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Economic evaluation of Chagas disease screening of pregnant Latin American women and of their infants in a non endemic area

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ABSTRACT

Migration is a channel through which Chagas disease is imported, and vertical transmission is a channel through which the disease is spread in non-endemic countries. This study presents the economic evaluation of Chagas disease screening in pregnant women from Latin America and in their newborns in a non endemic area such as Spain. The economic impact of Chagas disease screening is tested through two decision models, one for the newborn and one for the mother, against the alternative hypothesis of no screening for either the newborn or the mother. Results show that the option "no test" is dominated by the option "test". The cost effectiveness ratio in the "newborn model" was 22 €/QALYs gained in the case of screening and 125 €/QALYs gained in the case of no screening. The cost effectiveness ratio in the "mother model" was 96 €/QALYs gained in the case of screening and 1675 €/QALYs gained in the case of no screening. Probabilistic sensitivity analysis highlighted the reduction of uncertainty in the screening option. Threshold analysis assessed that even with a drop in Chagas prevalence from 3.4% to 0.9%, a drop in the probability of vertical transmission from 7.3% to 2.24% and with an increase of screening costs up to €37.5, "test" option would still be preferred to "no test". The current study proved Chagas screening of all Latin American women giving birth in Spain and of their infants to be the best strategy compared to the non-screening option and provides useful information for health policy makers in their decision making process.

1. Introduction

Chagas disease is a parasitic disease caused by *Trypanosoma cruzi*. The disease is endemic in Latin America and shows very heterogeneous levels of prevalence across, as well as within countries. The vector responsible for spreading the parasite is a bug living in the poor rural areas as well as in the outskirts of the main urban centres: this makes Chagas a disease of poorer people (WHO, 2002).

The acute infection, consisting in a self-limited febrile illness, is often unrecognized. The acute phase of the infection precedes the chronic phase. It is estimated that around 30–40% of chronically infected individuals will develop symptomatic heart or gastrointestinal diseases, usually between 10 and 25 years after contracting the infection. The indeterminate phase is the period of infection with neither symptoms nor signs of cardiac/gastrointestinal tract involvement. Around two thirds of the infected people remain in the indeterminate phase for life (Rassi et al., 2010).

The current treatment for Chagas disease consists in Benznidazole or Nifurtimox. The efficacy of these two drugs depends on the age of the patient, and on the time since the infection is established: best therapeutic results are shown in acute or recent infections, and cure rates close to 100% have been reported in children treated in the first year of life (Oliveira et al., 2010; Viotti et al., 2009). Beneficial effects of antiparasitic treatment in adult chronic infections remain debated (Sosa Estani et al., 1998).

Chagas disease is a public health issue in non-endemic countries as a consequence of a social phenomenon characterizing the same subset of poor people that are most exposed to Chagas disease in endemic areas: migration (Frank et al., 1997; Schmunis, 2007). Immigrants from Latin America are not the only potential victims of the disease. In non-endemic areas, transmission through blood derivates, organ transplant and through vertical transmission is an increasing problem (Munoz et al., 2007; Piron et al., 2008; Tibayrenc and Telleria, 2010). Spain is a frequent destination of immigration from Latin America. Currently, around 1.7 million migrants from endemic Latin-American countries live in Spain. The Bolivian community, the group most affected by Chagas disease, is composed of 236,048 immigrants and 103,291 of them are women of fertile age (Instituto Nacional Estadistica (INE))

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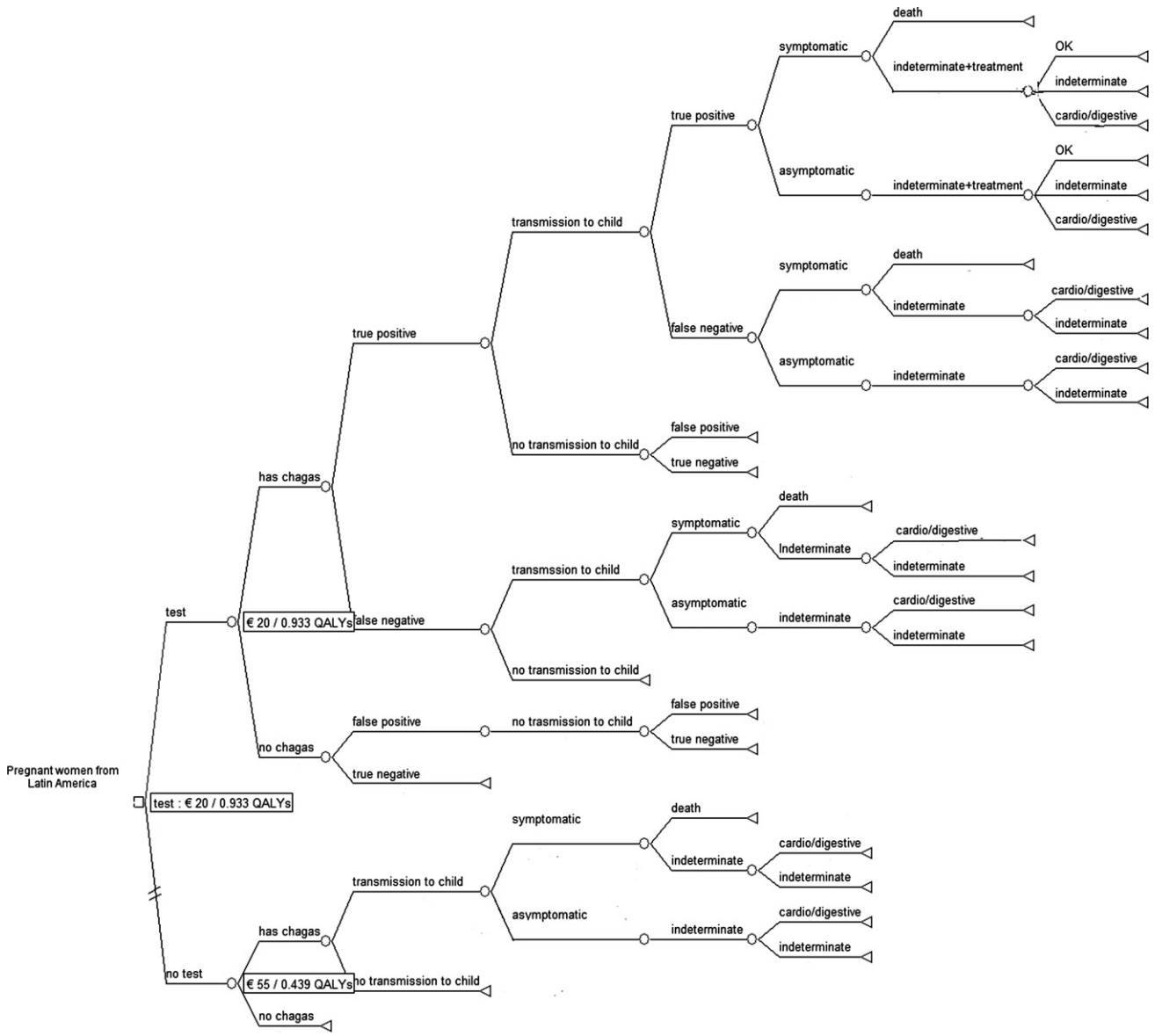

Fig. 1. Decision tree (newborn model). The decision tree shows expected values at terminal nodes; reported probabilities represent the mean values of the distributions assigned to each input variable.

The magnitude of Chagas disease in Spain has been shown in a study conducted at the maternity wards of two hospitals of Barcelona (Munoz et al., 2009). Results showed a prevalence of Chagas of 3.4% among Latin American pregnant women and a vertical transmission rate of 7.3%. Considering that 707,000 Latin American women of fertile age were present in Spain at the time of the study and assuming one pregnancy only per woman, the study highlighted the possibility to have around 1750 infected newborn over about 10 years.

Pregnancy and delivery of Latin American women living in Spain are crucial moments for the Spanish National Health System (SNHS) to detect and treat the disease: antenatal clinic attendance is one of the most certain contacts, often the only one, Latin American women experience with the SNHS (Gascon and Pinazo, 2008).

Because of the high variability of prevalence of the disease across and within endemic countries, it would be difficult to identify which women from Latin America should receive *T. cruzi* screening and which should not, by simply depending on their country of provenience. At the same time, many screening tests offer a cheap and precocious diagnosis of Chagas and, especially in infants, they allow to start an early treatment which could avoid almost all negative consequences of the progression of the disease later in life.

Just a few economic evaluations have been conducted on Chagas disease interventions (Basombrio et al., 1998; Castillo-Riquelme et al., 2008; Miyoshi et al., 1994; Vazquez-Prokopec et al., 2009; Wilson et al., 2005), with only one focusing on the economic aspects of congenital transmission in an endemic area (Billot et al., 2005).

This is the first study analysing the economic convenience of undertaking Chagas disease screening to all pregnant women from Latin America in a non endemic area, providing decision makers with a model able to assess which is the best option between screening or not screening. To do this, the current study aims to evaluate the convenience of undertaking Active Detection of the Infection (ADI) in all Latin American pregnant women in Spain when they attend the antenatal clinic (ANC) and if they have a positive result, then an ADI is repeated in their newborn. The intervention includes treatment to mother and children with positive screening results. Two decision models using epidemiological data with reference to the study conducted in Barcelona is estimated (Munoz et al., 2009). Economic data were collected at one of the

hospitals where the vertical transmission study was undertaken. Both costs and benefits of the screening are considered. Benefits are the avoided costs, thanks to a precocious diagnosis, of treating Chagas disease sooner rather than later in life, when the disease would be much more developed.

2. Materials and methods

A cost-effectiveness analysis of the unique intervention consisting in Chagas disease screening and treatment in case of positive result, of Latin American pregnant women and of their infected children, was developed using two separate decision models (Ades et al., 1999; Claxton et al., 2002; Drummond et al., 2008; Gold, 1996). The intervention towards the mother and the child was split into two models in this economic evaluation for methodological reasons only. Specifically, some parameters take different values for the mother and the child, e.g. cost and efficacy of the treatment and probability of infection, leading to the need of evaluating separately costs and benefits related to the two recipients of this intervention.

(1) *Model 1*: Decision tree focused on the newborn. This model compared the option of undertaking the test with the option of not undertaking any test, in the mother and, if she is positive, in the newborn. The tree developed, then, considering costs and benefits of an early diagnosis and the consequent treatment of the newborn only.
(2) *Model 2*: Decision tree focused on the mother. This considered the option of undertaking the test, against the option of not undertaking it, as well as the eventual treatment, of the mother only.

Data analysis was undertaken using Tree Age Pro 2008.

2.1. The models

All input parameters, as well as the information about distributions used in the probabilistic sensitivity analysis, are reported in Table 1.

Both models considered sensitivity and specificity values of the screening, as well as all the costs associated with treating false positive cases and not treating false negative cases.

Model 1. Fig. 1 considered the probability of vertical transmission conditioned on the prevalence of Chagas disease in pregnant mothers; the latter was interpreted as probability for the mother of being infected. If vertical transmission occurs, Chagas disease in the newborn can present as symptomatic or asymptomatic. If symptomatic, it can lead to death or it can develop into indeterminate phase. The indeterminate phase can last for life or it can develop into chronic, cardiac or digestive problems. In the case of absence of symptoms, the disease can remain indeterminate for life or, alternatively, it can develop into cardio-digestive problems during adulthood. In the "test" arm of the tree, if Chagas disease is correctly diagnosed in infants (conditioned on being correctly diagnosed in the mother), the treatment starts and the probability for the baby to be completely cured is 100%. If Chagas is not diagnosed or not correctly diagnosed and, thus, not immediately cured, all potential future medical costs, including screening costs, consequent to a delayed symptomatic manifestation of the disease are considered (Fig. 2).

Model 2. Fig. 3 considered the probability of the disease to be symptomatic or asymptomatic in mothers and, if symptomatic, to develop into indeterminate or chronic forms of the disease, as a function of Chagas disease prevalence. If Chagas disease is correctly diagnosed, treatment can start and the probability to stop the progression of the disease is between 40 and 70%. If Chagas disease is not diagnosed and, thus not immediately cured, all future potential medical costs, including screening costs, relative to a delayed symptomatic manifestation of the disease are considered.

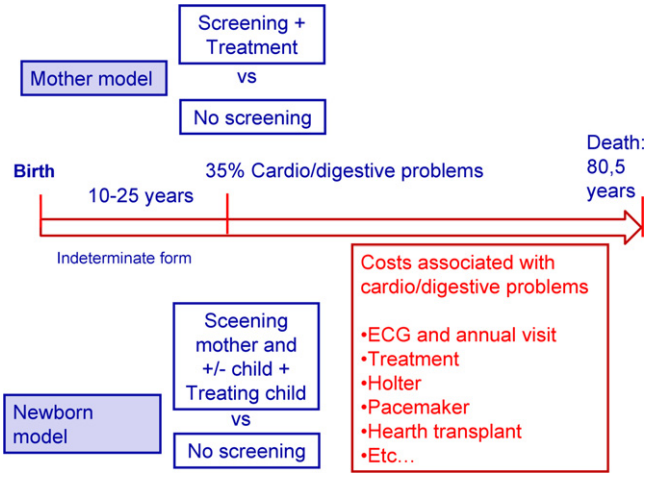

Fig. 2. Life long pattern of care of an infant Chagas infected from vertical transmission.

2.2. Intervention and associated costs

Costs of the intervention were the costs of the test and the cost of the treatment (Benznidazole) in cases of positive test. In the case of the child, serology is undertaken at nine months of age, following a parasitological diagnose at birth using microhematocrit technique. In the case of the mother Chagas disease test consists of a serology during pregnancy. Serology (crude and recombinant antigens) is always confirmed with a second test for diagnosis purposes. Average total screening costs include, thus, recurrent costs imputable to both the parasitological and serological tests, such as materials and consumables, as well as the value of time of the personnel involved. As a result, a screening test was estimated to cost, on average, €10. While screening cost is the same for the mother and the newborn, being calculated by averaging all the cost components for the two recipients, the cost of the treatment differs because the dosage is diverse for children (7.5–10 mg/kg/d/60 d) than for adults (5 mg/d/60 d).

2.3. Costs of treating the consequences of Chagas disease

The consequences of Chagas disease can result in a series of life-long treatments and medical visits. The potential pattern of care Chagas disease could lead to, for a newborn who contracts the infection from the mother, is represented in Fig. 2. Although Fig. 2 focuses on the newborn, the same pattern of cares and associated costs, were also considered for the mother who contracted the infection in the country of origin.

After an indeterminate phase of between 10 and 25 years around 35% of cases develop cardio/digestive problems. Cardio digestive problems due to Chagas disease, in addition to the pharmacological treatment, implies the need of an electrocardiography (ECG) and a medical visit every year, a Doppler every five years, a probable Holter, a probable pacemaker, and as far as a probable heart transplant.

Differently from Castillo-Riquelme et al. (2008), the use of resources for Chagas treatment was not taken from patients' records. This information was, instead, derived from interviews

Table 1
Economic evaluation of Chagas disease screening: input variables.

Input variable	Details of variable	Probability distribution	Sources
Intervention cost	Estimated average screening cost	Triangular Mean: €10	Our estimate
Chagas prevalence	Chagas prevalence among pregnant women	Triangular Mean: 0.034	Munoz et al. (2009)
Congenital transmission	Probability of vertical transmission	Triangular Mean: 0.073	Munoz et al. (2009)
Test sensibility	Probability of false negative	Triangular Mean: 0.995	Flores-Chávez et al. (2010)
Probability of syntomatic Chagas	Probability Chagas presents syntoms	Triangular Mean: 0.075	Prata (2001), Rassi et al. (2010)
Test specificity	Probability of false positive	Triangular Mean: 0.99	Flores-Chávez et al. (2010)
Case fatality rate in case of symptomatic disease	Probability of death in case of symptomatic disease	Triangular Mean: 0.075	Pinto Dias (2000)
Chronic infection if symptomatic	Probability Chagas in indeterminate phase	Triangular Mean: 0.925	Pinto Dias (2000)
Prevalence of cardio-digestive	Probability of cardio-digestive consequences	Triangular Mean: 0.35	Pinto Dias (2000), Prata (2001)
Efficacy of treatment in children	Efficacy of treatment in children	Triangular Mean: 1	Suarez et al. (2005)
Efficacy of treatment in adults	Efficacy of treatment in adults	Triangular 0.55	Pinto Dias (2000), Viotti et al. (2006)
Prob. colonic barium X-ray	Probability to undertake a colonic barium X-ray	Triangular Mean: 0.20	Based on clinical experience
Prob. Holter monitor	Probability to undertake Holter	Triangular Mean: 0.10	Based on clinical experience
Prob. effort cardiac ultrasonography	Probability to undertake an effort cardiac ultrasonography	Triangular Mean: 0.08	Based on clinical experience
Prob. pacemaker	Probability pacemaker is necessary	Triangular Mean: 0.02	Based on clinical experience
Prob. automatic implantable defibrilator	Probability automatic implantable defibrilator is necessary	Triangular Mean: 0.03	Based on clinical experience
Prob. intestinal transit test	Probability intestinal transit is necessary	Triangular Mean: 0.20	Based on clinical experience
Prob. heart transplant	Probability heart transplant is necessary	Triangular Mean: 0.01	Based on clinical experience
Prob. digoxina	Probability of prescribing Digoxina	Triangular Mean: 0.05	Based on clinical experience
Initial indeterminate form	Period (years) of indeterminate form after infection	Uniform (10; 25)	Rassi et al. (2010)
Years rent	Duration of periodical cares in chronic phase	Triangular Mean: 55.5	Our estimate based on life expectancy and duration of initial indeterminate form
Discount rate	Factor to calculate the present value of costs for Chagas treatment	Triangular Mean: 0.03	Assumed
LE at birth	Average life expectancy at birth in Spain	Triangular Mean: 80.5	Spanish National Institute of Statistics
LE with Chagas	Average life expectancy at birth with “uncomplicated” Chagas	Triangular Mean: 80.13	Spanish National Institute of Statistics and Wilson et al. (2005)
Weight cardiac	Weight applied in QALYs calculation in case of cardiac/digestive complications	Triangular Mean: 0.72	Our elaboration from Wilson et al. (2005)
Weight death	Weight applied for QALYs calculations in case of death	0	Wilson et al. (2005)
Weight health	Weight applied for QALYs calculations in case of perfect health	1	Wilson et al. (2005)
Weight indeterminate	Weight applied in QALYs calculation in case of indeterminate phase	Triangular Mean: 0.96	Our elaboration from Wilson et al. (2005)
YLL	Years of life lost	Triangular Mean: 0.44	Our elaboration from Wilson et al. (2005)

with clinicians who reported the pattern of treatment and examinations.

Costs of all visits and tests were taken from the price list of the Hospital Clínic of Barcelona (Table 2), one of the major hospitals in the country and one of fewer where Chagas disease is known and studied. In order to have the real cost of every clinical service, prices were reduced by a structural margin of and, where applicable, of a mark up (Adam et al., 2003; Cohen et al., 1993; Nigrovic and Chiang, 2000; Zupancic et al., 2003).

Two different types of costs apply to Chagas disease treatment: recurrent and non-recurrent costs. Recurrent costs can be split into yearly costs (ECG + general visits) and every five year costs (Ecocardio-Doppler). Non-recurrent costs, instead, are sustained just once during the life of Chagas disease patients (Holter, pacemaker, transplant, etc.). Both types of cost, recurrent and non-recurrent, are assumed to be faced after 25 years of indeterminate phase. The present value of non-recurrent costs, weighted by the probability that these could occur was estimated applying a 25-year discount factor (rate of 3%). Recurrent costs were treated as 2 participated rents, each with duration of 55.5 years (average life expectancy in Spain – 80.5 years – 25 years of indeterminate phase). The two rents have the following different characteristics:

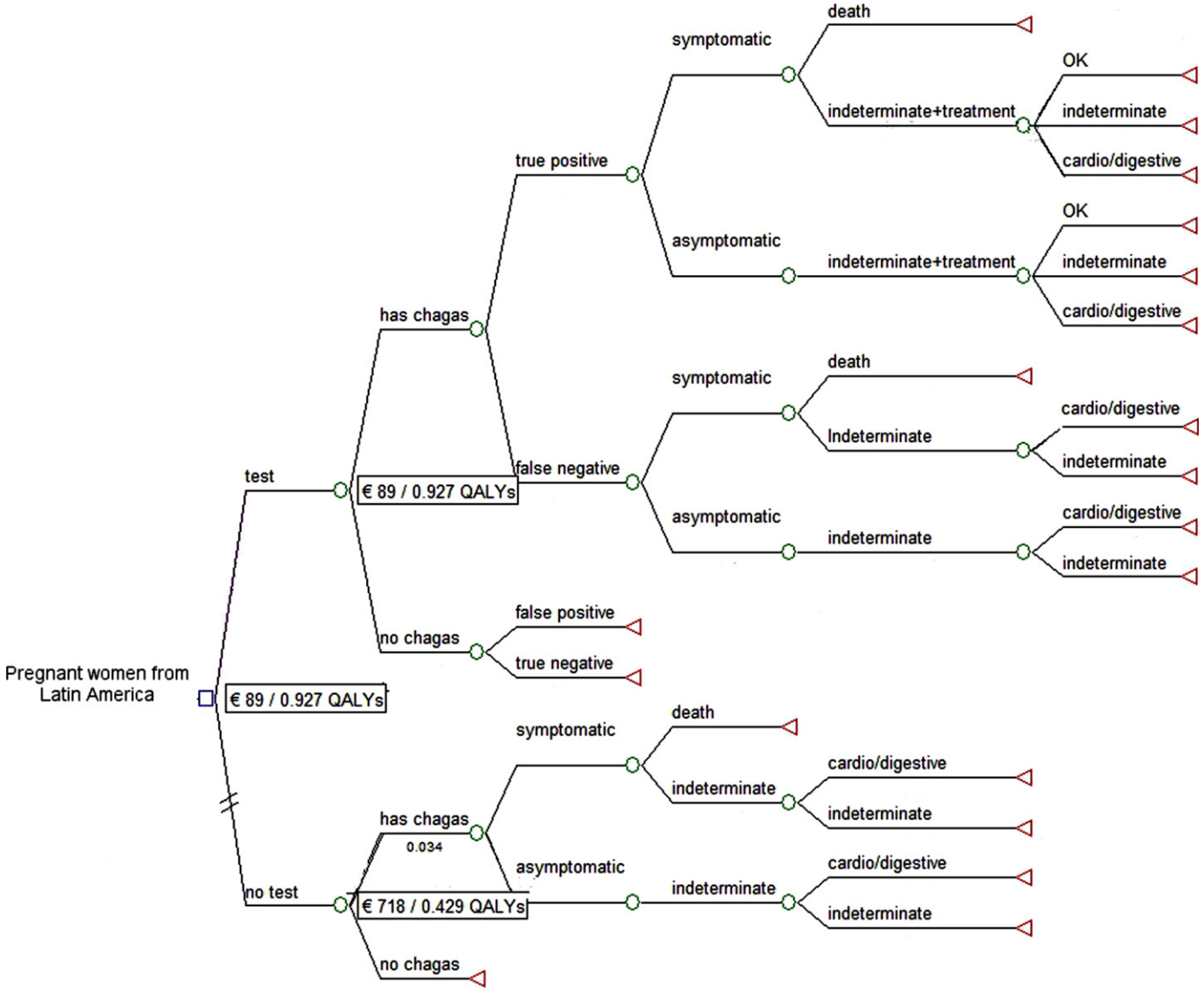

Fig. 3. Decision tree (mother model). The decision tree shows expected values at terminal nodes; reported probabilities represent the mean values of the distributions assigned to each input variable.

Table 2
Costs of treating Chagas.

Description of the health service	Price[a] (€)	Cost[b] (€)
Chest X-ray	22	20.35
Medical visit	129	119.325
Electrocardiogram	18	16.65
Cardiac ultrasonography	167	123.58
Holter	104	96.2
Electrophysiological study	1525.00	1128.5
Effort cardiac ultrasonography	273	202.02
Pace-maker implantation	2536.00	1876.64
Automatic implantable defibrilator	2804.00	2074.96
Hearth transplant	64,398.00	47,654.52
Intestinal transit	146	135.05
Colonic barium X-ray	83	76.775
Enalapril	90.72	
Digoxina	26.6	
Furosemida	30.12	

[a] Prices applied to the private or to the public (National Health Service) counterpart.
[b] Costs obtained reducing prices of a structural margin an of a mark up when applicable.

one is an "every five years" rent and the instalment is the cost of an Ecocardio-Doppler; the other is an annual rent in which the instalment is given by the cost of a medical visit plus the cost of an ECG.

The present value of the two rents at the year 25 was further anticipated at year zero by applying a discount rate of 25 years at the rate of 3%. No inflation was assumed. In the formula, the present value of the whole treatment process, among patients who develop cardio/digestive complications, considering both annual and every five years visits, and considering all necessary health interventions (with the probability that these may occur) is the following (details of variables in Tables 1 and 2):

Net present value of Chagas disease treatment among patients with cardio/digestive complications was calculated according to the following formula: $\frac{S+Rx+V+R+D*pd*[1-(1+\delta)^{-t}/\delta]+\sum_j^J A_J*[1-(1+\delta)^{-t}/\delta]+\sum_m^M B_m p_m}{(1+\delta)^T}$ where (see Tables 1 and 2): S is the screening cost; Rx is the X ray cost; V is the medical visit cost; R is the cost of Benznidazole; D is the cost of digoxina; p_d is the probability of digoxina; δ is the discount rate; t is the rent years; T is the indeterminate phase duration in years;

A_j ($j = 1, \ldots, J$) is the cost of a set of drugs and/or clinical tests; B_m ($m = 1, \ldots, M$) is the cost of a set of drugs and/or clinical tests; p_m ($m = 1, \ldots, M$) is the probability that m might happen.

2.4. QALYs

QALYs were calculated with reference to parameters estimated in (Wilson et al., 2005). This study estimated life expectancy with no Chagas disease, in Latin America, to be of 68.78 years and life expectancy with no vector control of the disease and with a very low annual incidence of Chagas disease (about 0.0015) to be of 67.91 years.

In Wilson et al. (2005), estimate of weights to adjust for quality of life loss due to time spent with the disease was based on a measure used for Disability Adjusted Life Years (DALYs). Specifically, this study used as a measure of quality weights for QALYs the reversed value of average disability weights calculated from two different sources (Akhavan, 1996; Murray and Lopez, 1996). As a consequence, quality weights used in the current study were 0.9625 for the indeterminate phase and 0.71705 for the case of cardio/digestive problems, the latter being an average between mild cardio problems – 0.769 – and strong cardio problems – 0.6651.

In the current study QALYs were calculated assuming a linear relationship between life expectancies estimated in Wilson et al. (2005) and life expectancy of a person with Chagas disease living in Spain, considering that life expectancy with no disease in Spain is 80.5 years (=average LE between men – 77 – and women – 84).

2.5. Sensitivity analysis

Because of the uncertainty existing around the parameters used, sensitivity analysis was a crucial part of the calculation (Briggs, 2000; Briggs et al., 2002). Both probabilities and costs were considered as distributions rather than as point estimates.

Monte Carlo simulations (10.000 interactions) were undertaken after assigning to all input variables a triangular distribution; the only case in which a uniform distribution was assigned was with reference to the variable representing the duration time of the indeterminate phase, being that this is constrained between 10 and 25 years and with no evidence of presenting any distributional picks.

Because in most of the cases no individual data were available, the ranges of the distributions assigned to variables were assumed to be 25% less and more than the mean or "most likely" values taken from various sources (Table 1); a wider range of 50% less and more than the mean value was assigned to the prevalence of Chagas among Latin American women because of the high variability that this parameter can assume (Blanco et al., 2000; Di Pentima et al., 1999); a lower bound of 5% was used for the distribution of the probability that the disease can be cured in infants.

Threshold analysis, based on one way sensitivity analysis, was undertaken on Chagas disease prevalence in Latin American pregnant women, on screening costs and on the probability of vertical transmission in Model 1; on Chagas disease prevalence in Latin American pregnant women in Model 2. Threshold analysis allowed the estimation of the cut-off points of Chagas prevalence and of probability of vertical transmission at which the choice between "test" and "no test" changes.

3. Results

"No test" is the dominated strategy in both decision trees. Table 3 reports the results of the cost-effectiveness analysis of the newborn's model and of the mother's model. Cost-effectiveness ratio of the strategy "test" in the newborn's model was 22 €/QALYs gained against 125 €/QALYs gained of the strategy "no test". Cost effectiveness ratio of the strategy "test" in the mother's model was 96 €/QALYs gained while this was 1675 €/QALYs gained in the "no test" strategy.

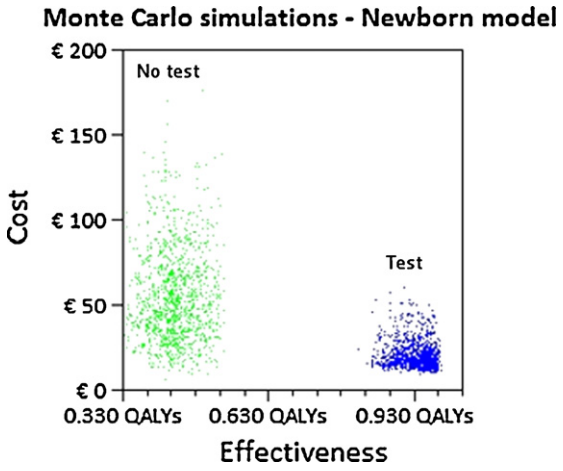

Fig. 4. Result of probabilistic sensitivity analysis – newborn model.

On average, undertaking the screening of a Latin American pregnant woman and, if positive, of the newborn, treating the newborn in the case of vertical transmission or, eventually treating the newborn in later years in case Chagas disease, despite the screening, was not correctly detected, today costs €20.4. Performing the screening on a Latin American pregnant woman, treating her in case of positive diagnosis or treating her in later years in case of false detection, today costs on average €89.

Output of Monte Carlo simulations (Table 4) confirmed results obtained through the deterministic analysis. Simulations also allowed to assess that the "no test" strategy presents a higher level of uncertainty as shown by the wider confidence intervals of all the "no test" outcomes. Probabilistic cost-effectiveness results of Monte Carlo simulations are shown in Figs. 4 and 5. Better performances of the strategy "test" both in terms of lower costs and higher effectiveness and a lower degree of uncertainty (represented by the narrowest cloud of simulated dots), are visible in both figures.

With reference to Model 1, threshold analysis showed that the best option switches from "test" to "no test" in case the prevalence of Chagas disease in Latin American pregnant women drops to 0.9% and below and in case the probability of vertical transmission drops

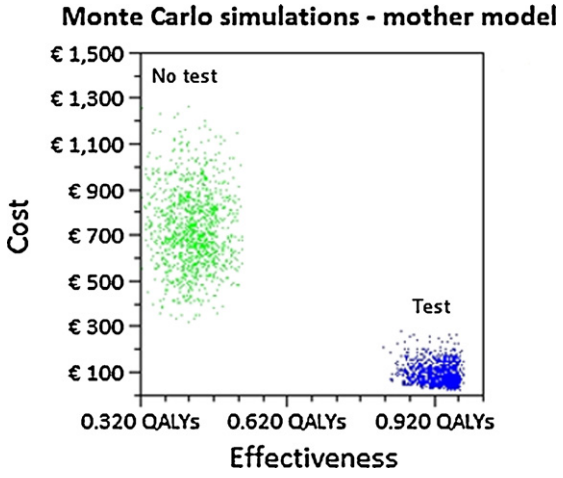

Fig. 5. Result of probabilistic sensitivity analysis – mother model.

Table 3
Cost effectiveness report of the newborn model.

Strategy	Cost	Incremental cost	Eff.	Incr. eff.	C/E	Incr. C/E (ICER)
Newborn model						
Test	€20.4		0.933 QALYs		22 €/QALYs	
No test	€55.0	€34.7	0.439 QALYs	−0.494 QALYs	125 €/QALYs	(Dominated)
Mother model						
Test	€89		0.927 QALYs		96 €/QALYs	
No test	€718	€629	0.429 QALYs	−0.499 QALYs	1675 €/QALYs	(Dominated)

Dominance report: the strategy "no test" is dominated by "test".
Extended dominance report: no strategies were eliminated by extended dominance.

Table 4
Results of sensitivity analysis.

Model	Strategy	Outcome	Mean value	Confidence interval (95%)	
Newborn	Test	Cost	€20	€11	€42
		Effectiveness	0.933 QALYs	0.860 QALYs	0.978 QALYs
	No test	Cost	€56	€15	€122
		Effectiveness	0.439 QALYs	0.354 QALYs	0.523 QALYs
Mother	Test	Cost	€89	€27	€197
		Effectiveness	0.927 QALYs	0.854 QALYs	0.974 QALYs
	No test	Cost	€720	€411	€1076
		Effectiveness	0.429 QALYs	0.345 QALYs	0.512 QALYs

to 2.24% and below (Table 5). The option "test" would no longer be chosen if screening costs increase beyond €37.5.

With reference to Model 2, threshold analysis showed that the best option switches from "test" to "no test" in the case the prevalence of Chagas in Latin American pregnant women drops to 0.3% and below (Table 5).

4. Discussion

This study shows that undertaking ADI of Chagas disease at the antenatal clinics of all Latin American pregnant women and, if they are positive, to repeat the test in their newborns is more cost-effective than not undertaking it. Not only is the "test" option cheaper for the health system than the option "no test", but also the quality of life insured to patients, expressed in terms of QALYs, considerably increases.

Furthermore, confidence intervals of the main outcomes estimated through Monte Carlo simulations undertaken in this study demonstrate that the option "test" dramatically reduces the uncertainty of costs (Briggs et al., 1999). The benefit of reducing confidence intervals is the lower uncertainty the health system faces when preparing its budget. Lower uncertainty in the economic planning also translates into better opportunities to better allocate resources within the health system. However, this may be especially true in the case of the mother rather than in the case of the newborn since for the newborn the moment in which the disease may present symptoms could be too far in the future to be considered within the budgetary plans of a national health system.

Table 5
Threshold analysis based on one way sensitive analysis.

Variable	Current value[a]	Cut-off point[b]
Newborn model		
Prevalence of Chagas in Latin American mothers	3.4%	0.9%
Probability of vertical transmission	7.3%	2.4%
Screening cost	€10	€37.5
Mother model		
Prevalence of Chagas in Latin American mothers	3.4%	0.3%

[a] Values used in the analysis.
[b] Value at which the best option would change from "test" to "no test".

Threshold analysis highlighted that even if Chagas disease prevalence and probability of congenital transmission were much lower, undertaking the test of all Latin American pregnant women and if positive, of their babies, would still be the best option to be taken. On one hand, threshold levels identified for prevalence (0.9%) and for congenital transmission (2.4%) allow to enforce findings of this study against a possible decrease of migration from Latin America and, in particular, from Bolivia to Spain (Pellegrino, 2004). On the other hand, these threshold levels do not allow to uncritically extend findings obtained in this study to areas where migration from Latin America and, in particular, from Bolivia is not as large as in Spain, such as the North of Europe and the United States (Bern and Montgomery, 2009).

The only study focused on the economic aspects of congenital Chagas disease was Billot et al. (2005). In comparison with Billot et al. (2005) the current study does not simply aimed to estimate costs associated with the intervention (screening plus treatment) and the costs of illness. The present study aimed to include those costs into a decision model able to provide information to policy makers about whether and until what level of important factors it is convenient to extend Chagas disease screening to all Latin American women, to their newborns in case of positive result in the mother and to treat those who are positive, among mothers and children.

This study considers as screening costs the cost of serology only. From a health policy point of view, the debate is focused on whether a more accurate screening process should include further tests (Oliveira et al., 2010). The threshold analysis undertaken in this study suggests that screening costs can rise up to €37.5 and the option "test" would still be preferred to the option "no test". As the cost of the screening was considered to be €10, there is room for an increase of up to €27.5, and this gap may be sufficiently wide to include costs of more expensive diagnostic tools.

The costs of scaling up the intervention to all the Spanish territory has not been considered in this study. However, these costs are likely to be low. The type of diagnostic test (serology) to be undertaken to check for Chagas disease does not imply any additional structural cost to the SNHS. The existing laboratories spread all over Spain do not need any additional equipment to perform this test.

Costs of Chagas disease treatment were estimated assuming biotechnology to be constant in time. In other words, a heart transplant in 50 years was assumed (despite the discount rate applied) to have the same cost as today. It was not possible to foresee eventual cost variations due to biotechnology progress.

Treatment costs for the societal perspective were not included in this analysis. While direct treatment costs sustained by families are very little because the SNHS is in charge of almost all costs, indirect costs could be conspicuous. However, including these avoided costs in the current analysis would translate the "test" into an even more desirable option.

In conclusion, this study shows the relevance of an early diagnosis of Chagas disease through ADI at the antenatal clinic. Despite the fact that this evaluation was undertaken with Spanish data, both economic and epidemiological, these findings are likely to hold for every non endemic area characterized by a relevant immigration from Latin America, particularly from Bolivia.

Competing interests

The authors declare that they have no competing interests.

Contributions

ES and JG conceived of the study and helped to draft the manuscript. ES analysed the data. JM, MJP, EP, JS and PA participated in the design of the study and reviewed and edited all previous drafts. All authors read and approved the final manuscript.

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