Cost-effectiveness modelling to optimise active screening strategy for *gambiense* human African trypanosomiasis in the Democratic Republic of Congo — Summary

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Abstract

Gambiense human African trypanosomiasis (gHAT) has been brought under control recently with village-based active screening playing a major role in case reduction. In the eve of elimination, we investigate how to optimise active screening in villages in the Democratic Republic of Congo, such that the expenses of screening programmes can be efficiently allocated while continuing to avert morbidity and mortality. We implement a cost-effectiveness analysis using a stochastic gHAT infection model for a range of active screening strategies and we calculate the net monetary benefit (NMB) of each strategy. High-coverage active screening strategies, occurring approximately annually, attain the highest NMB. We find that, for strategies stopping after one to three years of zero case reporting, the expected cost-benefits are very similar and we highlight the current recommended strategy (three years before stopping) is likely cost-effective, in addition to providing valuable information on whether transmission has been interrupted.

Motivation

When considering different gHAT interventions, active screening is known to be effective in reducing case numbers and hence the infection in the population (***Robays et al., 2004***; ***Büscher et al.,***

Table 1. Descriptions of the variables used for defining an active screening strategy.

Variable	Name	Definition	Value range
c	Screening coverage	Proportion of the village population screened in a visit.	0–90%
t	Screening interval	Time between active screening visits to a village.	0.25–5 years
z_a	Active zero-detections	Number of consecutive active screenings where no cases are detected for the cessation of active screening.	1–5 screenings
z_r	Reactive zero-detections	Number of consecutive reactive screenings where no cases are detected for the cessation of reactive screening.	1–3 screenings

Table 2. Active screening strategies considered in the probability of cost-effectiveness calculations. We show the mean total cost and the total number of DALYs averted for each strategy with the 95% prediction given across all stochastic realisations. The ACER is the change in cost over the change in DALYs averted as compared to the baseline strategy, while the ICER is compared to the next best strategy (given in the table footnotes). Costs are in 2018 US dollars.

No.	Strategy	Screening coverage, c (%)	Screening interval, t (years)	Active zero-detections, z_a	Total cost ($)	Total DALYs	ACER ($/DALY)	ICER ($/DALY)
1	Passive surveillance only[1]	0	N/A	N/A	37197 [17726, 58928]	2488.8 [1207.8, 3912.6]	Coût minimum	Coût minimum
2	Biennial screening with one zero for cessation	55	2	1	55316 [33037, 91751]	1338.9 [437.8,1755.7]	15.8	15.8[2]
3	Biennial screening with two zeros for cessation	55	2	2	55862 [34302, 91930]	1339.4 [436.3,1755.5]	16.2	Dominated
4	Biennial screening with three zeros for cessation	55	2	3	56300 [35080, 92357]	1340.1 [434.8,1756.5]	16.6	Dominated
5	Annual screening with one zero for cessation	55	1	1	61184 [29968, 83446]	1027.9 [570.3, 2262.7]	16.4	18.9[3]
6	Annual screening with two zeros for cessation	55	1	2	61871 [30847, 83641]	1027.7 [570.6, 2264.3]	16.9	2503.4[4]
7	Annual screening with three zeros for cessation	55	1	3	62467 [31492, 83773]	1027.4 [572.9, 2261.9]	17.3	2739.0[5]

[1]The comparator strategy. [2]Relative to Strategy 1. [3]Relative to Strategy 2. [4]Relative to Strategy 5. [5]Relative to Strategy 6.

2017). Thus, with a limited number of active screening teams and resources for them to carry out their duties, it is important to optimise their activities with the aim of driving towards elimination.

Methods

We use the stochastic, village-level, compartmental model from ***Davis et al.*** (***2019***) to simulate different strategies for active screening that vary: screening coverage c, screening interval t, active zero-detections z_a, and reactive zero-detections z_r (see ***Table 1***). The model is parameterised by using screening and case data from Kwamouth health zone in former Bandundu province, DRC. Further sensitivity analysis (SI) examines Mosango health zone to compare results in different two different endemicity settings.

The cost of an active screening strategy is a function of several component costs: implementing the screening test, confirmation of the infection, carrying out treatments, setting up and maintaining the mobile screening teams, and the change in number of passive tests and treatments caused by the change in active screening activity. We do not consider the additional costs of passive surveillance, such as capital costs, only the costs directly affected by active screening. As well as considering the changes in monetary costs, we want to consider the change in the health benefit of implementing different active screening programmes, since health problems are not just a burden for the individual, but are an obstacle to economic and human development.

We evaluate the net monetary benefit (NMB) to assess the cost-effectiveness. For each active screening strategy, the net monetary benefit (NMB) was calculated as:

$$\text{NMB} = \text{WTP} \times \text{DALYs averted} - \text{Cost of active screening strategy compared to passive surveillance only.} \quad (1)$$

The willingness to pay (WTP) is the maximum amount of money that the funder is prepared to pay to gain the health benefit of averting one DALY.

Results

We restrict the number of strategies we consider to seven options: doing no active screening and six realistic proposal schemes for active screening including biennial and annual screening with different cessation criteria (see ***Table 2***). We aim to account for uncertainty and consider each individual realisation of the stochastic epidemic process to measure the probability a strategy is cost-effective. Therefore, we have simulated the infection dynamics of each strategy one million times to compare how the costs and DALYs vary.

We see that the strategy with the highest probability of being cost-effective is annual screening with only one active zero-detection before initial cessation for most willingness to pay (WTP) values, although more years of active zero-detections have a higher probability of being cost-effective for larger WTP values.

Conclusion

These quantitative results suggest that, to optimise the cost-effectiveness of the gHAT medical strategy, active screening should occur approximately annually in endemic villages, with the screening coverage as high as possible. This is in line with current gHAT strategy in DRC and recommendations by WHO. At this village scale, a cessation criterion of zero cases detected for one year appears to have the highest probability of being cost effective if reactive screening would occur following any passive case detection. However, the screening interval has a much more significant impact on the results than the active zero-detections, and it is important to note that a single year of zero cases detected does not provide high certainty that there is village-level elimination of transmission. Multiple years of zero case detections may still be desirable, especially for larger villages ***Davis et al.*** (***2019***).

References

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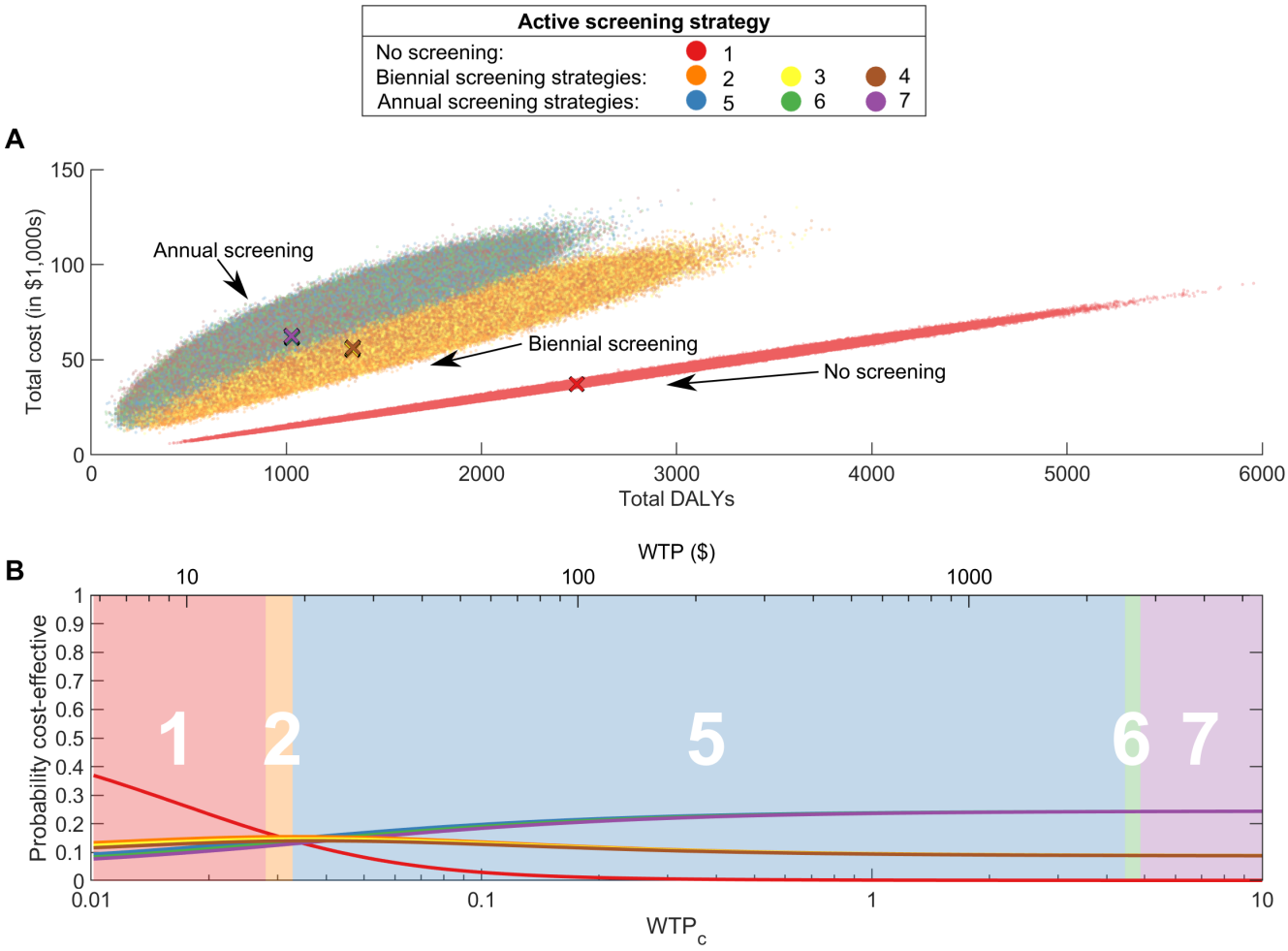

Figure 1. The cost-effectiveness of active screening strategies. (A) Cost-effectiveness plane showing the total cost of a strategy and the associated total number of DALYs averted from the mean value of the comparator strategy. Mean values for each strategy are shown by the coloured crosses. (B) Cost-effectiveness acceptability curves (CEACs) for each strategy are shown by lines, with the cost-effectiveness acceptability frontier (CEAF) shown by the numbered background colour, which demonstrated the values for the ICER. WTP is shown in 2018 USD on the top and as the WTP_c coefficient on the bottom, where the coefficient is the multiplier of the GDP per capita of the DRC.