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Microsimulation Models for Malaria Cost Estimation & Generation of Evidence to Support Policy

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Outline

- Introduction.
- Model structure.
- Calibration and validation.
- Example output.
- Results.
- Conclusion and recommendations.

Introduction

What is Microsimulation?

- Computer modelling technique that operates at the unit level.
- The individuals are a true reflection of the population.
- Used to evaluate the impact of a proposed intervention or policy.
  - Generate base case.
  - Test different scenarios.
  - Compare the base case and the scenarios to evaluate the impact of the intervention.
- Policy recommendations.

Why Microsimulation?

- Cost effectiveness.
- Time.
- Accuracy.
- Heterogeneity in population.

What is Malaria?

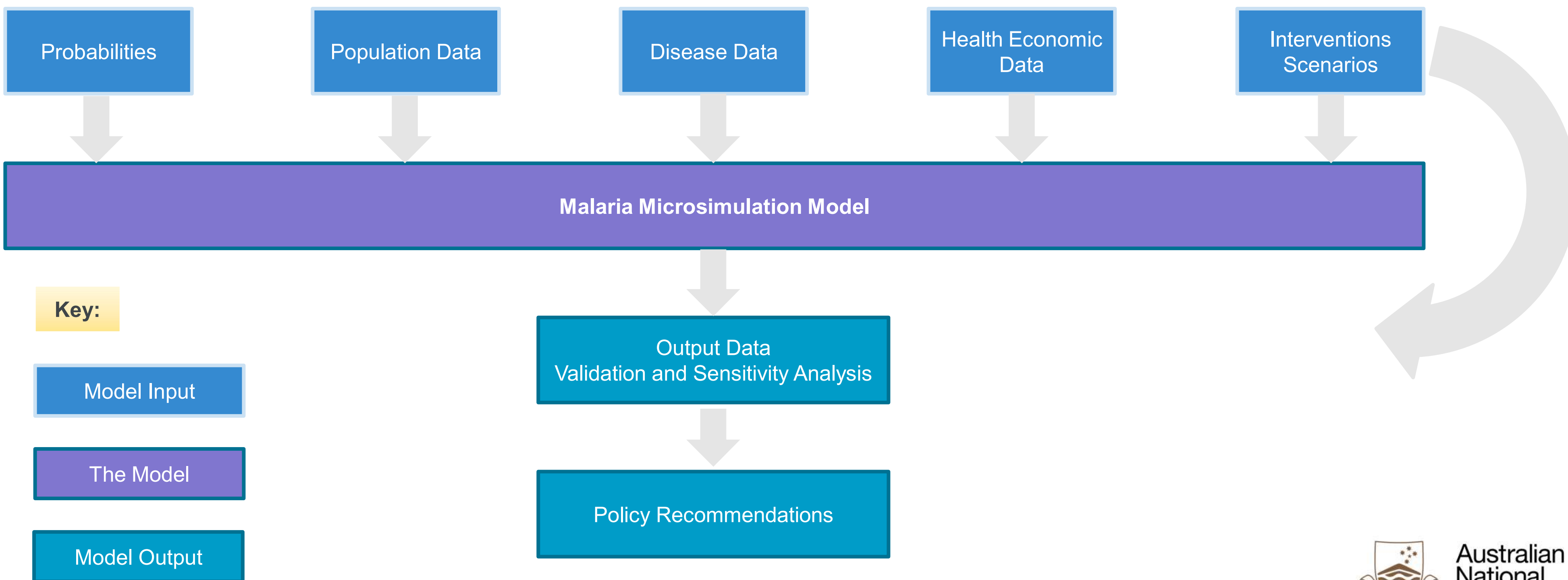
- Disease by a *plasmodium* parasite, transmitted by infected female Anopheles mosquito.
- In 2021: 247m cases and an estimated 620k deaths, 77% of whom were children under 5.
  - Cf: covid19 claimed about 2000 lives of children under five each year.
- Treatment through Artemisinin-based Combination Therapy (ACT) for uncomplicated malaria.
  - Concerns about the emergence of ACT drug resistance.
- Accurate age-specific treatment cost is unavailable.
- Recent rollout of a malaria vaccine.

Goals

- Generate age-specific cost estimates.
- Quantify the evolution of antimalarial resistance.
- Evaluate the vaccination program.
- Evidence-based policy recommendations.

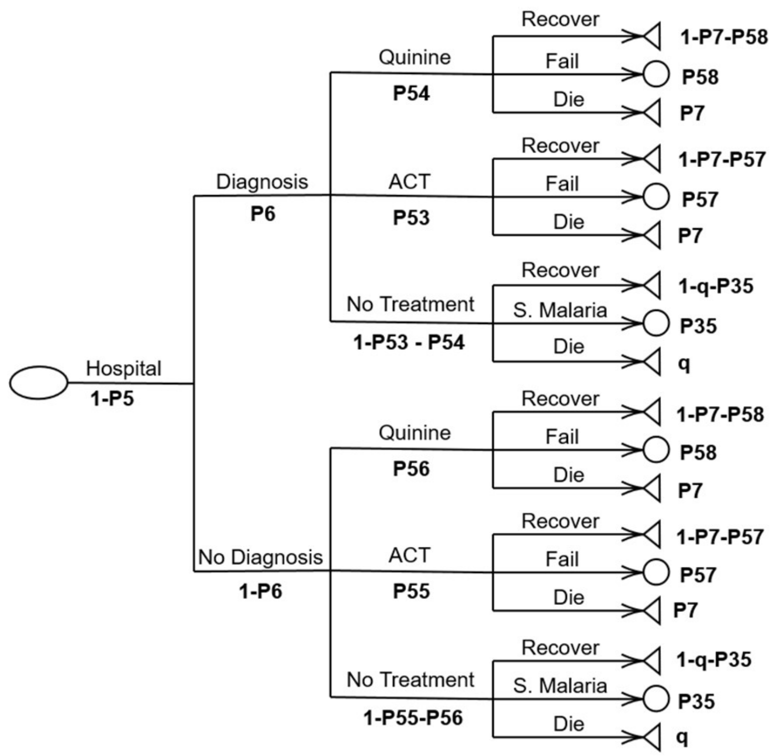
Model Structure

Microsimulation Model Structure

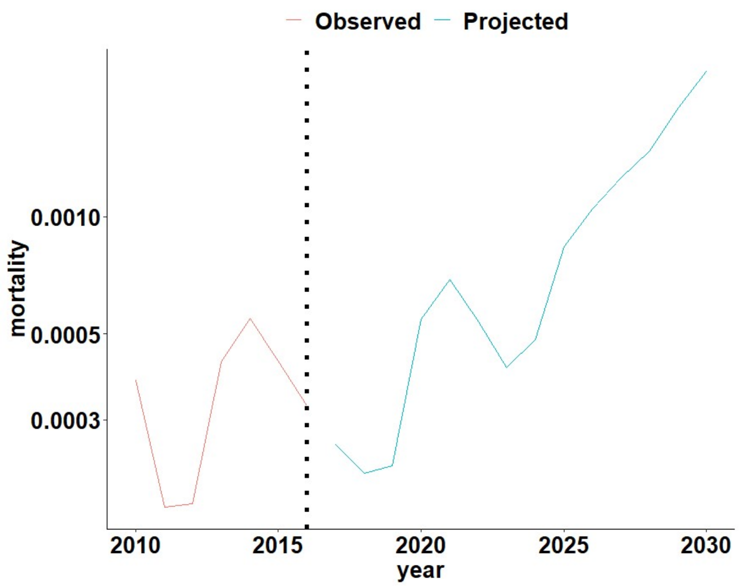


Calibration and Validation

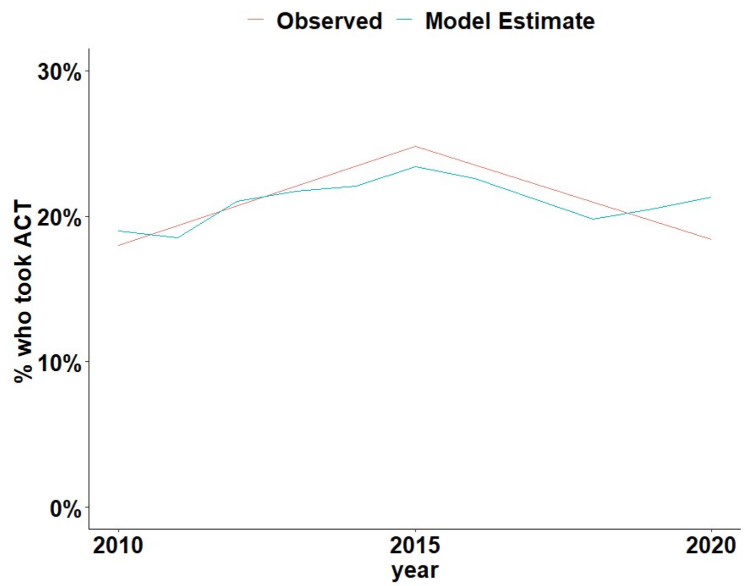
Calibration Example



Example Validation Results



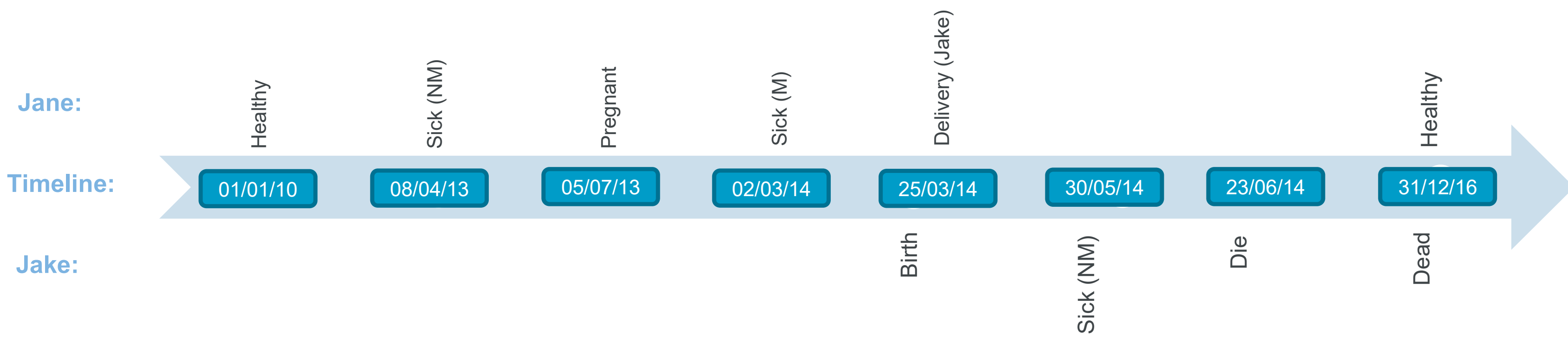
Handover plot



ACT usage

Example Output

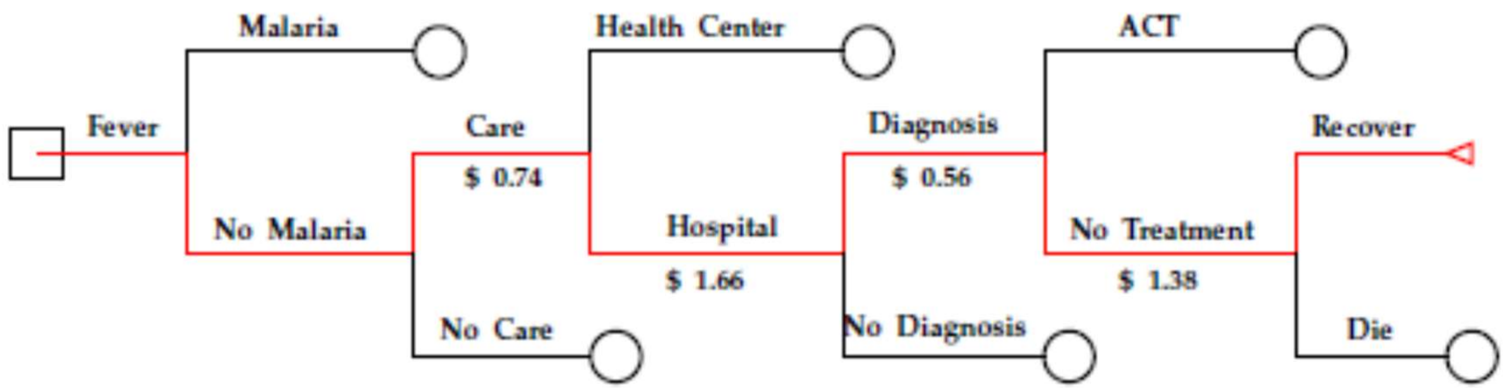
The Case of Jane (and Jake)



- Currently aged 37, entered model at age 30.
- Gets sick twice, with malaria once.
- Gives birth to Jake, and exits the model with a neurological sequelae.

The Case of Jane (and Jake) Cont'd

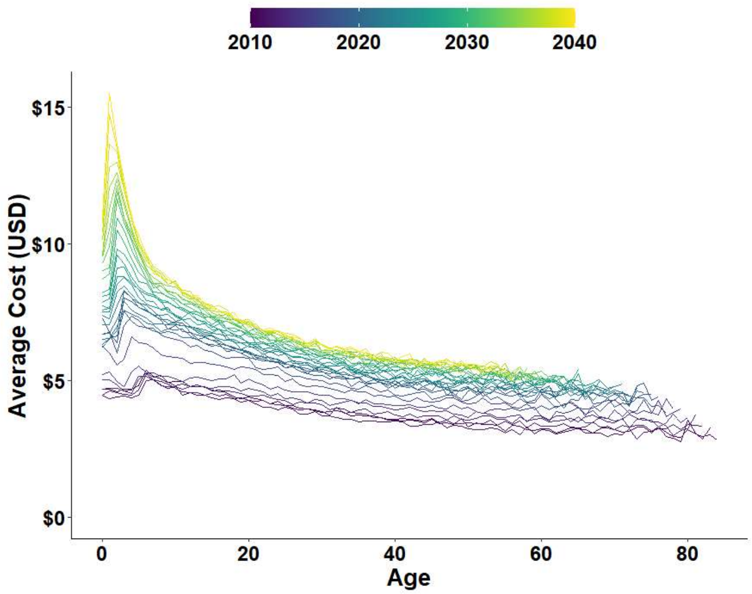
- On the week of April 08, 2013:



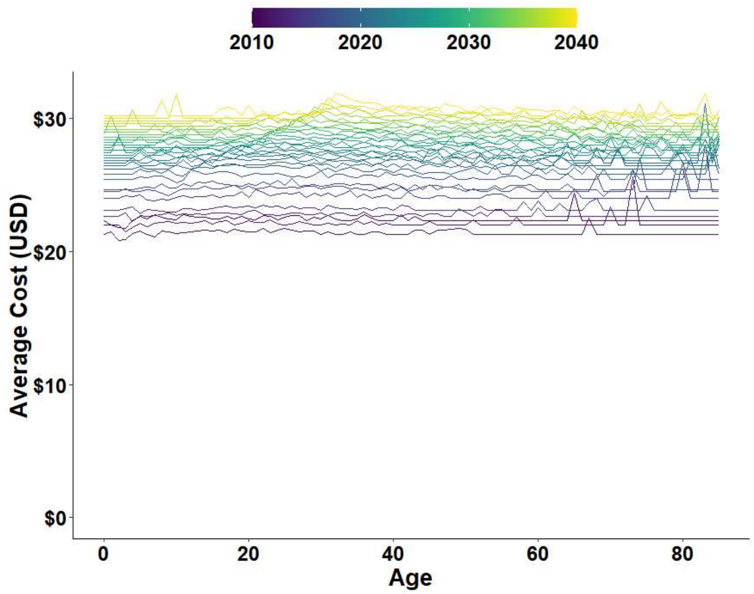
- Actual cost (to the patient): $\$0.74 + \$3.9 \times (1 - 0.37) \times (1 - 0.325) + \$0.56 + 0.9212 \times 1.2 \times 1.25 = \$4.34.$

Results

Age-Specific Costs

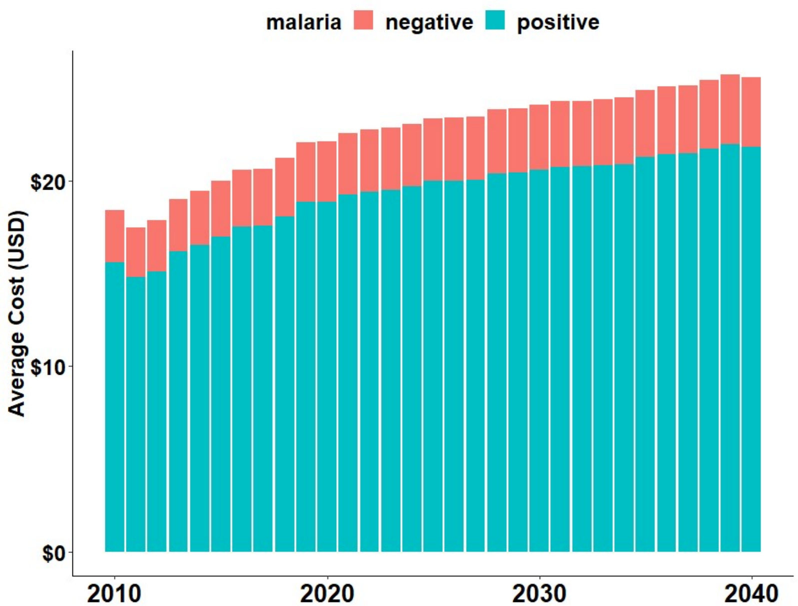


Average cost per visit, patient

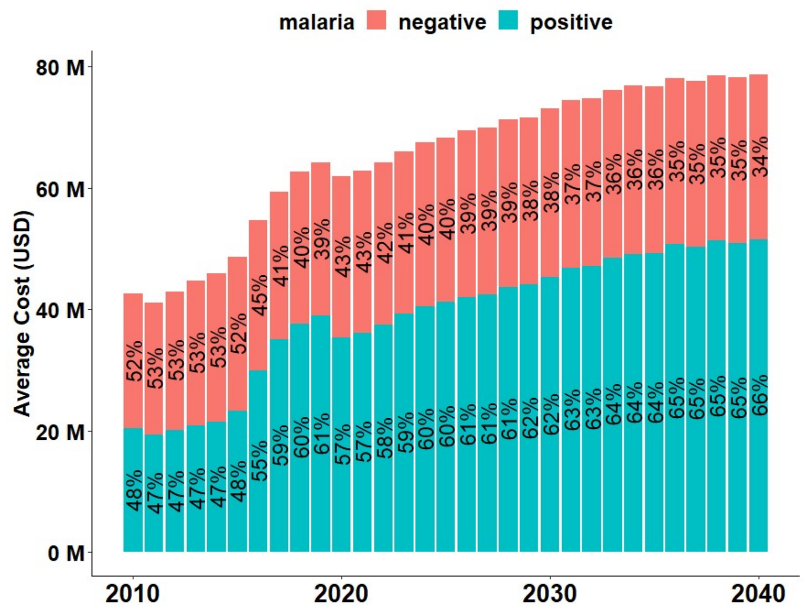


Treatment failure and severe malaria, patient

Treatment Cost Trends

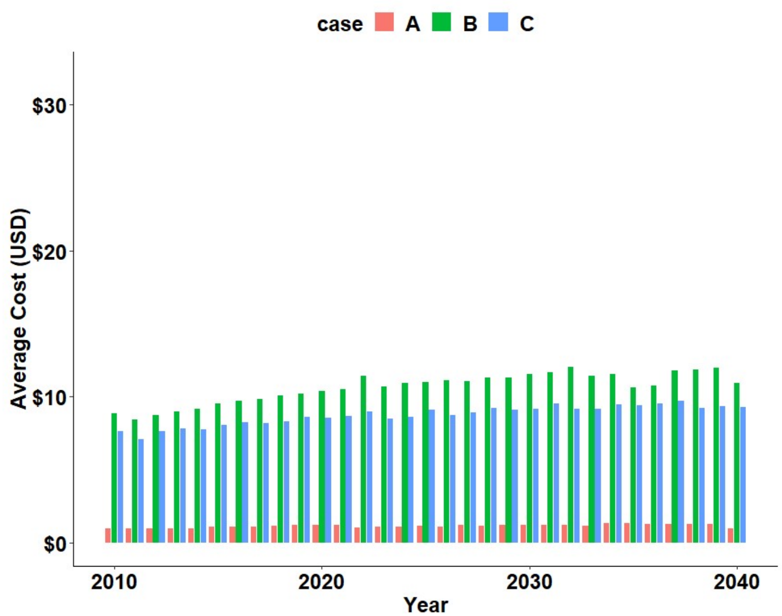


Uncomplicated malaria treatment costs

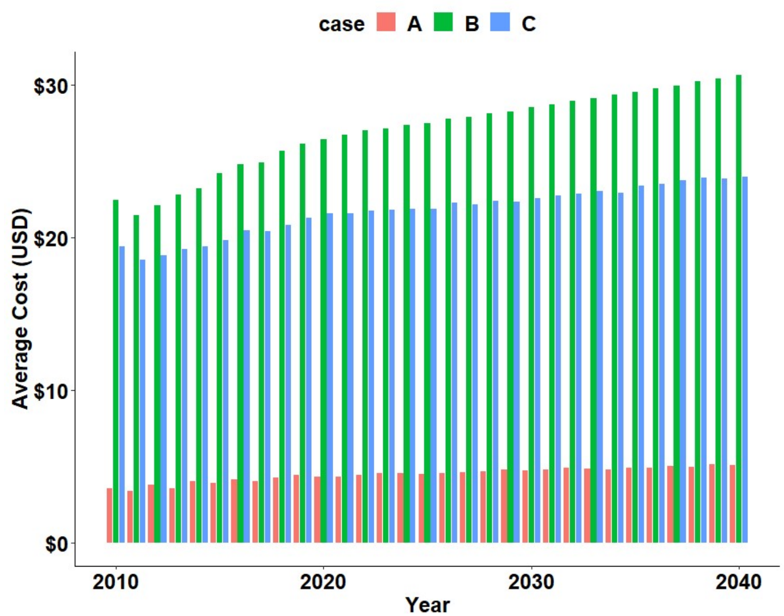


Uncomplicated malaria treatment costs (total)

Treatment Cost Trends Cont'd



Uncomplicated Malaria treatment failure, provider



Uncomplicated Malaria treatment failure, patient

A: Failed first-line treatment but did not progress to severe malaria

B: Failed first-line treatment that progressed to severe malaria

C: Any severe malaria case.

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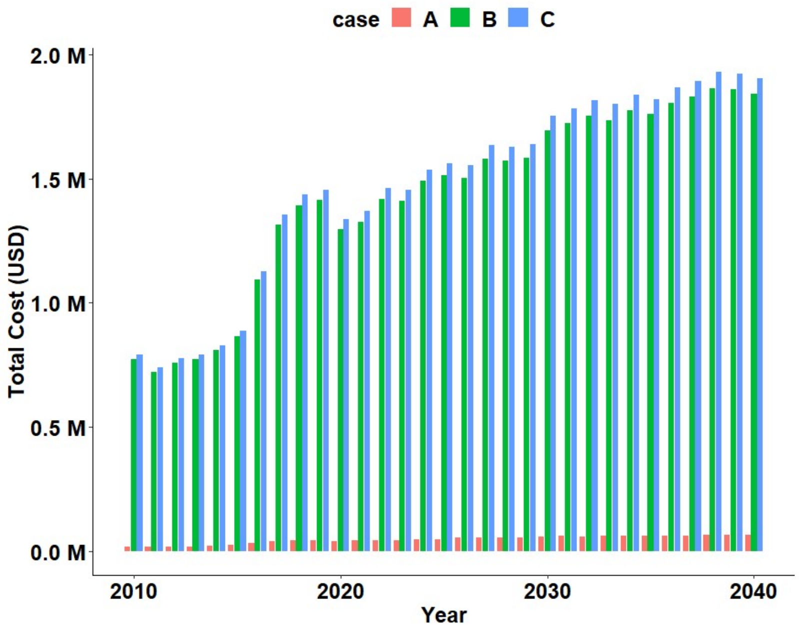
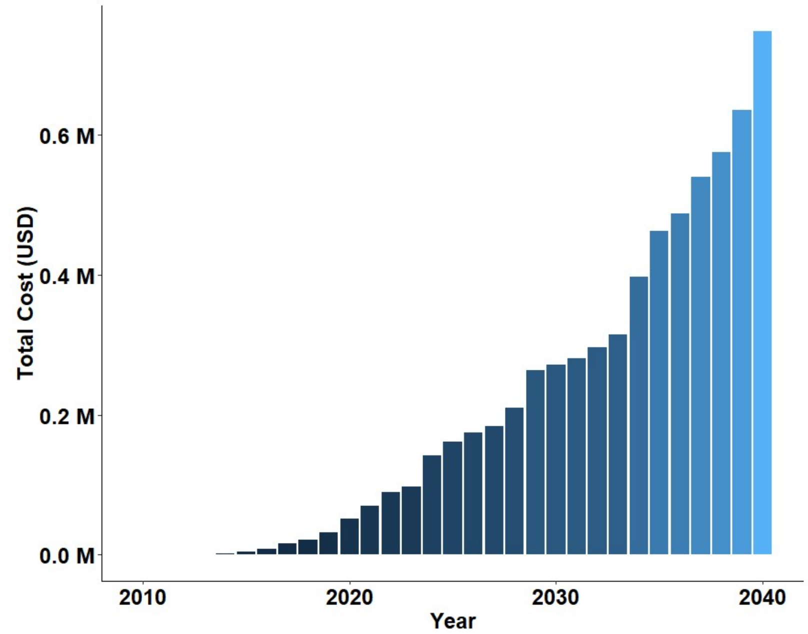
Treatment Cost Trends Cont’d



Uncomplicated Malaria treatment failure costs (total)



Cost of resistance

Scenario Analysis & Vaccination Evaluation

	DALYs Averted Per Cost Saving		
	Low Transmission	Moderate Transmission	High Transmission
RDT	0.00381	0.00732	0.00729
RDT + Vaccine	0.00390	0.00559	0.00910
ACT	(0.00293)	(0.00378)	(0.00719)
ACT + Vaccine	(0.00318)	(0.00411)	(0.00927)
CHWs	0.00517	0.00710	0.00892
CHWs + Vaccine	0.00719	0.01009	0.02018
Combined	0.00416	0.00582	0.00931
Combined + Vaccine	0.00398	0.00661	0.00926

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Conclusion and Recommendations

Conclusions and Recommendations

- Analysing malaria costs at the unit level presents an opportunity for targeted treatment options and funding.
  - Intermittent screening and treatment at schools (assuming no extra costs) resulted in a similar outcome as stocking RDTs in health centres.
- There’s scope to enhance the utilisation of malaria treatment resources for better outcomes.
  - Based on the ACT and vaccination assumptions, reducing RDT stock-outs to 1 in 28 days in health centres results in the best health outcomes.
  - The vaccine performed poorly in low and moderate transmission settings at the current efficacy levels.
    - More research to be put into improving vaccine efficacy.
    - With an efficacy of above 85%, the vaccine becomes effective in most settings.
- Training CHWs could give the best results, but quantifying the cost of training CHWs is needed.


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