CHAPTER 26

Chagas Disease

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Chagas disease, first described in 1909 by Carlos Chagas, is endemic throughout Central and South America. An estimated 8 million people are infected with *Trypanosoma cruzi*, the etiologic agent of this disease. *T. cruzi*, a protozoan of the order Kinetoplastida, has a complex lifecycle passing between insects and mammals. Blood-sucking triatomine bugs serve as the principal transmission vector by depositing *T. cruzi*-infected feces onto the skin. The parasite is then inoculated into dermal breaks or mucosal surfaces by inadvertent rubbing or scratching. Most transmission occurs in rural areas of Latin America, where poor housing conditions promote contact with the insect vector. *T. cruzi* can also be transmitted by transfusion of blood from chronically infected donors, by organ transplantation, from mother to fetus, in laboratory accidents, and by contaminated food or drink. Infection is lifelong if not treated.

Progress in reducing vector- and blood-borne transmission in endemic areas and migration within endemic countries and to non-endemic countries are changing the epidemiology of Chagas disease. It is becoming an increasingly global problem. Based on limited data from seroprevalence studies among blood donors and other populations, an estimated 300,000 people residing in the United States are infected with *T. cruzi*. Most are unaware of their infection and remain undiagnosed.

EPIDEMIOLOGY

Parasite Distribution versus Disease Distribution

T. cruzi infection of vertebrate hosts and insect vectors occurs widely throughout the Americas from 42° North latitude to 46° South latitude. This encompasses much of the United States and extends through Mexico and Central America to most of South America. The risk of vector-borne transmission to humans is low in the United States, probably because of better housing conditions and less efficient vectors; however, autochthonous transmission is increasingly recognized in the southern United States. Transmission to humans by vector occurs mainly in endemic areas in Mexico, Central America (Belize, Costa Rica, El Salvador, Honduras, Guatemala, Nicaragua, Panama), and South America (Argentina, Bolivia, Brazil, Colombia, Ecuador, Guyana, Suriname, French Guiana, Paraguay, Peru, Venezuela). Interestingly, the Amazon region with mainly sylvatic triatomine species is an area with relatively low prevalence of Chagas disease in humans. Successful vector control programs in the "Southern Cone" of South America have substantially reduced transmission by reduviid bugs. Uruguay, Chile, and parts of Brazil have been certified free of vector-borne transmission. Despite these successes, Chagas disease represents a serious health problem in 17 countries in Latin America, with 20% of the population living in endemic areas. The prevalence of infection in Latin America is estimated to be ~8 million seropositive individuals; 100 million are estimated to be at risk for acquiring the infection.

Due to emigration of seropositive individuals, Chagas disease is increasingly found in countries without vectorial transmission (**Fig. 26.1**).

Vectors

T. cruzi is transmitted to mammalian species by insects of the family Reduviidae, subfamily Triatominae (**Fig. 26.2**). More than 100 triatomine species exist, each with its own feeding pattern, vertebrate host preference, and geographic/ecologic distribution. In the sylvatic cycle, the bugs prefer forested areas, but they become domesticated as a result of conversion of natural habitat to domestic uses. Most bug species prefer tropical climates with a

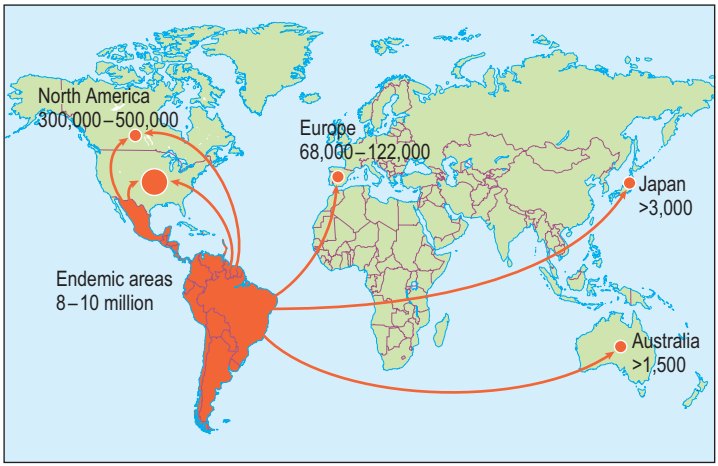

Fig. 26.1 Worldwide distribution of Chagas disease. Cases outside the Latin Americas are mainly due to seropositive individuals who have moved to these locations. (From: Barcelona Institute for Global Health. Available at <http://www.infochagas.org/en/en-que-paises-hay-chagas>.)

Fig. 26.2 *Triatoma infestans* feeding on a human arm. One of many species of reduviid bugs capable of transmitting *Trypanosoma cruzi*. (With permission from: Wallace, P., Pasvol, G., 2007. Atlas of Tropical Medicine and Parasitology, sixth ed. Elsevier, Mosby, image #1TF231.)

TABLE 26.1 Popular Regional Names for Triatomine Bugs

Name	Countries Where Used
Barbeiros, *bicudos*, *chupanca*, *fincao*, *percevejo da parede*	Brazil
Vinchucas	Argentina, Uruguay, Bolivia, Chile
Chirimacha or *chinchon*	Peru
Chupasangre	Ecuador
Chinche or *chincha*	Mexico, Colombia, Venezuela, Central America
Chinchona, *chince picuda*, or *pik*	Mexico
Chinchorro or *chinchorra*	Ecuador, Guatemala
Timbuck or *chincha-guasu*	Paraguay
Telepate	Guatemala, El Salvador
Bush chinch	Belize
Pito	Colombia
Cone nose bugs, kissing bugs, assassin bugs, Arizona tigers	USA

From: Garcia-Zapata, M.T.A., Marsden, P.D., 1986. Chagas' disease. Clin. Trop. Med. Commun. Dis. 1, 558.

temperature range from 24 to 30°C and relative humidity from 60 to 70%. Climatic factors account for increased transmission during the warmer months.

Triatoma infestans, *Triatoma dimidiata*, *Panstrongylus megistus*, and *Rhodnius prolixus* are important vectors in human transmission. Colloquial names for the reduviid are commonly used (**Table 26.1**). In northeast Brazil, for example, they are known to locals as *barbeiros* or *bicudos*. The word *barbeiro* comes from the Portuguese word for "barber," used because the bugs like to bite the exposed chin and neck. In Argentina, Uruguay, Bolivia, and Chile they are referred to as *vinchucas*. In English, one hears the terms *bed bugs* or *kissing bugs*, which refer to the insect's preference for feeding at night and about the face of sleeping children. Adult bugs are about 2.5 cm in length. They should not be confused with bed bugs of the Cimicid family (adults are 4-5 mm) found around the world.

Reservoir Hosts

T. cruzi is found in a broad range of species of sylvan mammals including monkeys, sloths, rodents, marsupials, rabbits, bats, and various carnivores. Birds, amphibians, and reptiles are naturally resistant. Humans can become infected by entering into the sylvatic transmission cycle of *T. cruzi*, but transmission primarily occurs because the reduviid vectors move into the domestic environment and infect peridomiciliary, then domestic animals. In endemic areas, the seroprevalence among domestic animals is high; studies in South America have shown the following rates: 80% in dogs, 60% in cats, 19% in sheep, and 9% in goats. Guinea pigs and rabbits are often domesticated and have been shown to have a seroprevalence of 60% and 12%, respectively. Among rodents, up to 90% of mice and 60% of rats have been shown to be infected. In most cases, animals acquire their infection directly from insect bites, but in others the acquisition of infection appears to be via the food chain (e.g., cats eating infected mice).

Transmission by Vector

Transmission by insect vector occurs in both sylvan and domestic cycles. It is the interface of these cycles, brought about by infected peridomiciliary animals such as rodents and, particularly, opossums, that leads to high rates of infection of more domestic animals, such as dogs, and eventually of humans. Chagas disease tends to occur in low socioeconomic settings because of the primitive type of housing the triatomine bugs prefer. They tend first

to colonize outbuildings and move into houses built with walls of sticks and mud and covered with thatched roofs. Cracks in the walls and roofs provide the insects with a daytime hiding place and ready nighttime access to domestic animal and human hosts to obtain blood meals.

In some animals, acquisition of the parasite is via the food chain. Human outbreaks following ingestion of food or drink contaminated with infected insects or their feces have been documented and often associated with fatal cases.

TRANSMISSION RELATED TO TRANSFUSIONS AND ORGAN TRANSPLANTS

Although most people chronically infected with *T. cruzi* are asymptomatic, low levels of parasites are present in blood and other tissues. Blood transfusion is considered the second most common mode of transmission. Between 12 and 48% of recipients of blood from a *T. cruzi*-seropositive donor become infected, depending on the volume and type of blood product transfused and the level of donor parasitemia.

Many Latin American countries have made considerable progress in improving blood safety in the past two decades. In 10 of the 17 endemic countries, >99% of donated blood is screened by at least one assay for *T. cruzi* antibodies. However, a substantial risk of blood-borne *T. cruzi* infection is still present in countries with low screening coverage (e.g., Costa Rica, Panama) or in countries with relatively good, but incomplete, coverage and a high prevalence of infection (e.g., Bolivia).

Increased Latin American immigration to the United States has generated concerns about the presence of *T. cruzi* in the US blood supply. Based on seroprevalence data, the overall risk is estimated at 1 in 27,500 donations, although it varies with location and may be as high as 1 in 3000 in areas with large Latino populations. At least eight cases of transfusion-associated transmission have been reported in the United States and Canada. These were mainly detected in immune-suppressed patients who developed serious infection, but it is likely that many additional cases have occurred but were unrecognized, because acute *T. cruzi* infection in immunocompetent patients is usually a mild illness. The Food and Drug Administration approved a screening assay for *T. cruzi* antibodies in blood donations, and in early 2007, screening was implemented by blood collection agencies accounting for ~70% of the blood supply. As a result, clinicians in the United States are likely to encounter an increasing number of patients with suspected or confirmed Chagas disease. For more information from the Centers for Disease Control, see http://www.cdc.gov/parasites/chagas/resources/A_Test%20Positive_Chagas_Flyer_508.pdf.

Transmission of Chagas disease can also occur through solid organ or bone marrow transplantation from chronically infected donors. In the United States, at least five cases of infection associated with solid organ transplantation have been reported. Newly acquired *T. cruzi* is of special concern in transplant recipients because of their limited ability to control the infection. It is now recommended that donors who have resided in endemic areas be screened for Chagas disease.

CONGENITAL TRANSMISSION

Congenital transmission is a more serious problem than previously realized, especially in highly endemic areas of Bolivia, Chile, and Brazil, where prevalence among offspring from seropositive pregnant mothers ranges from 1 to 8%. Congenital *T. cruzi* infection may be responsible for prematurity and low birth weight, although most infected newborns are asymptomatic.

It is known that parasitemia is common among infected neonates; hepatosplenomegaly, meningoencephalitis, hemorrhagic disorders, and disseminated cutaneous lesions are also well described.

Transmission by breast feeding deserves mention because of the conflicting information previously available. Despite sporadic anecdotal reports implicating breast milk, the most recent systematic studies from Bahia (Brazil), Cordoba (Argentina), and Santa Cruz (Bolivia) do not support transmission of *T. cruzi* via colostrum. Current World Health Organization

(WHO) policy explicitly states "there is no reason to restrict breast-feeding by *T. cruzi*–infected mothers."

CLINICAL FEATURES

Infection in humans is characterized by two principal phases: acute and chronic.

Acute Disease

Along with fever, patients experience local swelling at the inoculation site; this is referred to as a chagoma. If the conjunctiva or eyelid is the portal of entry, one may develop the classic unilateral periophthalmic cellulitis and palpebral edema referred to as Romaña sign (**Fig. 26.3**). This is a reliable diagnostic indicator seen in 90% of recognized acute cases acquired through the eye. Flu-like symptoms such as malaise, fever, rash, anorexia, diarrhea, and vomiting are common but nonspecific.

Acute Chagas disease often passes undetected. It is diagnosed in only 1-2% of all cases, but electrocardiographic (EKG) or radiographic evidence of acute myocarditis is found in as many as 30% of acute cases if it is sought. Fulminant systemic symptoms requiring hospitalization occur only occasionally during acute Chagas disease but include generalized lymphadenopathy, hepatosplenomegaly, severe myocarditis, and meningoencephalitis. Disease of sufficient severity to require hospitalization carries a 5-10% mortality rate. The younger the patient at the time of acquisition, the more severe the acute syndrome,

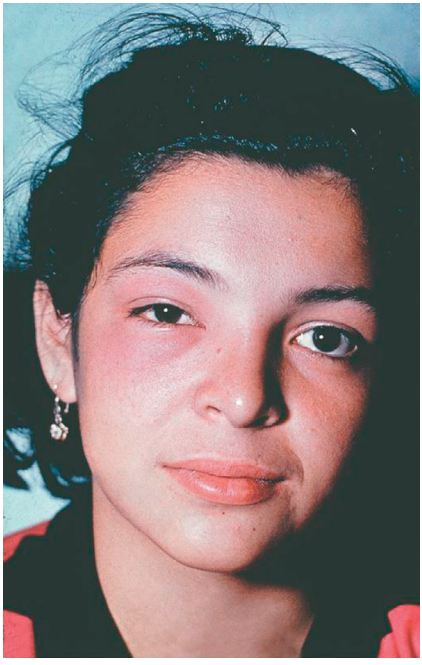

Fig. 26.3 Romaña sign. A symptom of acute Chagas disease characterized by unilateral conjunctivitis and periorbital swelling due to rubbing infected reduviid bug feces into the eye. (With permission from: Wallace, P., Pasvol, G., 2007. Atlas of Tropical Medicine and Parasitology, sixth ed. Elsevier, Mosby, image #1TF235.)

especially if the patient is ≤2 years old. After the initial infection, widespread dissemination of *T. cruzi* occurs; this is followed by lifelong infection. Incubation periods of 20-60 days have been observed in transfusion recipients. In most instances, acute symptoms resolve within 4-8 weeks. The host then enters the chronic phase of infection.

Chronic Disease

Most chronically infected individuals are asymptomatic and will remain asymptomatic for their lives. These patients have so-called indeterminate infection characterized by a positive serology, normal electrocardiogram and chest radiograph, and the absence of gastrointestinal symptoms. Despite a lack of symptoms, persons with chronic infection have a low level of circulating parasites. Parasitemia can be detected in ~50% of patients using polymerase chain reaction or the technique of xenodiagnosis (i.e., allowing laboratory-reared reduviids to feed on subjects' blood and monitoring the reduviids for *T. cruzi* infection). Conversion from asymptomatic to symptomatic disease occurs at a rate of ~2% per year. By the fourth decade of life, 20-30% of chronically infected individuals have progressed to symptomatic disease.

Symptomatic chronic Chagas disease is characterized by cardiac, gastrointestinal, and neurologic disorders. Cardiac problems include conduction system disturbances (high-degree heart block or arrhythmias), progressive dilated cardiomyopathy with congestive heart failure, and thromboembolic events. The most common digestive syndromes include megaesophagus, with symptoms similar to idiopathic achalasia, and megacolon, which causes bloating, constipation, and abdominal pain. Co-existence of cardiac and gastrointestinal symptoms can occur in the same patients. Neurologic symptoms of the central, peripheral, and autonomic nervous systems have been described in chronic Chagas disease, but these are rare and not well studied.

Theories of the pathogenesis of Chagas disease have evolved in recent decades. Due to the paucity of parasites observed by microscopy in affected tissues, it was long believed that autoimmune mechanisms drove the pathological response. This view contributed to the perceived lack of value in providing etiologic treatment for *T. cruzi* infection. However, in recent decades more sensitive laboratory methods such as polymerase chain reaction (PCR) convincingly demonstrate that *T. cruzi* are in fact present in involved tissues. These parasites are thought to drive the inflammatory response responsible for tissue damage. Consequently, antiparasitic treatment is now viewed to be important in managing patients, particularly before end-stage organ disease has manifested. As will be discussed below, ideal anti-*T. cruzi* chemotherapeutics have unfortunately not been developed.

Table 26.2 summarizes the salient clinical features of each of the three principal manifestations of chronic infection ("indeterminate," cardiac, and gastrointestinal).

Host factors alone may not entirely explain the striking regional differences in disease manifestations that occur throughout Latin America. Areas in northern Brazil have cardiac disease two to three times more commonly than intestinal disease, whereas in Argentina, Chile, and some parts of Bolivia, gastrointestinal megasyndromes predominate. These geographic differences may be due in part to differences among strains of the parasite rather than to host factors.

Chronic *T. cruzi* Infection in Immunosuppressed Patients

T. cruzi-infected patients who become immunocompromised may experience a reactivation of the infection, characterized by high levels of parasitemia and by increased intracellular parasite replication. The incidence is unknown, but reactivation occurs more often with the use of highly immunosuppressive regimens. It also occurs in a subset of patients co-infected with human immunodeficiency virus (HIV). Clinical features of reactivated Chagas disease depend on the underlying type of immunosuppression (i.e., the manifestations in transplant patients differ from those in patients with acquired immunodeficiency syndrome). In bone marrow or solid organ transplant recipients, subcutaneous nodules containing large numbers of parasites, inflammatory panniculitis, and myocarditis are frequent manifestations of

TABLE 26.2 Clinical Features of Chronic Chagas Disease

- Indeterminate[a]
  - Applies to 50-80% of chronically infected people
  - Begins 8 weeks post-infection and lasts decades, if not for life
  - Serologic tests for *T. cruzi* are positive
  - Sensitive methods of parasite detection (e.g., PCR or xenodiagnosis) demonstrate low levels of circulating *T. cruzi*
  - Physical examination, EKG, and chest radiograph studies are normal
  - Patients are asymptomatic and capable of normal activity
  - As many as one-third of this population may have minor abnormal findings in echocardiographic or autonomic testing
  - Patients are often unaware of infection and serve as reservoirs
- Cardiac[b]
  - Most frequent symptoms are palpitations, dizziness, syncope, dyspnea, edema, and chest pain
  - Arrhythmias of many varieties are a hallmark of chronic chagasic heart disease
  - Multifocal PVCs are commonly seen early in the course
  - Sick sinus syndrome and sinoatrial block also occur frequently
  - Right bundle branch block with left anterior hemiblock is the classic and most common conduction abnormality
  - Complete heart block requiring mechanical pacing is not uncommon
  - Sudden death is not rare and is usually due to ventricular fibrillation
  - Cardiomegaly is common and causes regurgitant systolic murmurs
  - Congestive heart failure is due to chronic inflammatory changes in the myocardium, not coronary artery disease
  - Apical left ventricular aneurysms are seen frequently at autopsy; they predispose patients to arterial embolization
  - Pancarditis is seen on histopathology
- Gastrointestinal syndromes[c]
  - Most commonly affected segments are the esophagus and rectosigmoid colon
  - Pathologic inflammatory lesions are found in Auerbach plexus, which is responsible for the autonomic coordination of peristalsis
  - Esophageal dysmotility may result in progressive dilation of the lumen
  - Patients experience variable degrees of dysphagia and regurgitation
  - In the extreme form of esophageal disease, radiographic evaluation shows megaesophagus, contraction abnormalities, and distal esophageal stricture
  - Colonic dysmotility is manifest initially by constipation
  - Progressive obstipation leads to dilated megacolon, fecaloma, and severe abdominal pain
  - Volvulus may occur

[a]Disease state is labeled indeterminate because it is unclear when, or if, patients will develop symptomatic Chagas disease.
[b]Consider chagasic heart disease in a young patient from an endemic area (or who has a history of blood transfusion) who presents with unexplained cardiomyopathy, EKG abnormalities, or arterial emboli.
[c]Consider Chagas disease in any patient from an endemic area who presents with megaesophagus or megacolon.
EKG, Electrocardiogram; *PCR,* polymerase chain reaction; *PVC,* premature ventricular contraction.

reactivation, and central nervous system involvement is uncommon. However, in patients co-infected with HIV who have low $CD4^+$ lymphocyte counts, the clinical picture most often includes meningoencephalitis and space-occupying central nervous system lesions that can resemble those of toxoplasmosis. Reactivation in HIV-infected patients can also cause acute myocarditis.

DIAGNOSIS

The vast majority of diagnoses for Chagas disease are made during the chronic phase in patients with appropriate epidemiological risk factors. Serology is the most import tool for establishing chronic infection. During acute infection or in immune-compromised patients with reactivation, direct parasite detection methods become important.

Serologic Detection Methods

Antibodies appear during the acute phase and generally persist for life. The most widely used serological tests are immunofluorescent antibody detection (IFA), hemagglutination, and enzyme-linked immunoassay (ELISA). Antigens from epimastigote lysates or recombinant proteins are used for detecting *T. cruzi* antibodies (usually IgG antibodies, except when using IFA, which can distinguish between IgG and IgM). Sensitivity for these tests in reliable laboratories with standardized reagents and careful quality-control practices is on the order of 98%. False-positive results can occur with sera from patients with leishmaniasis (a co-endemic infection in many areas of Latin America) or *Trypanosoma rangeli*, an animal trypanosome nonpathogenic to humans. Because of variable test specificity, most authorities recommend performing at least two different types of serologic tests based on different antigens (e.g., whole parasite lysate and recombinant antigens) or principles (e.g., IFA and ELISA) per patient.

The Parasitic Diseases Division of the Centers for Disease Control and Prevention (CDC) (404-718-4745; email chagas@cdc.gov) is available for consultation regarding the diagnosis and therapy of Chagas disease.

Parasite Detection Methods

During the acute phase, one may culture *T. cruzi* from the blood or see circulating trypomastigote forms on direct examination of the blood. Although they can be seen on Giemsa-stained specimens either by thin or thick smear (sensitivity 60-70%), superior methods of detection are microscopic examination of peripheral blood buffy coat wet preparations, culture, or PCR, all of which have a detection rate of 90-100% in the acute phase.

Blood Cultures

Centrifugation blood culture in liver infusion tryptase or brain–heart infusion medium can detect parasites in about 30% of chronically infected patients. Cultures can be repeated serially to increase yield, although time to positivity can take weeks.

Polymerase Chain Reaction

Detection of *T.* cruzi DNA in blood can now be achieved using PCR. DNA is extracted after whole blood lysis by using various techniques; unique *T. cruzi* gene fragments are then amplified in a thermocycler. PCR-based methods have a high sensitivity when used for diagnosis of acute infection or for monitoring reactivated disease. However, the performance of PCR for patients with chronic Chagas disease is variable, and it is used primarily as a research tool.

EVALUATION AND TREATMENT

Evaluation

Patients newly diagnosed with chronic Chagas disease should have a complete medical history recorded, physical examination, and a resting 12-lead electrocardiogram with a 30-second lead II rhythm strip. If the initial evaluation is normal, it should be repeated annually. Patients with symptoms or signs suggestive of Chagas heart disease should receive a complete cardiac evaluation, including 2D echocardiogram, 24-hour ambulatory EKG monitoring, and exercise testing. Barium studies should be performed for patients with gastrointestinal symptoms.

Antitrypanosomal Agents

Antitrypanosomal treatment is strongly recommended for all cases of acute, congenital, and reactivation infection, as well as for all children with infection and patients up to 18 years of age with chronic disease. Antitrypanosomal drugs should generally be offered to adults aged 19-50 without advanced heart disease; it is optional for those >50 years of age, because the benefit has not been proven in this group. Nonrandomized clinical trials in patients with chronic Chagas disease show slowed progression of cardiac disease in patients receiving etiological therapy. However, the drugs are usually not provided to patients with advanced symptoms of Chagas disease (cardiac or gastrointestinal) due to poor tolerability and ineffectiveness. The current drugs (benznidazole and nifurtimox) are contraindicated in pregnancy, although strong consideration should be given to treatment of reproductive-age women, because this may reduce the risk of congenital transmission. The drugs are also contraindicated in patients with severe renal or hepatic dysfunction. Treatment should also be considered for patients who have not been previously treated and who anticipate future immunosuppression. Antitrypanosomal therapy of reactivated disease in immunosuppressed patients results in improvement of symptoms and a decrease in the intensity of parasitemia. The need for secondary prophylaxis in these patients has not been established.

Two antiparasitic drugs, benznidazole (Rochagan) and nifurtimox (Lampit) have proven efficacy in Chagas disease. Unfortunately, these trypanocidal agents carry the risk of serious toxicity and should be used only if clearly indicated. Benznidazole is usually regarded as the first-line agent, because it is slightly better tolerated than nifurtimox. Neither drug is currently licensed in the United States; however, both drugs are available from the CDC for use under investigational protocols (see http://www.cdc.gov/parasites/chagas/health_professionals/tx.html).

Table 26.3 provides a summary of these medications and precautions associated with their use. Alternative therapy with posaconazole, itraconazole, or allopurinol has not been shown to be efficacious in humans.

Proving parasitological cure after treatment is a challenge due to the localization of parasites in tissues and difficulty detecting low levels of circulating parasites. Negative seroconversion using conventional assays may take years to occur after successful treatment. The

TABLE 26.3 Chemotherapy for Acute Chagas Disease

Drug	Dosage	Adverse Effects
Benznidazole (preferred due to shorter duration and fewer side effects)	Adults 5-7 mg/kg per day p.o. divided b.i.d. × 60 days Children 5-10 mg/kg per day p.o. divided b.i.d. × 60 days	1. Photosensitive rash: 30% 2. Peripheral neuropathy: 30% 3. Anorexia and weight loss 4. Hematologic abnormalities (bone marrow suppression): rare
Nifurtimox	Adults 8-10 mg/kg per day p.o. divided t.i.d. or q.i.d. × 90 days Children (11-16 years): 12.5-15 mg/kg per day p.o. divided t.i.d. or q.i.d. × 90 days ≤10 years: 15-20 mg/kg per day p.o. divided t.i.d. or q.i.d. × 90-120 days	1. Anorexia and weight loss: 50% 2. Polyneuropathy 3. Tremors and excitation 4. Insomnia 5. Nausea/vomiting 6. Myalgia

b.i.d., Twice per day; *p.o.,* by mouth; *q.i.d.,* four times per day; *t.i.d.,* three times per day.

interval between treatment and negative seroconversion appears to be related to the duration of infection (up to 5 years for acute infection, up to 10 years for <10 years' duration of infection, and up to 20 years in patients with duration >10 years). PCR-based techniques are useful for monitoring for treatment failure after therapy of acute disease but are of limited utility for patients treated for chronic *T. cruzi* infection.

Symptomatic Treatment

Therapeutic approaches are dictated by the type and severity of end-organ damage. Patients with Chagas heart disease may benefit from the use of angiotensin-converting enzyme inhibitors, amiodarone, pacemaker placement, or intracardiac defibrillator implantation. Patients who undergo heart transplantation for Chagas disease have survival rates equal to or greater than patients transplanted for idiopathic dilated cardiomyopathy. Megaesophagus can be managed by non-invasive dilation or by surgical intervention to remove strictured regions. Megacolon should be surgically treated by resection of the dilated segment before fecaloma or vascular complications occur. Recurrences of gastrointestinal megasyndromes that require multiple surgeries are known to occur.

PROGNOSIS

The overall prognosis of patients with chronic Chagas disease is fairly good: 70% or more will remain in the seropositive but asymptomatic indeterminate phase, and the survival of these individuals is the same as the general population. Symptomatic chronic Chagas disease carries a variable prognosis depending on severity of end-organ damage. Ventricular conduction defects (typically right bundle branch block or left anterior fascicular block) are early manifestations of Chagas heart disease that develop years before the onset of symptoms and are associated with increased mortality risk. Predictors of increased mortality risk among patients with symptomatic disease include congestive heart failure (NYHA class III or IV), cardiomegaly, ventricular systolic dysfunction on echocardiography, nonsustained ventricular tachycardia on 24-hour ambulatory monitoring, low QRS voltage, and male sex. Patients in the highest risk group for these factors have only about a 15% 10-year survival rate. Digestive syndromes are better tolerated and tend to progress slowly over decades. It is difficult to know the morbidity and mortality directly attributable to Chagas disease, but overall life expectancy in endemic areas is estimated to be 9 years less than in non-endemic areas.

PREVENTION

For Persons Living in Endemic Areas

Prevention strategies in endemic areas are a major priority of the WHO, the Pan American Health Organization, and the health ministries of many Latin American countries. In the absence of vaccines and fully effective therapies, control focuses on surveillance and vector control. Several approaches to control are used: (1) blood bank screening to eliminate transfusion-related transmission, (2) insecticide spraying to eradicate domiciliated triatomine bugs, and (3) housing improvements to minimize contact between the insect vector and human hosts.

For Persons Traveling to Endemic Areas

For the traveler to Latin America, protecting oneself against *T. cruzi* infection is largely a matter of educational awareness; there are no prophylactic medications or vaccines available. Travelers should be encouraged to become familiar with pictures of the triatomine bug before departure. However, the typical traveler is at low risk for infection. It is estimated that risk of infection by one encounter with a reduviid bug is only 1 in 1000. In 25 years of CDC surveillance, there have been no cases of acute Chagas disease in US travelers to endemic areas. Preventive measures include the following:

1. Be aware of the risk of transmission in each of the endemic areas.
2. Be familiar with the regional names and appearance of triatomine (reduviid) bugs.

3. Avoid overnight stays in poor-quality housing constructed of adobe brick, mud, or thatch. The insects typically infest cracks and roofing and feed at night.
4. If overnight stays in high-risk areas are unavoidable, spraying infested dwellings with residual-action insecticide and sleeping under an insecticide-treated bed net may offer some protection.
5. Be aware that blood products may not always be screened routinely for Chagas disease.
6. Seek medical attention as early as possible if signs or symptoms of acute Chagas disease occur. Antitrypanosomal therapy is most effective in the early stages of Chagas infection.

The findings and conclusions in this chapter are those of the authors and do not necessarily represent the views of the Centers for Disease Control and Prevention.

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