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The hidden Chagas disease burden in Europe

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Chagas disease in non-endemic countries - that is, in countries outside Latin America with exceptional or no vectorial transmission such as in Europe - has come to light since the beginning of 2000. The emergence of the disease in those countries was mainly linked to population mobility, notably migration. During the last century, Chagas disease cases were detected in non-endemic countries in North America (Canada and the United States) and the Western Pacific Region (mainly Australia and Japan), and only more recently in Europe [1,2].

The history of Chagas disease in Europe can be divided in three significant periods. The initial period, started at the beginning of the 1980s, when the first Chagas disease case in Europe was published [3], 72 years after Carlos Ribeiro Justiniano Chagas discovered the disease in Brazil [4]. Since then, successive sporadic publications have started to draw attention to the existence of Chagas disease cases in different European countries and the existence of the responsible parasite *Trypanosoma cruzi*. These publications describe infection transmission in Europe through different non-vectorial routes such as transfusional, congenital and laboratory-accident transmission, as well as sporadically through the arrival of infected travellers such as tourists, people visiting friends and relatives and adopted children [5].

The year 2000 marked the beginning of a second period, characterised by an increase in the number of cases reported in the scientific literature in many European countries [6]. According to the International Organization for Migration an important increase of migration between Europe and Latin America, predominantly to southern European countries, and mainly to Spain, was documented. Major causes contributing to this migration phenomenon were the economic hardship caused by the recession and high poverty levels in Latin America and tightening of visa regimes in the United States after 2001. The close cultural and historic ties of Latin American countries to Europe and the possibility for many Latin Americans to appeal to dual nationality because they frequently have European ancestors, have also facilitated population mobility in that direction. Demographically, the migrant population was young, with high rates of labour force participation and relatively high rates of educational attainment, with great capacity to integrate into European societies. Additionally, they represented a prime example of the current worldwide trend towards the feminisation of migration, which is relevant in the context of Chagas disease because of the possibility of congenital transmission from infected mothers. Finally, there was also a significant number of undocumented migrants, and that irregular migration posed a significant challenge to governments [7].

The year 2007 marked the beginning of a third period in the history of Chagas disease in Europe, characterised by various initiatives launched at different levels. In July 2007, the World Health Organization (WHO) and the Pan American Health Organization (PAHO) convened a meeting entitled *Revisiting Chagas disease: from a Latin American health perspective to a global health perspective*, with participants of 28 Latin American and non-Latin American countries where the disease was present. A major outcome of the meeting was to highlight the presence of *T. cruzi* infection outside Latin America in the so-called non-endemic countries and an initiative to deal with Chagas disease in non-endemic countries, supplementing the existing intergovernmental initiatives for the control of Chagas disease in Latin America [8].

With the main objectives of assessing the burden of Chagas disease as a public health problem in non-endemic countries and formulating an appropriate response, the WHO organised a series of meetings in 2008 and 2009 that culminated in the Informal Consultation on the Control and Prevention of Chagas disease in Europe, in the first profiles of European countries with Chagas disease cases and the first statement acknowledging that the disease has emerged as an important public health challenge [5,9].

In May 2010 the 63rd World Health Assembly approved the new resolution WHA63.20 which recognises the increased number of cases of Chagas disease in countries where the disease is not endemic and states that all transmission routes have to be tackled. It further promotes the integration of patients with acute and

chronic clinical forms of Chagas disease into primary health services and calls for a mobilisation of national and international, public and private financial and human resources, for the promotion of intersectorial efforts and collaboration, and for the facilitation of networking between organisations and partners [10]. The 63rd World Health Assembly also called for the establishment of an initiative of non-endemic countries aiming at interconnecting all those regions and countries that have patients. Finally, in October 2010, the first WHO report on neglected tropical diseases included Chagas disease as one of the 17 listed diseases [2].

From the point of view of the legal framework, the first official reference to Chagas disease at the European Union level was made in the European Commission's Directive 2004/23/CE [11] amending Directive 2002/98/CE [12] of the European Parliament and Council (2003) on quality and safety of blood, which concerns technical criteria relating to blood and blood donations. Annex III of the directive defines the admission criteria for blood donors or blood types and the minimal exclusion criteria for donations from donors who have or had parasitological diseases; the exclusion of Chagas disease carriers is specified. Other European directives, including 2005/62/CE, establish norms to be followed by institutions when carrying out blood transfusions with blood imported from other countries. In February 2006, the European Parliament published a new directive 2006/17/CE [13] on the donation and control of human tissues and cells, which referred to Chagas disease. The directive relates to the screening of donors based on their epidemiological history and travel to endemic areas. Aligned with European Union directives, France, Spain and the United Kingdom implemented national measures to control transfusional transmission of Chagas disease [14,15].

The present timely special edition of *Eurosurveillance*, published in two parts, is a useful instrument to review and update diverse aspects of Chagas disease in Europe related to topics such as the current epidemiological situation, primary and secondary prevention of *T. cruzi* infection, including congenital cases, control of transmission by transfusion and organ transplantation, care of patients, information, education and communication instruments, and the information and surveillance systems in place in countries within and outside of the European Union.

Basile et al. [16] review the epidemiological situation of the nine European countries with the highest estimated prevalence of *T. cruzi* infection, and the difficulties of dealing with a frequently silent and under- or misdiagnosed disease for which neither acute nor chronic cases are captured by compulsory notification. They point out the need for and challenge of an information and surveillance system in Europe that considers also the number of undocumented migrants. The lack or inconsistency of accurate epidemiological numbers of people with *T. cruzi* infection or Chagas disease can perpetuate the vicious circle of a silent and, in a way, silenced disease.

Along the same lines, the characteristics of patients attended and documented in the EuroTravNet provide precious information on the epidemiological and clinical profile of most of patients, together with the urgent necessity of implementing active measures to increase detection and access to diagnosis and treatment [17]. Other very interesting examples describing possible mechanisms to increase detection and care, and to make the disease more visible, are offered in articles from Italy and Switzerland [18,19]. These are countries with high absolute and relative numbers of *T. cruzi*-infected people, especially in certain regions or cantons. They have even seen reported acute cases of congenital transmission or oral transmission in a tourist coming back from a short trip to an endemic country. The need of an interdisciplinary approach, from the medical to the sociological sciences, taking into account all involved actors, including the patients themselves, is appointed as the unique solution to break the disease silence [20].

In terms of the possibility of implementing secondary prevention of congenital transmission linked to an information system in Europe, two pioneer experiences from Spain illustrate faced challenges and successful strategic measures to enhance the number of screened mothers and limit the number of lost patients in the after birth follow-up [21,22]. Nevertheless, as described by Navarro et al., implementing a protocol for the screening of pregnant women and the early diagnosis of infected newborns and their siblings requires also an essential component of information, education and communication (IEC), adapted to the emotional meaning Chagas disease for the affected population and their knowledge about it [23]. Moreover, any IEC component should include all involved actors, from health personnel to patients, including local non-governmental associations. Also from Spain comes a significant study by Valerio et al. reviewing the epidemiological data of *T. cruzi* infection and Chagas disease clinical chronic manifestations, especially in groups at risk of being infected. These studies evidence that it is essential to know the characteristics of the migrated population in terms of age, country of origin and exposition to infection, in order to propose adequate cost-effective protocols for laboratory and clinical screening and diagnosis, patient care and preventive and control measures [23,24].

It is necessary to move ahead with the description of Chagas disease in Europe. At-risk groups of migrants who lived in endemic areas before Chagas disease control measures were implemented in Latin America can have a high prevalence of infection and disease. But it is also logical to think that Chagas disease in non-endemic countries, with a reduced possibility of reinfection or co-infections with other parasitic diseases, with high standards of hygiene and nutritional status,

could be characterised by a lower morbidity and mortality. We are convinced that this special issue will stimulate further lively discussions around this disease, but also the implementation of the necessary measures to make it visible, stop transmission and provide care to patients in Europe.

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Clinical, electrocardiographic and echocardiographic abnormalities in Latin American migrants with newly diagnosed Chagas disease 2005-2009, Barcelona, Spain

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Following Latin American migration, Chagas disease has inevitably appeared in non-endemic countries in Europe and elsewhere. New policies are necessary to prevent transmission in those countries but the long, often undetected chronic period of the early stages of the disease also renders epidemiological studies important. The main objective of our study was to determine the presence of clinical, electrocardiogram (ECG) and echocardiographic abnormalities in a population of Latin American migrants infected with *Trypanosoma cruzi* at the moment of diagnosis. We performed a hospital-based observational study of 100 adult patients with newly diagnosed Chagas infection between January 2005 and December 2009. Thirty-seven patients were classified within the Brazilian Consensus on Chagas cardiomyopathy early cardiac stages (A or B1) and 49 presented pathological findings (stage B2) according to the Panamerican Health Organization Classification. Overall, 49 patients showed ECG and/or echocardiographic alterations. The presence of ECG and ecocardiographic alterations were significantly associated (p=0.038). The most frequent ECG and echocardiographic findings were right bundle branch block (12 cases) and impaired left ventricular wall relaxation (24 cases), respectively. In conclusion, ECG and echocardiographic alterations coherent with Chagas cardiomyopathy were found in a large proportion of newly diagnosed Latin American migrants infected with *T. cruzi*. In the mid-term, Chagas disease might become an important cause of chronic cadiomyopathy in our attendance area.

Introduction

Chagas disease is a zoonosis caused by the parasite *Trypanosoma cruzi*, a flagellated protozoa mainly transmitted to humans by the faeces of blood-sucking triatomine bugs (*Triatoma infestans* and others). A hundred years from its description, Chagas disease remains a neglected tropical disease and is as such recognised by the World Health Organization [1]. Until the late twentieth century, Chagas had a geographical distribution that was confined to that of its vector, namely in Central and South America. Today, the disease is no longer confined to Central and South America. Non-endemic countries in Europe and elsewhere have seen the emergence of Chagas disease following migration of chronically infected individuals from endemic areas. In Europe, for example, there are an estimated 2,300,000 Latin American migrants, both documented or undocumented [2,3] and non-endemic countries need to consider implementing preventive policies concerning blood transfusion, organ transplantation and vertical transmission [4,5].

Acute Chagas disease manifests clinically with fever and lyphadenopathy, unspecific general malaise and is self-limiting. It is followed by a long asymptomatic period of latency (or chronic disease) characterised by the presence of antibodies against *Trypanosoma cruzi*. In this stage, clinical examination of the chest, oesophagus and colon may be normal, the 12-lead electrocardiogram (ECG) can show no irregularities or minor alterations. After decades of undetected, asymptomatic disease, over 40% of infected individuals develop clinical symptoms reflecting the tissue damage. They usually involve the heart or digestive tract. The clinical outcome of the chronic phase of Chagas disease ranges from the absence of sings and symptoms to sudden premature deaths due to silent severe cardiomyopathy. Classically it is considered that up to a 30% of those infected will develop cardiac symptoms or ECG alterations within 10-30 years after the initial infection [6].

Although the pathogenesis of Chagas is not completely understood, a growing consensus points to a combination of direct tissue effects of the parasite with an immunologic response that may paradoxically increase

the tissue inflammation and thus over time lead to fibrosis [7]. Such low-intensity inflammation causes the specific Chagas cardiomyopathy and sooner or later affects the conduction system. This affection is reason for the often pathological ECG findings in Chagas patients [8].
Chagas cardiomyopathy marks the prognosis of the disease. It results in impairment of contractile function and final dilation of all four heart chambers. Eventually, ventricular tachycardia or refractory congestive heart failure threaten the lives of those affected [9].

Spain has become the main European destination of Latin migration in recent decades [10]. We undertook a hospital-based descriptive study to determine the presence of cardiac (clinical, ECG and echocardiographic) alterations in of a population of infected Latin American migrants at the moment of the diagnosis as well as to estimate their clinical and functional cardiac staging.

Methods

Between January 2005 and December 2009, we studied all consecutive adult patients newly diagnosed with Chagas infection at the Unitat de Salut Internacional Metropolitana Nord. The Unitat de Salut is a referral unit shared by the Primary Care Service and the tertiary care Hospital Universitari Germans Trias i Pujol. Both are located in the Barcelona Metropolitan Area, Spain; they serve a population of over two million people of which approximately 6% are Latin American migrants. The unit belongs to the Institut Català de la Salut, the main public health provider in Catalonia and, therefore, the medical visits were free of charge. The majority of patients were referred by family practitioners as foreseen in the protocol of the Chagas screening program for populations at risk (i.e. Latin American pregnant women, Bolivian natives, other Latin American migrants with any risk factor for Chagas disease) at primary care level in Catalonia [11].

Exclusion criteria for the study were: (i) documented previous diagnose of Chagas infection or antichagasic treatment, (ii) age less than 15 years, (iii) presence of hypertension, diabetes, coronary artery disease or other concurrent diseases associated with cardiomyopathy and, (iv) pregnancy.

Individuals were considered as Chagas cases when two commercialised enzyme-linked immuno sorbent assay (ELISA)-based serological tests against crude and recombinant *T. cruzi* antigens, were positive. In case of discrepant results, a third test, based on indirect immunoflourescence (IIF) was performed.

All newly-diagnosed Chagas patients underwent a clinical evaluation, including full medical history, physical examination, ECG with 30 seconds DII strip and a two-dimensional and Doppler echocardiography.

The following variables were assessed: age, sex, country of origin and having lived in rural environment (yes/no), previous adobe housing (yes/no) self-reported family history of Chagas infection (yes/no), mother with Chagas infection (yes/no), cardiac symptoms, ECG alterations, echocardiographic abnormalities, debut as acute cardiac event (i.e. tachyarrythmia, cardiac syncope, pulmonary or systemic tromboembolism and acute heart failure) and Chagas cardiomyopathy staging.

The variable "cardiac symptoms", assessed as a dichotomy variable (yes/no) included at least one of the following features: antecedents of chest pain, palpitations, syncope, pulmonary thromboembolism, stroke and symptoms of heart failure such as oedema of the lower legs or dyspnoea on exertion.

The ECG alterations assessed were: sinus bradycardia, right bundle branch block, left anterior fascicular block, left bundle branch block, posterior fascicular block, atrial fibrillation, any degree of atrioventricular block, ventricular extrasystoles and Q wave or diffuse ST-T changes presence.

Figure 1

Classification schemes to grade Chagas cardiomyopathy

Brazilian Consensus Classification [12]
A: Abnormal ECG findings. Normal echocardiogram. No signs of CHF.
B1: Abnormal ECG findings. Abnormal echocardiogram with LVEF› 45%. No signs of CHF.
B2: Abnormal ECG findings. Abnormal echocardiogram with LVEF‹ 45%. No signs of CHF.
C: Abnormal ECG findings. Abnormal echocardiogram. Compensated CHF.
D: Abnormal ECG findings. Abnormal echocardiogram. Refractory CHF.

Panamerican Health Organization Consensus [13]
A. Acute Chagas disease
A.1. Symptomatic disease
A.2. Asymptomatic disease
B. Chronic Chagas disease
B.1. Absence of pathological findings
B.2. Presence of pathological findings

CHF: congestive heart failure; ECG: electrocardiogram; LVEF: left ventricular ejection fraction.

The echocardiographic alterations assessed were: left ventricular wall dysfunction, ventricular aneurysm (apical or other), low ejection fraction (if <50%) and valve disease attributable to Chagas endocardial fibrosis.

For the Chagas cardiomyopathy staging we used the Brazilian Consensus [12] and the recent Panamerican Health Organization Classification of Chagas cardiomyopathy [13] (Figure 1). The Brazilian Consensus classification categorises "left ventricular low ejection fraction" according to data based on echocardiographic outcomes (Figure 1).

The relative frequency of the variables and their association with socio-demographic (age, sex, family history and mother with Chagas infection) or setting characteristics (having lived in rural environment, previous adobe housing) were analysed using SPSS 12.0 software (SPSS Inc, Chicago, IL). The chi-square test was applied to compare qualitative variables.

We performed a multivariate logistic regression. Depending variables were to have cardiac symptoms, and to present ECG or echocardiographic alterations; independent variables were age, sex, previous adobe housing and reported family or mother with *T. cruzi* infection.

Results were presented in terms of crude and adjusted (by age, sex and rural environment) odds ratios (OR) and 95% confidence intervals (95% CI). A tendency test compared ECG or echocardiographic alterations' presence with the Brazilian Consensus staging of cardiomyopathy. The p value was set at 0.05 for statistical significance.

Results

During the study period, 116 Latin American immigrants were newly-diagnosed with *T. cruzi* infection. Patients were excluded because of previous diagnosis or treatment of Chagas infection (8), age under 15 years (2), concurrent cardiovascular diseases (2), pregnancy (4). One hundred patients remained in the study. The median age of the patients was 38.2 (SD= 10.2) years, 65 were female and the vast majority were from Bolivia. Socio-demographic and clinical characteristics are shown in Table 1.

Overall, 41 patients had some ECG alteration at the moment of the diagnosis. The most common alteration was a single right bundle branch block (12 cases) which, combined with any other alteration, accounted for 18 of 41 abnormal ECG findings. Echocardiographic changes were seen in 31 patients, and allowed the diagnosis of Chagas cardiomyopathy in eight individuals with a normal ECG (Table 2). The presence of ECG and echocardiogram alterations showed a significant association (p= 0.038).

Table 1

Socio-demographic and clinical characteristics of newly diagnosed Chagas disease patients, hospital-based study Barcelona, Spain 2005-2009 (n= 100)

Variable	N (%)
Mean Age	38.2 (10.2)
Sex	
Male	35 (35)
Female	65 (65)
Country of origin	
Bolivia	95 (95)
Other Southern American countries[1]	5 (5)
Rural environment	93 (93)
Adobe house	91 (91)
Reported family history of *T. cruzi* infection[2]	66 (67%)
Reported mother with *T. cruzi* infection[3]	19 (20%)
Single ECG alterations	
Sinus bradycardia	7 (7)
Right bundle branch block	12 (12)
Left anterior fascicular block	6 (6)
Left bundle branch block	0
Posterior fascicular block	1 (1)
Atrial fibrillation	1 (1)
Atrioventricular block	3 (3)
Ventricular extrasystoles	0
Q wave/ST-T changes	1 (1)
2 alterations	9 (9)
3 alterations	1 (1)
Total ECG alterations	**41 (41)**
Abnormal echocardiographic alterations	
Left ventricular wall dysfunction	24 (24)
Ventricular aneurysm (apical or other)	2 (2)
Low ejection fraction (<50%)	4 (4)
Valve disease i.e Mitral regurgitation|	1 (1)
Total echocardiographic alterations	**31 (31)**
Total ECG and/or echocardiogram alteration	**49 (49)**
Debut as cardiac event	3 (3)[4]
Cardiac symptoms	31 (31)

ECG: Electrocardiogram.

[1] Ecuador (2), Brasil (1), Uruguay (1), Venezuela (1).

[2] Information available for n= 98 patients.

[3] Information available for n= 95 patients.

[4] Pulmonary tromboembolism (1), rapid atrial fibrillation (1), syncope (1).

Table 2

Electrocardiogram and echocardiographic findings in newly diagnosed Chagas disease patients, hospital-based study Barcelona, Spain 2005-2009 (n= 100)

ECG		Echocardiogram		Total
		Normal	Abnormal	
	Normal	51	8	**59**
	Abnormal	18	23	**41**
Total		**69**	**31**	**100**

p=0.038

No statistically significant relations were found between cardiac symptoms, ECG or echocardiographic alterations and age or sex (Table 3).

According to the Panamerican Health Organization Classification, none of the patients was classified as stage A, 100 were in stage B and of those 51 in stage B1, and 49 in stage B2. According to the Brazilian Consensus, 25 patients were in stage A and 14 in stage B, of those 12 in stage B1 and two in stage B2, none were in stage C. Overall, 37 patients were in an early stage of Chagas cardiomyopathy (stage A and B1).
The tendency test comparing the Brazilian Consensus classification and the presence of ECG and echocardiographic alterations was performed. For both variables, test results were complementary. They showed a statistically significant association between higher grade in the Brazilian Consensus classification and ECG or echocardiographic alterations respectively; for ECG alterations the p value was <0.001, the OR 11.03 (95% CI: 6.7-18.1) and for echocardiographic alterations p<0.001 and OR 3.4, (95% CI: 1.6-7.1).

Discussion and conclusion

In our study of newly diagnosed Chagas disease patients, previous adobe housing was associated with presence of ECG alterations. This may be explained by the high probability of repetitive exposure of those living in adobe houses to triatomine bites with subsequent reinfections that can trigger autoimmune reaction and greater tissue damage [14]. In contrast with the majority of Chagas epidemiological studies, the presence of reported infection in the family and mother were associated with a decreased risk of ECG abnormalities. Several articles published, although not in a conclusive way, suggest the opposite. A familial aggregation could exist among Chagas cardiomyopathy cases due to a higher number of mother-to-child transmissions by highly infectious *T. cruzi* strains or due to a longer infection period [15,16]. This fact could be explained by taking into account that the infected individual, usually asymptomatic and mainly with normal cardiac tests, was considered as "reference case" and a *T. cruzi* active research was done among close asymptomatic relatives. Of course, it was also carried out among patients with a beginning cardiac complication but, on the whole, family clustering tends to occur in chronic asymptomatic cases and overestimates their relationship with the asymptomatic stages of the disease. In our study, the presence of family and maternal history of Chagas infection relied on reported information from the patients; as relatives could not be serologically tested, this result should be interpreted cautiously. Overall, it likely represents a bias exemplifying the inherent shortcomings in studying a disease outside its own bio-geographic, endemic framework.

Factors consistently related in the literature to poor prognosis, such as age, male sex and multiple ECG alterations were not confirmed in our analysis. However, age is a risk factor for Chagas cardiomyopathy beyond any doubt [17,18], and it should be taken into account that in our small study group only 11 individuals were over 50 years old.

Table 3

Cardiac symptoms, electrocardiographic and echocardiographic alterations in newly diagnosed Chagas disease patients by age, sex, housing and infections in the family, hospital-based study Barcelona, Spain 2005-2009 (n= 100)

	Univariate analysis		Multivariate analysis	
Cardiac Symptoms	OR (95% CI)	p	OR (95% CI)	p
Age	1.01 (0.9-1.1)	0.7	1.01 (0.9-1.0)	0.8
Sex	2.34 (0.9-6.3)	0.08	2.45 (0.8-7.5)	0.1
Adobe housing	0.39 (0.1-1.4)	0.1	0.29 (0.1-1.3)	0.1
Reported family history of *T. cruzi* infection	0.83 (0.3-2.1)	0.7	0.79 (0.3-2.3)	0.7
Reported mother with *T. cruzi* infection	0.34 (0.1-1.3)	0.1	0.28 (0.1-1.2)	0.09
ECG alterations				
Age	0.98 (0.9-1.0)	0.3	0.98(0.9-1.0)	0.3
Sex	0.78 (0.3-1.8)	0.6	1.42 (0.5-4.0)	0.5
Adobe housing	5.87 (1.1-31.6)	0.02	11.52 (1.8-75.9)	0.01
Reported family history of *T. cruzi* infection	0.23 (0.1-0.7)	0.003	0.12 (0.04-0.4)	0.001
Reported mother with *T. cruzi* infection	0.30 (0.1-0.9)	0.02	0.23 (0.1-0.7)	0.01
Echocardiographic alterations				
Age	1.05 (0.9-1.1)	0.2	1.07 (0.9-1.2)	0.2
Sex	0.38 (0.1-1.8)	0.2	0.21 (0.02-1.7)	0.1
Adobe housing	0.61 (0.1-4.5)	0.5	0.66 (0.04-9.8)	0.8
Reported family history of *T. cruzi* infection	0.53 (0.1-3.1)	0.5	0.65 (0.1-7.3)	0.7
Reported mother with *T. cruzi* infection	0.56 (0.1-2.8)	0.5	0.68 (0.1-5.2)	0.7

CI: confidence interval; T: Trypanosoma.

Fourty-one of our patients showed some of ECG alterations, a far higher prevalence compared with that obtained in recent studies in other European countries such as Switzerland (11.3% [19], France (23.6% [20] or even Barcelona urban area (19%) [21]. In contrast, it seems to follow a pattern similar to that described in studies carried out in endemic areas in South America: Northern Argentina (37.5%) [22] and Bolivia (50.8%) [23]. This may be explained by the origin of our study population. Nearly all patients came from rural high-prevalence Bolivian environments, especially from Santa Cruz and Cochabamba Departments.

The prognosis of our patients is cause for concern. In one study carried out in rural Brazil, mortality over a six-year period was approximately 20% among infected persons with right bundle branch block [24]. Right bundle branch block was by far the most common ECG alteration in our sample (12 cases). Considering that the treatment given to patients, a 60-day course of benznidazol, could at best retard the progression of cardiac disease [25], close clinical follow up and early identification of complications are crucial. They are the only realistic options with benefit for patients. However, close follow up remains a challenge due to the often great instability of migrant populations in terms of employment and housing.

The predominant echocardiographic abnormalities were alterations in left ventricular wall relaxation, usually to a moderate degree, as a likely reflection of the underlying fibrosis [26]. Unlike the ECG, echocardiography is a dynamic test that requires experience. Even in specialised centres, major disparities between echocardiographic features and post-mortem lesions have been described in Chagas disease patients [27]. However, we were able to identify with echocardiography eight of cardiac abnormalities that would not have been picked up through ECG results alone. This could be due to presence of very early fibroid lesions without ECG changes in a study population that was mainly in the early stages of heart disease.

Coherently with the outcomes of other studies [28, 29], it may be reasoned that ECG and echocardiogram evaluate different aspects i.e. conduction system and structural-functional situation of the left ventricle, respectively of a specific cardiomyopathy in which left ventricular relaxation can be often identified as the earliest alteration [30]. Hence, both tests should be routinely carried out at the moment of diagnosis [31].

The Brazilian Consensus classification of Chagas cardiomyopathy proved useful in categorising the cardiac function based on ECG or echocardiogram abnormalities. As in a recent Swiss study, it was considered as a suitable tool to staging Chagas cardiomyopathy in Europe [19]. The PAHO classification, however, may give a better idea of the Chagas disease burden at public health level as it clearly divides the infected population into those with and without pathological (clinical, ECG or echocardiographic) findings.

The central limitation of our study was the lack of patients in advanced stages of Chagas cardiomyopathy. Therefore, it was not possible to estimate the association between the severity of heart disease and the presence of concrete ECG or echocardiographic findings. Besides, the absence of a Latin American-migrant control group without Chagas disease makes it impossible to determine to what extent the described cardiac alterations are attributable to Chagas disease in Latin Americans. Moreover, the study population may not be fully representative of all Latin American migrants in the European Union or other non-endemic countries due to a possible under-representation of non-Bolivian or middle class patients. Patients assessed had been "filtered" by their family doctors and, therefore, they probably do not reflect exactly the clinical situation of Latin American patients in the community.

Our study results show that clinical, ECG and echocardiographic alterations coherent with Chagas cardiomyopathy were found in a large proportion of Latin American migrants with chronic Chagas disease. The majority were in early asymptomatic stages of the disease. Given these findings and the high number of migrants from endemic areas in our attendance area, Chagas disease might become an important cause of chronic cadiomyopathy in the mid-term in our attendance area. It should be considered in every Latin American patient with unexplained ECG abnormalities, cardiac symptoms or acute cardiovascular events. Chagas disease should no longer be perceived as an exotic disease. Due to its multiorgan, particularly cardiac manifestation, we recommend to involve a multidisciplinary collaborative patient management, including primary care physicians, cardiologists and tropical-medicine experts. Every effort directed towards identifying asymptomatic infected Latin American migrants should be encouraged st

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Targeted screening and health education for Chagas disease tailored to at-risk migrants in Spain, 2007 to 2010

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Chagas disease is endemic in Latin America, but migration has expanded the disease's geographical limits. Spain is the most affected country in Europe. From 2007, a specific Chagas disease programme aimed at at-risk migrants was developed in three Spanish cities (Madrid, Jerez de la Frontera and Alicante). The objectives of the programme were to increase participants' knowledge and decrease their fears about the disease and to encourage them to undergo screening for *Trypanosoma cruzi* infection. The programme was specially focused on migrants from Bolivia and Latin American women of childbearing age. Culturally tailored interventions were carried out in non-clinical settings. A total of 276 migrants were screened using a rapid immunochromatographic test following talks on the disease: the results were then later confirmed by standard serological tests. Of those tested, 44 (15.9%) were confirmed cases of Chagas disease. All of them came from Bolivia and a quarter were pregnant women. Of the 44 cases, 31 were later followed up at a specialised Chagas disease clinic. We consider that the adaptation of the programme to the target population's needs and collaboration with non-governmental organisations and migrants' associations contributed to the acceptance of the programme and the increasing number of patients seen at a specialised clinic

Background

Chagas disease, caused by the parasite *Trypanosoma cruzi*, is naturally transmitted in endemic areas by triatomine vectors. Between 8 and 10 million people are estimated to be infected worldwide [1]. In Latin America, where it is endemic, it is the leading cause of cardiomyopathy [1]. After the 1990s, migration from Latin America resulted in an expansion of the disease's geographical limits, to include non-endemic regions, where other modes of transmission (blood and organ donation and mother-to-child transmission) may spread the infection [2].

Among European countries, Spain has the largest number of migrants from Latin America, globally ranking second to the United States [3]. There is evidence that Chagas disease is a serious challenge to public health in European countries, with being Spain the most affected country: in 2009, it was estimated that between 39,985 and 65,258 migrants were infected in Spain, mostly people from Bolivia [4]. After the first cases of the disease due to blood transfusion were diagnosed [5,6], the Spanish Government implemented in 2005 a law regulating the screening of blood donors from endemic areas [7]. To tackle health issues related to *T. cruzi*-infection of migrants, in 2007 the Tropical Medicine Unit at the Ramón y Cajal Hospital in Madrid developed a holistic approach to the management of Chagas disease.

All clinical and non-clinical activities described in this analysis were provided free of charge for every patient. The study was approved by the Ramón y Cajal Hospital's ethics committee.

Chagas disease clinic, Ramón y Cajal Hospital

The Tropical Medicine Unit at the Ramón y Cajal Hospital is a referral centre for tropical diseases and parasitology within the national health system. In addition to providing assistance to migrants [8], a specialised clinic was set up four years ago for the diagnosis, evaluation, follow-up and treatment of patients with Chagas disease, according to a specific protocol [9]. There is also a telephone consultation service, to facilitate patients' access to the doctors even if they cannot attend the clinic. This clinic offers the patients free access to healthcare (without the need for prior referral by a physician) and free-of-charge assistance, including antiparasitic treatment with benznidazole, even if they are not legal residents.

Building up a Chagas disease programme

'*New citizens, new patients*', a culturally tailored community-based health education programme for migrants settled in Spain, was set up in 2007. The programme is run by a multidisciplinary team of physicians, intercultural mediators and a psychologist. A Chagas disease-specific programme was developed, focused primarily on migrants from Bolivia and Latin American women of childbearing age. Its objectives were to improve migrants' knowledge and decrease their fears regarding the disease and to encourage them to undergo screening for *T. cruzi* infection, particularly Latin American women of childbearing age. Staff of non-governmental organisations (NGOs) and migrants' associations promoted talks on the disease to migrants using their services and used a variety of approaches to encourage them to participate, such as placing advertisements on the walls of their premises and talking to people in person or by telephone.

In an initial phase, we obtained background information on migrants' knowledge and beliefs about Chagas disease in order to tailor our planned activities to the target population. First, from May to July 2007, we carried out qualitative research consisting of nine in-depth interviews with migrants in Madrid (seven women and two men) from different areas of Bolivia (Cochabamba, Santa Cruz, Potosí, Oruro and La Paz) [10]. This research revealed a general lack of knowledge about the disease, as well as many fears and false beliefs. In addition, the questionnaires demonstrated a lack of knowledge regarding vertical transmission and symptoms of the disease [10].

Second, in June to November 2007, the data obtained through the qualitiative research were used to design a questionnaire and to tailor educational material to the target population. The questionnaire comprised two sets of questions: one regarding social and demographic characteristics and the other on knowledge and beliefs about the disease.

Delivering information about Chagas disease

Development of a leaflet about Chagas disease

A culturally tailored leaflet about the disease was designed following the qualitative research. Healthcare staff and intercultural mediators participated in its design. It was fully illustrated in order to make it understandable, regardless of the reader's educational level. It was used to illustrate talks that were given and was also distributed during social events. The material is freely available on the Internet, from the Tropical Medicine Unit, Ramón y Cajal Hospital [11]: information about Chagas disease and specialised centres is provided in Spanish, English and French, so that patients, professionals in both health and social fields and the general population may benefit from it.

Talks to groups of migrants in non-clinical settings

From December 2007 to July 2010, we organised talks on Chagas disease to groups of migrants in Madrid, Jerez de la Frontera (Cádiz) and Alicante. These cities were chosen because of the proportion of resident at-risk migrants, the absence of any similar ongoing public health activities related to the disease and the availability of specific consultations for Chagas disease in the cities. A total of 487 migrants from Latin America were informed about Chagas disease through 44 talks, organised in collaboration with five NGOs and migrants' associations in Madrid (42 talks), Jerez de la Frontera, Cádiz (one talk) and Alicante (one talk). Of the participants, 350 (72%) were from Bolivia and 299 (61%) were women) (Table 1). The above-mentioned questionnaire was filled out by participants just before the talks took place. On the basis of the completed questionnaires, the speakers were able to adapt their talk accordingly. The speakers were experienced healthcare workers, who were assisted by a Latin American intercultural mediator (specifically trained for this purpose). The NGOs and migrants' associations involved have considerable influence over Bolivians living in Madrid, Cádiz and Alicante. Another organisation is focused on pregnant women and young mothers at risk of social exclusion. Staff of the organisations encouraged migrants to attend the talks and informed them when they would be held.

Spreading information through the media and social events

General information about Chagas disease and information regarding the ongoing programme was also spread through media (press and radio) targeting migrants and social events for people from Latin

Table 1

Characteristics of participants attending talks on Chagas disease, Spain, December 2007–July 2010 (n=487)

Item	Number (%)[a]
Talks	44
Participants	
Total	**487**
Mean per talk	11
Median age in years (range)	32 (1–68)
Sex	
Female	299 (61.4)
Male	188 (38.6)
Women of childbearing age[b]	257 (52.8)
Country of origin	
Bolivia	350 (71.9)
Ecuador	60 (12.3)
Peru	31 (6.4)
Other	46 (9.4)

[a] Unless otherwise indicated.

[b] 15–45 years.

America, such as the Bolivian National Day celebrations in Madrid in 2008 and 2009. The leaflet was also distributed at such social events. Participants were encouraged to share the information they had received in this kind of event (as well as in the talks) with their friends and relatives.

Targeted screening for *T. cruzi* infection

During 2008 and 2009, a rapid immunochromatographic test (ICT) (Simple Chagas WB, Operon) was offered to participants after the talks. A finger-prick blood sample was also collected on filter paper and sent to the reference laboratory (the National Microbiology Centre) for confirmation, using both indirect fluorescent antibody technique and enzyme-linked immunosorbent assay.

Each screened participant (or parent, if a young child was tested) was informed of the result immediately after the ICT (confidentiality was maintained). Pre- and post-test counselling were provided for all who participated. Once the results of the serological tests from blood samples on filter paper had been obtained, every patient was informed by telephone. Those found to be positive for *T. cruzi* were given an appointment at the specialised clinic. Psychological support was provided if requested.

From May 2008 to December 2009, 276 (78.4%) of participants attending the talks were screened (Table 2). Among the 76 who chose not to be tested, 15 had been previously screened: 13 in Spain and two in Argentina (six were *T. cruzi* positive and nine were negative).

Table 2

Targeted screening for *Trypanosoma cruzi* infection: results and characteristics of participants, Spain, May 2008–December 2009 (n=276)

Item	Number/total (%)[a]
Participants in talks	352
Participants who were tested by rapid immunochromatographic test	276/352 (78.4)
Country of origin of tested participants	
Bolivia	211/276 (76.4)
Ecuador	29/276 (10.5)
Peru	16/276 (5.8)
Other	20/276 (7.2)
Sex of tested participants	
Female	179/276 (64.9)
Male	97 /276 (35.1)
Confirmed positive cases	
Total	**44/276 (15.9)**
From Bolivia	44/44
Pregnant women	11/44
Confirmed *T. cruzi*-positive patients who later attended the Chagas disease clinic	31/44

[a] Where appropriate.

The ICT yielded six false-negative (2.2%) and 13 false-positive (4.7%) results, giving a sensitivity of 86.3%. A total of 44 (15.9%) participants were confirmed cases of Chagas disease. All of them came from Bolivia and 33 were from the regions of Cochabamba and Santa Cruz. The seroprevalence rate in the Bolivians who were screened was 20.9% (44/211). Of the 44 infected with *T. cruzi*, 30 were women of childbearing age. Of these 30 women, 11 were pregnant.

Despite our efforts to contact all infected patients, 13 of the 44 confirmed cases did not attend the Chagas disease clinic. Eight of these patients were contacted by telephone after they failed to attend their scheduled appointment: five of them stated they did not attend because they had been working and the other three had moved to other cities. All eight indicated that they had intended to request an alternative appointment. It was impossible to reach the five remaining patients who did not attend their appointment.

Consultations for Chagas disease

We have seen an increasing number of consultations for Chagas disease since 2003. The most remarkable increase took place between 2007 and 2008, after the Chagas disease programme has been established: twice as many patients were seen in 2008 compared with 2007 (394 versus 191) [10].

Discussion and conclusion

The establishment of Chagas disease – a neglected tropical disease – in countries of the European Union (EU) – represents a challenge for public health. The strength of the Chagas disease-specific programme described here was that it was accessible and tailored to at-risk migrants. This was mainly thanks to the cultural adaptation of all the activities and the adaptation of the team according to the migrants' circumstances and needs. The programme consisted of practical interventions, such as talks, delivering of information and targeted screening, to detect infected people in order to offer them clinical follow-up and treatment. It could also help to avoid new infections. Its weakness is that it relies on the need for financial support and an enthusiastic and dynamic group willing to adapt to the target population's needs. This is especially hard in the current economic crisis. A clinical centre for referral is also necessary.

Our background qualitative research showed a lack of knowledge about vertical transmission of the parasite [10]. Congenital transmission rates up to 7% have been documented in Spain [12]: it is important to note that 30 of the 44 confirmed cases of Chagas described in this study were women of childbearing age.

Migrants from Latin America are often not aware of Chagas disease. Particularly if they are asymptomatic, they may be less likely to access healthcare facilities to request screening [10]. In addition, it may be difficult for them to attend for screening, due to their working

hours. Collaboration with NGOs and migrants' associations enabled us to bring the programme closer to these groups. We also adapted our working hours to meet the needs of the target population.

Probably due to this flexibility, there was a good uptake of the rapid test: more than 78% of participants at the talks were screened. Unfortunately, the ICT used did not prove to be sufficiently sensitive to allow its use as a screening tool without performing an additional test to confirm all results. Consequently, since January 2010 it has no longer been used. However, if a highly sensitive rapid test using peripheral blood samples were available, it would be an ideal method for screening at-risk populations in the EU.

The prevalence of the disease may vary according to the screened population and the recruitment scenario. It is expected that the prevalence among those recruited in primary healthcare or in non-clinical settings will be lower than that found in referral clinical settings [9,13]. Among those screened in our study, the prevalence was 15.9%. This figure is greater than the 12.8% recently found in a Swiss cohort [14], but less than the 23.6% found in another similar study in France following a public information campaign [15]. The mean prevalence of these three series combined was 15.2% (234/1,542), rising to 24.6% (226/918; range: 20.9–26.2%) among participants who were from Bolivia.

According to studies performed in specialised centres, many patients with Chagas disease in Spain are female Bolivian migrants aged 30–40 years who may transmit the parasite vertically or horizontally through blood or organ donation [9]. Although screening for *T. cruzi* is currently performed for at-risk blood and solid organ donors in Spain, there are no official national guidelines for screening pregnant women in the country. In our study, 11 infected pregnant women were detected: all the mothers and their babies were followed up in the clinic. No newborns were infected in this cohort.

Not all patients with confirmed infection later attended the Chagas disease clinic. Their failure to attend may have been due to work-related problems or because they were no longer in Spain (more than 22,000 Bolivians in Spain migrated to another country during 2009) [16]. This highlights the need to increase efforts to adapt the intervention programme to the target population.

As migrants usually do not know about the existence of specialised centres for tropical diseases in the host country, we consider it crucial to provide information about where people should go for diagnosis, follow-up and treatment of Chagas disease. We included this information in the talks, which may have contributed to the high percentage of *T. cruzi*-positive participants who later attended the Chagas disease clinic.

An increasing number of consultations for Chagas disease was observed, which may be a result of the programme. Information on the disease was also delivered through media specifically targeting migrant groups. This initiative had a great impact: for example, a 50% increase in the number of patients attending the Chagas disease clinic was seen (unpublished data) after an article on healthcare resources for the disease in Spain was published in 2008 in a newspaper aimed at people from Latin America [17].

In conclusion, the holistic approach described in this article can help to reduce the public health problem of Chagas disease in non-endemic countries. Moreover, referral of *T. cruzi*-infected people to a specialised clinic with free access, follow-up and treatment should also contribute to it success. Early diagnosis can also lead to an improvement in the quality of life and prognosis of patients with the infection.

Our programme is currently ongoing, delivering information in non-clinical settings and offering management of patients with the disease at a specialised unit. As Spain is the country in Europe most affected by the disease, our programme may not be directly relevant to some European countries. Nevertheless, we believe this programme could help to guide the implementation of prevention and control strategies in other countries in Europe affected by the disease.

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The current screening programme for congenital transmission of Chagas disease in Catalonia, Spain

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Due to considerable numbers of migrants from Chagas disease-endemic countries living in Catalonia, the Catalonian Health Department has recently implemented a screening programme for preventing congenital transmission, targeting Latin American pregnant women who attend antenatal consultations. Diagnosis of *Trypanosoma cruzi* infection in women is based on two positive serological tests. Screening of newborns from mothers with positive serology is based on a parasitological test during the first 48 hours of life and/or conventional serological analysis at the age of nine months. If either of these tests is positive, treatment with benznidazole is started following the World Health Organization's recommendations. The epidemiological surveillance of the programme is based on the Microbiological Reporting System of Catalonia, a well established network of laboratories. Once a positive case is reported, the responsible physician is asked to complete a structured epidemiological questionnaire. Clinical and demographic data are registered in the Voluntary Case Registry of Chagas Disease, a database administered by the Catalonian Health Department. It is expected that this programme will improve the understanding of the real burden of Chagas disease in the region. Furthermore, this initiative could encourage the implementation of similar programmes in other regions of Spain and even in other European countries.

Introduction

Due to migration flows the traditional epidemiological pattern of Chagas disease has dramatically changed during the past decades [1]. Previously defined as a mainly rural vector-borne disease confined to South America [2], Chagas disease is nowadays diagnosed all over the world wherever there are Latin American migrants [3]. With a view to eliminating the transmission of Chagas disease in non-endemic countries, the World Health Organization (WHO) recommends strengthening national and regional capacities in order to prevent and control congenital transmission, and improving case management of congenital and non-congenital infections, including strategies for case finding, diagnosis and treatment at different health-care levels [4,5].

Unlike vector and oral transmission of the causative pathogen *Trypanosoma cruzi*, which is only possible in endemic areas, infection through blood and organ transplantation or vertical transmission of the parasite can occur in any country [6]. During the past decade some non-endemic countries, among others France, Spain and the United Kingdom, have established legal requirements to ensure the safety of blood supply and organ transplantation by monitoring them for Chagas disease [7,8]. However, systematic screening for *T. cruzi* among pregnant Latin American women in non-endemic countries is still uncommon.

To date only a few cases of congenital transmission in non-endemic countries have been published, the majority, seven of ten, from Spain [9]. The remaining three cases were reported in Switzerland (two cases) [10] and in Sweden (one case) [11]. These few documented cases do probably not reflect the true situation but rather reflect a lack of screening programmes and surveillance systems following *T. cruzi*-positive pregnant women and their children.

The clinical characteristics of congenital *T. cruzi* infection are heterogeneous, ranging from asymptomatic (60-90% of infected newborns) [12-14] or oligosymptomatic infants to severe cases with meningoencephalitis, myocarditis or respiratory distress syndrome (RDS) [13,15]. Whilst effectiveness of Chagas disease treatment in women of reproductive age, aimed to prevent or reduce the likelihood of vertical transmission, remains controversial [16], treatment of infected children during the first year of life ensures therapeutic success in almost 100% of cases [17]. This highlights the importance of routinely testing newborns from *T. cruzi*-infected women.

The need for early detection and treatment of congenitally transmitted cases prompted the Catalonian Health Department to implement a systematic screening programme for Chagas disease among Latin American pregnant women and their children [18]. In this paper we describe this screening programme that was developed thanks to the collaboration between different Catalonian experts on Chagas disease and the WHO Department of Control of Neglected Tropical Diseases. It was implemented in Catalonia from January 2010.

The programme encompasses serological screening of Latin American pregnant women attending antenatal consultation, screening and treatment of their newborns, and an epidemiological surveillance system.

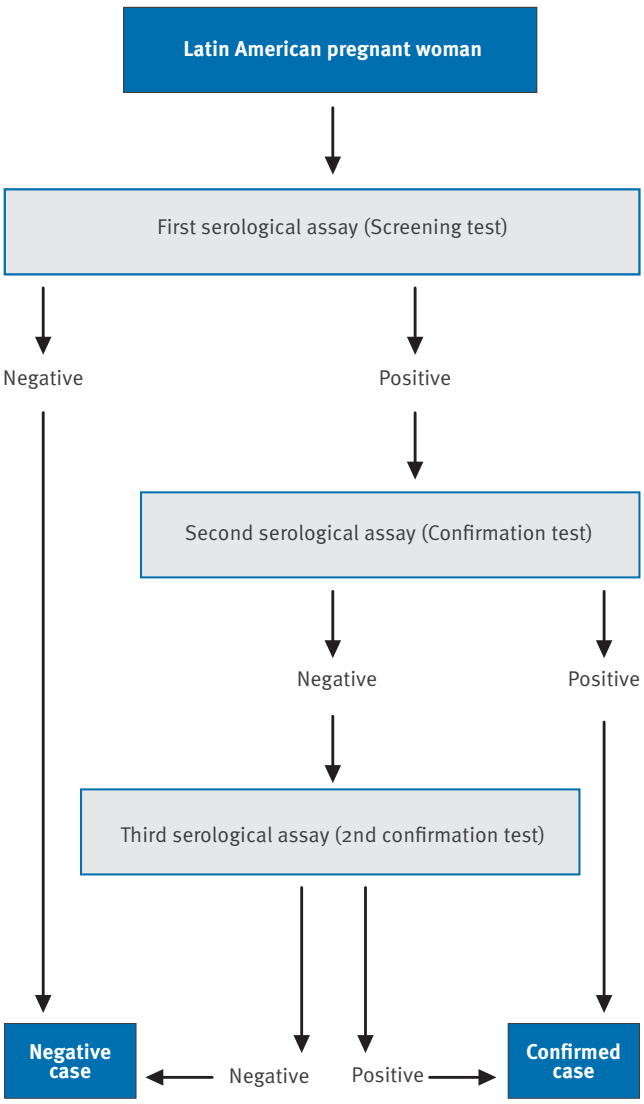
Screening strategy

Screening of pregnant women

The main target population of the programme is Latin American pregnant women attending antenatal consultation in Catalonia. The health system in Spain is universal and free of charge, thus it is unlikely that pregnant migrants, even if undocumented, will not attend the antenatal consultations. Screening for Chagas disease is offered during the first trimester of pregnancy (or whenever the women sought healthcare in the case of uncontrolled pregnancies) to all Latin American women from endemic countries (Argentina, Belize, Bolivia, Brazil, Chile, Colombia, Costa Rica, Ecuador, El Salvador, Guatemala, Guyana, French Guyana, Honduras, Mexico, Nicaragua, Panama, Paraguay, Peru, Surinam, Uruguay, Venezuela), Spanish women born to Latin American mothers (second generation) and Spanish female travellers who have been living in endemic areas for more than one month [18].

Figure 1

Serological screening of pregnant Latin American women for Chagas disease, Catalonia



The laboratory diagnosis during the chronic phase of Chagas disease is based on two serological tests. Commercially available assays use either lysates of the epimastigote form of the parasite grown in liquid culture or recombinant antigens [19]. Given the lack of a widely accepted standard for serological diagnosis of chronic *T. cruzi* infected patients, the Pan American Health Organization (PAHO) recommends to perform the diagnosis with two serological assays performed in parallel [20]. Within these limits, the 40 laboratories participating in the programme use their own testing algorithm for the screening pregnant women (Figure 1). The different serological assays used in the region are summarised in the Table. If the two chosen serological techniques give conflicting results, one additional test is performed in a reference laboratory [18].

When the diagnosis of *T. cruzi* infection is established, the women are referred to medical consultation. Specific treatment for Chagas disease in these women is only offered once they have stopped breast-feeding.

Table

Assays available in Catalonian laboratories for the diagnosis of chronic Chagas disease

Enzyme-linked immunosorbent assays (ELISA)
Bioelisa Chagas (Biokit, Lliça d'Amunt, Barcelona, Spain)
ELISA cruzi Chagas disease (BioMerieux, Marcy-L'Etoile, France)
Whole Cell Lysate Antigen ORTHO Trypanosoma cruzi ELISA Test System (Johnson and Johnson, HighWycombe, United Kingdom)
Chagas IFA IgG + IgM (Vircell, Granada, Spain)
Architect Chagas (Abbott, Spain)
Indirect immunofluorescence (IF)
Chagas IFA IgG + Ig M (Vircell, Granada, Spain)
Inmunofluor Chagas (Biocientifica S.A., Buenos Aires, Argentina)
IFI Mardx Diagnostics inc. (Trinity Biotech, Ireland)
Rapid tests
OnSite Chagas AB (CTK, Biotech, Inc., San Diego, United States)
Simple Stick Chagas (Operon S.A., Zaragoza, Spain)
Others assays
In house Western blot (WB)

Screening of newborns and their siblings

Diagnostic screening is provided for newborns born from serological positive mothers. Direct microscopic examination of the buffy coat of blood from heparinised microhaematocrit tubes or using the Strout technique were the standard parasitological tests used for diagnosis of congenital transmission in the Catalonian programme [18]. The screening for *T. cruzi* infection is preferably carried out within the first 48 hours of the newborn's life whether it has symptoms or not. If the microhaematocrit is positive, the newborn is considered infected and specific treatment is started. When screening is not performed early in life or if the parasitological test is negative in the first hours, the children continue normal follow-up until they are nine months old. At that age the children are tested with a conventional serological analysis to detect specific immunoglobulin G (IgG) (Figure 2). IgG maternal antibodies against *T. cruzi* disappear in non-infected infants older than eight months [21]. In the case of a positive parasitological test at birth or a positive serological result at nine months, treatment is carried out according to WHO recommendations [5]. The most widely used drug for treating congenital Chagas disease in Spain is benznidazole, although nifurtimox has a similar efficacy profile [22]. Screening and, if necessary, treatment for Chagas disease are also extended to the other children of *T. cruzi*-positive mothers.

Although some studies have suggested that PCR can be more sensitive than parasitological techniques for early detection of congenital infections [23], the PCR was not included in the programme [18] following WHO recommendations [5]. It seems reasonable to assume that standardisation of PCR techniques will lead to the inclusion of this tool in the future.

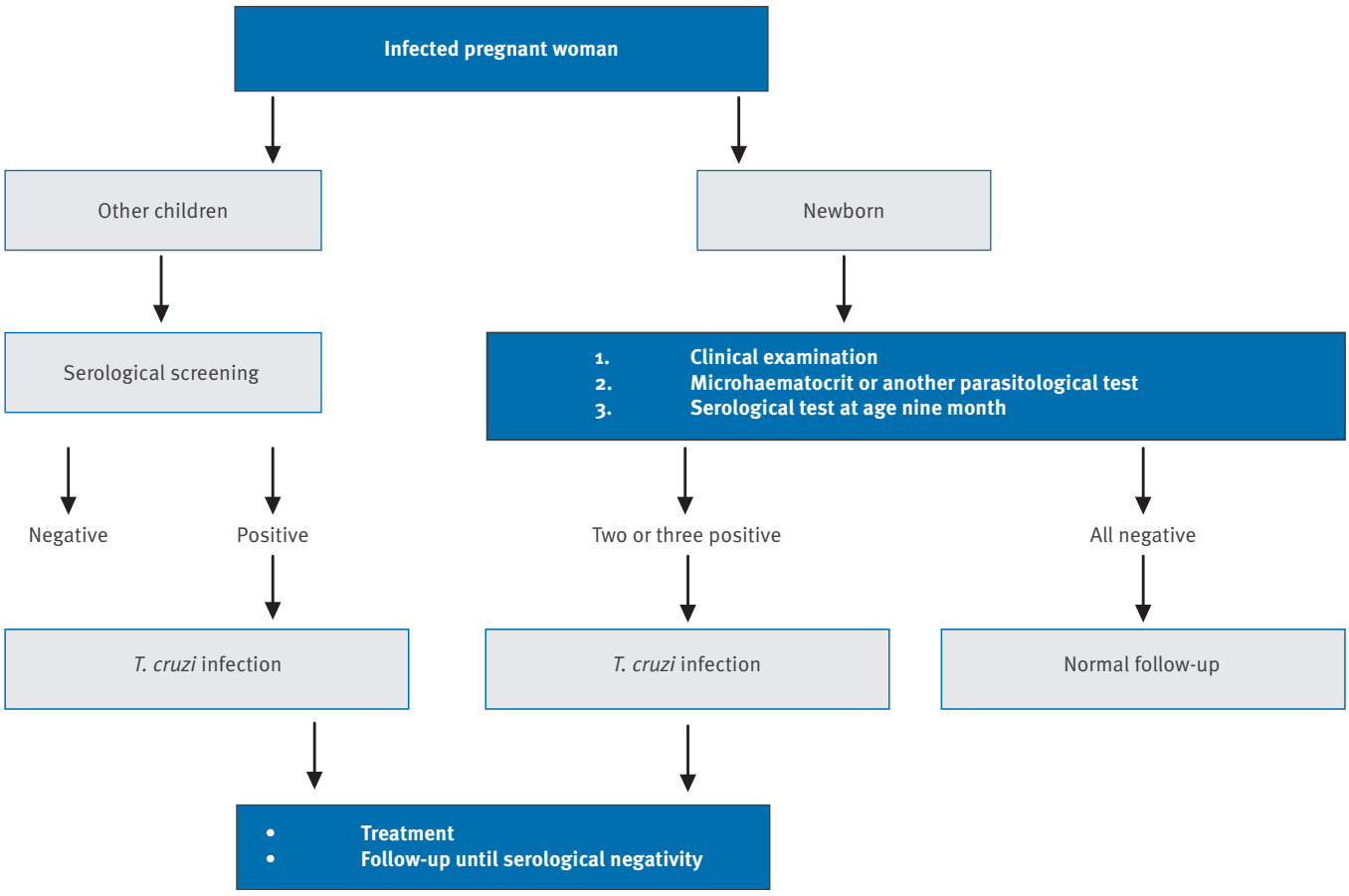
Epidemiological surveillance system

The epidemiological surveillance of Chagas disease for the screening programme is based on the Microbiological Reporting System of Catalonia (MRSC). This is a collaborative network of Catalonian laboratories that has been collecting information from different pathogens of public health importance since 1993. A total of 40 microbiology laboratories encompassing 47 hospitals and health centres throughout Catalonia participate in this system. These centres include the largest hospitals and represent more than 80% of hospital beds in the region (a list of the laboratories is available at: http://www.gencat.cat/salut/depsalut/html/ca/dir2088/labs_notif_microb.pdf).

When a positive case of *T. cruzi* infection among pregnant women or their children are reported by laboratories to the MRSC, the Catalonian Health Department contacts the physician in charge of the patient and a structured epidemiological questionnaire is completed.

Figure 2

Serological screening for Chagas disease of Latin American newborns and their siblings, Catalonia



Clinical and demographic collected data is registered in the Voluntary Case Registry of Chagas Disease, a database administered by the Catalonian Health Department (Figure 3).

The main goals of this surveillance system are to assess the implementation of the protocol in the region and to periodically report the results to health providers and public health authorities.

Discussion

Different factors contributed to the decision of the implementation of this screening programme in Catalonia [18]. Firstly, due to migration flows, the Latin American migrant population in Spain has increased dramatically in the last 10 years, reaching just under two million migrants in 2010 [24]. Ecuador, Argentina and Bolivia were the predominant countries of origin, and represented almost 50% of all Latin American migrants living in the country [24]. Consequently, the estimated number of patients infected with Chagas disease was also high in Spain and vertical transmission of this disease a potential risk [25]. Applying the seroprevalence estimates published by the PAHO in 2006 it was estimated that between 39,985 and 65,258 *T. cruzi*-infected individuals were living in Spain in 2008 [5]. Taking into account that 35,525 children were born to Latin American women during that year, it was estimated that between 914 and 1,656 of these mothers were infected with *T. cruzi*. Assuming a transmission rate between 4.5% and 7.3%, the expected number of infected newborns would range between 41 and 121 [5].

For Catalonia, it was estimated that between 10,000 and 20,000 *T. cruzi*-infected migrants were living in this region in 2010 [26]. The number of pregnancies in women from endemic countries during that year was of 6,795. Considering that between 203 and 387 women could be infected, the expected number of *T. cruzi* infected newborns within this region for 2010 could range between seven and 16 (personal communication: Maternal and Child Health Programme, Directorate of Public Health, Generalitat of Catalonia, September 2011).

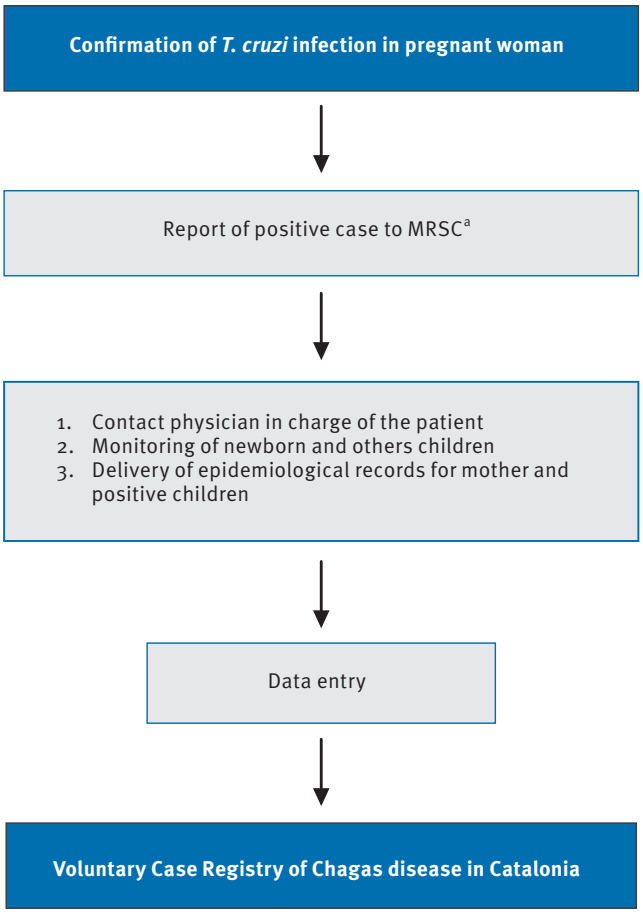
Secondly, a study carried out in the main maternity wards in Barcelona between 2005 and 2007 documented that the potential risk for vertical transmission of Chagas disease in Catalonia was already a reality [27]. During these years 1,350 Latin American pregnant women from endemic countries were tested, and 46 were found to be positive for *T. cruzi*, with a general seroprevalence of Chagas disease of 3.4% (27,5% among Bolivian women). Three of the 41 children with follow-up in that survey were infected, giving a vertical transmission rate of 7.3% [27]. Two further cases of vertical transmission, not related to the above study, were also reported in the region in 2004 [28] and in 2006 [29].

Finally, a study assessing the economic impact of Chagas disease screening programmes among pregnant women in a non-endemic area such as Spain was carried out in Barcelona in 2009 [30]. Two decision models were evaluated; the option of screening the newborn and the mother versus not screening either of them [30]. In this study the screening of Latin American pregnant women and their infants was the more cost-effective strategy compared with the option not to screen [30].While the therapeutic success in chronic infected adults with Chagas disease is poor, between 8% and 25% [31], treatment of infected children during the first year of life ensures therapeutic success in almost 100% of cases [17] and avoids all medical costs relative to a delayed symptomatic manifestation of the disease.

Currently, recognition of Chagas disease in Europe is low and there are no programmes for the prevention of vertical transmission implemented at national level in any European country. In Spain, a similar regional initiative has been implemented in the Valencian Community in 2009, although with the difference that an epidemiological surveillance system linked to the programme was not established [32].

Figure 3

Surveillance system for the Chagas disease screening programme, Catalonia



[a] Microbiological Reporting System of Catalonia

During the implementation of the Catalonian screening programme, we noticed that the knowledge of healthcare providers about Chagas disease was limited, a situation that is similar in other non-endemic countries [33]. To solve this inadequacy, continued training and information brochures has been offered to all personnel involved in the diagnosis and care of patients with Chagas disease.

The main challenge in the implementation of this protocol has been the coordination between the different levels of the health system. It is essential to increase networking between primary healthcare providers and hospitals and to reinforce the communication with public health authorities. To achieve the goal of the elimination of Chagas disease transmission, the WHO aims to reinforce regional and national capacities and strengthen worldwide epidemiological surveillance systems [4]. In this sense, one of the strengths of this programme is the source of data. The MRSC is an already well established network for public health surveillance that encompasses the majority of diagnostic laboratories in Catalonia. This system provides robust and reliable information, decreasing the risk of information bias.

The main limitation of this surveillance system is that the MRSC does not cover all the laboratories within the region. To solve this problem, hospitals and laboratories not covered by the MRSC network are asked monthly to report *T. cruzi*-infected patients. Moreover, in the surveillance system only positive cases are collected, so for now it is difficult to calculate the programme coverage without the information on all screened cases. Regard this problem; other solutions are currently being explored.

Conclusions

Non-endemic countries should consider congenital *T. cruzi* infection as a public health problem. Estimation of the burden of Chagas disease among migrants from endemic countries is essential to develop preventive measures and the right tools for the management of this disease in destination countries.

A screening program for *T. cruzi* in Latin American pregnant women, such as the one currently in place in Catalonia, would improve the knowledge about the real burden of Chagas disease in a non-endemic setting. This protocol is only a small step towards the goal of controlling Chagas disease worldwide, but we hope it may encourage the implementation of similar programmes in other regions of Spain and even in other European countries.

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Surveillance of Chagas disease in pregnant women in Madrid, Spain, from 2008 to 2010

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One of the most important modes of transmission of *Trypanosoma cruzi* infection in areas where it is not endemic is vertical transmission: from mother to child. The objective of this report is to assess the efficacy of different programmes of serological screening to monitor infection with *T. cruzi* in pregnant Latin American women living in Madrid (Spain). To achieve this, a retrospective study was undertaken from January 2008 to December 2010 in seven hospitals in the Autonomous Community of Madrid. Serological screening programmes were classified in two main strategies: a selective one (pregnant women from Bolivia) and a universal one (pregnant women from Latin America). A total of 3,839 pregnant women were tested and the overall prevalence was 3.96%. The rate of congenital transmission was 2.6%. The current monitoring programmes have variable coverage ranging between 26% (selective screening) and 100% (universal screening). Monitoring of pregnant women from Latin America only reaches full coverage if universal screening of pregnant women is carried out at any moment of pregnancy, including at delivery. A common national regulation is necessary in order to ensure homogenous implementation of screening.

Introduction

In the last ten years, due to the increase in the immigrant population from Latin America, *Trypanosoma cruzi* infection has become one of the most common imported parasitoses in Spain. By the end of 2009, around 3,600 cases had been confirmed, although estimates that take into account the prevalence of *T. cruzi* infection in Latin America suggest that between 40,000 and 65,000 affected people currently reside in Spain [1].

Taking into account the data provided by the Spanish Statistical Institute (INE) in January 2010, 25.7% (429,826 of 1,670,196) of the immigrant population from *T. cruzi*-endemic areas were residing in the Autonomous Community of Madrid (Figure). Of this population, 39.1% (167,917 of 429,826) were women aged between 15 and 44 years [2].

The three main transmission routes of *T. cruzi* in non-endemic regions are: transfusion of blood products, vertical transmission and organ transplantation [1]. That is why, between March 2002 and December 2004, the Madrid branch of the Spanish Red Cross carried out the first serological screening of candidates for blood donation from areas where Chagas disease is endemic, to establish their suitability as donors. The potential donors, who were not born in Spain, were interviewed and 44% of them were identified as coming from endemic areas. The prevalence of *T. cruzi* antibodies in the donors coming from endemic areas was 0.8% and 75% of those who tested positive were from Bolivia [3].

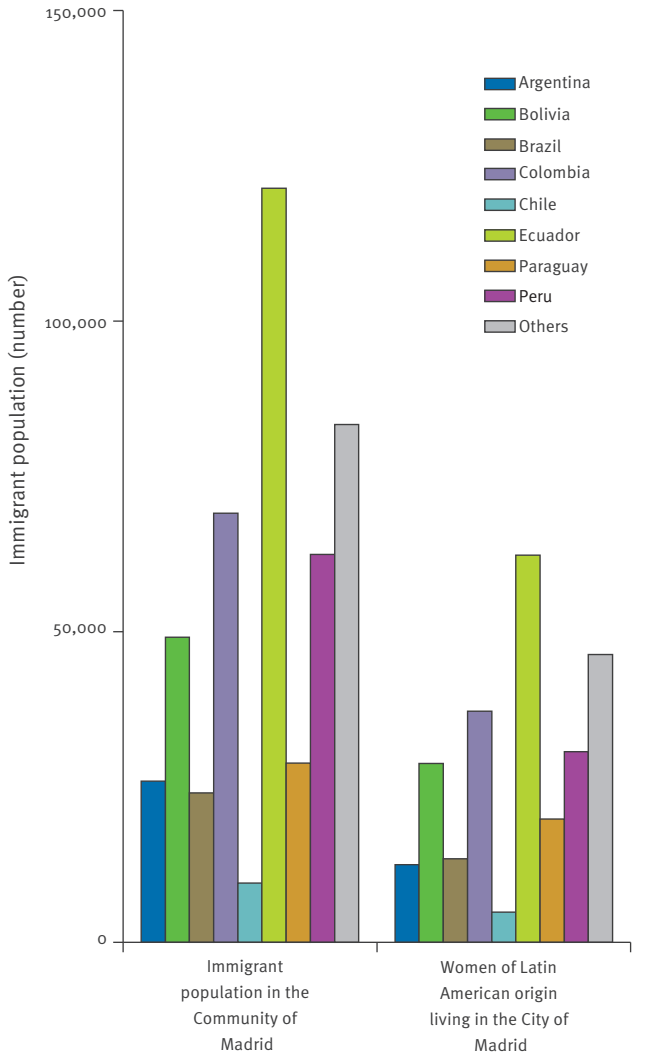
Since September 2005, in accordance with the Royal Decree RD1088/2005 [4], all blood transfusion centres in Spain have been obliged to carry out serological screening of the population considered to be at risk [4]. This means that they systematically exclude from donation individuals (i) who come from areas where Chagas disease is endemic, (ii) who were born to mothers from such areas, and (iii) who have received transfusions or have spent prolonged periods of time in such areas (one month or longer in mainly rural areas) [5,6]. In the past 22 years, there have been at least six cases of transfusional Chagas disease in Spain: one of them was reported in Madrid and proved fatal [7,8].

Another important mode of infection is vertical transmission from a seropositive mother to her child during pregnancy or delivery. At present, there is no national Spanish policy that establishes monitoring of Chagas disease in pregnant women and their newborns. Only the Autonomous Communities of Valencia and Catalonia have regulations in place and have systematically performed screening since November 2007 and February 2009, respectively [9,10]. Nevertheless, it is important to mention that there are different initiatives in other Communities. To date, cases of congenital infection have been reported in Valencia, Catalonia, Murcia, Aragon, the Basque Country and Andalusia [1].

In Madrid, as in other areas of Spain, the birth rate has increased among the migrant population in the last five years. In 2009, of the 35,038 deliveries registered in Spain to mothers from Latin America, 9,171 (26.2%) were to mothers resident in Madrid. The most common countries of origin of these mothers were: Ecuador, Colombia, Bolivia and Peru (27.9%; 12.9%; 12.7% and 11.7%) [2].

Figure

Immigrant population and women born in Latin America and registered in the Municipal Register of Madrid, Spain, January 2010



Source: Spanish Statistical Institute (www.ine.es).

Currently, the only way to control Chagas disease in pregnant women is determining the presence of *T. cruzi* antibodies in those who come from areas where the infection is endemic, thus facilitating early diagnosis and treatment of congenital infection and also allowing postnatal treatment of the mother to reduce the risk of transmission in future pregnancies. Therefore, the main objective of this report is to describe and assess different programmes to monitor pregnant women coming from different areas in Latin America, because treatment of children leads to a cure rate next to 100% whereas it is much lower in adults [11].

Material and methods

The serological screening of pregnant women at risk of *T. cruzi* infection was implemented within the framework of the Working Group on Chagas Disease of the Madrid Autonomous Community. This study assesses observationally and retrospectively the general coverage of the screening programme, the prevalence of infection and the rate of congenital transmission. The study included seven hospitals serving 48.5% (3,131,315 of 6,458,684) of the population of the Autonomous Community of Madrid, according to INE data in January 2010.

The programme included meetings to inform healthcare personnel and managers in the public hospitals involved and to draw attention to the need to incorporate a test to detect *T. cruzi* antibodies as an additional routine test performed on pregnant women from areas where Chagas disease is endemic.

Since there is no standard reference test, each hospital chose a serological test in accordance with its infrastructure. This determined the type of screening, which was either universal (applied to all pregnant women from countries where the disease is endemic - option 1; or to all pregnant women from Latin America - option 2) or selective (applied only to pregnant Bolivian women - option 1; or to pregnant Bolivian women plus pregnant women born in both low-risk and high-risk areas according to maps indicating distribution in particular countries or other risk indicators - option 2). For this last option, all pregnant Bolivian women were considered to be from a high-risk area, and the rest of Latin American pregnant women were considered to come from low-risk areas. The serological screening for Chagas of low-risk pregnant women was carried out taking into account the recommendations and maps for the selection of blood donors [5,6,12] and their clinical epidemiological background.

On the other hand, depending on the specific organisation of each hospital and the attendance of pregnant women at their prenatal sessions, serological screening was systematically performed only in the first or

second trimester, or at any moment of the pregnancy including delivery (Table 1).

For the detection of cases of congenital infection, an agreed follow-up protocol was used which involved monitoring children born to seropositive mothers during the first nine months of life [13]. Tests were performed at delivery, after one month, and at nine months of age, while the option of performing more tests during the first nine months was not ruled out. The parasite detection was carried out by direct microscopic observation, microhaematocrit test [15] and PCR [8].

Data were collected via a form designed for the analysis of aggregate data. The coverage of each screening programme was calculated as the proportion of pregnant women tested of the total number of pregnant women attending the seven hospitals from areas where the disease is endemic, from January 2008 to December 2010. The overall prevalence was calculated as the proportion of pregnant women confirmed as positive of the total number of pregnant women tested. Any pregnant woman born in Cuba, the Dominican Republic or any other country where Chagas disease is not endemic, was excluded from the analysis. The prevalence by country of origin was defined as the proportion of pregnant women confirmed as positive from each country of the total number of pregnant women tested from that country. For this last calculation, the data used were those from hospitals that recorded the country of origin of the entire population of pregnant women included in the programme (five of the seven hospitals).

The rate of congenital transmission was calculated as the proportion of children infected of the total number of pregnant women confirmed as positive.

Table 1

Characteristics of hospitals and screening programmes for *Trypanosoma cruzi* infections in pregnant women, Madrid, Spain, January 2008–December 2010

Hospital	Number of beds	Attending population	Number of deliveries (2010)		Start date of screening	Type of screening	Screening tests	Confirmation / Complementary tests[a]
			Total	Endemic zone / Bolivia				
1	1,750	750,000	7,513	1,826 / 443	Jul 2008	Selective[b] (pregnancy or delivery)	ICT[c]	ELISA + IFI / PCR
2	1,328	787,000	6,599	1,359 / 191	Dec 2007	Selective[d] (pregnancy or delivery)	ICT[e]	ELISA + IFI / PCR
3	616	397,083	3,193	272 / 15	Nov 2008	Universal[f] (first trimester)	ICT[c] (Nov 2008-Feb 2010); ELISA[a] +IFI[a] (Feb-Dec 2010)	ELISA + IFI / PCR
4	630	213,654	2,010	81 / 2	Oct 2008	Universal[g] (2008-2009 first trimester; 2010 second trimester)	ELISA[a]+IFI[a]	ELISA + IFI
5	362	264,691	2,288	115 / 3	Jan 2008	Universal[f] (first trimester)	ELISA[a]+IFI[a]	ELISA + IFI / PCR
6	447	189,359	1,647	123 / 6	Feb 2008	Universal[g] (pregnancy or delivery)	ELISA[h]/ ICT[c]	ELISA + IFI / PCR
7	1,136	529,528	2,700	361 / 77[i]	Mar 2008	Universal[g] (pregnancy or delivery)	ICT[g] + ELISA[j]	ELISA + IFI

ELISA: Enzyme-linked immunosorbent assay; ICT: Immunochromatographic test; IFI: Indirect immunofluorescence; PCR: Polymerase chain reaction.

[a] In-house tests at the National Microbiology Centre, Instituto de Salud Carlos III [14].

[b] Pregnant women from Bolivia or risk areas according to maps indicating distribution in particular countries, and pregnant women with any other previous clinical or epidemiological risk.

[c] Simple Stick Chagas (Operon S.A., Zaragoza, Spain).

[d] Only Bolivian pregnant women.

[e] Ab Combo Rapid Test (CTK Biotech. Inc., San Diego, USA).

[f] Pregnant women from Latin America except Cuba and the Dominican Republic.

[g] Latin American women without exceptions.

[h] Bioelisa Chagas (Biokit, Lliça d'Amunt, Spain).

[i] Initially monitored in Hospital 7, delivery in Hospital 1.

[j] Chagas ELISA (Vircell S.L., Granada, Spain).

Results

The characteristics of the hospitals, number of deliveries, start date of screening, type of screening, and both screening and confirmation tests are described in Table 1. Two hospitals carried out the selective serological screening and the rest adopted a universal screening. The proportion of deliveries to women from areas where the disease is endemic over the total number of deliveries attended in 2010 for each hospital, ranged from 4% (81/2,010) in Hospital 4 to 24.3% (1,826/7,513) in Hospital 1 (Table 1). The coverage of monitoring only reached 100% in the hospitals that adopted a universal serological screening programme (all pregnant women from Latin America, without excluding those who came from countries where the disease is not endemic) at any moment during the pregnancy as well as at delivery (Hospital 6 and 7). The hospitals that adopted a universal screening programme systematically applied in the first or second trimester of pregnancy, did not cover pregnant women who were only attended at the time of delivery, Hospitals 3, 4 and 5 (Table 2).

A total of 3,839 pregnant women were tested, and the overall prevalence was 3.96% (152/3,839). The hospitals that adopted a universal screening programme found a prevalence between 0.5% (Hospital 5) and 4.2% (Hospital 7). In contrast, the hospitals that selectively screened only pregnant Bolivian women (Hospital 2) or pregnant Bolivian women plus pregnant women from other countries with clinical and epidemiological background (Hospital 1) registered a prevalence of 10% and 6.2%, respectively (Table 2). The data from Hospitals 1, 2, 3, 4 and 6 which had recorded the country of origin of the pregnant women included in the study identified a prevalence of 11.4% in Bolivian women. Data from hospitals which had not recorded the country of origin indicated a 3.1% prevalence in all the Latin American pregnant women. The prevalence in pregnant women from other countries was not calculated, as the data regarding distribution by country of origin were incomplete (Table 3). The rest of seropositive women were from Argentina, Colombia, Paraguay and Peru. Detectable parasitaemia was present in 44% (27/62) of all the pregnant seropositive women who were tested by PCR (Table 2).

Four infected children were detected and they were all born to Bolivian mothers. Given that 95.4% (145/152) of seropositive mothers were from Bolivia, the overall rate (2.6%) of congenital transmission was similar to that for Bolivians (2.8%). Three of the four children were born asymptomatic and two of them received specific treatment with benznidazole in the hospitals where they were diagnosed. The first child was monitored during 15 months. The parasitological tests were negative after treatment (two months). Serological tests returned a negative result three months after treatment and they remained negative for the whole monitoring period (15 months). The other child was diagnosed in December 2010, parasite clearance was

Table 2

Distribution of the pregnant women included in the study and cases of congenital transmission of *Trypanosoma cruzi* infections by hospital, Madrid, Spain, January 2008–December 2010 (n=3,839)

Hospital	Number of pregnant women						Congenital cases (%)	
	Tested before December 2010	Coverage %	Positive screening test	Confirmed positive[a]	Prevalence[b] %	Positive PCR		
1	257	31[c]/26[d]	30	16 / 18	6.2	7 / 15	2[e]	(12.5)
2	521	100[c]/38[d]	53	52 / 53	10	15 / 40	1[f]	(1.9)
3	292	452	4	4 / 4	1.4	1 / 2	0	(0.0)
4	209	NC	7	2 / 4	1	ND	0	(0.0)
5	219	NC	3	1/ 3	0.5	1 / 1	0	(0.0)
6	639	100[d]	13	6 / 9	0.9	3 / 4	1[g]	(16.7)
7	1,702	100[d]	71	71 / 71	4.2	ND	0	(0.0)
Total	**3,839**		**181**	**152 / 165**	**4**	**27 / 62**	**4**	**(2.6)**

NC: not calculated; ND: not determined.

[a] Number of women confirmed as positive compared to those pregnant women with a positive result in the screening.

[b] Calculated from the number of pregnant women confirmed as positive out of the total number of pregnant women tested.

[c] Based on the number of pregnant women tested out of the total number of deliveries to Bolivian women (selective screening).

[d] With respect to the total number of pregnant women from areas where infection is endemic (universal screening).

[e] Diagnosed using PCR and direct observation.

[f] Diagnosed using microhaematocrite and PCR.

[g] Diagnosed using PCR in two independent samples.

obtained one month after treatment and in March 2011 serology was still positive. This child is currently under serological monitoring. The mother of the third asymptomatic child moved to another region where the treatment and follow-up were completed. The fourth child was born with Down's syndrome and congenital cardiopathy. It was treated first with benznidazole, and then with nifurtimox. After recovering from *T. cruzi* infection, it died suddenly at the age of nine months.

Discussion

According to estimates from the Pan American Health Organization (PAHO), the number of people infected with *T. cruzi* in Latin America has come down from the 20 million that they estimated in the 1980s to 8 million in 2005 [16]. This reduction is believed to have been achieved due to the different control initiatives that have been set up (Southern Cone Initiative to Control/ Eliminate Chagas Disease - INCOSUR, Initiative of the Andean Countries to Control Vectoral and Transfusional Transmission of Chagas Disease - IPA, Andean´s Countries Initiative for controlling Chagas disease - ICA and Initiative of the Amazon Countries for Surveillance and Control of Chagas Disease - AMCHA) and the commitment of the governing authorities in each of the countries involved.

Table 3

Distribution and prevalence of *Trypanosoma cruzi* infection in pregnant women by country of origin, Madrid, Spain, January 2008–December 2010 (n=3,839)

Country of origin	Number (%)	Number of confirmed positive cases	Prevalence %
Colombia	239 (13.3)	0	0
Ecuador	379 (21.1)	0	0
Peru	192 (10.7)	0	0
Venezuela	18 (1)	0	0
Brazil	39 (2.2)	0	0
Bolivia	798 (44.4)	91	11.4
Chile	15 (0.8)	0	0
Paraguay	60 (3.3)	0	0
Argentina	17 (0.9)	0	0
Nicaragua	4 (0.2)	0	0
Other	38 (2.1)	0	0
Total pregnant women from countries where the disease is endemic	1,799 (100)	91	5.1
Total pregnant women from countries where the disease is not endemic	59 (100)	0	0
Data not available[a]	1,981 (100)	61[b]	3.1
Total	**3,839 (100)**	**152**	**4**

[a] Hospitals that did not collect information on the country of origin.

[b] Includes pregnant women from: Bolivia (n=54); Argentina (n= 1); Paraguay (n=1); Colombia (n=2); Peru (n=2) and of unknown origin (n=1).

In the past, Spain has registered cases associated with the three main modes of infection in non-endemic regions: transfusion of blood products [7,8], organ transplantation [17] and vertical transmission [18-20] At present, according to the Royal Decree 1088/2005 [4], blood donations from donors who come from areas considered to be at high risk, or with a history of being exposed to high risk, must be tested in order to avoid the use of contaminated blood. The same measures were adopted by the Spanish National Transplant Organization [21,22]. However, there are no national regulations in Spain for the monitoring of pregnant women from areas where the disease is endemic.

This paper shows that, given the absence of regulations, each hospital adopted a screening programme that fitted its own organisation and facilities, and this means that the current monitoring programmes have variable coverage.

Despite the lack of homogeneity, according to the data collected, the observed overall prevalence of seropositive pregnant women coming from endemic areas for Chagas disease of 3.9% (152/3,839) was similar to that described in hospitals in Catalonia and Valencia: 3.4% (46/1,350) and 4.7% (29/624), respectively. However, the prevalence reported here among pregnant Bolivian women in Madrid (11.4%) was lower than that reported in other studies carried out in Catalonia and Valencia, 22% (42/46) and 17.5% (24/29), respectively [18,23]. As in those studies, the pregnant women who tested positive generally came from Cochabamba and Santa Cruz, regions in Bolivia where the disease is hyperendemic. Since data were not collected on pregnant Bolivian women who tested negative, it is probable that the difference in prevalence between regions in Spain reflects the origin of the Bolivians living in those regions and the prevalence in those areas of origin [24]. On the other hand, the overall rate (2.6%) of congenital transmission found in Madrid was lower than that reported in Catalonia (7.3%) [18], although the proportion of pregnant women with detectable parasitaemia was similar (27/62 in Madrid compared with 18/35 in Catalonia). Taking our data into account, it can be concluded that there are two possible screening options: (i) screen only pregnant Bolivian women (the high-risk population), or (ii) screen all pregnant women from areas where the disease is endemic. In 2008 when the programme began, there were insufficient automatic high-throughput serological tools, but this situation has changed in the recent years. At present, testing pregnant women for *T. cruzi* antibodies when they first come into contact with the healthcare system, would represent a cost of approximately EUR 2 each, if this test is added to the tests for ToRCHeS syndrome (Toxoplasma, Rubella, Cytomegalovirus, Herpes simplex, syphilis, HIV). Taking into account the data in Table 3, the screening of the 798 Bolivian women would have costed EUR 1,596 for the three years. This means that the detection of one congenital case would cost on average EUR 399. If universal screening was carried

out, the detection of one congenital case would cost EUR 1,920 (3,839 x EUR 2 / 4 congenital cases). Thus, selective screening of pregnant Bolivian women is more cost-effective than screening all pregnant women from areas where the disease is endemic. However, it is important to highlight that cases of congenital infection were also reported in children born to Argentinean mothers [19,20]. If screening is not carried out under either of these protocols, the question would remain on the cost to be incurred by the healthcare system for the treatment of 30% to 50% of these children who would develop severe forms of Chagas disease in the future.

Furthermore, the monitoring of pregnant women also offers the possibility of detecting other adult family members for the first time, together with the detection of children whose condition was previously overlooked. According to data from one of the hospitals included in this study, between three and five affected family members can be detected together with every pregnant infected woman identified (E Vilalta, personal communication, February 2011). As the immigrant population is predominantly composed of young adults [18,23] monitoring pregnant women would facilitate not only the treatment of infected children, but also the passive detection of the relatives and the other infected immigrants who could be treated. Thus, universal serological screening is an important ethical requirement and would still prove to be cost-effective by reducing the risk of developing severe illness that may result from infection.

Conclusion

Monitoring of pregnant women only reaches full coverage if universal screening of pregnant women from Latin America is carried out at any moment of pregnancy, including the delivery. A common national regulation is necessary in order to ensure homogenous implementation of screening. Thus, newborns can be cured if they are treated at an early stage of the disease.

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