe appropriate treatments for bedbug, lice, and scabies infestations.
5. List the four phases in the approach to management of emerging infections.
6. Explain the key steps in implementing each of the four phases.
7. Use all recommended approaches for prevention of health care-associated infections.
8. Determine appropriate types of infection precautions for patients hospitalized with infectious diseases.

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FP Essentials™ Editorial Mission and Policies

FP Essentials is an editorially independent, peer-reviewed publication of the American Academy of Family Physicians (AAFP). It, and its derivative product *FP Comprehensive™,* are produced to assist family physicians and other learners in meeting their continuing medical education (CME), practice, and board certification goals.

Editorial Mission

The mission of *FP Essentials* is to provide practicing family physicians, family medicine residents, and other clinicians and trainees with high-quality, cost-effective educational content that emphasizes new advances in clinical practice.

Objectives

1. To provide learners with information on advances in clinical practice to aid them in providing up-to-date care for their patients.
2. To assist learners in preparing for the American Board of Family Medicine (ABFM) certification and recertification examinations. Each monthly edition of *FP Essentials* is part of a 9-year curriculum that presents topics with areas of emphasis similar to those on the ABFM examinations.
3. To provide learners with content that meets their CME needs and requirements.
4. To present the content of *FP Essentials* in both print and online formats, thus enabling learners to have access to information anywhere, anytime.

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How to Write or Review Content

Manuscripts are solicited from family physicians and subspecialists. For information about writing or peer reviewing, contact Medical Editor Barry D. Weiss, MD, FAAFP, at bdweiss@u.arizona.edu.

Pretest Questions

1. In low-resource settings, a tourniquet test can be used for diagnosis when patients have clinical findings consistent with which one of the following mosquito-borne viral illnesses?

- ❑ A. Chikungunya.
- ❑ B. Dengue.
- ❑ C. Japanese encephalitis virus infection.
- ❑ D. Yellow fever.
- ❑ E. Zika virus infection.

2. Up to half of patients with which one of the following mosquito-borne viral infections experience a postinfection arthritis syndrome?

- ❑ A. Chikungunya.
- ❑ B. Dengue.
- ❑ C. Japanese encephalitis virus infection.
- ❑ D. Yellow fever.
- ❑ E. Zika virus infection.

3. A patient recently had a bedbug infestation in her home, which was confirmed and eradicated by a professional exterminator. The patient comes to your office because she is experiencing intensely pruritic skin lesions. On physical examination, you note lesions consistent with bedbug bites. Which one of the following is appropriate management for the pruritic skin lesions?

- ❑ A. Antihistamines.
- ❑ B. Ivermectin.
- ❑ C. Manual removal of bedbugs from the skin lesions.
- ❑ D. Topical benzyl benzoate.

4. Crusted scabies often is associated with which one of the following patient groups?

- ❑ A. Children.
- ❑ B. Elderly patients.
- ❑ C. Infants.
- ❑ D. Pregnant women.
- ❑ E. Young and middle-age adults.

5. In relation to an infectious disease, which one of the following defines an epidemic?

- ❑ A. An increase in disease incidence that can be sudden or abrupt.
- ❑ B. Disease involving multiple countries or continents.
- ❑ C. Infections involving pathogens not previously known to infect humans.
- ❑ D. Infections with pathogens that have reemerged because of social or environmental changes.

6. A case of measles was diagnosed in the community elementary school. You have an 8-year-old boy in your practice whose parents declined to have the measles-mumps-rubella (MMR) vaccine administered. The parents ask you whether the boy, who is feeling well, should attend school. Which one of the following is the best advice to give them?

- ❑ A. He can attend school if he has not been in contact with the child with measles.
- ❑ B. He can attend school if he receives the measles-mumps-rubella vaccination.
- ❑ C. He should not attend school for 25 days.
- ❑ D. He should not attend school until 21 days after the onset of rash in the last child in the school to contract measles.

7. Which one of the following is a common mechanism through which central line-associated bloodstream infections occur?

- ❑ A. Bacteremia from an infection at another site (eg, pneumonia, urinary infection).
- ❑ B. Contaminated gloves.
- ❑ C. Contaminated intravenous fluid.
- ❑ D. Contamination by microorganisms from the patient's skin.

8. Which one of the following is the most common hospital-acquired infection in acute care hospitals?

- ❑ A. *Clostridium difficile* diarrhea.
- ❑ B. Central line-associated bloodstream infection.
- ❑ C. Pneumonia.
- ❑ D. Surgical site infection.
- ❑ E. Urinary tract infection.

Pretest Answers

Question 1: The correct answer is B.
In low-resource settings, clinical findings consistent with dengue and a positive tourniquet test result are sufficient for diagnosis. *See page 13.*

Question 2: The correct answer is A.
Studies show that a postviral arthritis called post-chikungunya chronic inflammatory rheumatism occurs in up to half of patients with chikungunya. *See page 14.*

Question 3: The correct answer is A.
Management of bedbug bites primarily is limited to symptomatic relief through the use of antipruritic drugs, including antihistamines, topical or oral corticosteroids, and over-the-counter topical anesthetics. (This is an off-label use of some antihistamines and some corticosteroids.) *See page 19.*

Question 4: The correct answer is B.
Crusted scabies often is associated with elderly patients, severe underlying disease, or immunocompromise (eg, HIV infection). *See page 22.*

Question 5: The correct answer is A.
An epidemic is defined as an increase in disease incidence that can be sudden or abrupt. *See page 25.*

Question 6: The correct answer is D.
In measles outbreaks, unvaccinated students should not attend school or other social settings until 21 days after the onset of rash in the last measles case. *See page 28.*

Question 7: The correct answer is D.
Central line-associated bloodstream infections can be caused by multiple mechanisms, but a common cause is colonization of the intravascular catheter by microorganisms from the patient's skin or, less commonly, the skin of the health care workers handling the device. *See pages 30-31.*

Question 8: The correct answer is C.
A recent multistate survey found that pneumonia (hospital-acquired pneumonia and ventilator-associated pneumonia combined) was the most common hospital-acquired infection in acute care hospitals. *See page 32.*

Key Practice Recommendations

1. Advise pregnant women to avoid travel to any area with risk of Zika virus transmission. For pregnant women whose partner has had potential exposure, recommend abstinence or condom use during the entire pregnancy.

2. For bedbug control, recommend use of comprehensive, integrated pest management programs. These programs include methods such as removal of clutter, sealing of cracks and crevices where bedbugs take refuge, heat treatment, vacuuming, and application of chemical and nonchemical pesticides.

3. For management of scabies, prescribe use of permethrin 5% cream, oral ivermectin, or benzyl benzoate 25% lotion as a first-line treatment. (This is an off-label use of ivermectin.)

4. For individuals at increased risk of mumps during an outbreak (ie, individuals in institutional settings with close contact with others or in close-knit communities), administer a third dose of measles-mumps-rubella vaccine.

5. Consider de-escalation of antimicrobial therapy in patients with community-acquired pneumonia, hospital-acquired pneumonia, ventilator-associated pneumonia, urosepsis, and other bloodstream infections when cultures and susceptibility results become available.

Evidence Ratings and Sources

1. **Evidence rating: SORT C**
   Source: *MMWR Morb Mortal Wkly Rep*, reference 10.
   Website: https://www.cdc.gov/mmwr/volumes/66/wr/mm6629e1.htm?s_cid=mm6629e1_w

2. **Evidence rating: SORT C**
   Source: Centers for Disease Control and Prevention, reference 57.
   Website: https://stacks.cdc.gov/view/cdc/21750

3. **Evidence rating: SORT B (SORT C for benzyl benzoate)**
   Source: *J Eur Acad Dermatol Venereol*, reference 72.
   Website: https://onlinelibrary.wiley.com/doi/epdf/10.1111/jdv.14351

4. **Evidence rating: SORT B**
   Source: *MMWR Morb Mortal Wkly Rep*, reference 102.
   Website: https://www.cdc.gov/mmwr/volumes/67/wr/mm6701a7.htm?s_cid=mm6701a7_w

5. **Evidence rating: SORT B**
   Source: *Int J Infect Dis*, reference 151.
   Website: https://www.ijidonline.com/article/S1201-9712(16)31085-2/fulltext

Strength of Recommendation Taxonomy (SORT)

Strength of Recommendation	Definition
A	• Recommendation based on consistent and good-quality patient-oriented evidence.[a]
B	• Recommendation based on inconsistent or limited-quality patient-oriented evidence.[a]
C	• Recommendation based on consensus, usual practice, opinion, disease-oriented evidence,[a] or case series for studies of diagnosis, treatment, prevention, or screening.

[a]Patient-oriented evidence measures outcomes that matter to patients: morbidity, mortality, symptom improvement, cost reduction, and quality of life. Disease-oriented evidence measures intermediate, physiologic, or surrogate end points that may or may not reflect improvement in patient outcomes (eg, blood pressure, blood chemistry, physiologic function, pathologic findings).

(From Ebell MH, Siwek J, Weiss BD, et al. Strength of recommendation taxonomy [SORT]: a patient-centered approach to grading evidence in the medical literature. Am Fam Physician. *2004;69:548-556.)*

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SECTION ONE

Mosquito-Borne Viral Illnesses

Due to rapid globalization and ease of travel, mosquito-borne viral infections are now a concern for family physicians throughout the United States. Zika virus infection is one such concern. It is spread via mosquito bites or by sexual contact with an infected individual. Most patients are asymptomatic, and when symptoms occur, they are mild and nonspecific. The main concern is the potential of the infection to cause fetal anomalies. Dengue is another mosquito-borne viral infection. Symptoms of initial infection are mild, and may include arthralgias. Subsequent infection with a different serotype can cause life-threatening hemorrhagic fever or shock. Chikungunya virus infection is widespread in the Americas and symptoms are similar to those of dengue. However, it can cause a postviral chronic inflammatory rheumatism in up to half of patients. Yellow fever occurs mostly in sub-Saharan Africa and can cause hepatic failure. Encephalitis viruses, most commonly West Nile in the United States and others such as Japanese encephalitis virus, can cause neuroinvasive disease, most often in older adults. Vaccines are available for yellow fever and Japanese encephalitis viruses but the keys to prevention are insect avoidance, mosquito eradication, and use of mosquito repellants.

Case 1. Sheri is a 27-year-old woman who comes to your office with a 5-day history of fever, body aches, conjunctivitis, and a macular rash. She recently returned from a weeklong vacation in the Florida Keys with her husband to celebrate their 5-year anniversary. She is not taking any contraceptives because she and her husband are hoping to start a family soon. She has no other history of recent travel and her husband is not ill.

Due to rapid globalization and ease of travel, mosquito-borne viral infections are now a concern for family physicians throughout the United States, and are nationally notifiable diseases. Point mutations in the viruses, expansion of mosquito vector territories because of climate change, and lack of effective vaccines all contribute to the increasing prevalence of these infections.

The clinical features of these infections can be similar. Careful attention to recent travel, possible exposures, and vaccination history as well as a high index of suspicion are required to ensure accurate and timely diagnosis. Several of these viral illnesses can result in long-term sequelae for patients and their children. This section discusses the most common recently emerging and reemerging endemic and sporadic infections.

Zika Virus Infection

Biology and Epidemiology

Zika virus is a single-stranded RNA virus of the family *Flaviviridae*, genus *Flavivirus*. Transmission primarily is via mosquitos, such as *Aedes aegypti* and *Aedes albopictus*.[1] Secondary transmission can occur through blood transfusion, laboratory exposure, organ and tissue transplantation, sexual contact, and vertical transmission during pregnancy.[2] The main reservoirs are humans and nonhuman primates.[1]

Originally identified in Uganda, Zika virus infections now occur throughout Africa, the Americas, Asia, and the Pacific.[1] Local mosquito-borne transmission has been documented in the United States since 2016 in two locations: Brownsville, Texas, and Miami-Dade County, Florida.[3] Since then, sexual transmission also has been reported.[4]

Clinical Presentation

Zika virus infection is asymptomatic in 80%-85% of patients. When symptoms occur, they typically last several days to weeks, are mild and nonspecific, and include conjunctivitis, fever, headache, muscle and joint pain, malaise, and rash. Guillain-Barre syndrome occurs rarely.[1,5]

For pregnant women or women seeking to become pregnant, fetal anomalies are a major concern. An association with congenital neurologic complications was discovered during the Brazilian outbreak in 2015, and was retroactively identified in the French Polynesian outbreak in 2013.[1] In one study of US pregnant women with laboratory evidence of possible exposure

to Zika virus, potentially related birth defects were identified in 6% of fetuses and infants.[6]

Birth defects include intrauterine growth restriction, microcephaly, intraocular calcifications, microphthalmia, cataracts, cerebellar abnormalities, cerebral calcifications, brain atrophy, absent corpus callosum, ventriculomegaly, clubfoot, and congenital arthrogryposis (multiple joint contractures).[7] This constellation of anomalies is referred to as congenital Zika syndrome.[8] A recent single mutation of the structural prM protein of the virus is thought to be responsible for these abnormalities.[9]

Diagnosis and Management

Zika virus infection should be suspected if a patient has a history of potential exposure and symptoms consistent with infection. Exposure is suggested by a history of travel to or residence in an area associated with risk of mosquito-borne transmission, or sex with a partner who has traveled to or resides in an area with risk of mosquito-borne transmission.[10] Zika virus RNA has been detected in semen long after symptom onset, with a median persistence of 34 days and up to 188 days.[2]

Diagnosis is confirmed with nucleic acid testing (NAT) through 14 days after symptom onset or with Zika virus immunoglobulin (Ig) M antibody testing if more than 14 days have elapsed from symptom onset.[8,11] A nonnegative Zika virus IgM antibody test result should be sent to the Centers for Disease Control and Prevention (CDC), a CDC-designated laboratory, or a public health laboratory for further tests with a Zika virus plaque reduction neutralization test (PRNT) and a dengue virus PRNT.[10,12] A Zika virus PRNT result of 10 or greater and a dengue virus PRNT result of less than 10 is interpreted as positive for Zika virus infection.[10] The PRNT test is not yet commercially available.

Management is symptomatic because the infection typically is self-limited. Acetaminophen for myalgias and an antihistamine for rashes are appropriate.[1]

Pregnant women should avoid travel to any area with risk of Zika virus transmission. Women of childbearing age and their sexual partners should carefully consider such travel.

Avoidance is the only approach to prevention. Pregnant women should avoid travel to any area with risk of Zika virus transmission. Women of childbearing age and their sexual partners should carefully consider such travel; if they choose to travel, they should abstain from sex or use condoms for 6 months after exposure. For pregnant women whose partner has had potential exposure, abstinence or condom use is recommended during the entire pregnancy. Asymptomatic patients who potentially have been exposed and have ongoing exposure, should be offered NAT (not an IgM antibody test) three times at intervals throughout pregnancy (assuming timely initiation of prenatal care). Those with laboratory-confirmed infection should receive regular fetal ultrasonography for detection of structural birth defects. All pregnant women should be asked about Zika exposure at every prenatal visit.[10,13]

Dengue

Biology and Epidemiology

Dengue virus is a single-stranded RNA virus of the family *Flaviviridae*, genus *Flavivirus*, with four distinct serotypes. Dengue is the most common vector-borne viral disease in the world, with up to 100 million annual clinical cases and an estimated 10,000 deaths.[14,15]

Transmission primarily is via the mosquitos *A aegypti* and *A albopictus*. Transmission also can occur through blood transfusion, organ transplantation, needle stick, blood exposure, and possibly breastfeeding. Humans and nonhuman primates are the main reservoirs.[14,16]

Dengue is endemic in at least 128 countries, including many in the Americas (*Figure 1*).[17] Initial local transmission in the continental United States occurred in Texas in 2005. Mosquito transmission of dengue virus has been documented in Florida, Hawaii, Texas, Puerto Rico, the US Virgin Islands, and Guam.[16]

Clinical Presentation

Symptoms of dengue can vary from mild to life-threatening. Initial infection typically results in mild signs and symptoms, including arthralgias of the knees and shoulders; fever; headache; retro-orbital pain; myalgias of the back, arms, and legs; nausea and vomiting; and rash on the face and limbs. These initial infections are associated with a low mortality rate.

However, subsequent infections with a different serotype can result in dengue hemorrhagic fever or

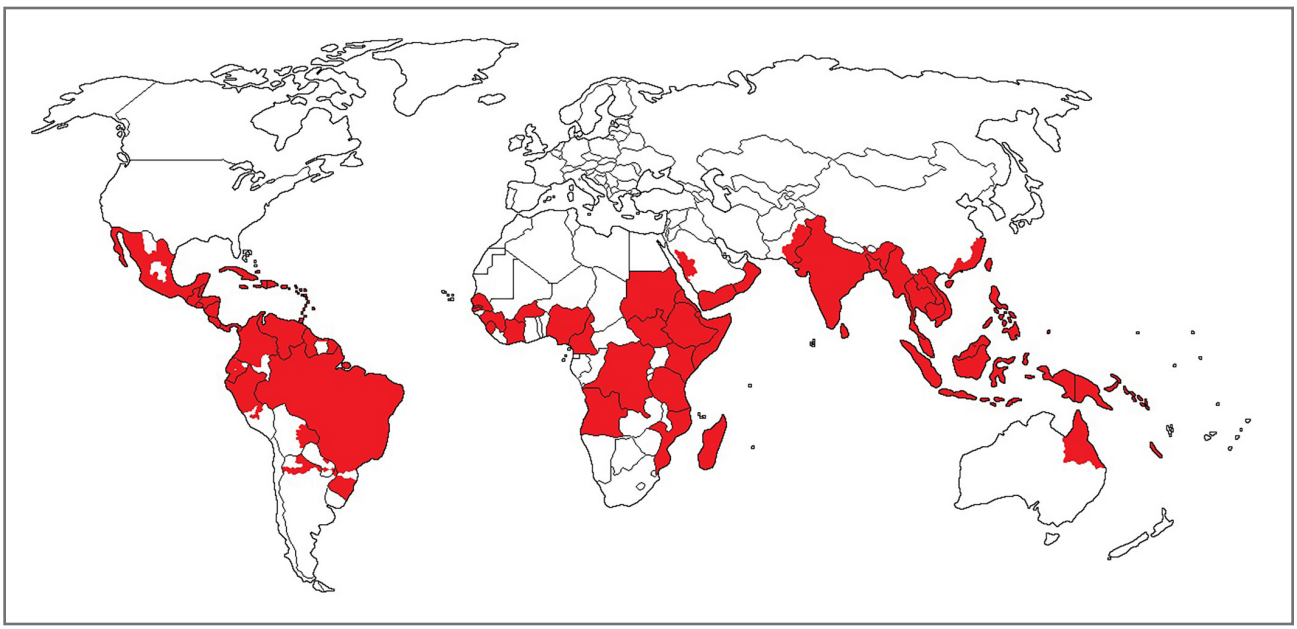

Figure 1. Dengue Risk Areas

Data from Outline World Map Images. Available at http://www.outline-world-map.com/; Centers for Disease Control and Prevention. Dengue. Epidemiology. 2014. Available at https://www.cdc.gov/dengue/epidemiology/index.html.

dengue shock syndrome.[15] Approximately 3 to 7 days after subsequent symptom onset, patients develop severe abdominal pain, bleeding from the gums, hematemesis, petechial rash on the face and limbs, and shock. These findings primarily are due to increased capillary permeability. Although the mortality rate is less than 5% if individuals are treated, the rate exceeds 50% if individuals are untreated.

Diagnosis and Management

Diagnosis of dengue in the first 4 days of illness can be made by detection of viral RNA via reverse transcriptase-polymerase chain reaction (RT-PCR). Rapid diagnostic tests for viral antigens such as NS1 (nonstructural protein 1) by enzyme-linked immunosorbent assay (ELISA) also may help in making the diagnosis. After the initial phase, a more than fourfold increase in IgM/IgG titers or viral cultures can confirm the diagnosis.[18,19]

In low-resource settings, clinical findings consistent with dengue and a positive tourniquet test result are sufficient for diagnosis. A tourniquet test is performed with inflation of a sphygmomanometer to mean arterial pressure for 5 minutes. If more than 10 petechiae/sq in are produced, the test result is positive.[18,19]

In mild dengue, other findings include thrombocytopenia, neutropenia, lymphopenia, and elevated transaminase levels.[15] Severe disease also can cause an elevated hematocrit level (due to capillary leakage); hypoproteinemia; and elevated prothrombin time, partial thromboplastin time, and fibrin split product levels.[19]

Management of mild dengue is symptomatic, with avoidance of nonsteroidal anti-inflammatory drugs (NSAIDs), including aspirin because of the risk of bleeding.[15] Although mild dengue may be managed with outpatient treatment, severe dengue requires hospital admission with hydration and administration of blood products.

Chikungunya

Biology and Epidemiology

Chikungunya virus is an RNA virus of the family *Togaviridae*, genus *Alphavirus*. Transmission is through the mosquito vectors *A aegypti* and *A albopictus.* Chikungunya occurs in more than 60 countries, including many in the Americas (*Figure 2*). Humans and nonhuman primates are the main reservoirs. Locally acquired cases in the United States have been documented in Florida and Texas, in 2014 and 2015, respectively. Blood-borne transmission of the virus among laboratory workers also has occurred.[20,21,22]

Clinical Presentation

Symptoms develop 3 to 7 days after exposure.[21] Common findings include fever, bilateral arthralgia in

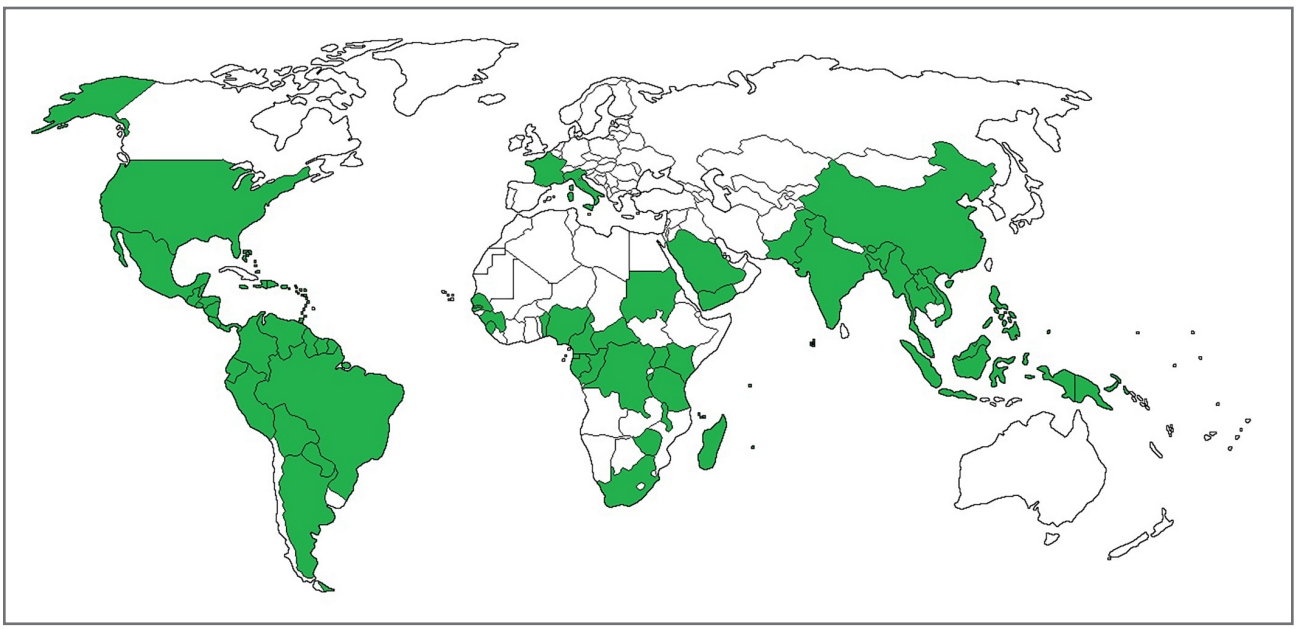

Figure 2. Current or Previous Local Transmission of Chikungunya Virus

Data from Outline World Map Images. Available at http://www.outline-world-map.com/; Centers for Disease Control and Prevention. Chikungunya virus. Geographic distribution. 2018. Available at https://www.cdc.gov/chikungunya/geo/index.html.

the small joints, conjunctivitis, edema, and rash on the trunk and limbs.[15,20]

The most significant long-term sequela is a postviral arthritis called post-chikungunya chronic inflammatory rheumatism (pCHIK-CIR). Studies show that it occurs in up to half of patients. Severe chikungunya disease, which tends to occur in adults older than 65 years, women, and individuals with comorbidities, such as diabetes or hypertension, increases the risk of persistent arthralgias. pCHIK-CIR also is more likely to occur when the initial symptoms include arthralgia of the hands and wrists, myalgia, and lymphopenia. pCHIK-CIR is mediated by a type I interferon response to persistent viral presence that results in bone resorption and loss. Congenital infection may result in subsequent neurocognitive deficiencies.[20,21,23]

Signs and symptoms of dengue and chikungunya overlap, and differentiation can be difficult. Findings more suggestive of dengue include bleeding from the gums or nose, retro-orbital pain, back pain, restlessness, loss of appetite, nausea, and vomiting. Patients with chikungunya are more likely to have joint pain mainly in small joints.[15,24]

Diagnosis and Management

Diagnosis is by anti-chikungunya IgM, IgG ELISA more than 4 days after symptom onset, RNA-PCR within the first 8 days, or viral culture with samples taken within the first 3 days.[23] Ancillary tests may show thrombocytopenia, lymphopenia, and elevated transaminase levels.[21]

Management is symptomatic with analgesics. If the diagnosis is uncertain and dengue is a possibility, use of aspirin and NSAIDs should be avoided because of the risk of bleeding.[15,21]

Yellow Fever

Biology and Epidemiology

Yellow fever virus is a single-stranded RNA virus of the family *Flaviviridae*, genus *Flavivirus*. Transmission is via mosquitos of the *Aedes* and *Haemagogus* species. Reservoirs are humans and nonhuman primates. Yellow fever is present in 44 countries, mostly in sub-Saharan Africa and some in South America (*Figure 3*). Approximately 90% of infections occur in Africa.[25,26,27]

Clinical Presentation

Although most patients are asymptomatic, symptoms typically manifest 3 to 6 days after exposure. The initial phase consists of fever, headache, muscle pain, nausea, and vomiting. A secondary phase with hepatic dysfunction occurs in up to 14% of symptomatic patients, beginning 24 hours after resolution of the initial phase, with abdominal pain, jaundice, dark urine, vomiting,

and bleeding. The mortality rate can be up to 50% for patients who develop the secondary phase.[25,26]

Diagnosis and Management

Laboratory tests can aid in diagnosis but the diagnosis primarily is clinical because false-positive test results can occur. RT-PCR or IgM and IgG ELISA typically are used but positive results should be confirmed by PRNT.[25] This is because prior yellow fever vaccination can cause IgM and IgG level elevations that persist for years, and serum from the RT-PCR can cross-react with other flaviviruses, such as West Nile and dengue viruses. New test modalities are being developed.[27,28]

Management is symptomatic relief.[25] Use of NSAIDs should be avoided because of the risk of bleeding if hepatic dysfunction develops. Patients with hepatic dysfunction often require hospitalization.

Encephalitis Viruses

Multiple mosquito-borne viruses capable of causing encephalitis contribute to sporadic outbreaks of infection and others are ubiquitous. These infections have similar clinical presentations and management is supportive. Patients with these infections usually are minimally symptomatic. They occasionally progress to more serious neurologic symptoms such as altered mental status, movement disorders, and seizures.

West Nile virus is the leading cause of vector-borne viral disease in the United States, accounting for 95% of all arbovirus disease cases in 2015.[15,29,30] Most cases are asymptomatic or mild resulting in febrile illness consisting of headache, myalgias, joint pain, vomiting, nausea, and rash. Although rare, neuroinvasive disease can occur, with an overall incidence of 0.45 cases per 100,000 individuals and a 5%-10% mortality rate.[15,29] It is more likely to develop in older adults.[29] Multiple mosquito species can be effective vectors; birds are the primary reservoir.[15,30]

Japanese encephalitis virus (JEV) is a flavivirus found in pigs and birds. Each year 50,000 cases of JEV occur in Asia and Australia, where it is endemic, resulting in 10,000 deaths annually. Before introduction of vaccinations, most children in endemic countries are infected with the virus but have asymptomatic infections.[31]

Intermittent outbreaks of encephalitis occur that are associated with mosquito-borne viruses such as La Crosse, St. Louis encephalitis, Jamestown Canyon, Powassan, and eastern equine encephalitis. La Crosse virus causes the majority of pediatric neuroinvasive disease in the United States.[29]

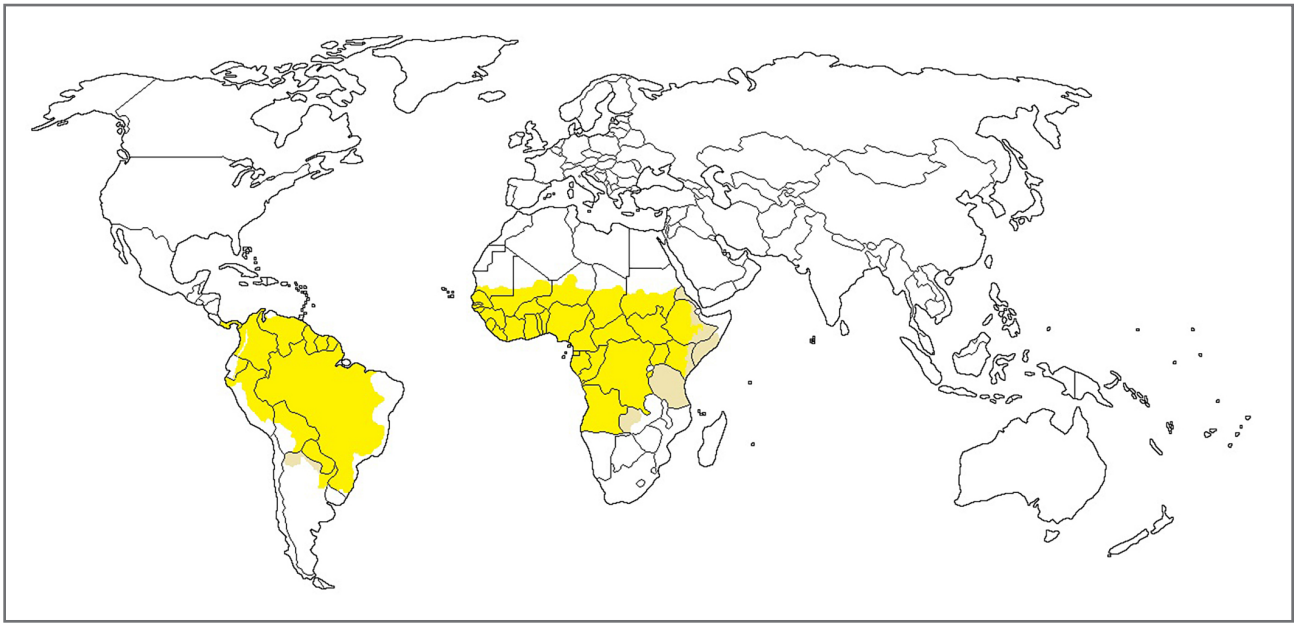

Figure 3. Areas With Risk of Yellow Fever Virus Transmission

Yellow shading indicates areas in which vaccination is recommended. Tan shading indicates areas in which vaccination typically is not recommended. Unshaded areas indicate regions where vaccination is not recommended.

Data from Outline World Map Images. Available at http://www.outline-world-map.com/; Centers for Disease Control and Prevention. Yellow fever maps. 2018. Available at https://www.cdc.gov/yellowfever/maps/index.html.

Less Common Viruses

Other viruses that have the potential for widespread mosquito-borne dissemination include Bourbon, Cache Valley, Heartland, Itaqui, and Oropouche viruses. Mayaro virus, transmitted by *Haemagogus* species and possibly *A aegypti*, has been isolated in Trinidad, Bolivia, Brazil, Venezuela, and Haiti. Infection symptoms are similar to those of chikungunya. Mayaro virus may be the next emerging arbovirus to reach the United States.[32]

Control and Prevention

Vaccines

Yellow fever. The live vaccine for yellow fever (Stamaril, YF Vax) is highly effective and provides long-lasting immunity, with seroconversion rates of 89%-98% with one dose. Vaccination is recommended for individuals 9 months or older who are traveling to or live in high-risk areas. Effective protection is achieved after 10 days. Adequate coverage for outbreak prevention in endemic populations occurs when 60%-80% of the affected population has received the vaccine.[33]

A routine 10-year booster dose is no longer required. Special populations such as infants and children, individuals with HIV infection, severely malnourished individuals, and pregnant women show a decreased and delayed immunologic response to vaccination.[33] These individuals may need a booster dose.

Travelers need officially documented proof of vaccination (ie, a vaccine certificate) for entry into certain countries.[25,33]

Japanese encephalitis virus. An effective inactivated JEV vaccine (Je-Vax, Ixiaro) is available and recommended for individuals older than 2 months planning extended travel (ie, longer than 1 month) to an endemic area or with occupational exposure. Travelers to nonurban areas during the rainy season are at highest risk.[34,35]

Others. With the exceptions of yellow fever and JEV vaccines, safe and effective vaccines are lacking. A commercially available dengue vaccine, Dengvaxia, became available in certain countries in 2016 but its use was suspended in the Philippines in December 2017 over safety concerns. The World Health Organization (WHO) recommends that it should be administered only to people who previously have been infected with dengue virus. Development of effective vaccines for other mosquito-borne viral diseases is a priority, with several currently being evaluated in trials.[36,37,38,39,40]

Insect Avoidance and Control

Exposure prevention via insect avoidance is the most effective defense. General recommendations for areas with the potential to harbor populations of vector mosquitos include reduction of breeding grounds; routine spraying with synthetic, residual pesticides; and education about personal mosquito avoidance. The latter involves avoiding outdoor exposure from dusk to dawn, when mosquitoes are most active. In areas with adequate housing (ie, well-screened windows), wearing clothing that limits the amount of skin exposed combined with personal application of insect repellants while outside should suffice.[15,41,42]

Mosquitoes are the vector for dozens of diseases in addition to the viral infections discussed in this *FP Essentials*. Control and eradication campaigns are ongoing around the world. Pesticides are used but insect resistance to them is a progressive threat.

Effective repellents include N,N-diethyl-m-toluamide (DEET); permethrin, picaridin; oil of lemon eucalyptus (*Corymbia citriodora*); and 3-[N-butyl-N-acetyl]-aminopropionic acid, ethyl ester (IR3535) (*Table 1*).[15,41,42] These typically are applied to the skin, though they also can be applied to clothing. The only exception is permethrin, which can be applied directly on clothing but should not be applied to the skin. The effectiveness of permethrin (0.5%) applied to clothing lasts through several wash cycles. In areas with significant risk of mosquito-borne illness, the use of bed nets sprayed with permethrin is recommended.[43]

The emergence of increasingly virulent strains and the recent spread of previously obscure mosquito-borne viruses into the developed world has prompted accelerated development of new vector-control tools and strategies. One example is novel trials involving the release of *A aegypti* mosquitos infected with endosymbiotic *Wolbachia* bacteria, which show promising results in decreasing the effectiveness of virus transmission.[44]

Case 1, cont'd. Sheri's physical examination results and symptoms are consistent with several viral infections, including Zika virus, dengue, and chikungunya. She is hemodynamically stable with no signs of bleeding. Ancillary laboratory tests show a negative pregnancy test result, mild thrombocytopenia, and mildly elevated transaminase levels. Enzyme-linked immunosorbent assay shows a positive immunoglobulin M antibody result for dengue and Zika virus infections. The test result is forwarded to the Centers for Disease Control and Prevention for a

Table 1
Mosquito Repellents

Active Ingredient	Concentration (%)	Protection Time (hr)	Products[a]
DEET (N,N-diethyl-m-toluamide or N,N-diethyl-3-methyl-benzamide)	20-30	10	Off!, Cutter, Sawyer, 3M Ultrathon
Picaridin (2-(2-hydroxyethyl)-1-piperidinecarboxylic acid 1-methylpropyl ester)	9-20	6-8	Cutter Advanced, Avon Skin-So-Soft Bug Guard Frontier
Oil of lemon eucalyptus (para-menthane-3,8-diol)	30	2-6	Repel, Off! Botanicals (Note: essential oils of lemon eucalyptus are not effective)
IR3535 (3-[N-butyl-N-acetyl]-aminopropionic acid, ethyl ester)	20	8	Avon Skin-So-Soft Bug Guard Plus IR3535 Expedition, Coleman Skin Smart

[a]*Includes but not limited to products listed.*

Information from Webb CE, Hess IM. A review of recommendations on the safe and effective use of topical mosquito repellents. Public Health Res Pract. *2016;26(5):e2651657; Environmental Protection Agency. Insect repellants: use and effectiveness. 2018. Available at https://cfpub.epa.gov/oppref/insect_s/pdf_results.cfm?export=true.*

plaque reduction neutralization test (PRNT). The results show dengue virus PRNT greater than 10 and Zika virus PNRT less than 10, which indicates a diagnosis of dengue.

You treat Sheri's symptoms, and she makes an uneventful recovery. You educate her on mosquito avoidance measures and caution her that a second dengue infection with a different serotype may be more serious.

SECTION TWO

Bedbugs, Lice, and Mites

Bedbugs, mites, and scabies are ectoparasites that commonly affect humans. Bedbugs (*Cimex* species) were once rare in the United States but are now common. They cause intensely pruritic lesions on areas of exposed skin. The bites are highly allergenic and can cause asthma exacerbations or anaphylaxis. Management of bedbug bites involves symptomatic relief of itching and dealing with patient anxiety. Identification and elimination of infestation are most important. Another ectoparasite of concern is lice (*Pediculus* and *Pthirus* species), which causes head, body, and pubic infestations. Patients can experience hypersensitivity to the saliva of lice, but such symptoms often do not develop until several weeks after infestation. Diagnosis involves identification of nits (ie, eggs) or lice on the skin or hair. Several pediculicides are used for management but wet combing without use of pediculicides may be more effective. A third common ectoparasitic infestation, scabies (ie, infestation with the mite *Sarcoptes scabiei*), affects 5% of the world's population. Patients present with pruritic lesions in skin folds, finger webs, and areas in which clothing is tight. The diagnosis can be confirmed with dermatoscopy or microscopy. Management involves use of permethrin cream, oral ivermectin, or benzyl benzoate.

Case 2. Tyrone, a 15-year-old boy, comes to your office with his parents because of scattered pruritic skin lesions. The family recently returned from a camping trip to Missouri, though they spent one night in a motel because of severe thunderstorms. Since returning from vacation, Tyrone's mother, a social worker, visited the home of one of her clients and took the client's children to a physician for treatment of head lice.

Bedbugs

Biology and Epidemiology

Bedbugs (*Cimex* species) have been recognized as household pests for centuries. Peak levels of infestation in the United States occurred in the 1920s and 1930s. Synthetic residual pesticides primarily eliminated them as a significant concern after World War II.[45] By the mid-1990s, bedbugs were virtually eradicated. However, by the late 1990s, there were reports of bedbugs becoming more prevalent.[46] The current prevalence of bedbugs in the United States is the continuation of infestations first identified in 2006. The increase in US infestations has followed increases in the United Kingdom and Australia. Populations of bedbugs have grown in many countries and the pests have spread as trade and travel have increased. Decreased use of pesticides also has occurred in the United States and other countries during the same time period.[47]

Although they frequently are perceived as disproportionately affecting the poor, bedbugs now commonly infest hotels, stores, and movie theaters.[45,47] Unlike many other household pests, bedbugs are not associated with hygienic deficiencies. A clean home environment does not significantly affect their presence. However, they can find places of refuge in the clutter that can accumulate in homes.[45]

The life cycle of bedbugs has 7 stages.[48] In all stages except the egg, bedbugs require a blood meal before molting (ie, shedding of the exoskeleton before the next life stage).[48,49] Attracted by body heat and exhaled carbon dioxide, they feed only through the skin. This makes common extermination strategies such as baiting and trapping ineffective.[45]

The endosymbiotic bacteria *Wolbachia* has been identified in bedbugs. Found in many invertebrates, this organism appears to be essential for normal fertility and reproduction of bedbugs and may represent a potential target for control.[50]

Clinical Presentation and Diagnosis

Patients with bedbug bites present with intensely pruritic lesions. These typically are erythematous, indurated, and may be hemorrhagic. The diagnosis is clinical, with the typical bite pattern being linear.[48] This distribution distinguishes the lesions from those of scabies. Scabies tends to occur in skin folds, finger

webbing, and areas where clothing is tight such as beltlines, whereas bedbugs bites tend to occur on easily accessible, exposed areas.[49,51]

The bites are extremely allergenic and have been implicated in asthma exacerbations and anaphylaxis.[48,52] In severe infestations, severe anemia from extensive blood loss has been reported.[53] Secondary infections of the bites may occur. Although many pathogens can survive ingestion by bedbugs, the insects do not appear to be competent vectors to transmit those pathogens to humans.[48] However, significant psychiatric symptoms commonly are associated with bedbug infestations. These can be incapacitating in severity and include anxiety, obsession, and depression to the point of suicide.[54,55]

Management and Control

Patients with bedbug bites require treatment of symptoms related to the bites and elimination of the underlying bedbug infestation.

Patient treatment. Management of bites primarily is limited to symptomatic relief through the use of antipruritic drugs, including antihistamines, topical or oral corticosteroids, and over-the-counter topical anesthetics. (This is an off-label use of some antihistamines and some corticosteroids.) In the rare situation in which secondary infection develops, antibiotics may be indicated.[56] Psychological symptoms also must be addressed. Counseling is an effective management for these symptoms; short-term use of antidepressants or anxiolytics also may have a role in some cases.

Elimination of infestation. The first step in eradicating a bedbug infestation is to identify it. In light infestations, evidence of the location may be limited. In moderate to heavy infestations, debris consisting of molted exoskeletons, dark feces, and eggs often are seen at the site of infestation. Locations not reachable by vacuum cleaner are the best places to examine, such as the bottom of dresser drawers, the corners of the room, and on or under mattresses and box springs.[57] Some success has been shown with use of a variety of detectors or monitors, including devices and bedbug-sniffing dogs.[48]

Extermination efforts use a variety of methods. The most commonly used chemicals are permethrins, the same chemicals that have been proven effective in antimalarial bed-net programs.[50,58] Typically, at least two applications are required but widespread resistance has developed, so permethrins may not be effective.[58] Physical strategies including heat treatment and the use of desiccant dusts, such as silica gel and diatomaceous earth, have been shown to be effective.[57,59]

The Centers for Disease Control and Prevention (CDC) recommends use of comprehensive, integrated pest management programs to control bedbugs. These programs include methods such as removal of clutter and sealing of cracks and crevices where bedbugs take refuge. These measures are combined with heat treatment, vacuuming, and application of chemical and nonchemical pesticides. This approach is labor- and time-intensive and can be costly.[57]

Xenointoxication (ie, treatment of the host with drugs such as ivermectin, which are lethal to the ectoparasite) is an approach that is effective in other ectoparasitic infestations and may be beneficial for bedbug control (*Table 2*).[60] (This is an off-label use of ivermectin.)

Table 2
Ivermectin Dosages for Ectoparasite Management[a]

Ectoparasite	Condition	Oral Dosage[b]
Sarcoptes scabiei	Scabies	0.2 mg/kg, repeat dose in 2 weeks
Pediculosis capitis	Head lice	0.2 mg/kg, every 10 days × 2 doses; or 0.4 mg/kg, every 7 days × 2 doses
Pediculosis corporis	Body lice	12 mg, every 7 days × 3 doses
Cimex species	Bedbugs	Not yet defined; suggested potential regimens include: 0.2 mg/kg, every other day for 2 weeks; 37 or 30 mg, repeat dose in 2 to 3 weeks

[a]*This is an off-label use of this drug.*
[b]*For patients weighing ≥15 kg (33 lb).*
Information from various sources.

Lice

Biology and Epidemiology

Lice of medical significance include *Phthirus pubis* and *Pediculus humanus*. The former are pubic lice, though they can affect other hair-covered portions of the body, including the face and scalp. The latter species consists of two ecotypes, *P humanus capitis* (head lice) and *P humanus corporis* (body lice). As with bedbugs, lice are dependent on endosymbiotic bacteria (*Candidatus*). However, unlike bedbugs, lice serve as vectors for a variety of human pathogens, including those responsible for epidemic typhus, louse-borne relapsing fever, and trench fever.[61]

Pediculus complete three molts (averaging 3 days each) after hatching to reach adulthood. Females lay 10 eggs (nits)/day for approximately a month before reaching the end of their life span.[62] The life cycle of *Phthirus* is similar. Head and pubic lice spend the duration of their lives on the skin or hair of the host; body lice live in clothing.[61]

Transmission primarily is through direct contact. Epidemiologic studies show a widely variable incidence of head lice around the world. The historical incidence of pubic lice has averaged approximately 2% worldwide but the incidence appears to be decreasing.[63,64]

Clinical Presentation and Diagnosis

Head lice. Head lice are the most common of these ectoparasites. Pruritus of the scalp due to hypersensitivity to louse saliva is the most common symptom, though it may not develop until several weeks into the infestation.[45,46,47]

Diagnosis is made by identification of the eggs, which typically are seen on the hair shaft within 1 cm of the scalp, along with the presence of nymphs or adults (the latter being fast-moving). The presence of eggs or adult lice may precede symptom development but their presence is diagnostic. Use of a louse comb can be helpful in obtaining specimens in suspected cases.[62]

None of the pediculicides are 100% ovicidal; manual egg removal (nit-combing) for head lice after treatment with a product decreases the risk of treatment failure.

Body and pubic lice. Patients with body lice infestation present with nocturnal pruritus, which is similar to that observed in head lice infestation except the affected areas are the shoulders, trunk, back, axilla, and groin rather than the scalp. Small, centrally hemorrhagic maculopapular lesions may be present and can be accompanied by other signs of allergic reaction such as urticaria and eczematous changes.[65]

Diagnosis is based on the history and physical examination, with evidence of pruritis, particularly on the trunk. Findings of hemosiderin-stained purpuric macular lesions denoting sites of previous bites also are suggestive. The diagnosis can be further confirmed by findings of lice or eggs in clothing (commonly along seams of inner garments).[65]

Pubic lice infestations appear similar to body lice infestations but with a more limited anatomic distribution. The diagnosis is confirmed by detection of lice on the patient.

Management, Control, and Prevention

Management of head lice never should be started empirically. Indiscriminate use of some drugs has led to emerging resistance. Furthermore, after the diagnosis is confirmed, management strategies should consider ease of use, cost, and local resistance patterns.[62]

Table 3 summarizes the drugs commonly used to manage head lice in the United States. A previous systematic review of relative efficacies of the various drugs, which was completed before the emergence of resistance, has been withdrawn. A new study currently is in progress.[66]

Management of pubic and body lice uses the same drugs. None of the pediculicides are 100% ovicidal; manual egg removal (nit-combing) for head lice after treatment with a product decreases the risk of treatment failure.[64] Fine-tooth combing of wet hair without use of pediculicides is safe and may be more effective than use of pediculicides alone.[67] Shaving of the head, although effective, is not necessary.[62]

Potential emerging control strategies parallel those for bedbugs; mainly xenointoxication through treatment of the human host with ivermectin or by targeting the endosymbiote with doxycycline or trimethoprim-sulfamethoxazole.[62] (This is an off-label use of all three drugs.)

Transmission of head lice can be prevented by avoiding contact with infested individuals. Sharing of hats, other headgear, and hair care instruments should

be discouraged. Direct head-to-head contact should be avoided.[62]

All members of the household of a diagnosed patient should be examined, and infested individuals should be treated. Some guidelines recommend treatment only of individuals who share a bed with the patient. Extensive home cleaning measures are not necessary. Screening of contacts outside of the household (eg, schoolmates) has not been shown to be effective. Absence from school is no longer recommended.[62]

An effective delousing strategy for body lice consists of a change of clothing along with destruction or laundering of clothes at more than 54.44°C (130°F) and machine drying using the hot cycle.[68] Improving personal hygiene practices and avoiding overcrowded living conditions decrease the likelihood of this infestation.[65]

Pubic lice infestation may be prevented by avoiding close personal contact with infected individuals and with the personal articles of infected individuals, such as used clothing, towels, and bed linens.[64] Condoms are not effective in preventing transmission during sex. The increasingly common practice of pubic and body hair removal correlates strongly with a decrease in incidence of pubic lice.[64]

Mites

Scabies

Etiology and epidemiology. Scabies has been recognized as a human disease for millennia. Early reports suggested that scabies pandemics occurred in a 30-year cycle. This interval primarily appears to have been related to climate and periods of population overcrowding rather than a change in the biology of

Table 3
Commonly Used Topical Pediculicides

Agent	Availability	Cost[a]	Notes
Benzyl alcohol 5% lotion	Prescription	$$$	Saturate scalp and entire length of hair Repeat in 7 days Safety not established in children <6 months
Ivermectin 0.5% lotion	Prescription	$$$$	Apply, rinse after 10 min, no retreatment is required Safety not established in children <6 months Resistance has been reported
Malathion 0.5% lotion	Prescription	$$$$	Apply, air dry; shampoo in 8 to 12 hours Safety not established in children <6 years Resistance has been reported
Permethrin 1% lotion	OTC	$	Apply, rinse in 10 min If live lice seen on day 9, retreat Resistance has been reported
Pyrethrins plus piperonyl butoxide	OTC	$	Apply, rinse in 10 min If live lice seen on day 9, retreat Resistance has been reported
Spinosad 0.9% suspension	Prescription	$$$$	Saturate scalp and entire length of hair If live lice seen on day 7, retreat Safety not established in children <6 months

[a] *$ = <$25; $$ = $26 to $99; $$$ = $100 to $199; $$$$ = $200 to $299.*

OTC = over-the-counter.

Adapted from Devore CD, Schutze GE. Head lice. Pediatrics. *2015;135(5):e1355-1365;* Clinical Pharmacology. *Available at https://www.clinicalpharmacology.com/.*

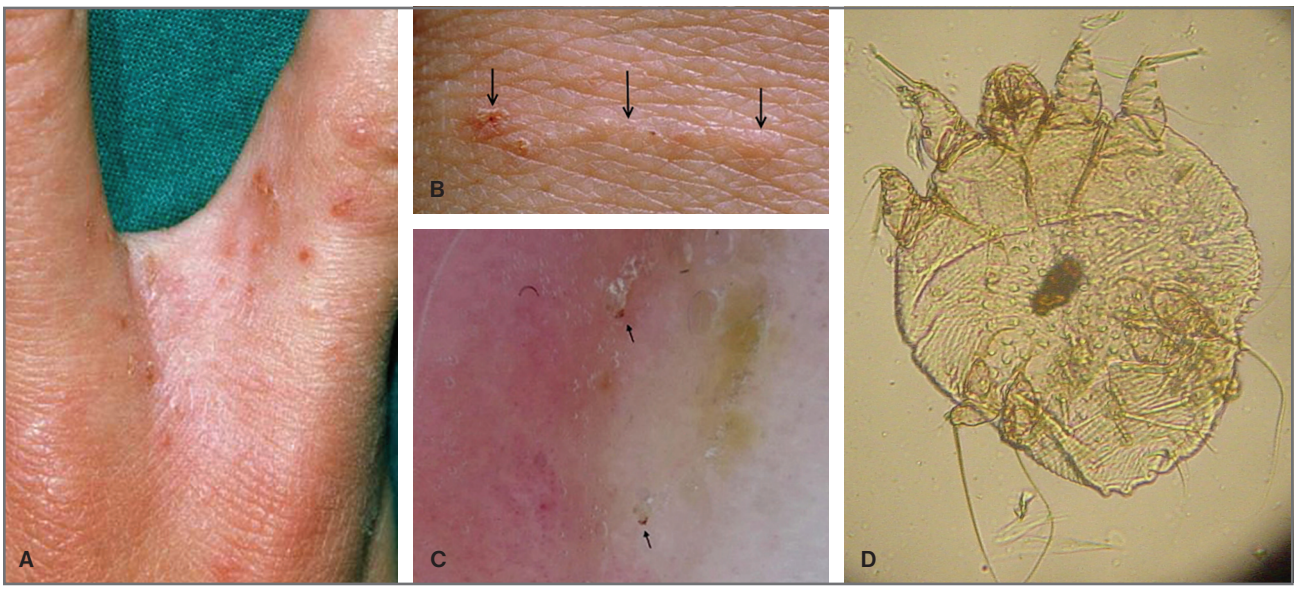

Figure 4. Scabies

(A) Scabies lesions between the fingers; (B) typical burrow (black arrows) with the entry visible at the left end; (C) typical dermatoscopic view, with the parasites within the burrows denoted by the black arrows; (D) adult Sarcoptes.

Reprinted from Primary Care Dermatological Society. Scabies. 2018. Available at http://www.pcds.org.uk/; Wikipedia. Sarcoptes scabiei. *2018. Available at https://en.wikipedia.org/wiki/Sarcoptes_scabiei.*

the parasite. Approximately 5% of the world population has been shown to have scabies.[69] In 2015, scabies accounted for 0.21% of disability-adjusted life-years from all conditions.[70]

Scabies mites (*Sarcoptes scabiei*) live within the stratum corneum of the skin.[71] The mite molts through 4 stages.[51] Larvae, nymphs, and the mature males move across the skin surface, enter hair follicles, or burrow in the keratinized layer. Mature females burrow into the stratum corneum and wait for the males; after mating, they continue to burrow for the remainder of the 4- to 6-week life span, laying eggs at a rate of 2 to 4 per day. Eggs hatch in 3 to 5 days. Scabies is transmitted through direct skin contact.[71]

Clinical presentation and diagnosis. After an asymptomatic 1- to 2-month incubation period, allergy-mediated symptoms begin. Patients with common scabies typically present with pruritic, often serpentine, lesions in skin folds, finger webbing (*Figure 4A*), and areas where clothing is tight, such as beltlines. Lesions also may occur elsewhere.[71]

The lesions are the burrows (*Figure 4B*) created by the mature female mites. The burrows are approximately 0.4 mm in width, with a scale that may be noted at the entrance and often a vesicle at the advancing end. Some patients have pruritic papules but this is less common than burrow lesions. Occasionally, small dusky nodules in the genital or axillary regions may be observed. Although the diagnosis often is made clinically based on the presence of these features, dermatoscopy (*Figure 4C*) or microscopy (*Figure 4D*) can confirm it.[71]

Crusted scabies (also known as Norwegian or hyperkeratotic scabies) is a more serious infestation. This often is associated with elderly patients, severe underlying disease, or immunocompromise (eg, HIV infection), though it also can be a complication of management of common scabies with topical steroids.[71]

Lesions of crusted scabies are characterized by vesicles and marked hyperkeratosis and may be accompanied by erythroderma; pruritus may be absent.[51,71] These lesions are susceptible to secondary bacterial infection and complications such as poststreptococcal glomerulonephritis. Early recognition and management are essential. Crusted scabies is extremely contagious.[51]

Management. Evidence-based management guidelines have been developed but these differ among groups.[71,72] The guideline from the European Academy of Dermatology and Venereology (EADV) is widely used. It recommends use of permethrin 5% cream (head-to-toe application, remove by washing in 8 to 12 hours, repeat in 1 to 2 weeks), oral ivermectin

(0.2 mg/kg orally for two doses, 1 week apart), and benzyl benzoate 25% lotion (applied at night on 2 consecutive nights, repeat in 1 week). (Scabies is an off-label use of ivermectin.) Alternatives include malathion 0.5% aqueous lotion; ivermectin 1% lotion; and sulfur 6%-33% cream, ointment, or lotion.[72]

Specific management recommendations for special situations include a topical scabicide (daily for 1 week, then 2 times/week until infestation resolves) plus oral ivermectin (0.2 mg/kg on days 1, 2, and 8) for crusted scabies. For mass management campaigns, single-dose oral ivermectin (0.2 mg/kg) is recommended.[72] Single- or multiple-dose oral ivermectin has been associated with a higher risk of treatment failure than topical permethrin for scabies. However, the increased risk of treatment failure with ivermectin was not found to be statistically significant.[73]

Treatment is recommended for members of the same household. All potentially exposed individuals should undergo treatment at the same time as the infested patient to prevent possible reinfestation. In general, treated patients may return to work, school, and day care the day after treatment.[51] Treatment typically is well-tolerated[73]; adverse reactions typically are limited to allergic reactions (particularly with permethrins in patients with allergies to ragweed or chrysanthemums).

Control and prevention. Scabies transmission typically requires prolonged skin-to-skin contact but crusted scabies can spread via brief skin contact or exposure to bedding, clothing, or furniture.[71] Patients with crusted scabies should maintain contact precautions for 1 to 2 weeks after initiation of treatment. Rooms used by patients with crusted scabies should be thoroughly cleaned and vacuumed after use, but pesticide fumigation is not necessary.[51]

Scabies mites are not susceptible to soap and water or alcohol-based hand sanitizers. Gloves should be used by clinicians caring for affected patients to prevent transmission.[69]

Other Mites

Several other species of mites are of minor medical significance (*Table 4*). Some of these are common and the skin lesions associated with them can appear similar. For example, like scabies lesions, the bites of chiggers (*Trombicula* species) can manifest with pruritic dermatitis in areas where clothing fits tightly, though chiggers do not burrow into the skin.[74]

Case 2, cont'd. Tyrone has a history suggestive of a risk of bedbug infestation (the motel) and had potential exposure to lice (his mother's client). However, a careful physical examination reveals grouped papules with a few bullae—a pattern most suggestive of chigger bites. Vigorous washing and symptomatic management of the itch with an oral antihistamine resolve the symptoms.

Table 4
Diagnosis and Management of Minor Mite Infestations

Organism	Presentation	Diagnosis	Management
Demodex (hair follicle mites)	Facial folliculitis with rosacealike papules and pustules, does not improve with antibiotics	KOH examination of skin; skin biopsy Clinical correlation is essential—mites may be present without causing pathology	Permethrin[a] 5% topically: apply, rinse off in 8 to 12 hours, repeat in 7 days Ivermectin[a] 0.2 mg/kg orally, every 7 days × 2 doses
Eutrombicula (chiggers)	Intense pruritis with dermatitis, particularly in areas where clothing fits tightly Grouped papules or bullae that progress to persistent ecchymoses Secondary bacterial infections may occur	Clinical history and physical examination	Vigorous washing to remove the mites (they attach to the skin but do not burrow into it) Symptomatic management of itch
Trombicula (chiggers)	Pruritic dermatitis similar to that seen with *Eutrombicula* Vector for *Rickettsia tsutsugamushi* (organism associated with scrub typhus)	Clinical history and physical examination	Vigorous washing to remove the mites (they attach to the skin but do not burrow into it) Symptomatic management of itch
Ornithonyssus, *Liponyssoides*, *Dermanyssus*, *Pyemotes*, *Glycyphagus*, *Tyrophagus*, *Acarus* (zoonotic mites)	Pruritic dermatitis *Liponyssoides* is a vector for *Rickettsia akari* (organism associated with rickettsialpox)	Clinical history and physical examination	Vigorous washing to remove the mites (they attach to the skin but do not burrow into it) Symptomatic management of itch

[a]*This is an off-label use of these drugs.*

KOH = potassium hydrochloride.

Information from various sources.

SECTION THREE

Community Response to Emerging Infectious Diseases

Emerging infectious diseases are those that are newly discovered, recently have increased in prevalence, or are expected to increase in prevalence in the future. Family physicians play an important role in leading community response to emerging infectious diseases. As with other types of disasters, the general approach to outbreaks has four stages: preparedness, response, recovery, and mitigation. Preparedness includes promotion of community health, maintenance of high vaccination rates, development of protocols for hospitals and family medicine practices, preparation of patients for international travel, and consideration of volunteering in case of disasters. Response includes treatment of infected patients, minimization of the risk of transmission to other individuals, education of the public, and disease reporting to local health departments. Recovery can be physical and emotional. Mitigation efforts attempt to minimize long-term effects of the outbreak and apply lessons learned to prevent or minimize the effects of similar events in the future.

Case 3. You are called to the emergency department to admit Kayla, a 6-year-old girl with fever; cough; conjunctivitis; and an erythematous, macular, blanching rash covering most of the body. On physical examination, you note she is dehydrated, and gray and blue papules are present on the buccal mucosa. When you inquire about immunizations, her mother says that she has received all vaccines except the measles-mumps-rubella (MMR) vaccine because of fear of autism. You are concerned that Kayla might have measles. You wonder what you need to do to isolate her in the hospital as well as how to protect your small community from more cases.

Emerging infectious diseases are those that are newly discovered, recently have increased in prevalence, or are expected to increase in prevalence in the future. There are many recent examples of emerging infectious diseases, including the Ebola epidemic in West Africa that killed more than 11,000 individuals, the emergence of Zika virus infection in the Western hemisphere, and the H1N1 influenza pandemic in 2009.[75]

There also are many less widely known outbreaks such as the development of drug-resistant fungal infections involving *Candida auris* in hospitals, the reemergence of syphilis on some Native American reservations, and an outbreak of *Escherichia coli* related to contamination of flour.

The Centers for Disease Control and Prevention (CDC) maintains a list of current outbreaks.[76] Although infectious disease experts and epidemiologists play key roles in management and containment of these infections, family physicians often are on the front lines of diagnosing and caring for patients with these infections and protecting their communities.

Terminology

Novel pathogens are new pathogens that previously have not been identified or were not known to infect humans. Reemergence occurs when previously limited infections become more widespread because of new means of transmission; organism mutation; a decrease in vaccination rates; development of treatment-resistant drugs; or social, cultural, or environmental changes.

An epidemic is defined as an increase in disease incidence that can be sudden or abrupt. An outbreak is similar to an epidemic but typically refers to a more limited geographic area. A pandemic refers to an epidemic that expands to multiple countries or continents. The World Health Organization (WHO) defines six phases of pandemics.[77]

Disaster management experts have divided the approach to emerging infectious diseases into four phases, which comprise a cycle: preparedness, response, recovery, and mitigation.[78,79,80]

Preparedness

The first phase of emergency management, preparedness, is multifocal, and should begin before an outbreak occurs.

Baseline Community Health

Preparedness can begin before it is known which specific infection needs to be prevented. With pro-

motion of high levels of health in patients and communities as a whole, morbidity and/or mortality rates related to an emerging infection likely will be lower regardless of the specific disease pathogen involved. Patients should be encouraged to identify a family physician before an emergency, which can improve personalization and accuracy of care.[78,80,81]

Family physicians may be the first to notice clusters of unusual or expected illnesses. Groups of respiratory or diarrheal illnesses, possible food- or waterborne diseases, or multiple illnesses in one school or childcare setting should prompt reporting to the local and/or state health departments. For example, an *E coli* outbreak in 1993 from undercooked hamburgers from a chain restaurant that killed 4 individuals and sickened approximately 700 individuals was first noted when a physician reported a cluster of children with bloody diarrhea and hemolytic uremic syndrome to the state health department.[82]

Vaccination

One of the most effective interventions that family physicians can provide is to encourage patients to receive appropriate vaccines. The CDC Advisory Committee on Immunization Practices (ACIP) offers recommendations based on age and underlying medical conditions.[83,84]

Patient refusal of vaccination for themselves or their children occurs for many reasons and physicians should explore these reasons with patients.[84,85] Vaccine refusal has contributed to the inability to fully eradicate such diseases as measles and pertussis.[86]

Underuse of vaccines also is a significant problem. Multiple reasons have been identified for underuse, including health care worker misunderstanding of contraindications and vaccine shortages.[87] Review of a health maintenance or vaccine flowsheet at every visit, including visits for illnesses, has been shown to increase immunization rates.[88,89]

Family Practice, Hospital, and Community Protocols

Family physicians should be leaders in preparing protocols for practices and hospitals in case of outbreaks. Plans for patient isolation should be in place. Personal protective equipment (PPE) should be easily accessible and not stored past its expiration date.[78,79]

An Ebola virus disease outbreak occurred in West Africa from 2013-2016.[90] In 2014, two nurses contracted the disease after caring for a patient in a community hospital in Texas. Standardized training in PPE use and waste management led to containment of the disease in the United States. However, before this event, many hospitals and practices did not have protocols in place for management of this type of infection. Family medicine practices and hospital staff should be familiar with use of PPE and should practice its use on an annual basis.[91]

The potential for absenteeism also should be considered. Health care workers may become ill, stay home to care for infected family members, or be afraid to come to work for fear of contracting the infection. Such a shortage of health care workers occurred during the 2009 H1N1 pandemic. Many hospitals have since created pandemic influenza plans with updated staffing protocols. Such plans include methods to pool resources in cases of epidemics or pandemics. They also can include support for health care workers in times of public health crises by providing for their basic needs, such as meals and child care to allow those with children to continue working.[78,92,93]

International Travel

In a world of increasing globalization, international travel allows for faster spread of infectious diseases. To address this, the US government maintains US Quarantine Stations at ports of entry and land border crossings nationwide. These are staffed by the CDC Division of Global Migration and Quarantine (DGMQ), which includes physicians, veterinarians, and epidemiologists who can assess travelers who appear ill, monitor cargo and animals, and review health records of refugees or other immigrants. The DGMQ works closely with Customs and Border Protection as well as the airline and cruise ship industries.[94,95]

However, this system is not foolproof. This was shown in 2007, when an American man was found to have extensively drug-resistant tuberculosis after he had traveled to Italy. The CDC asked the individual to stay in Italy while it determined next steps. The individual instead flew to Montreal, where he was able to bypass border patrol to enter the United States, despite a detention order having been issued.[96]

This case brought to public attention the many legal and ethical issues involved with isolation and quarantine.[96] This individual was under quarantine, which is different from isolation. Isolation involves the separation of individuals ill with a contagious disease from

well individuals. Quarantine refers to restriction of the movement of well individuals who were exposed until they are determined to no longer be at risk.[94,96]

All international travelers should complete a pretravel consultation with a family physician or practice that specializes in travel medicine. This should include a detailed discussion of travel plans, highlighting infectious and noninfectious risks. Additional vaccines and drugs (eg, for malaria prophylaxis) may be required. The risk of Zika virus infection must be considered, as the virus has become more prevalent in popular vacation destinations such as the Caribbean.[97]

Many patients do not discuss travel plans with their physicians before traveling. Patients should be asked about recent travel during office visits, particularly when patients have symptoms of infectious disease.

Volunteering

The federal government has created the Emergency System for Advance Registration of Volunteer Health Professionals (ESAR-VHP) to provide each state with funding to create a precredentialed group of medical volunteers who can be available to help in a health care emergency. The ESAR-VHP does not obligate participating health care workers to volunteer for a specific emergency but ensures that there is a pool of qualified volunteers available.[98] Family physicians can contact their state health departments if they are interested in volunteering.

In addition to working with government organizations, family physicians can volunteer with other organizations such as the Red Cross, Samaritan's Purse, and Doctors Without Borders. Volunteering through such organizations is recommended over self-deployment; self-deployment to a disease outbreak area can be unsafe, may not make best use of the volunteer's skills, and may hinder on-site interventions by aid organizations.[98,99]

Response

The response phase occurs in the setting of an outbreak. It involves implementation of the plans and protocols developed in the preparedness phase and is aimed at decreasing overall morbidity and mortality from infection.[78] Local health departments and the CDC can provide guidance in this phase.

Patient Care

Physicians should treat patients with infectious disease following protocols and recommendations provided by local health departments and the CDC. Consultation with infectious disease experts should be considered when there is uncertainty about the correct approach. When drug shortages occur, antibiotics and antiviral drugs may be obtained from the CDC Strategic National Stockpile.[100] The approach to outbreak management may need to be modified, depending on events.

Decreasing Transmission

Decreasing transmission of infection in a family practice and other settings starts with a triage protocol to identify patients with suspected infection.[78,101]

Isolation. Isolation of patients with specific symptoms may be warranted upon arrival at the physician office. In addition to isolation of possibly infected patients, protocols should be activated that may include separate waiting areas for patients who may be at increased risk of infection, such as young children, pregnant women, and patients with immunocompromise.[101] Guidelines for isolation precautions in health care settings are available from the CDC and are discussed in more detail in *Section Four*.

Protection of health care workers. The number of health care workers caring for a potentially infected patient should be limited to the minimal number required to provide adequate care. Protection of clinicians should not be neglected. When clinicians become ill, resources may be diverted to their care rather than to care of patients. Adequate PPE must be stocked and easily accessible.[78,94,101]

Vaccination. Some infection outbreaks will require establishment of additional vaccination clinics. This can aid in increasing vaccination rates for already recommended vaccines, such as during influenza outbreaks.[78] In certain situations, extra vaccinations are recommended. For example, the CDC has recommended that a third dose of measles-mumps-rubella vaccine be administered to individuals identified by public health authorities as at increased risk of

Self-deployment to a disease outbreak area can be unsafe, may not make best use of the volunteer's skills, and may hinder on-site interventions by aid organizations.

mumps during a mumps outbreak (ie, individuals in institutional settings with close contact with others or in close-knit communities).[102]

Home and school interventions. During the annual influenza season and during influenza pandemics, the CDC recommends voluntary home isolation for ill individuals, use of respiratory etiquette (ie, covering of the mouth when coughing or sneezing) and hand hygiene, and use of environmental surface cleaning measures. During influenza pandemics, the CDC also may recommend voluntary home quarantine of exposed household members and use of face masks by ill individuals.[103]

The Community Preventive Services Task Force recommends preemptive school closures or dismissals during severe influenza pandemics, but there is insufficient evidence to recommend for or against this during mild and moderate influenza pandemics.[104] During mumps outbreaks in schools, students who are unvaccinated for medical, religious, or other reasons should not attend school until 25 days after the onset of parotitis in the last patient diagnosed with mumps.[105] Similarly, in measles outbreaks, unvaccinated students should not attend school or other social settings until 21 days after the onset of rash in the last measles case.[106]

Reporting

Health departments rely on physicians for accurate and timely reporting of infectious disease cases. Every state health department maintains its own list of reportable infectious diseases and state laws require reporting of some diseases. Physicians should be aware of the specific requirements in their state. Most states post these requirements on their websites.

The CDC maintains a list of voluntary notifiable diseases. In addition, the CDC maintains the National Outbreak Reporting System (NORS), a computer database that tracks disease outbreaks via cases reported by state and local health departments.[107]

Disease-Specific Education

High-profile infections inevitably lead to patient questions at medical appointments. Social media contributes to incorrect and potentially harmful information about these infections. Physicians should ensure that they provide accurate information to patients. In addition to education provided in the examination room, family physicians can reach larger audiences with presentations to community groups and via the media.

Case 3, cont'd. You review Centers for Disease Control and Prevention recommendations regarding measles, and review the infectious disease isolation protocol for your hospital. You then admit Kayla to the hospital where she is isolated in a negative pressure room, airborne precautions are instituted, and the number of clinicians involved in her care is limited. You discover that Kayla has 2 siblings who have not received the MMR vaccine. You recommend that the siblings stay home until 21 days after exposure and arrange for their vaccination, as the parents are now agreeable.

While awaiting results of confirmatory laboratory tests, you consult an infectious disease expert and report the suspected measles case to the local health department within 24 hours. After the infection is confirmed, you work with hospital administration to offer immunization clinics for individuals who are unvaccinated or did not receive an MMR booster.

Recovery

The next phase in emergency management is recovery. After an immediate outbreak is contained, attention should turn to the physical and emotional recovery of affected families and health care workers. Typically, there is no defined end point of an infectious disease outbreak, so there is often overlap between the response and recovery phases.[80]

Physical Recovery

Clinicians must restock depleted supplies.[78,79] With large-scale outbreaks, preventive health care and management of chronic diseases may have been neglected when attention was focused on the outbreak. Resources may need to be reallocated to routine health care.

Emotional Recovery

In communities affected by infectious disease outbreaks with significant mortality, community members will experience grief over the loss of friends and family members. Clinicians may feel guilty about adverse outcomes they could not prevent. Distrust of the health care system may be present, as well as worry about future outbreaks. Clinicians may experience physical and emotional exhaustion and rates of burnout may increase.[108]

Mitigation

Mitigation involves activities undertaken to minimize the long-term consequences of the outbreak

and to apply information learned to prevent future outbreaks. Mitigation takes place before and after emergencies.[78]

Efforts to minimize long-term effects include confining an outbreak to its site of origin, addressing disabilities resulting from the infection, and confronting challenges the outbreak presented to the supply chain, workforce, and chronic disease care.

Things to consider after an outbreak include: What was missed in the preparedness phase? Is there a more effective vaccination strategy? Should larger amounts of specific antibiotics or antiviral drugs be produced and stored? Should more effective nonpharmacological interventions be used, such as quarantines and school closures? Is there a need for more effective regulation of food and water sources?

Case 3, cont'd. Kayla gradually recovers; however, one of her brothers also develops measles. While maintaining the family's privacy, you speak on a local television news program regarding measles and how it can be prevented by immunization, with the hope of preventing future outbreaks in your community.

SECTION FOUR

Health Care-Associated Infections

Health care-associated infections (HAIs) are a major cause of morbidity and mortality, with 2 million US patients per year developing HAIs. This results in 90,000 deaths and billions of dollars in preventable expenses annually. Common HAIs include central line-associated bloodstream infection, catheter-related urinary tract infection, surgical site infection, hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP), methicillin-resistant *Staphylococcus aureus* (MRSA) infection, *Clostridium difficile* infection (CDI), and others. Many factors contribute to HAIs, including inadequate hand hygiene by health care workers, inappropriate antibiotic use, increasing prevalence of multidrug-resistant organisms (MDROs), suboptimal disinfection and cleaning of hospital rooms and equipment, and use of invasive medical devices. HAP and VAP together represent the most common HAIs. Control of HAIs involves high- and low-tech solutions, including pulsed xenon light as a room disinfection adjunct, improving health care worker adherence to hand hygiene and standard precautions, as well as regular cleaning of cell phones and stethoscopes. Antibiotic stewardship programs have been shown to reduce inappropriate prescribing of antibiotics, a significant contributor to MDROs and CDI. Bundled interventions to control MRSA and CDI have been effective. Artificial intelligence applications likely will be involved in identification of patients at risk of HAIs in the future.

Case 4. Byron is a 64-year-old man with chronic alcohol use disorder and stage IV prostate cancer who comes to your office in poor condition. He is admitted to the hospital for adult failure to thrive. He improves with supportive care but develops pneumonia on day 7 in the hospital. Vancomycin and cefepime are started, and Byron is subsequently discharged with a 14-day prescription for amoxicillin-clavulanate.

Three weeks later Byron is readmitted to the hospital with atrial fibrillation and diarrhea. Test results are positive for Clostridium difficile *infection (CDI). The diarrhea improves with appropriate treatment and he is discharged with 14-day prescriptions for oral metronidazole and vancomycin.*

Despite recognition of the problem, health care-associated infections (HAIs) remain a major cause of morbidity and mortality. Every year in the United States, approximately 2 million patients develop an HAI and an estimated 90,000 (approximately 5%) die. These statistics make HAIs the fifth leading cause of death in acute care hospitals in the United States, with an estimated cost of $28-$45 billion per year. In 2008, to stimulate hospital HAI prevention efforts, the Centers for Medicare and Medicaid Services (CMS) discontinued hospital reimbursement for costs related to certain HAIs.[109]

Health care-associated infections involving the use of invasive medical devices can be costly. Given this fact, acute care hospitals that receive Medicare payments are required to report rates of certain HAIs to the Centers for Disease Control and Prevention (CDC) National Healthcare Safety Network (NHSN): central line-associated bloodstream infections (CLABSIs), catheter-associated urinary tract infections (UTIs), and surgical site infections (SSIs). Reporting of hospital-acquired methicillin-resistant *Staphylococcus aureus* (MRSA) and *Clostridium difficile* infections (CDIs) also is required.[110] See *Table 5* for microbes commonly implicated in HAIs.

Types

Central Line-Associated Bloodstream Infections

Central line-associated bloodstream infections are among the most deadly HAIs, with a mortality rate estimated at 12%-25%. It is estimated that every year in US hospitals, approximately 250,000 bloodstream infections occur.[111] Most are associated with use of intravascular devices.[112] Each infection increases the cost of care by approximately $50,000.[112,113]

Such infections can be caused by multiple mechanisms, but a common cause is colonization of the intravascular catheter by microorganisms from the

patient's skin or, less commonly, the skin of the health care workers handling the device.[112]

Urinary Tract Infections

Any physician involved in the care of elderly patients, whether in the hospital or a long-term care setting, has to make decisions about use of indwelling bladder catheters. Catheter-associated UTIs are a major cause of morbidity and mortality in hospital settings. Approximately 70% of health care-associated UTIs involve use of urinary catheters.[114] Patients with an indwelling urinary catheter have a 5.8 times

Table 5
Organisms Implicated in Hospital-Acquired Infections

Organism	Transmission	Associated Carrier State	Significance or Features
Acinetobacter baumannii	Direct contact Fomites	Yes	Inhabits water and soil Forms oral biofilms Able to infect multiple systems Resistant to many commonly prescribed antibiotics
Clostridium difficile	Fecal to oral	Yes	Associated with an estimated 29,000 deaths/year Often associated with antibiotic use Virus may survive for long periods on surfaces Not neutralized by alcohol-based hand sanitizers
Legionella species	Contaminated water	No	Associated with aspiration of potable water
Methicillin-resistant *Staphylococcal aureus* (MRSA)	Direct contact with infected or colonized individual	Yes	Forms biofilms on invasive devices Increases complications, length of hospital stay, and mortality risk
Norovirus	Fecal to oral Airborne droplets of vomitus	Infrequently	Virus is relatively stable in the environment Not neutralized by alcohol-based hand sanitizers
Vancomycin-resistant enterococcus	Direct contact with infected or colonized individuals	Yes	Reside in the gastrointestinal tract Has a wide range of infectious clinical manifestations
Other less common but emerging organisms responsible for hospital-acquired infections include extended-spectrum beta-lactamase (ESBL)-producing Enterobacteriaceae, carbapenem-resistant Enterobacteriaceae (CRE), multidrug-resistant *Pseudomonas aeruginosa*, colistin-resistant *Escherichia coli* (*mcr-1*)			

Information from various sources.

increased risk of bacteriuria than patients without indwelling catheters; that risk increases with the number of days the catheter is in place.[115] Differentiation between catheter-associated UTIs and simple bacteriuria can be challenging, frequently leading to inappropriate management of bacteriuria, which can result in the development of antimicrobial resistance.

Surgical Site Infections

The rate of SSIs in the United States is relatively low, at approximately 1.9% overall.[116] However, the number of procedures performed annually (approximately 80 million/year according to 2006 data) makes SSIs a major health issue. In addition, because approximately 50% of SSIs are not detected until after hospital discharge, this percentage likely underestimates the actual SSI rate.[117]

Although some SSIs are fairly minor, others can be difficult to manage. For example, the costs related to an infected prosthetic joint implant can exceed $90,000.[118] One study showed that as many as 55% of SSIs may be preventable using current evidence-based strategies.[119]

Pneumonia

In 2005, the American Thoracic Society (ATS) and the Infectious Diseases Society of America (IDSA) published guidelines for the management of adults with hospital-acquired pneumonia (HAP), ventilator-associated pneumonia (VAP), and health care-associated pneumonia (HCAP). Subsequent studies showed that when HCAP is diagnosed, there is no significant risk that the infection has been caused by a multidrug-resistant pathogen.[120] Therefore, in the 2016 update of the ATS and IDSA guidelines, the HCAP designation was eliminated and pneumonia cases arising during a hospital stay were divided into the mutually exclusive categories of HAP and VAP.[121]

A recent multistate survey found that pneumonia (HAP and VAP combined) was the most common hospital-acquired infection in acute care hospitals.[122]

Three of the most important causes of health care-associated infections are antibiotic misuse, inadequate adherence to infection control practices, and contaminated surfaces.

Although HAP typically is considered to be less significant than VAP, it is associated with serious complications in approximately half of patients.[121] VAP is associated with a greater number of days in the intensive care unit (ICU), longer hospital stay, and approximately $40,000 in excess costs per patient.[123]

Infectious Diarrhea

Gastrointestinal infections can spread easily within health care facilities. Norovirus, the most common cause of gastroenteritis globally, accounts for 23 million infections and 50,000 hospitalizations per year in the United States.[124,125] Long-term care facilities frequently are affected by Norovirus outbreaks. CDIs often are the result of antibiotic-associated changes in the gut microbiome. There are approximately 50,000 cases of CDI per year in the United States.[126]

Etiologies

Numerous issues contribute to HAIs, including patient, institutional, and clinician factors. Patients who are extremely ill require vascular access and often endotracheal intubation, both of which are risk factors for HAI. Institutions may struggle with balancing optimal disinfection with the need to keep rooms available to accommodate new patients.[119,122,127]

Clinicians may be colonized with pathogenic bacteria, including multidrug-resistant organisms (MDROs), and spread them to patients. Clinicians frequently have difficulty adhering to hand hygiene measures, and spore-forming pathogens such as *C difficile* may persist despite appropriate hand hygiene. Additional factors that contribute to HAIs include a growing population of patients with immunosuppression and the overuse and misuse of antibiotics. Low staffing levels on medical units may lead staff members to take risky shortcuts.[127,128]

Three of the most important causes of HAIs are antibiotic misuse, inadequate adherence to infection control practices, and contaminated surfaces.[127]

Antibiotic Misuse

Any use of antibiotics can lead to the development of antimicrobial resistance but the inappropriate use of antibiotics in humans and the livestock industry hastens this process.[129] Up to 50% of all antibiotics prescribed for humans worldwide are not necessary or are inappropriately prescribed.[130]

Some physicians may overprescribe because of outdated and nonevidence-based practices, and additional variables may contribute to inappropriate prescribing. Patients may pressure physicians to prescribe antibiotics when they are not indicated. *Table 6* lists infections for which this commonly occurs.

A simple and inexpensive intervention to address this involves display of poster-sized physician-commitment letters in examination rooms. In the letters, physicians commit to avoiding inappropriate antibiotic prescribing for acute respiratory infections. A 19.7% absolute percentage reduction in inappropriate prescribing has been shown with this intervention.[131]

Inadequate Adherence to Infection Control Practices

Perhaps the simplest cause of HAIs is the failure of clinicians to diligently follow standard isolation precautions for preventing transmission of infection (*Table 7*). These precautions include use of proper hand hygiene, personal protective equipment when indicated, and respiratory hygiene/cough etiquette.[127]

The importance of hand washing between patient contacts has been understood for 170 years[132]; however, physicians and other clinicians do not regularly follow hand hygiene rules. The same principles apply to the use and cleaning of personal devices, including stethoscopes and cell phones.[127] Isolation precautions of various types often are not followed strictly by clinicians. For example, use of nonsterile gloves as a contact precaution does not eliminate the need for hand hygiene after the gloves are removed, yet this step frequently is omitted.[133]

Table 6

Common Conditions or Situations in Which Antibiotics Are Used Inappropriately

Acute bronchitis[a]
Asymptomatic bacteriuria[a]
Sinusitis (most resolves in 7-14 days without antibiotic treatment)
Upper respiratory tract infections[a]
Duration of antibiotic use >7 days (durations of ≤7 days have been shown to be as effective as longer durations)
Empiric treatment of urinary tract infections with fluoroquinolones (narrow-spectrum drugs typically are effective)

[a]*Does not require antibiotic treatment.*

Information from Rafailidis PI, Pitsounis AI, Falagas ME. Meta-analyses on the optimization of the duration of antimicrobial treatment for various infections. Infect Dis Clin North Am. *2009;23(2):269-276; Lim CJ, Kong DC, Stuart RL. Reducing inappropriate antibiotic prescribing in the residential care setting: current perspectives.* Clin Interv Aging. *2014;9:165-177.*

Invasive Medical Devices

The use of invasive medical devices, particularly in the ICU, is closely linked to HAIs. CLABSIs are a major problem worldwide but recent efforts in the United States have resulted in a significant and sustained decrease in rates of these infections.[134] The rate of CLABSIs decreased by 58% in 2009.[135] This is important because microorganisms such as MRSA, which are able to form biofilms on indwelling catheters and implanted hardware, are more resistant to treatment with antimicrobials.[127]

Indwelling urinary catheter use is extremely common, as is catheter-associated UTI. Approximately 25% of patients with bacteriuria symptoms with an indwelling catheter will develop symptoms of UTI.[136]

Endotracheal tubes are another commonly used invasive medical device. VAP is defined as a pneumonia that develops more than 48 hours after endotracheal intubation. Intubated patients who develop VAP typically are very ill at baseline, and often have multiple comorbidities. An estimated 10% of mechanically ventilated patients will develop VAP, with an associated mortality rate of 13%.[121]

Ventilator-associated pneumonia and HAP may be caused by MDROs; this is more likely with VAP.[121] Therefore, the choice of initial antimicrobial agents in cases of HAP or VAP is a critical one. The 2016 IDSA/ATS guidelines delineate risk factors associated with MDROs in their recommendations for empiric antibiotic management of HAP and VAP.

Risk factors for multidrug resistant (MDR) HAP and VAP pathogens include[121]:

- Prior intravenous antibiotic use within 90 days;
- Septic shock at time of VAP onset;
- Acute respiratory distress syndrome preceding VAP onset;
- Hospitalization 5 or more days before VAP onset; and
- Acute renal replacement therapy before VAP onset.

Contaminated Surfaces

Patients in ICU beds and hospital rooms have been shown to be at higher risk of acquiring an HAI when placed in a bed or room previously occupied by a patient with an MDRO, even when that room has been disinfected using currently accepted protocols. The formation of biofilms on dry surfaces, failure to disinfect all medical equipment surfaces, and the propensity of some MDROs to persist in the environment likely contribute to this. In addition, contamination of mobile medical equipment is known to occur.[137]

Control

Health Care Worker Behavior

The simplest and most important intervention for HAI prevention is thought to be appropriate hand hygiene.[127] The CDC in 2002 and the World Health Organization in 2009 published an updated detailed guideline for hand hygiene in health care settings.[132,138]

In the past 20 years, alcohol-based hand sanitizers have become ubiquitous in health care settings, though their use by clinicians remains suboptimal.[132] The main impediment to the implementation of effective hand hygiene is the difficulty with which human behavior is changed.

Variables that negatively influence hand hygiene by health care workers include the fact that microbial pathogens are not visible to the naked eye, there typically is no immediate positive or negative feedback for following hand hygiene protocols, and catastrophic patient outcomes may be difficult to connect with specific failures to follow protocols. Although many hand hygiene improvement efforts have shown only temporary effects, others have shown a sustained increase in hand hygiene with a corresponding decrease in HAIs.[132,139]

One study found that 80% of stethoscopes are contaminated with bacteria, including MRSA.[140] Similar

Table 7
Types of Infection Precautions and Indications for Their Use

Contact precautions are used for patients with known or suspected infections that are easily transmitted by direct patient contact or by contact with items in the environment. Personal protective equipment for contact precautions includes gloves and gowns. Examples of such infections include:

- Enteric infections: *Clostridium difficile*, rotavirus, or any enteric infection
- Respiratory infections: respiratory syncytial virus, parainfluenza virus
- Highly contagious skin infections: herpes simplex virus (neonatal or mucocutaneous), impetigo, major (noncontained) abscesses, decubiti, pediculosis, scabies, staphylococcal furunculosis in infants and young children, zoster (disseminated or in an immunocompromised patient), viral/hemorrhagic conjunctivitis, or viral/hemorrhagic infections caused by viruses such as Ebola, Lassa, or Marburg

Droplet precautions should be used for patients with known or suspected infections transmitted by large particle droplets. Droplet precautions entail the use of a mask in addition to gown and gloves when within 3 feet of a patient. Examples of such infections include:

- Invasive *Haemophilus influenzae* type b disease, including meningitis, pneumonia, epiglottitis, and sepsis
- Invasive *Neisseria meningitidis* disease, including meningitis, pneumonia, and sepsis
- Other serious bacterial respiratory infections: diphtheria (pharyngeal), *Mycoplasma pneumoniae* infection, pertussis, pneumonic plague, streptococcal pharyngitis, pneumonia, or scarlet fever in infants and young children
- Serious viral infections: adenovirus, influenza, mumps, measles, parvovirus B19, or rubella

Airborne precautions should be used, in addition to contact precautions, for patients with known or suspected infections transmitted by airborne droplet nuclei (ie, droplets <5 mcm in diameter). Airborne precautions involve special air and ventilation systems such as airborne infection isolation rooms. Clinicians also should wear a N95 mask or respirator. Examples of such infections include:

- Measles, varicella (including disseminated zoster), tuberculosis[a]

[a]*For more information about precautions for tuberculosis, see the Centers for Disease Control and Prevention guidelines available at https://www.cdc.gov/mmwr/preview/mmwrhtml/rr5417a1.htm.*

Information from Siegel JD, Rhinehart E, Jackson M, Chiarello L. 2007 guideline for isolation precautions: preventing transmission of infectious agents in healthcare settings, 2007. Am J Infect Control. *2007;35(10 Suppl 2):S65-164.*

results have been found with clinicians' cell phones. Daily cleaning with alcohol has been shown to prevent growth of pathogenic bacteria on cell phones and would be a logical step toward reducing rates of HAIs.[141]

Disinfecting wipes are available for use on medical devices, including stethoscopes, although the effects of such wipes on electronic devices is not entirely clear. Effective disinfection of smartphones also can be accomplished with gadget cleaners that use UV light.[142]

Hospital-Based Interventions

Prevention of HAIs requires commitment from hospital administrations along with effective surveillance; outbreak investigation; and training of clinicians, support staff, and management. A thorough discussion of each of these topics is beyond the scope of this *FP Essentials*, but several key strategies are discussed.

Hand hygiene. Controlling HAIs is challenging, but it can be accomplished. For example, in 2007, the Veterans Affairs (VA) implemented a quality improvement initiative with a goal of reducing the rate of hospital-acquired MRSA infection in acute care VA hospitals. The four components of this initiative were: universal nasal surveillance for MRSA, contact precautions for patients colonized or infected with MRSA, proper hand hygiene, and a change in the institutional culture whereby infection control would become the responsibility of every clinician who had contact with patients. These groups of interventions significantly decreased the transmission of MRSA infection. It also resulted in lower rates of *C difficile* in non-ICU settings and vancomycin-resistant enterococcus infections in ICU and non-ICU settings.[143]

Disinfection of contaminated surfaces. Contamination of environmental surfaces in hospital rooms is an inevitable consequence of providing care to infected patients, including patients with MDROs. Several enhanced disinfection techniques have been used with varying degrees of effectiveness.

The addition of UV light to usual disinfection protocols has been shown to decrease bacterial contamination of surfaces in hospital rooms.[144] A similar benefit has been shown using hydrogen peroxide vapor for decontamination.[145] Each of these options reduces pathogen levels but each has limitations, including cost, logistical issues, and time required to perform cleaning.

Several studies have shown improved cleaning of ICU rooms with use of a black light indicator monitoring system to provide feedback to cleaning staff.[137]

Antiseptic use. A low-tech intervention that can potentially reduce rates of multiple types of HAIs is the daily bathing of patients in ICUs with chlorhexidine gluconate. Though studies have yielded conflicting results, this is an inexpensive measure that may be effective.[146]

Based on results of randomized controlled trials, the CDC recommends use of chlorhexidine-impregnated dressings to reduce the risk of bloodstream infections related to intravenous catheters in patients 18 years and older.[147] Intravenous catheters impregnated with antibiotics or antiseptics have been used widely in the United States for years. A recent Cochrane review showed that CLABSI rates were reduced with their use in ICU settings, though no clear decrease in clinical sepsis or mortality rates could be attributed to use of catheters impregnated with antimicrobials.[148]

Integrated programs that used increased monitoring of data and feedback along with clinician education to increase adherence to recommended best practices for the insertion of central venous catheters resulted in substantial reductions in CLABSI rates.[123] Because of these efforts, half of CLABSIs now occur outside the ICU, with outpatient dialysis units representing a major source.[135]

Urinary catheters. Urinary catheters should be inserted only when absolutely necessary. They should be removed as soon as possible.[114]

***C difficile* test.** Current recommendations for control of CDI call for prompt testing of diarrheal stools of hospitalized patients. Testing of stool from asymptomatic patients is not recommended. However, one recent trial showed a decrease in CDI cases in a hospital that tested all patients for *C difficile* and isolated patients found to be colonized.[149]

Other interventions. Most family physicians do not perform major surgical procedures, but they should be aware of evidence-based interventions to help prevent SSIs. These are outlined in *Table 8*.

Hospital-based antibiotic stewardship programs (ASP) have been effective in reducing inappropriate use of antibiotics and have led to improvements in clinical outcomes.[150,151] While ASPs vary widely from hospital to hospital, the CDC recommends that every acute care hospital implement its own version of an ASP.[150]

One aspect of antibiotic stewardship is de-escalation of antimicrobial therapy. A recent meta-analysis found that de-escalation was not inferior to standard therapy in management of the original condition, with a trend

Table 8
Interventions to Prevent Surgical Site Infections

Administer the appropriate parenteral prophylactic antimicrobial drugs before skin incision in all cesarean delivery procedures
In clean and clean-contaminated procedures, do not administer additional prophylactic antimicrobial doses after the surgical incision is closed in the operating room, even in the presence of a drain
Implement perioperative glycemic control and use blood glucose target levels <200 mg/dL in patients with and without diabetes
Maintain perioperative normothermia
For patients with healthy pulmonary function undergoing general anesthesia with endotracheal intubation, administer increased F_{IO_2} during surgery and after extubation in the immediate postoperative period. To optimize tissue oxygen delivery, maintain perioperative normothermia and adequate volume replacement
Advise patients to shower or bathe (full body) with soap (antimicrobial or nonantimicrobial) or an antiseptic agent on at least the night before the operative day

F_{IO_2} = fraction of inspired oxygen.

Adapted from Berrios-Torres SI, Umscheid CA, Bratzler DW, et al. Centers for Disease Control and Prevention guideline for the prevention of surgical site infection, 2017. JAMA Surg. *2017;152:784-791.*

toward better outcomes in the de-escalation groups, though the studies were of low quality. De-escalation of antimicrobial therapy should be considered in patients with community-acquired pneumonia, HAP, VAP, urosepsis, and other bloodstream infections when cultures and susceptibility results become available.[151]

The Future

Although the fundamentals of hand hygiene are not likely to change, a recent development in this area could affect hand hygiene policies. Starting in 2004, the Joint Commission began focusing on organizational policies regarding hand hygiene. Noting that health care organizations have had sufficient time to implement appropriate policies and train personnel, as of January 1, 2018, it changed its focus from evaluating institutional hand hygiene practices. It now evaluates individual actions, noting that "any observation by surveyors of *individual* failure to perform hand hygiene in the process of direct patient care will be cited as a deficiency resulting in a Requirement for Improvement under the Infection Prevention and Control chapter for all accreditation programs."[152]

Among future possibilities for improved disinfection of hospital rooms and equipment is the development of self-disinfecting surfaces, which are created by coating surfaces with biocides such as heavy metals or antimicrobials.[153] Another technology in development involves application of light-activated photosensitizers (ie, titanium dioxide nanoparticles) to surfaces followed by use of UV light to generate reactive oxygen species that eliminate any organisms present.[154]

Artificial intelligence and machine learning are being used to identify patients at risk of specific complications related to health care, including HAIs. The effectiveness and prevalence of these technologies are expected to grow.[155]

Case 4, cont'd. After a few days of normal stools, Byron experiences a recurrence of diarrhea, and 4 weeks later he is admitted to the intensive care unit with sepsis secondary to CDI. After effective treatment with intravenous (IV) vancomycin and fidaxomicin, Byron is discharged with a prescription for a 30-day course of a probiotic.

Over the next 12 months, Byron has had no further recurrence of CDI, despite a hospital admission for a central line-associated bloodstream infection in which the port became infected with methicillin-sensitive Staphylococcus aureus. *This required removal of the device and a 4-week course of IV cefazolin.*

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Online Resources

Organization	Description	Website
Skin Conditions		
American Family Physician	*AFP* by Topic, Skin Conditions	https://www.aafp.org/afp/topicModules/viewTopicModule.htm?topicModuleId=21
Mosquito-Borne Viruses		
Centers for Disease Control and Prevention	Yellow fever	https://wwwnc.cdc.gov/travel/yellowbook/2018/infectious-diseases-related-to-travel/yellow-fever https://www.cdc.gov/yellowfever/vaccine/index.html
	Zika	https://www.cdc.gov/zika/laboratories/lab-guidance.html
	Protection against mosquitoes, ticks, & other arthropods	https://wwwnc.cdc.gov/travel/yellowbook/2018/the-pre-travel-consultation/protection-against-mosquitoes-ticks-other-arthropods
World Health Organization	International travel and health	http://www.who.int/ith/en
	Zika virus	http://www.who.int/mediacentre/factsheets/zika/en/
Ectoparasites		
Centers for Disease Control and Prevention	Bedbugs	https://www.cdc.gov/parasites/bedbugs/
	Lice	https://www.cdc.gov/parasites/lice/
	Scabies	https://www.cdc.gov/parasites/scabies/
Environmental Protection Agency	Bedbugs	https://www.epa.gov/bedbugs
World Health Organization	Scabies	http://www.who.int/lymphatic_filariasis/epidemiology/scabies/en/
Influenza		
Centers for Disease Control and Prevention	Pandemic influenza	https://www.cdc.gov/flu/pandemic-resources/index.htm
Hospital-Associated Infections		
Centers for Disease Control and Prevention	State-based HAI prevention activities	https://www.cdc.gov/hai/state-based/index.html
	Hand hygiene guideline	https://www.cdc.gov/handhygiene/providers/guideline.html
Infectious Diseases Society of America	Management of adults with hospital-acquired and ventilator-associated pneumonia: 2016 clinical practice guidelines	https://academic.oup.com/cid/article/63/5/e61/2237650

Posttest Questions

1. A patient recently returned from a trip to an area where numerous cases of Zika virus infection have been reported. Three days ago, she developed symptoms consistent with infection. Which one of the following tests should be used to confirm the diagnosis?

- ❑ A. Immunoglobulin (Ig) M.
- ❑ B. Nucleic acid test (NAT).
- ❑ C. Plaque reduction neutralization test (PRNT).
- ❑ D. Premembrane protein (prM) level.

2. In low-resource settings, a tourniquet test can be used for diagnosis when patients have clinical findings consistent with which one of the following mosquito-borne viral illnesses?

- ❑ A. Chikungunya.
- ❑ B. Dengue.
- ❑ C. Japanese encephalitis virus infection.
- ❑ D. Yellow fever.
- ❑ E. Zika virus infection.

3. Up to half of patients with which one of the following mosquito-borne viral infections experience a postinfection arthritis syndrome?

- ❑ A. Chikungunya.
- ❑ B. Dengue.
- ❑ C. Japanese encephalitis virus infection.
- ❑ D. Yellow fever.
- ❑ E. Zika virus infection.

4. Most cases of yellow fever occur in which one of the following regions?

- ❑ A. Africa.
- ❑ B. Central America.
- ❑ C. India.
- ❑ D. South America.
- ❑ E. Southeast Asia.

5. Which one of the following mosquito repellants can be applied directly on clothing but should not be applied on the skin?

- ❑ A. 3-[N-Butyl-N-acetyl]-aminopropionic acid, ethyl ester (IR3535).
- ❑ B. Diethyltoluamide (DEET).
- ❑ C. Oil of lemon eucalyptus (*Corymbia citriodora*).
- ❑ D. Permethrin.
- ❑ E. Picaridin.

6. Which one of the following best distinguishes the skin lesions of scabies from the bites of bedbugs?

- ❑ A. Associated allergy-mediated symptoms.
- ❑ B. Ecchymosis.
- ❑ C. Erythema.
- ❑ D. Itching.
- ❑ E. Location.

7. A patient recently had a bedbug infestation in her home, which was confirmed and eradicated by a professional exterminator. The patient comes to your office because she is experiencing intensely pruritic skin lesions. On physical examination, you note lesions consistent with bedbug bites. Which one of the following is appropriate management for the pruritic skin lesions?

- ❑ A. Antihistamines.
- ❑ B. Ivermectin.
- ❑ C. Manual removal of bedbugs from the skin lesions.
- ❑ D. Topical benzyl benzoate.

8. Which one of the following is true of head lice management?

- ❑ A. Fine-tooth combing of wet hair may be more effective than use of pediculicides alone.
- ❑ B. Head shaving is necessary.
- ❑ C. Manual egg removal (nit-combing) after use of a pediculicide does not decrease the risk of treatment failure.
- ❑ D. Most pediculicides are 100% ovicidal.

9. You diagnose an elementary school-age child with an infestation of head lice. The parents are upset because they have heard that children with head lice should not go to school. They work and do not have easy access to childcare. Which one of the following is true about return to school for children with head lice?

- ❑ A. It is not recommended that the child stay home from school.
- ❑ B. The child may return to school after two applications of permethrin.
- ❑ C. The child should not return to school for at least 10 days after treatment begins.
- ❑ D. The child should not return to school until no nits are seen on combing.

10. Crusted scabies often is associated with which one of the following patient groups?

- ❑ A. Children.
- ❑ B. Elderly patients.
- ❑ C. Infants.
- ❑ D. Pregnant women.
- ❑ E. Young and middle-age adults.

11. In relation to an infectious disease, which one of the following defines an epidemic?

- ❑ A. An increase in disease incidence that can be sudden or abrupt.
- ❑ B. Disease involving multiple countries or continents.
- ❑ C. Infections involving pathogens not previously known to infect humans.
- ❑ D. Infections with pathogens that have reemerged because of social or environmental changes.

12. Isolation and quarantine are measures used to stop the spread of infectious disease. Isolation involves the separation of individuals ill with a contagious disease from well individuals. Quarantine refers to restriction of the movement of well individuals who were exposed until they are determined to no longer be at risk.

- ❑ A. True.
- ❑ B. False.

13. Which one of the following is true of physician deployment to the site of a disease outbreak?

- ❑ A. Any such deployment must be through the Emergency System for the Advance Registration of Volunteer Health Professionals (ESAR-VHP).
- ❑ B. Self-deployment is safe and recommended.
- ❑ C. Self-deployment may hinder on-site interventions by other organizations.

14. A case of measles was diagnosed in the community elementary school. You have an 8-year-old boy in your practice whose parents declined to have the measles-mumps-rubella (MMR) vaccine administered. The parents ask you whether the boy, who is feeling well, should attend school. Which one of the following is the best advice to give them?

- ❑ A. He can attend school if he has not been in contact with the child with measles.
- ❑ B. He can attend school if he receives the measles-mumps-rubella vaccination.
- ❑ C. He should not attend school for 25 days.
- ❑ D. He should not attend school until 21 days after the onset of rash in the last child in the school to contract measles.

15. Which one of the following is true of reporting cases of infectious disease to health authorities?

- ❑ A. Each state maintains its own list of reportable infectious diseases.
- ❑ B. Patient privacy laws require clinicians to obtain patient permission before reporting infectious diseases to public health authorities.
- ❑ C. The Centers for Disease Control and Prevention (CDC) maintains a list of mandatory notifiable diseases.
- ❑ D. The CDC requires reporting of epidemics.

16. Which one of the following organisms is not neutralized by alcohol-based hand sanitizers?

- ❑ A. *Acinetobacter baumannii*.
- ❑ B. *Legionella*.
- ❑ C. Methicillin-resistant *Staphylococcus aureus.*
- ❑ D. Norovirus.
- ❑ E. Vancomycin-resistant enterococci.

17. Which one of the following is a common mechanism through which central line-associated bloodstream infections occur?

- ❑ A. Bacteremia from an infection at another site (eg, pneumonia, urinary infection).
- ❑ B. Contaminated gloves.
- ❑ C. Contaminated intravenous fluid.
- ❑ D. Contamination by microorganisms from the patient's skin.

18. Which one of the following is the most common hospital-acquired infection in acute care hospitals?

- ❑ A. *Clostridium difficile* diarrhea.
- ❑ B. Central line-associated bloodstream infection.
- ❑ C. Pneumonia.
- ❑ D. Surgical site infection.
- ❑ E. Urinary tract infection.

19. A patient is admitted to the hospital due to influenza. Which one of the following types of infection precautions are needed?

- ❑ A. Airborne precautions.
- ❑ B. Contact precautions.
- ❑ C. Droplet precautions.

20. Which one of the following is thought to be the most important intervention for preventing health care-associated infections?

- ❑ A. Appropriate hand hygiene.
- ❑ B. Bathing patients with antiseptics.
- ❑ C. Cleaning of contaminated surfaces.
- ❑ D. Early removal of urinary catheters.
- ❑ E. Regular cleaning of stethoscopes.

Posttest Answers

Question 1: The correct answer is B.
Zika diagnosis is confirmed with nucleic acid testing (NAT) through 14 days after symptom onset or with Zika virus immunoglobulin (Ig) M antibody testing if more than 14 days have elapsed from symptom onset. *See page 12.*

Question 2: The correct answer is B.
In low-resource settings, clinical findings consistent with dengue and a positive tourniquet test result are sufficient for diagnosis. *See page 13.*

Question 3: The correct answer is A.
Studies show that a postviral arthritis called post-chikungunya chronic inflammatory rheumatism occurs in up to half of patients with chikungunya. *See page 14.*

Question 4: The correct answer is A.
Yellow fever is present in 44 countries, mostly in sub-Saharan Africa and some in South America. Approximately 90% of infections occur in Africa. *See page 14.*

Question 5: The correct answer is D.
Permethrin can be applied directly on clothing but should not be applied to the skin. *See page 16.*

Question 6: The correct answer is E.
Scabies tends to occur in skin folds, finger webbing, and areas where clothing is tight such as beltlines, whereas bedbug bites tend to occur on easily accessible, exposed areas. *See pages 18-19.*

Question 7: The correct answer is A.
Management of bedbug bites primarily is limited to symptomatic relief through the use of antipruritic drugs, including antihistamines, topical or oral corticosteroids, and over-the-counter topical anesthetics. (This is an off-label use of some antihistamines and some corticosteroids.) *See page 19.*

Question 8: The correct answer is A.
Fine-tooth combing of wet hair without use of pediculicides is safe and may be more effective than use of pediculicides alone. *See page 20.*

Question 9: The correct answer is A.
Absence from school is no longer recommended for children with head lice. *See page 21.*

Question 10: The correct answer is B.
Crusted scabies often is associated with elderly patients, severe underlying disease, or immunocompromise (eg, HIV infection). *See page 22.*

Question 11: The correct answer is A.
An epidemic is defined as an increase in disease incidence that can be sudden or abrupt. *See page 25.*

Question 12: The correct answer is A.
Isolation involves the separation of individuals ill with a contagious disease from well individuals. Quarantine refers to restriction of the movement of well individuals who were exposed until they are determined to no longer be at risk. *See pages 26-27.*

Question 13: The correct answer is C.
Self-deployment to a disease outbreak area can be unsafe, may not make best use of the volunteer's skills, and may hinder on-site interventions by aid organizations. *See page 27.*

Question 14: The correct answer is D.
In measles outbreaks, unvaccinated students should not attend school or other social settings until 21 days after the onset of rash in the last measles case. *See page 28.*

Question 15: The correct answer is A.
Every state health department maintains its own list of reportable infectious diseases and state laws require reporting of some diseases. *See page 28.*

Question 16: The correct answer is D.
Norovirus is not neutralized by alcohol-based hand sanitizers. *See Table 5.*

Question 17: The correct answer is D.
Central line-associated bloodstream infections can be caused by multiple mechanisms, but a common cause is colonization of the intravascular catheter by microorganisms from the patient's skin or, less commonly, the skin of the health care workers handling the device. *See pages 30-31.*

Question 18: The correct answer is C.
A recent multistate survey found that pneumonia (hospital-acquired pneumonia and ventilator-associated pneumonia combined) was the most common hospital-acquired infection in acute care hospitals. *See page 32.*

Question 19: The correct answer is C.
Droplet precautions should be used for patients with known or suspected infections transmitted by large particle droplets. Examples of such infections include: invasive *Haemophilus influenzae* type b disease, including meningitis, pneumonia, epiglottitis, and sepsis; invasive *Neisseria meningitidis* disease, including meningitis, pneumonia, and sepsis; other serious bacterial respiratory infections (ie, diphtheria [pharyngeal], *Mycoplasma pneumoniae* infection, pertussis, pneumonic plague, Streptococcal pharyngitis, pneumonia, scarlet fever in infants and young children); and serious viral infections (ie, adenovirus, influenza, mumps, measles, parvovirus B19, rubella). *See Table 7.*

Question 20: The correct answer is A.
The simplest and most important intervention for prevention of health care-associated infections is thought to be appropriate hand hygiene. *See page 34.*

The next edition of AAFP FP Essentials™ *will be:*

Neurologic Conditions


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