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Cost-effectiveness of different strategies for screening and treatment of *Strongyloides stercoralis* in migrants from endemic countries to the European Union

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ABSTRACT

Background The best strategy for controlling morbidity due to imported strongyloidiasis in migrants is unclear. We evaluate the cost-effectiveness of six possible interventions.

Methods We developed a stochastic Markov chain model. The target population was adult migrants from endemic countries to the European Union; the time horizon, a lifetime and the perspective, that of the health system. Average and incremental cost-effectiveness ratios (ACER and ICER) were calculated as 2016 EUR/life-year gained (LYG). Health interventions compared were: base case (no programme), primary care-based presumptive treatment (PCPresTr), primary care-based serological screening and treatment (PCSerTr), hospital-based presumptive treatment (HospPresTr), hospital-based serological screening and treatment (HospSerTr), hospital-based presumptive treatment of immunosuppressed (HospPresTrim) and hospital-based serological screening and treatment of the immunosuppressed (HospSerTrim). The willingness to pay threshold (WTP) was €32 126.95/LYG.

Results The base case model yielded a loss of 2 486 708.24 life-years and cost EUR 3 238 393. Other interventions showed the following: PCPresTr: 2 488 095.47 life-years (Δ1 387.23LYG), cost: EUR 8 194 563; ACER: EUR 3573/LYG; PCSerTr: 2 488 085.8 life-years (Δ1377.57LYG), cost: EUR 207 679 077, ACER: EUR 148 407/LYG; HospPresTr: 2 488 046.17 life-years (Δ1337.92LYG), cost: EUR 14 559 575; ACER: EUR 8462/LYG; HospSerTr: 2 488 024.33 life-years (Δ1316.08LYG); cost: EUR 207 734 073; ACER: EUR 155 382/LYG; HospPresTrim: 2 488 093.93 life-years, cost: EUR 1 105 483; ACER: EUR −1539/LYG (cost savings); HospSerTrim: 2 488 073.8 life-years (Δ1365.55LYG), cost: EUR 4 274 239; ACER: EUR 759/LYG. One-way and probabilistic sensitivity analyses were undertaken; HospPresTrim remained below WTP for all parameters' ranges and iterations.

Conclusion Presumptively treating all immunosuppressed migrants from areas with endemic *Strongyloides* would generate cost savings to the health system.

Key questions

What is already known?

► To date, no study has evaluated the cost-effectiveness of different strategies for screening and treating strongyloidiasis in people migrating from endemic countries to Europe.

What are the new findings?

► Presumptively treating immunosuppressed migrants from endemic areas, without screening or testing, was a cost-saving strategy compared with the current base-case scenario.

What do the new findings imply?

► The results will have a direct impact on clinical guidelines and public health policy across Europe, allowing for cost savings.

BACKGROUND

Strongyloides stercoralis is an intestinal helminth that can cause strongyloidiasis, a parasitic disease in humans. While this nematode is most prevalent in the tropics and subtropics, its distribution is global, and it can also be found in temperate countries with favourable conditions.[1]

Some estimates suggest that at least 370 million people are infected worldwide,[2] and a recent systematic review estimated a pooled prevalence of 12.2% (95% CI 9.0% to 15.9%) in migrants from endemic areas residing in non-endemic areas.[3]

Strongyloidiasis frequently presents asymptomatically or with unspecific and mild clinical symptoms stemming from skin penetration (rash, urticaria, *larva currens*), migration through the body (cough, sore throat, pulmonary infiltrates) and presence in the intestine (abdominal pain and diarrhoea).[1]

The most serious health risk is the development of disseminated disease or hyperinfection syndrome, which usually occurs in immunosuppressed patients, particularly those using corticosteroids.[4] However, many other conditions causing immunosuppression (such as leukaemia or transplant) have also been associated with a severe form of the disease, with a reported mortality of up to 62%.[5]

Enhanced microscopic-based direct techniques, such as agar plate culture or the Baermann method, have improved diagnosis, but their sensitivity is still low because of the intermittent larval excretion and a low parasitic burden.[4] Due to its accuracy, simplicity and reproducibility, serology is the most widespread and recommended technique used,[4] having demonstrated a very high sensitivity, although the specificity is lower due to cross-reactions with other helminth infections. In terms of treatment, ivermectin is currently the drug of choice,[6] with an optimal dosage schedule of a single dose for uncomplicated strongyloidiasis.[7]

Migrants from strongyloidiasis-endemic countries can import the disease to non-endemic areas. There, the disease may remain undetected for long periods of time due to lack of healthcare provider awareness, the unspecific presentation and the ability of the helminth to reproduce indefinitely in the host.[8] If left untreated, the infection will be lifelong. In addition, the disease can be transmitted in non-endemic areas, for example, through solid organ transplantation.[9]

At the same time, in high-income countries or countries in economic transition, the increasing prevalence of chronic medical conditions and malignancies, combined with the availability of potentially harmful treatments, will likely increase the risk of severe complications from unrecognised chronic *S. stercoralis* infection in immunosuppressed patients.[2] Routine screening for strongyloidiasis in migrants at high risk of exposure to *Strongyloides* infection and in immunosuppressed migrants at intermediate risk has been recommended as a strategy to prevent severe complications.[10 11] However, several potential screening strategies could be implemented, so further cost-effectiveness studies are required to better understand and implement the most cost-effective approach.

This study aims to evaluate the cost-effectiveness of six possible public health interventions to address and prevent strongyloidiasis in migrants from endemic areas living in the European Union (EU).

METHODS

Target population setting and perspective

The target population of the study was migrants coming from *S. stercoralis*-endemic areas and living in non-endemic areas, specifically, migrants from South America, Central America, the Caribbean, Africa and Asia, and living in Europe. Although some EU countries are considered as endemic for *S. stercoralis* (such as Spain or Italy), the incidence reported is very low and limited to certain population subgroups. Thus, for the purpose of this study we considered all EU countries as non-endemic for the disease. The model was considered representative of the European setting, as the data used in the study originate from studies conducted in the region. Our analysis used a healthcare provider perspective.

Strategies evaluated

Both hospital-based and primary care-based interventions were evaluated from a health system (provider) perspective. These interventions were agreed on by an internal panel as the most suitable strategies for potential implementation. Six strategies were evaluated against a base-case scenario where no specific intervention is undertaken. This was considered the status quo, in which some cases can be detected through medical check-up when migrants present to the health centre for any reason. The evaluated interventions are as follows.

Primary care-based interventions

1. Primary care presumptive treatment (PCPresTr): providing presumptive treatment once at a primary care level to all migrants attended for any reason.
2. Primary care serology and treatment (PCSerTr): screening migrants at the primary care level with serology and treating positive cases.

Hospital-based interventions

1. Hospital-based presumptive treatment (HospPresTr): providing presumptive treatment with ivermectin to migrants attended at hospital for any reason.
2. Hospital-based serology and treatment (HospSerTr): screening migrants at hospital clinic with serology and treating only the positive cases.
3. Hospital-based presumptive treatment of immunosuppressed migrants (HospPresTrim): providing presumptive treatment with ivermectin to immunosuppressed migrants at the hospital level (eg, migrants with an active tumour, starting steroids, HIV infected).
4. Hospital-based serology and treatment of immunosuppressed (HospPresTrim): screening of immunosuppressed migrants at the hospital level with serology and treatment of positive cases.

Cost-effectiveness model

A compartmental Markov model was considered appropriate to answer the study's research question (figure 1). Due to the chronic nature of strongyloidiasis, a lifetime time horizon was chosen. A 3% yearly discount rate was applied to both costs and effectiveness.[12]

The model represents a cohort of 100,000 migrants aged 35 years from *S. stercoralis*-endemic countries. These individuals enter the model in one of two health states: infected or not infected with the disease. From there, infected migrants (state 1) can seek outpatient care (state 2) and be diagnosed and treated (state 3). They can then be cured and go to the non-infected patient state (state 4) or fail to achieve a cure and go back to the infected patient state (state 1). If infected migrants are not treated, they can develop disseminated strongyloidiasis

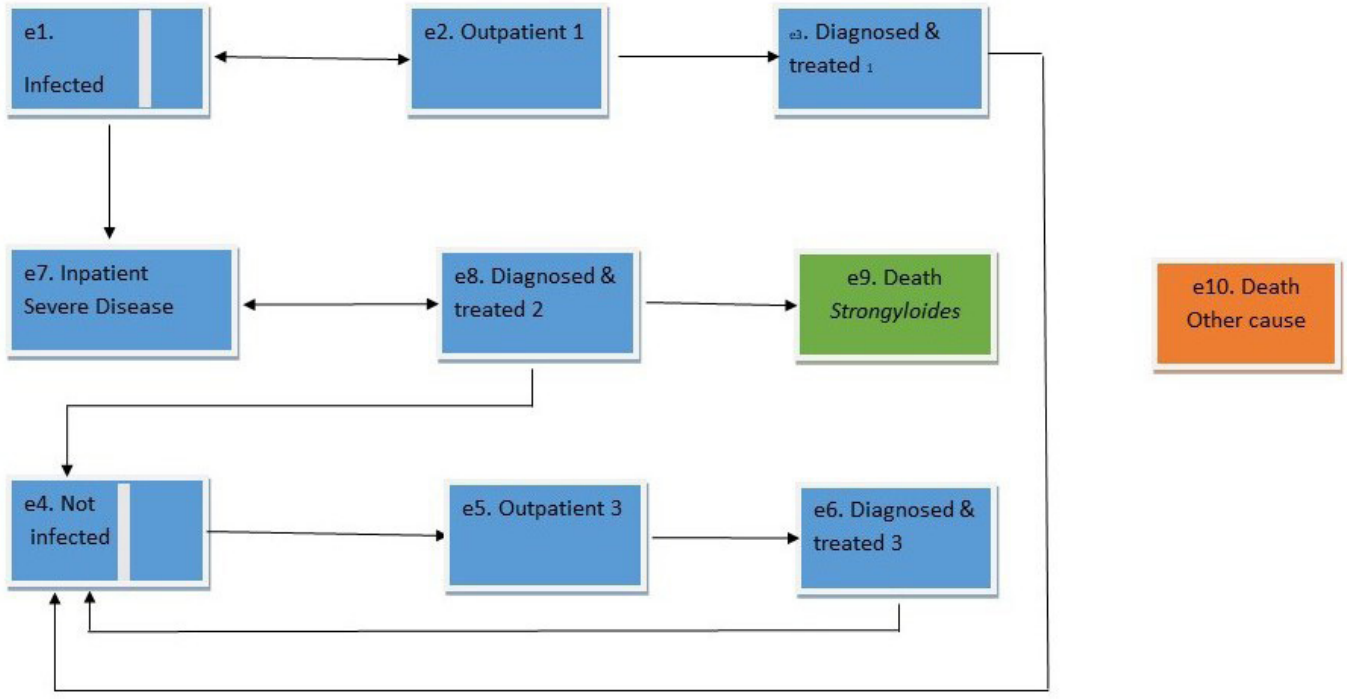

Figure 1 Compartmental Markov model for strongyloidiasis. No arrows to "death other cause" because patients from all states (except from death due to strongyloidiasis) can transition into this state; e1 is divided as patients that transition back from e2 cannot be treated or screened again; e4 is also divided as patients getting cured (ie, not infected) would not be tested or treated again.

and be admitted to hospital (state 7). Then they can be diagnosed and treated (state 8), achieving a cure (state 4) or dying (state 9). Non-infected migrants start at the non-infected state (state 4), can seek outpatient care (state 5) and get diagnosed and treated as false positive cases (state 6) and go back to the not-infected state (state 4). The model was terminated when all individuals reached the death state.

Several assumptions were built into the model:

1. The composition of the migrant population did not change over time.
2. The percentage of immunosuppressed migrants was constant.
3. Migrants could never be treated twice for strongyloidiasis, nor was the outcome tested.
4. There is no local transmission.
5. The availability of ivermectin was guaranteed.

Online supplementary appendix 1 presents the details of the model as well as its parameters (online supplementary material). The R code is available on reasonable request via email to the corresponding author.

Probabilities

The model parameters were obtained from direct measurements, systematic literature reviews and meta-analyses, and the Spanish Network for the Study of Infectious Diseases imported by Travellers and Migrants (+REDIVI).[13] Expert opinions were used when no other sources were found in the literature.

Life-years gained

There are no appropriate estimates of disease-adjusted life-years (DALY) or quality-adjusted life-year (QALY) weights for *S. stercoralis* infection. Previous studies have estimated QALYs by making assumptions that were logical and insightful, but still arbitrary.[14 15] Therefore, we used the objective measure of life-years gained (LYG) as the main outcome. With the model, the quantity of life-years for each strategy was calculated.

Costs

The cost estimates, sources, values, ranges and distributions are presented in online supplementary appendix 2 (online supplementary material). We used the pricelist of the Hospital Clinic de Barcelona, the official published costs of the National Reference Laboratory from the Instituto de Salud Carlos III, and different insurance reimbursement lists (online supplementary appendix 2). Adjustments were made to extrapolate costs to other European countries using purchasing power standards (PPS) (online supplementary appendix 2). Costs are presented as 2016 Euros (€).

Results are presented in terms of average and incremental cost-effectiveness ratios (ACERs and ICERs), measured as 2016 EUR per LYG. A strategy was considered cost-effective if the ICER was lower than the Gross Domestic Product per capita of the European Union in 2016 (EUR 32,127), the quantity selected as the willingness to pay threshold (WTP) for this analysis .[16]

Data analysis

The model was programmed in R software, V.3.4.2.[17]

Deterministic analysis was done with the most plausible value for each parameter. For each strategy, a one-way sensitivity analysis was undertaken, adjusting key parameters one by one according to ranges of possible values to evaluate the impact on the ACER. A probabilistic sensitivity analysis was also carried out: probability distributions were assigned to the model parameters to reflect uncertainty following guidelines.[18] Because individual data were not available in most cases, the SD of each parameter was assumed to be 20% of the mean values (online supplementary appendix 2). Using 1000 Monte Carlo simulations, the ICER of the different iterations was plotted on a cost-effectiveness plane. The number of iterations to produce stable results was estimated by visual inspection of a graphic representation of the cumulative average net monetary benefits. Cost-effectiveness probability curves are also presented.

The study complied with the Consolidated Health Economic Evaluation Reporting Standards (online supplementary appendix 3, online supplementary material).

Patient and public involvement

No patients participated in the study.

Role of the funding source

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RESULTS

Study parameters

Base-case transition probabilities are shown in table 1. The full list of probabilities, baseline values, sources, distributions and reasons of choice are shown in online supplementary appendix 1.

The prevalence of strongyloidiasis in migrants was considered to be 12.2% (95% CI 9.0% to 15.9%), based on a recent systematic review and meta-analysis.[3] For the baseline scenario, the healthcare seeking rate was set at 1/10,000 person-years, as reported by Valerio *et al*.[19] For the interventions, we considered that the healthcare seeking rates reported in the Spanish national health inquiry were appropriate: for primary care, 0.78 (95% CI 0.76 to 0.80); and for hospital-based interventions, 0.48 (95% CI 0.46 to 0.50).[20] The probability of being diagnosed was based on the sensitivity of the test (92%). The same probability was considered among those who are potentially immunosuppressed since health interventions targeting those populations should be implemented before the immunosuppression is established. The prevalence of immunosuppression was considered to be 2.7%.[21] The annual probability of developing a severe condition (0.0423) was calculated by adapting the method by Freeman and Hutchison with data from the study by Salvador *et al*.[21 22] To determine the effectiveness of the treatment with ivermectin, we used the results of

Table 1 Base-case scenario probabilities

Probabilities	Value and OWSA range	PSA distribution	Source
Probability of seeking outpatient consultation	Baseline: 0.001 Range: 0.009-0.0004	Beta (mean 0.001, SE 0.001)	Valerio *et al*[19]
Probability of being diagnosed and treated	Baseline: 0.92 Range: 0.969–0.877	Beta (mean 0.92, SE 0.03)	Bissofi *et al*[28]
Probability of clearing infection	Baseline: 0.84 Range: 0.72- 0.98	Beta (mean 0.84, SE 0.066)	Henriquez-Camacho *et al*[6]
Probability of seeking inpatient consultation due to severe disease	Baseline: 0.000423 Range: 0.000339–0.000508	Beta (mean 0.000423, SE 0.0001)	Salvador *et al*[21]
Probability of being diagnosed and treated for severe disease	Baseline: 0.92 Range: 0.969–0.877	Beta (mean 0.92, SE 0.03)	Bissofi *et al*[28]
Probability of curing and clearing infection in severe disease	1-CFR		CFR is estimated below
Probability of dying due to severe disease (CFR)	Baseline: 0.47 Range: 0.33–0.62	Beta (mean 0.47, SE 0.01)	Buonfrate *et al*[5]
Probability of misdiagnosis and treatment for *Strongyloides* infection	Baseline: 0.001 Range: 0.0069–0.001	Beta (mean 0.001, SE 0.001)	Bissofi *et al*[28]
Probability of death due to other causes	Mortality tables		Spanish National Statistical Institute[29]

CFR, case fatality ratio; OWSA, one-way sensitivity analysis; PSA, probabilistic sensitivity analysis.

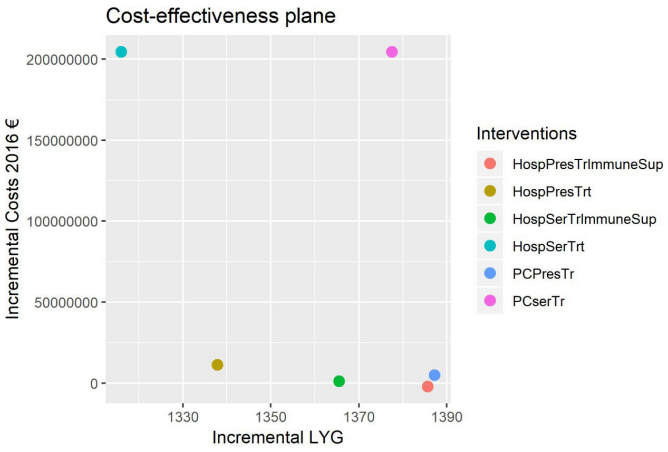

Figure 2 Cost-effectiveness plane representing the incremental costs in 2016 € Versus incremental effects in life-years gained (LYG). Hosp PresTr, hospital-based presumptive treatment; Hosp SerTr, hospital-based serology screening and treatment; HospPresTrImmuneSup, hospital-based presumptive treatment of immunosuppressed patients; HospSerTrImmuneSup, hospital-based serology screening and treatment of immunosuppressed patients; PC PresTr, presumptive treatment at a primary care setting; PCSerTr, serology screening and treatment at a primary care setting.

the Cochrane Review by Henriquez-Camacho *et al*.[6] The schedule was chosen as a single dose, according to the results of a recent randomised clinical trial.[7] The case fatality ratio of disseminated disease was considered to be 47% (range: 33%–62%).[5] The mortality increase due to ivermectin in migrants from *Loa loa* endemic areas was 11/10,000.[29]

Finally, pregnant women were not considered in the model since ivermectin has not been approved in this population.

Base-case scenario results

The base-case scenario (ie, no programme established) produced a total of 2,486,708.24 life-years with a cost of EUR 3,238,393.

Primary care presumptive treatment

Treating every migrant presumptively in the primary care setting yielded a total of 2,488,095.47 life-years (increase of 1387.23 LYG) at a cost of EUR 8,194,563 (increase of EUR 4,956,170), for an ACER of EUR 3573/LYG.

Primary care serology and treatment

Screening every migrant at the primary care level and then treating only those with confirmed infections yielded a total of 2,488,085.82 life-years (increase of 1377.57 LYG) at a cost of EUR 207,679,077 (increase of EUR 204,440,684). The ACER would be EUR 148,407/LYG.

Hospital-based presumptive treatment

Treating every migrant presumptively in a hospital-based setting yielded a total of 2,488,046.17 life-years (Δ1337.92 LYG) at total cost of EUR 14,559,575 (cost increase of EUR 11,321,182). The ACER would be EUR 8462/LYG.

Hospital-based serology and treatment

Hospital-based serology and treatment yielded a total of 2,488,024.33 life-years (ie, an increase of 1316.08 life-years) with a cost of EUR 207,734,073 and an ACER of EUR 1,155,382/LYG.

Hospital-based presumptive treatment of immunosuppressed

Presumptively treating only immunosuppressed migrants in the hospital setting yielded a total of 2,488,093.93 life-years (increase of 1385.68 LYG) at a cost of EUR 1,105,483, resulting in a total savings of EUR 2,132,910. As this strategy was found to be cost-saving, it had a negative ICER of EUR −1539/LYG.

Hospital-based serology and treatment of immunosuppressed

Screening immunosuppressed migrants and treating only those with confirmed infection in the hospital setting yielded a total of 2,488,073.8 life-years (Δ1365.55 LYG), at a cost of EUR 4,274,239, for an ACER of EUR 759/LYG.

Results of this deterministic analysis are represented in the cost-effectiveness plane in figure 2 and table 2. PCSerTr, HospPresTr, HospSerTr and HosptSerTrim interventions dominated. The most cost-effective strategy was HospPresTrim, which was actually cost saving (ICER EUR −1539). The next most efficient strategy was PCPresTr, but compared with HospPresTrim, the ICER was far from being cost-effective (ICER EUR 4,582,464/LYG).

Sensitivity analyses

To address parameter uncertainty, a one-way sensitivity analysis was carried out for each strategy evaluated (figure 3). The ICER of the HospPresTrim strategy remained below the cost-effectiveness threshold through the whole range of parameters.

A sensitivity analysis of structural uncertainty was undertaken, excluding the cost of the first visit in all intervention strategies based on the presumption that *Strongyloides* screening could be considered an opportunistic intervention as part of a consultation sought by the migrant for another reason. Therefore, visit costs were not imputed to the programme costs. Moreover, some centres routinely screen migrants for imported diseases the first time they present for consultation, so serology would simply be added. In this analysis, the HospPresTrim was the still most cost-effective strategy (ICER EUR −1461/LYG) (online supplementary appendix 4, online supplementary material).

A probabilistic sensitivity analysis was also carried out to evaluate overall uncertainty. Results are summarised in figure 4. The strategy with the highest probability of being cost-effective was HospPresTrim, with all iterations falling below the WTP.

As there is concern about the adverse effects that could occur when presumptive ivermectin is administered to

Table 2 Summary of the analysis results

	LYG	Lifetime costs (2016 EUR)	Incremental LYG	Incremental cost (2016 EUR)	ICER (2016 EUR / LYG)
Baseline	2,486,708.24	3,238,393	Baseline	Baseline	Baseline
HospSerTr	2,488,024.33	207,734,073	1316.08	204 495 681	Dominated
HospPresTr	2,488,046.17	14,559,575	1337.92	11 321 182	Dominated
HospSerTrIm	2,488,073.8	4,274,239	1365.55	1 035 846	Dominated
PCSerTr	2,488,085.82	207,679,077	1377.57	204 440 684	Dominated
HospPresTrIm	2,488,093.93	1,105,483	1385.68	–2,132,910*	–1,539*
PCPresTr	2,488,095.47	8,194,563	1387.23	4 956 170	4,582,463.62

Dominated: the strategy is less effective and more costly.
*Cost saving.
HospPresTr, hospital-based presumptive treatment; HospPresTrIm, hospital-based presumptive treatment of immunosuppressed migrants; HospSerTr, hospital-based serology screening and treatment; HospSerTrIm, hospital-based serology screening and treatment of Immunosuppressed migrants; PCPresTr, presumptive treatment at a primary care setting; PCSerTr, serology screening and treatment at a primary care setting.

migrants infested with *Loa loa* (mainly severe encephalitis), a sensitivity analysis was undertaken allowing for a mortality increase in all migrants, as migrants from *Loa loa*-endemic countries may have a high presence in specific settings. Nevertheless, the ICER still showed cost savings (EUR −1617/LYG) (online supplementary appendix 3).

DISCUSSION

Our results show that presumptively treating immunosuppressed migrants from *Strongyloides*-endemic countries was the most cost-effective strategy. In fact, it saved costs compared with current clinical practice. The rest of the strategies produced a gain in life-years but were not cost-effective using the chosen WTP or they were dominated (ie, they were less effective and more costly). Our findings were robust to the ranges of parameter alterations undertaken both deterministically and probabilistically.

Previous studies have evaluated different strategies in refugees to the USA, concluding that the most cost-effective strategy was to perform presumptive treatment overseas.[14 15] However, these studies evaluated only refugee populations in the USA, addressing mainly Asian populations, and the screening was not based on a serological test in a non-endemic setting. In our study, we decided to use serology as the only screening tool, as it is currently the most recommended strategy due to the low sensitivity of parasitological methods. In our model, we did not consider a lower sensitivity of the serological test and a lower efficacy rate in immunosuppressed migrants,[23] since under ideal conditions, a screening programme would be implemented before immunosuppression is established.

Given the uncertainty in some parameters of the model, we performed a sensitivity analysis. The parameters with the highest impact were the outpatient consultation costs and hospitalisation costs. Nevertheless, presumptively treating immunosuppressed migrants remained the most cost-effective strategy.

Importantly, the prevalence of strongyloidiasis did not alter the results of any of the strategies. This is a crucial issue since changes in migratory flows could also modify the scenarios contemplated in the near term. Dynamic models that consider demographic and migration flows could therefore be a reasonable strategy for adapting the results of this study to different contexts.

A major question regarding the implementation of a *Strongyloides* screening programme is whether the intervention should target all migrants or just specific high-risk groups. Our results make it clear that immunosuppressed migrants should be the target population for this kind of programme. Ideally, they should be captured before immunosuppression is established. Thus, migrants that will be potentially immunosuppressed (ie, migrants diagnosed with a disease that is likely to need immunosuppressant drugs in the short or medium term, eg, steroids for chronic obstructive pulmonary disease or chemotherapy for lymphoma) should also be included.

Due to the heterogeneity of national health systems, the implementation of a presumptive programme in immunosuppressed and potentially immunosuppressed migrants could be done at different levels of care. Whereas for most national health systems, the strategy is only feasible as a hospital-based intervention, in settings with outstanding primary care programmes and trained health professionals, the strategy could be based in primary healthcare, where screening uptake is higher.[24] Thus, emphasis must be placed on developing innovative and sustainable approaches to increasing the coverage of these programmes. For example, clinical decision-making tools may also be evaluated from a cost-effectiveness perspective.[25]

In addition, serological testing is not widely available in most clinical settings yet, which is a major drawback

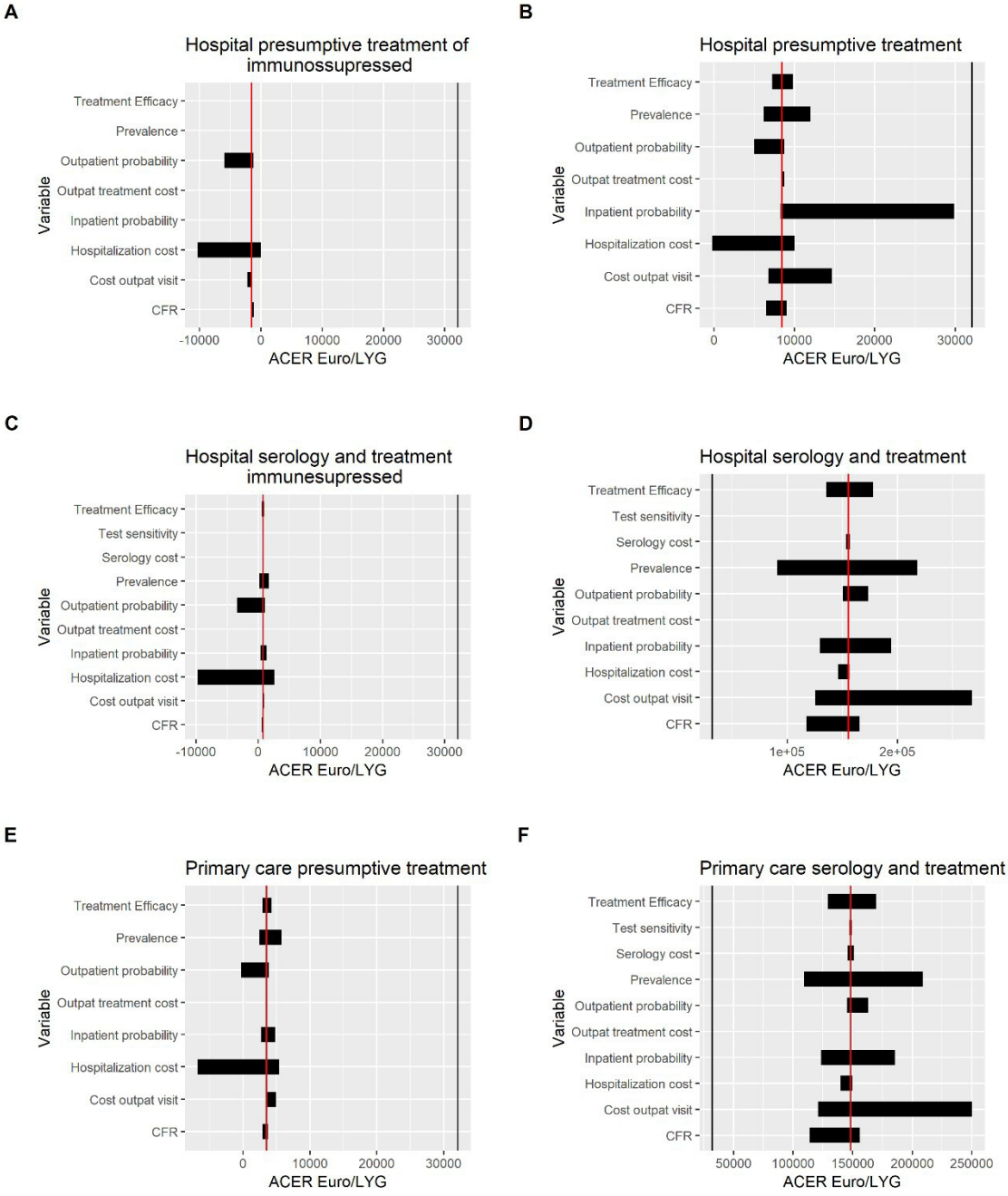

Figure 3 Tornado plots of the one-way sensitivity analysis for each strategy evaluated. Red vertical line represents the deterministic value of the ACER. The black vertical line represents the cost-effectiveness threshold. ACER, average cost-effectiveness rate; CFR, case fatality ratio; LYG, life-years gained.

when considering serology screening-based strategies at both the hospital and primary care level. Developing point-of-care methods to diagnose strongyloidiasis would be highly desirable and could potentially change the scenario, making serological strategies more cost-effective. Nevertheless, a presumptive treatment strategy whose target population is exclusively migrants might not be acceptable and could even be perceived as discriminatory, particularly since other screening plus treatment strategies have also been shown to be cost-effective compared with the base-case scenario. HospSerTrim, HospPresTr and PCPresTr had ACERs that fell below the WTP, especially when the cost of the first visit was not imputed to the programme. Therefore, these interventions could be considered as alternatives if other factors preclude HospPresTrim. PCPresTr would have the benefit of avoiding the risk of disseminated disease in migrants who become immunosuppressed in the future, as well as avoiding the theoretical reintroduction of local transmission.

An important novelty of our model is that we have accounted for excess mortality in individuals with concomitant *Loa loa* infection, as they have a higher mortality risk when treated with ivermectin.[26] Nevertheless, this

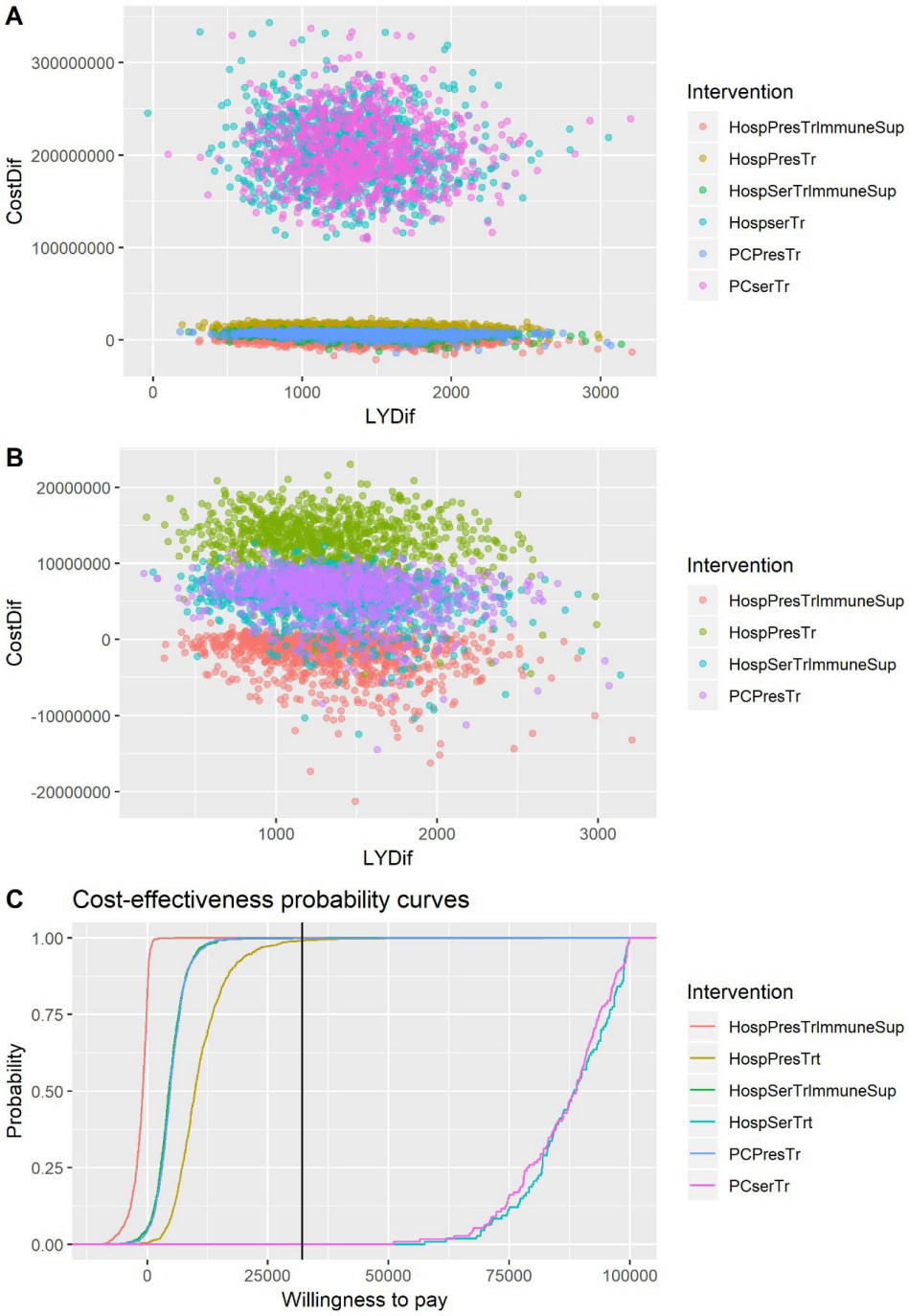

Figure 4 Probabilistic sensitivity analysis. (A) The cost-effectiveness plane is represented. (B) Cost-effectiveness plane removing the two least cost-effective strategies. (C) Cost-effectiveness probability curves. Hosp PresTr, hospital-based presumptive treatment; Hosp SerTr, hospital-based serology screening and treatment; HospPresTrImmuneSup, hospital-based presumptive treatment of immunosuppressed patients; HospSerTrImmuneSup, hospital-based serology screening and treatment of immunosuppressed patients; PC PresTr, presumptive treatment at a primary care setting; PCSerTr, serology screening andtreatment at a primary care setting.

mortality increase is not very high (0.0011) Therefore, presumptive treatment did not have an important impact on LYG. However, when implementing this kind of programme in clinical practice, this potentially severe side effect should be avoided, particularly if *Loa loa* infection can be easily ruled out.

On the other hand, presumptive treatments cannot estimate cases and treatment failures of the drug, and ivermectin is not easily accessible in European countries. Therefore, implementing a presumptive treatment programme could entail supply side problems. This possibility should be evaluated locally. However, pharmaceutical companies and European regulatory bodies have recently launched initiatives to increase the production of ivermectin and market it in EU countries, and we hope these results will encourage such endeavours.

Another major question is the kind of immunosuppression that poses the highest risk for severe strongyloidiasis. Further studies should evaluate and quantify the risk of progression to severe disease, depending on the level of immunosuppression. This knowledge would allow for a more targeted screening intervention, prioritising clinical units or patients at high risk.

Our study has several limitations. The model has not been prospectively validated and relies on a series of assumptions. We did not account for the possibility of local transmission, as it was considered non-existent, with a highly unlikely risk for reintroduction. Some of the parameters used for the model have a high degree of uncertainty. Another limitation is that there are no estimates for DALYs in *S. stercoralis* infection. Therefore, we used the objective measure of LYG. Nevertheless, this parameter does not account for quality of life and imposes a limitation on the results of our study. While chronic *Strongyloides* infection is not considered to substantially reduce quality of life, very few good quality studies have been published so far on its clinical burden, so this is an issue that undoubtedly needs further investigation.[27]

CONCLUSIONS

Presumptively treating for *S. stercoralis* infection in all immunosuppressed migrants from *Strongyloides* endemic countries seems to be a cost-saving strategy. Our findings provide an important basis to support the implementation of presumptive treatment programmes. However, other factors should also be considered, such as the heterogeneity of health system characteristics as well as the acceptability of this strategy, particularly in individuals at higher risk of developing severe side effects.

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