



MISCONCEPTIONS AND LIMITED AWARENESS OF CHAGAS DISEASE IN TEXAS AMONG SURVEYED HOUSTON PHYSICIANS

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“Misconceptions and Limited Awareness of Chagas Disease in Texas Among Surveyed Houston Physicians”

Abstract

Chagas disease impacts approximately 6–7 million people worldwide. It is caused by the *Trypanosoma cruzi* (*T. cruzi*) parasite that is transmitted by the triatomine bug. In Texas, cases of *T. cruzi* infection have been documented as early as the 1930s. More recently, evidence of autochthonous transmission and infection in human and canine populations has led experts to believe that the disease is prevalent in the region. The disease progresses from an acute phase—which has symptoms that are difficult to diagnose or can be asymptomatic—to a chronic disease, with significant cardiac and esophageal complications that can result in death. Currently, Chagas is only treatable in the acute phase or early chronic phase, which makes prompt diagnosis important. In this exploratory study, 16 emergency room physicians, pediatricians, and general practitioners in the Texas Medical Center in Houston, Texas, were interviewed to gauge their awareness of Chagas disease in Texas and assess their knowledge of the symptoms, transmission, and prevention of the disease. Responses indicated that the physicians interviewed were unaware of the specifics and the local burden of Chagas disease. Those who were able to provide details about the vector (triatomine bug) or pathogen (*T. cruzi*) made associations with only a few aspects of the disease, such as the chronic symptom of cardiomyopathy or the fact that triatomine bugs hide in thatched roofs. The physicians did not recognize that Chagas can be found and locally transmitted in Texas. Based upon these preliminary findings, there may be a similar lack of awareness of the disease within the greater population of Houston-based physicians. These findings suggest a need for increased physicians' education and awareness of Chagas—particularly in regions like Texas, where the triatomine bug and *T. cruzi* are present—in order to improve accurate diagnosis and timely treatment of patients.

Introduction

A group of communicable diseases prevalent in tropical and subtropical climates termed “neglected tropical diseases” (NTDs) affects over a billion people worldwide (World Health Organization 2017b). NTDs are particularly a problem among impoverished populations that lack sanitation infrastructure and live in close proximity to animal and insect disease vectors (World Health Organization 2017b). While NTDs impact a large number of people and affect their quality of life, because they tend to have lower mortality rates they receive less investment than other infectious diseases such as HIV/AIDS, malaria, and tuberculosis (Moran 2011). One such NTD is Chagas disease.

Chagas disease, also called American trypanosomiasis, affects about 6–7 million people worldwide, with an estimated 28,000 new cases in the Americas each year (Vos et al. 2016; Pan American Health Organization 2017). The vector of transmission is the triatomine bug, also known as the reduviid or kissing bug, which carries the *Trypanosoma cruzi* (*T. cruzi*) parasite (Rozendaal 1997) (see Figure 1). Triatomine bugs take blood meals from humans and animals including dogs, woodrats, and armadillos (Bern 2015). The bug typically bites humans around the face, leaving parasite-containing feces behind (Rozendaal 1997). When the person touches or scratches the site of the bite, *T. cruzi* is introduced into the open

wound or into the eye and subsequently into the bloodstream (Rozendaal 1997). In addition, *T. cruzi* can be transmitted via organ transplants, blood transfusions, and contaminated food, or passed from mother to child during pregnancy—a condition known as congenital Chagas disease (Hotez et al. 2013).

Figure 1. Kissing Bug and *T. cruzi* Parasite in Blood



Source: Centers for Disease Control and Prevention (CDC)

Triatomine bugs are commonly found outdoors under cement and beneath porches, in piles of brush or mulch, and in outdoor garages, barns, tents, and dog houses and kennels (Curtis-Robles et al. 2015). Indoors, triatomine bugs can hide in crevices between bricks and in thatched roofs (Rozendaal 1997). Certain animals, including domestic dogs, can also act as reservoirs for the *T. cruzi* parasite (Bern 2015). There is an established relationship between poverty and the transmission of Chagas disease, as poor-quality housing harbors triatomine bugs, and impoverished populations have less access to health education and health care (Hotez et al. 2013).

There are two symptomatic phases in the presentation of Chagas: acute and chronic. The acute phase occurs for the first few weeks or months after infection. It can be asymptomatic or have nonspecific flu-like symptoms including fever, headache, enlarged lymph glands, loss of appetite, and muscle pain (Centers for Disease Control and Prevention 2017; World Health Organization 2017a). Additional symptoms include difficulty breathing, swelling, abdominal or chest pain, skin lesions, and facial edema, or a swelling of the eyelid known as Romaña's sign (World Health Organization 2017a). Approximately 20–30 percent of people infected with *T. cruzi* will have an intermediate stage where, they are asymptomatic but still harbor the parasite, and later progress to chronic Chagas disease (Bern et al. 2011). In the chronic phase, *T. cruzi* parasites primarily localize in the heart and digestive muscles, causing cardiac, digestive, and, in some cases, neurological complications (World Health Organization 2017a). Consequently, Chagas can cause heart failure and sudden death (World Health Organization 2017a).

Existing antiparasitic drugs are more effective during the acute or early chronic phase. During the later chronic phase, when a patient has Chagas-associated heart disease, direct treatments have questionable benefits (Centers for Disease Control and Prevention 2017). At this point, treatment is usually provided for symptoms only. A trial comparing the drug trypanocide benznidazole to a placebo in patients with Chagas-associated cardiomyopathy demonstrated a significantly decreased serum parasite burden but had no significant effect on cardiac deterioration (Morillo et al. 2015). For this reason, early diagnosis is important. Currently, a Chagas diagnosis is typically made based on the presentation of clinical symptoms and the subsequent microscopic examination of a blood smear for parasites. However, this method of diagnosis is effective only in the acute phase, when parasites can be found circulating in the bloodstream. Serologic testing can be used to diagnose chronic Chagas, but multiple tests are required to achieve sufficient sensitivity and specificity for diagnosis (Centers for Disease Control and Prevention 2017).

While Chagas has historically been prevalent predominantly in Latin America, it is now found further north in the United States. One analysis estimates that more than 238,000 people in the United States had been infected as of 2012, with the leading number of cases in California (70,860) and Texas (36,977) (Manne-Goehler et al. 2015; Manne-Goehler et al. 2016). Additional studies conducted in Texas have also identified a significant level of autochthonous transmission of Chagas disease (Garcia, Woc-Colburn, et al. 2015; Garcia et al. 2016; Garcia et al. 2017; Gunter et al. 2017; Harris et al. 2017). In the Texas-Mexico border region, one study found 8 percent of coyotes and 4 percent of dogs in shelters were infected with *T. cruzi*. Furthermore, 0.4 percent of humans randomly studied (3 patients out of 841 tested) were positive for *T. cruzi* in a population of 1.3 million. A second survey of the same general region found that 20 percent of dogs and 1.3 percent of humans (223 tested) had the parasite (Curtis-Robles et al. 2017). Scientists are unable to determine if this is an increase in incidence or of effective identification of the parasite in the population. Neither the triatomine bug nor the *T. cruzi* parasite is new to Texas. The first documented cases of triatomine home infestations in Texas were recorded in the 1930s, when local residents were interviewed and triatomine bugs were tested for the *T. cruzi* parasite (Garcia, Woc-Colburn, et al. 2015).

Chagas became a reportable disease in Texas starting in 2013 (Texas Department of State Health Services 2018). Furthermore, recognizing the need for increased surveillance of NTDs, including Chagas, the 2015 Texas legislature passed House Bill 2055 to establish a data system for patients and develop physician education materials for these diseases (Davis and Schwertner 2015). However, the success of this legislation is predicated upon physicians being able to recognize symptoms and report presenting patients in order to collect epidemiological data.

Because of the consequences of untreated Chagas disease and its suspected prevalence in Texas, it is important for clinicians to be able to diagnose and treat this disease. A 2010 opt-in survey conducted by MedscapeCME found that 23 percent of cardiologists (n=280), 19 percent of infectious disease specialists (n=167), 47 percent of obstetricians and gynecologists (n=292), and 14 percent of primary care physicians (n=278) who responded

had never heard of Chagas disease (Stimpert and Montgomery 2010). A separate survey conducted by the American College of Obstetricians and Gynecologists found that 77 percent of respondents (n=421) described their knowledge of Chagas disease as “very limited” or “never heard of it” (Verani et al. 2010). If some of these doctors are expected to be the ones diagnosing and reporting Chagas disease, this lack of familiarity has long-term implications both for reporting statistics as well as for the treatment of this disease at its earliest stage. This is a concern because the prompt recognition of symptoms during the acute phase is critical to effectively deliver antiparasitic treatment in order to prevent disease progression.

In this exploratory study, we conducted a series of semi-structured interviews with 16 physicians from the Texas Medical Center (TMC) in Houston, Texas. Data obtained from the interviews will be used to develop targeted education materials, as well as to guide larger qualitative and quantitative studies of physicians in the state.

Respondents were asked questions to assess their knowledge related to the symptoms, transmission, and prevention of several NTDs, including Chagas disease, as well as their educational background on the topic. The goal was to determine the physicians’ awareness and knowledge of Chagas and how frequently they encountered infected patients in their practice, in addition to gaining insight on how information on Chagas and other NTDs should be disseminated to physicians.

Our findings indicated that the physicians interviewed were generally unaware of the specifics of Chagas disease and of the disease burden in Texas. Respondents mainly associated Chagas with international travel to regions where “thatched roofs” are common and missed the connection to local disease prevalence. This lack of awareness could mean that adequate surveillance of the disease burden in the state may be at risk.

Methods

The aim of this study was to gain preliminary data on the surveyed physicians’ awareness of Chagas disease in the Houston, Texas, area and assess their knowledge of the symptoms, transmission, and prevention of the disease. The physicians chosen as the study group were all from the TMC because of its large, diverse patient population and access to NTD materials, as well as because NTDs were previously identified in the area. A retrospective study of Houston’s Texas Children’s Hospital patients from 2004–2013 identified 43 pediatric patients treated for NTDs, including one for autochthonous Chagas disease (Sweet and Palazzi 2015). Another study based on a survey of homeless individuals in the Houston area (shown pictures of triatomines) found that one-third of survey participants reported seeing this vector for the *T. cruzi* parasite, in Houston—although the study did not test for the presence of the pathogen or of Chagas disease (Ingber et al. 2018). A third publication reported data from five patients from the Houston area with autochthonous Chagas infection, only one of whom had received the antiparasitic treatment benznidazole, while the other patients’ physicians either deferred treatment—stating they were asymptomatic—or suggested the result was a “false positive” (Garcia, Aguilar et al. 2015).

Furthermore, the TMC provides care for 10 million patient encounters each year from around the world. It is also home to the Baylor College of Medicine National School of Tropical Medicine, which hosts lectures, offers continued education programs and certificates on NTDs, and has established a Tropical Medicine Clinic at Ben Taub Hospital (Baylor College of Medicine 2018b). The National School of Tropical Medicine also collaborates with legislators and public policy organizations, including Rice University's Baker Institute for Public Policy and Texas A&M University's Bush School of Government and Public Service (Baylor College of Medicine 2018b). Consequently, given such vast resources, TMC clinicians should have greater than average access to information on Chagas disease (Texas Medical Center: Facts and Figures 2017). The gaps in knowledge are likely to be more substantial in physicians without an association to a medical school or academic research institution.

The TMC is located in Houston, the fourth most populous city in the United States with a population of approximately 2.3 million (The City of Houston: Demographic Data 2017). Notably, Houston has a climate hospitable to NTDs and pockets of poverty, which have an established link to NTD transmission (Hotez et al. 2013). Several cases of Chagas disease transmission have already been reported in the area, with indications that the total number is under-reported (Ingber et al. 2018; Garcia et al. 2017; Harris et al. 2017; Garcia, Aguilar et al. 2015; Sweet and Palazzi 2015).

Using convenience sampling with data obtained from the websites of TMC member institutions, emergency room physicians, pediatricians, and general practitioners were contacted via email and invited to participate in an in-person interview. These types of physicians were selected because they would be most likely to see patients with acute symptoms of Chagas disease. Semi-structured interviews were chosen as the means for data collection instead of a survey to allow for more discussion and to make the physicians feel more comfortable if they had limited knowledge. For each interview, an interview guide was used that included questions about the participant's background, current practice, and knowledge of Chagas disease (see Box 1). This guide was developed to make the questions appear less like a test and be more conversational, so that respondents would be less defensive about any gaps in knowledge they might have and would offer insights into whether they thought the information was vital to their performance as physicians.

One hundred and eighteen physicians were initially contacted via email from September to November 2015 to participate in this study. Approximately half of the physicians contacted were no longer at the TMC or were incorrectly identified as an emergency room physician, pediatrician, or general practitioner. Sixteen participants were individually interviewed, and no repeat interviews were conducted. The small sample size was due to time and funding restrictions.

Box 1: Interview Guide Questions

1. What is your job title?
 2. How old are you?
 3. How would you describe your ethnicity?
 4. What year did you graduate from medical school? Where did you attend medical school?
 - a. How about your residency, where was it located?
 - b. And your fellowship training, where was it located?
 5. As an estimate, how many patients would you say that you see daily?
 - a. What percentage of your patients are on Medicaid or do not have health insurance?
 - b. What percentage of your patients are ethnic minorities (non-white)?
 6. Have you spent time practicing medicine abroad? Where and when?
 7. Are you familiar with Chagas disease? Have you heard of it before?
 - a. Was Chagas covered in your medical training?
 - b. How much exposure to Chagas have you had in your career, if any?
 8. Have you ever had a patient with Chagas disease or that you suspected had Chagas disease?
 - a. [If yes] what symptoms did they present?
 - i. How many such patients have you seen?
 - ii. Have you ever diagnosed Chagas disease?
 - b. [If no] would you feel comfortable enough to identify the symptoms?
 - i. What are the most common?
 9. If I was a patient you suspected had Chagas disease,
 - a. How would you explain the disease transmission (vector and source)?
 - b. How would you describe the progression of the disease?
 - c. How would you treat the disease?
 - d. What steps would you recommend to help prevent transmission of Chagas disease?
 10. Some people have suggested that we include more details in medical education or in continuing education? How do you feel about this idea?
 11. Is there anything else you would like to add that you think I missed?
-

Participants were informed that the purpose of the research was to study physician awareness of lesser-known diseases in Houston and signed informed consent documents agreeing to participate in the project. Interviews were conducted by Kirstin Matthews, Ph.D., fellow in science and technology policy, and a postdoctoral fellow from Rice University's Baker Institute for Public Policy. The interviews were conducted in the participant's office, at a public location, or over the phone. Each of the interviews was audio recorded with the respondent's permission and transcribed. Following each interview, the interviewer also wrote context notes, which included perceptions of the interview

environment, the respondent’s interest and mannerisms, and overall impressions that were not necessarily captured in the audio recording. Both the transcription and context notes were used as data for this study.

Results and Discussion

Respondent Demographics and Medical Training

The length of the interview sessions ranged from 11 to 45 minutes, with the average being 23 minutes. Differences in the length of the interviews were related to the ability of the respondents to identify the pathogen, symptoms, and treatments. Interview responses from transcripts were compiled and coded by Melody Tan for general themes, which were derived from the data.

The average age of the respondent was 48, with the ages ranging from 34 to 73 years old (Table 1). They were a mix of male and female respondents and their primary roles were a mix of clinical care, teaching, and administrative positions. The location where the interviewees were trained was noted, with 11 of the 16 respondents having completed some portion of their medical training in Texas (Table 1). Six of the 16 physicians interviewed practiced medicine abroad, which includes both short-term trips and long-term placements. These placements were in countries in Central and South America, Sub-Saharan Africa, South Asia, Eastern Europe, and the Middle East.

Table 1. Demographics of Physician Respondents

Characteristic	# Respondents
Age	
30-34 years	8
45-59 years	4
60+ years	4
Gender	
Male	10
Female	6
Department*	
Emergency medicine	9
Pediatrics	12
Internal medicine	2
Infectious disease	2
Other	3
Training in Texas	
Medical school	7
Residency	9
Fellowship	7**
Any portion of training	11

*Includes training and current role; total adds up to more than 16 because respondent could be classified under multiple departments.

**Only 12 of the 16 respondents did a fellowship.

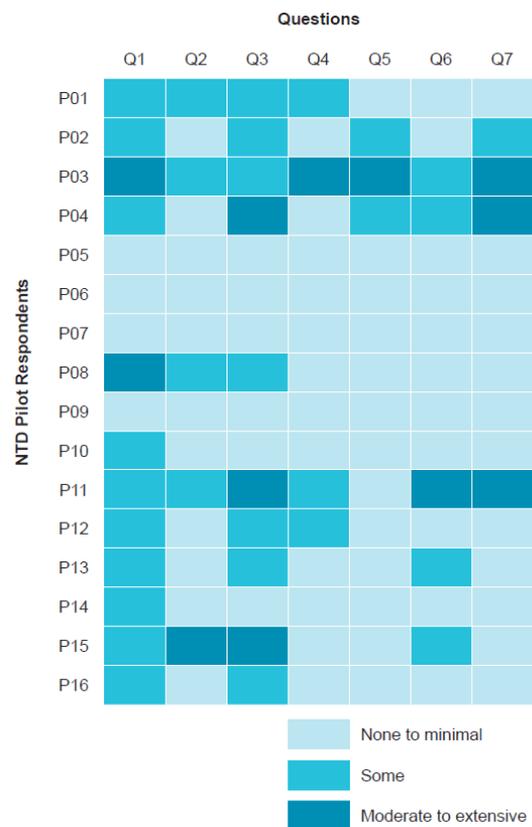
Analysis of Interview Data

For questions that tested the physicians’ knowledge of general information regarding Chagas (questions 7–9 listed in Box 1), responses were coded by the level of detail and accuracy of information provided (Figure 2). Inaccurate responses such as, “must be mosquito-borne,” (NTD-P09) or responses lacking detail such as, “I really don’t remember much about Chagas disease; I’d have to look it up” (NTD-P14) were coded as “none to minimal.” Responses that included basic information and details, as well as hesitant responses,

were coded as “some.” Example responses within this classification are statements such as, “I kind of remember it involves endocarditis, esophageal dysmotility. I’m thinking back to my little book, but I have to go back to med school to remember the presentation ... I think it’d cross my mind now if someone came in with heart failure” (NTD-P01), and “I know you can have cardiac complications from it because of the parasite infection that’s transmitted by a certain type of fly, I forgot which one” (NTD-P02). To be coded as “moderate to extensive,” responses had to provide accurate and specific information—for instance, recognizing the symptoms of “nausea, vomiting, fever, fatigue ... heart block” (NTD-P15) and “achalasia and ventricular aneurysms” (NTD-P11).

Figure 2. Physician Levels of Familiarity with Chagas Disease.

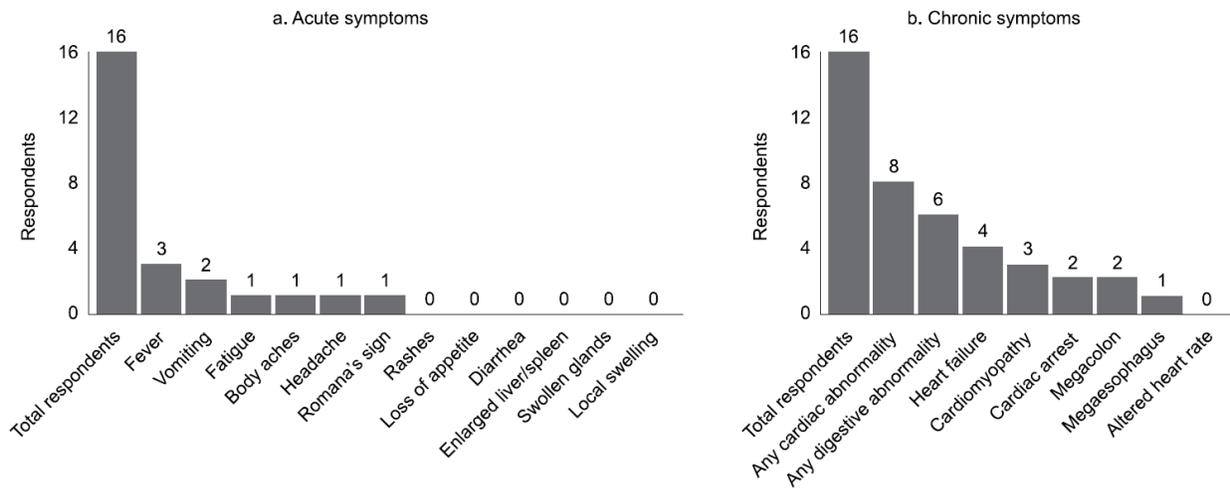
Physicians were questioned about their familiarity and awareness of Chagas disease. They were asked to describe:
 Q1) their medical training related to Chagas;
 Q2) their exposure to patients with Chagas;
 Q3) common symptoms of the disease;
 Q4) the disease transmission;
 Q5) the disease progression;
 Q6) treatments for Chagas; and
 Q7) Chagas prevention. Responses were coded as one of three categories: “none or minimal,” “some,” or “moderate to extensive.”



Knowledge of Symptoms and Progression

Overall, physicians were more successful at correctly identifying symptoms of chronic Chagas disease than of the acute stage of the disease (Figures 2 and 3). At best, recall of the acute symptoms was vague. This gap of knowledge is particularly concerning since effective current treatments for Chagas are best administered during the acute phase. One respondent with more extensive knowledge mentioned briefly, “Acute Chagas is flu-like symptoms. Chronic is achalasia, ventricular aneurysms” (NTD-P11). Another participant categorized as having “some” knowledge suggested, “Most of the [symptoms] I’ve heard of are the long-term sequelae. It can cause heart issues ... But in the short term, I don’t know off the top of my head” (NTD-P13). Another, defined as having “minimal to no” knowledge, asked, “It’s disfiguring, or is that not the one?” before realizing he had confused Chagas symptoms with those of elephantiasis, another NTD (NTD-P09).

Figure 3. Physician Awareness of Chagas Symptoms. Of the 16 physicians interviewed, only a few respondents accurately identified: a) acute and b) chronic symptoms of Chagas.



More of the physicians interviewed were able to recall chronic symptoms. These physicians tended to associate general cardiac and digestive abnormalities with Chagas disease. For example, a respondent noted, “Chagas has some cardiac components. I have not treated Chagas so I am not as familiar with it” (NTD-P12). A smaller number of respondents were able to name the specific symptoms. One mentioned, “The two manifestations that are most common are cardiac myopathy and congestive heart failure symptoms and dilated megacolon” (NTD-P04).

While it is important for physicians to have knowledge of chronic symptoms so that they can provide patients with supportive care as needed, being able to recognize Chagas during the acute phase is especially critical for the delivery of curative treatment or prompt referral to a specialist. The recognition of symptoms in the acute phase could be complicated by the fact that many of these symptoms—such as fever, vomiting, fatigue, and aches—are nonspecific and are also symptoms of a variety of conditions apart from Chagas.

Only a few physicians accurately described disease progression (Figure 2). The majority responded that they did not know or did not remember the specifics. A few other participants were minimally aware of the progression, with one stating the progression as being, “All the way from nothing to chronic Chagas and death” (NTD-P11). Another respondent was somewhat more descriptive, but still uncertain: “The parasite can be in your body for a long period of time before you get the complications, but I don’t know what the time course of that is commonly expected to be” (NTD-P02). One physician with more extensive knowledge identified Romaña’s sign, an early symptom involving swelling of the eyelid: “Usually it starts out with the Romaña’s sign with the eye swelling and then later on they can have the esophageal dilation or heart failure” (NTD-P03). Another physician also made the connection, guessing, “Is that the one where you get swollen

eyelids?” (NTD-P04). Overall, the physicians interviewed had limited knowledge of disease progression between the presentation of acute and chronic symptoms, which highlights a gap during which it is unlikely a patient would be diagnosed.

Knowledge of Transmission

Knowledge of transmission is important in identifying susceptibility, as well as determining appropriate prevention measures. Of the physicians interviewed, four correctly identified that Chagas disease is caused by a parasite, although only two identified *T. cruzi* by name (Figure 2). Two others believed Chagas to be a virus. Three physicians correctly identified the vector of transmission as the triatomine bug. One of the physicians with more minimal knowledge of Chagas identified it as an arbovirus and asked, “Is it mosquito-transmitted as well?” (NTD-P13), while another stated, “It’s a parasite transmitted by an insect that’s not a mosquito” (NTD-P02).

Several physicians incorrectly attributed Chagas transmission to other vectors or misidentified it with another NTD. One physician’s account seemed to partially confuse Chagas with Lyme disease: “It is a parasite but I forgot what insect carries that; it is a tick bite I think” (NTD-P15). Other respondents described some of the less common methods of Chagas transmission: “I think the classic board question was someone is in Peru and was eating raw meat, and now has some cardiac thing” (NTD-P12). Another with more extensive knowledge mentioned that, in addition to the triatomine bite, “people get it from organ donations, blood transfusions” (NTD-P03). Indeed, there are now recommendations that blood donations be screened for Chagas disease (Centers for Disease Control and Prevention 2017).

Knowledge of Prevention

Two physicians with more extensive knowledge of Chagas prevention correctly associated “thatched roofs” with Chagas and recommended that one “avoid bugs, get a better house, don’t go out at night ... because at least in the rural areas it’s the thatched houses that don’t have the good concrete walls that the bugs live in” (NTD-P03) (Figure 2f). Another said, “If you have thatched roofs, you are going to have these bugs. Having concrete structures definitely decreases your risk of exposure” (NTD-P04). This is accurate, as thatched roofs are common hiding places for triatomine bugs. However, these perceptions could lead to the assumption that Chagas is not a problem in Houston, where thatched roofs are uncommon. Thus, it is important for physicians to also be familiar with other places triatomine bugs can be found, such as under cement blocks and porches, in brush and mulch piles, and between bricks.

Knowledge of Treatment

Generally, physicians participating in the study were unfamiliar or minimally familiar with specific treatments for acute Chagas disease (Figure 2g). “I know there’s medicine for it. I don’t know what it is, I’d have to look it up,” stated one physician (NTD-P02). Another mentioned, “I think there is [a treatment]. I’m not a 100 percent sure. I don’t think there is a Chagas pill, per se” (NTD-P12). Only one physician was correct in recognizing that within the United States, treatment for Chagas is only available through the Centers for Disease Control and Prevention (Centers for Disease Control and Prevention 2017). She mentioned that “there are two to three drugs ... I don’t know if the CDC gives those drugs out” (NTD-P03).

Most responses addressed only the acute infection, for which drugs are available through the CDC, or the chronic disease, which involves the medical management of symptoms. One physician said that drugs “can’t reverse the esophageal dilation, so try to treat [Chagas] before it gets to that stage. That’s the problem, because they are not diagnosed unless they have a blood transfusion or give blood and they are picked up” (NTD-P03). Another replied that “there’s medical management for the cardiac myopathy. I don’t know what the medical management for the parasite is” (NTD-P04). Only one physician with more extensive knowledge (NTD-P11) mentioned using trypanocides for treatment of the acute disease.

Views on Increasing Training on Chagas

Physicians were asked about their views on adding more specific educational information in the medical curriculum or in continuing medical education on NTDs, including Chagas. Most of the physicians interviewed recognized at least some gaps in their knowledge of Chagas disease. Ten respondents either supported the idea or were ambivalent. “I think it’s ok to add a little bit more [to medical education] because we are going to be in Houston,” said one physician (NTD-P01).

In contrast, six opposed the addition of any extra curriculum content, largely because there is already too much content to cover in medical school: “You’re overwhelmed with information and a lot of it doesn’t stick” (NTD-P14). Some believed it was not their direct responsibility, “maybe because we don’t see it that often, maybe because we miss it. I wouldn’t put that at the top of my list. But I’m in emergency medicine and the things we focus on are the things that are going to impact us the greatest because we only have a little bit of time with the patients” (NTD-P05). Others believed that Chagas was nonexistent or extremely rare in the Houston area. A respondent explained, “Chagas is less relevant to the local population unless you are dealing with someone who has traveled to an endemic area” (NTD-P02). Another physician referenced Houston’s Third Ward, a historically black neighborhood near the TMC with sections of low-income housing: “They aren’t going to be [exposed to Chagas], not in the U.S. How is someone going to get exposed to Chagas in the Third Ward?” (NTD-P11).

These views of the physicians interviewed highlight the lack of awareness of the local disease burden, which perpetuates a possible cycle: physicians may have relatively little

knowledge of Chagas, so they fail to recognize it when presented, which then contributes to a belief that it is rare, consequently leaving them unmotivated to seek further training.

Conclusion

Overall, the results of the study of these 16 Houston-area physicians interviewed demonstrate that there is a general unawareness of the local burden of Chagas disease and that recognition is largely limited to some features associated with the disease, such as thatched roofs or cardiomyopathy. In addition, these limited results further suggest the likelihood of a larger issue within the community of physicians regarding their lack of awareness of Chagas disease and ability to identify it appropriately enough to test and treat the disease.

There have been efforts to increase the public's awareness of Chagas disease, including a University of Texas School of Public Health at San Antonio education and outreach project funded by the CDC ("The Kissing Bug in South Texas" 2017). Researchers at Texas A&M University have also utilized "citizen science" approaches to engage the public in collecting triatomine bugs for testing. Published results from this effort include the collection of about 2,000 specimens—99 percent of them from Texas; this work helped researchers to understand the geographic distribution and seasonal occurrence patterns of triatomine bugs within the state (Curtis-Robles et al. 2015). In addition, the National School of Tropical Medicine at Baylor College of Medicine is conducting extensive studies to document and understand the full level of autochthonous transmission in Texas (Garcia et al. 2017; Gunter et al. 2017; Harris et al. 2017). Although these initiatives are important, there is still a distinct need to educate physicians on the local relevance of Chagas disease and how to recognize it clinically. This point is especially true because of the limited time window for the treatment of Chagas. Accordingly, the National School of Tropical Medicine at Baylor College of Medicine has developed a course of study for physicians, medical students, and other health care professionals (Baylor College of Medicine 2017a); graduates receive a Diploma in Tropical Medicine. While this program has successfully trained a few physicians interested in tropical diseases, only one physician from the study reported completing the program, while others mentioned it but did not see a need to participate.

While this exploratory study assessed and noted a lack of awareness among the TMC physicians interviewed, we anticipate that knowledge of Chagas disease is even more limited outside of academic medicine. Further work to determine the level of knowledge held by physicians statewide should be done; this work should include a systematic survey of physician awareness of Chagas disease and additional in-depth stakeholder interviews in areas where Chagas has been documented.

In addition, the development of a sensitive and specific rapid diagnostic test for Chagas will help to address the challenges of diagnosis. With a rapid test, clinicians could routinely test patients for Chagas at the point of care, whether or not they recognize the clinical symptoms, catching the disease earlier in its progression.

To explain why physicians rarely diagnose Chagas, one respondent quoted the aphorism, “When you hear hoof beats, think of horses not zebras.” However, with limited knowledge of Chagas disease and its impact in Texas, physicians are likely underreporting cases and only treating a fraction of affected patients. To adequately manage and determine the true risk burden for this disease, it is important to educate physicians so they can make that connection.

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