Environmental surveillance for targeting typhoid conjugate vaccines: drivers of cost-efficiency in sub-national programs

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In the absence of expanded blood culture surveillance, can ES allow us to use vaccine more cost-efficiently?

- Typhoid conjugate vaccines (TCV) has been estimated to be cost-effective in evaluated settings (Antillon 2017)
- But, most countries have one (or fewer) reporting sites for typhoid: uncertainty in non-surveilled areas
- Typhoid Conjugate Vaccines (TCVs) are currently being rolled out in a number of endemic sites for both field trials (Malawi, Nepal, and Bangladesh) and emergency control (Pakistan).
- ES can aid in typhoid control in two primary ways:

Goal	Current challenge	Sample type
Burden evaluation	Most countries have one (or fewer) reporting sites for typhoid: uncertainty in non-surveilled areas	Sewage or other fecal catchment
Exposure evaluation	TCV will likely reduce burden, but to get to elimination, we need a better understanding of exposure pathways for targeted WASH interventions	Drinking water, river water, vegetables

Modeling Methods

Disease transmission model

- EMOD framework for typhoid transmission
- Heterogenous disease landscapes
- Custom environmental diagnostic tool

Costing model

- Cost-benefit analysis framework
- Health system perspective

Parameter	Value	Wastage	Variability	Reference
Vaccine	$1.50 per dose	10%	+/- 50%	UNICEF pricing tables
Syringes	$0.04 per syringe	10%	-	UNICEF pricing tables
Wastage box	$0.45 per box	10%	-	UNICEF pricing tables
Transportation cost	13% of vaccine cost	-	-	Gavi standard proposal template (MCV)
Campaign delivery	$0.74 per person	-	+/- 50%	Gandhi and Lydon, 2014
Routine delivery	$0.59 per person	-	+/- 50%	ImmunizationEconomics.org
Environmental testing	$33 per sample	-	+/- 50%	Correspondence
Acute Treatment	$103.87 per case	-	+/- 50%	Antillon, et al. 2017

Applied discount rate of 3% per year.

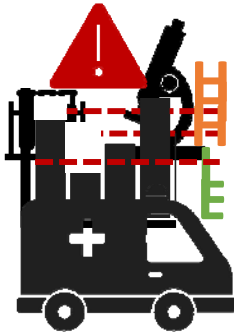
Scenario framework of the typhoid ES model

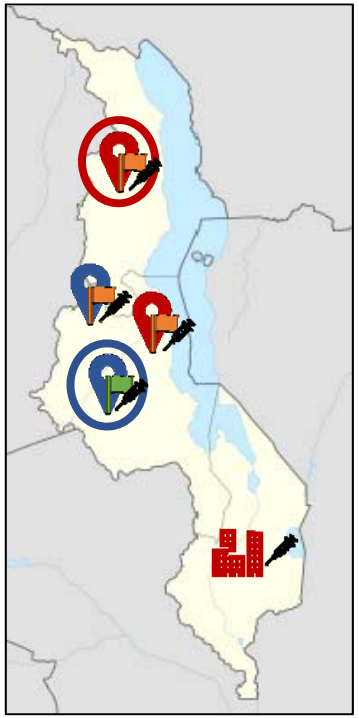
Endemicity

Surveillance coverage

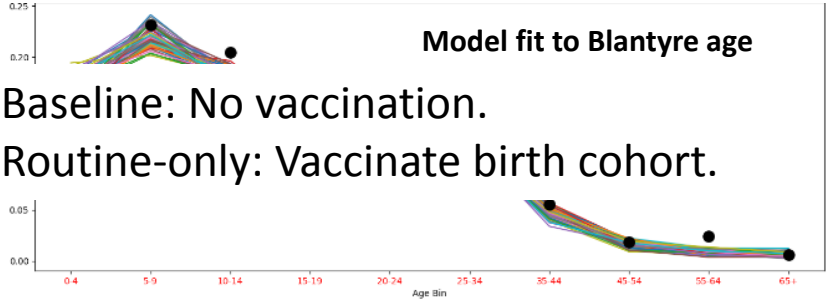
Test Sensitivity

Campaign strategy





Graphics by Mandy Izzo, IDM



Model fit to Blantyre age

Baseline: No vaccination.

Routine-only: Vaccinate birth cohort.

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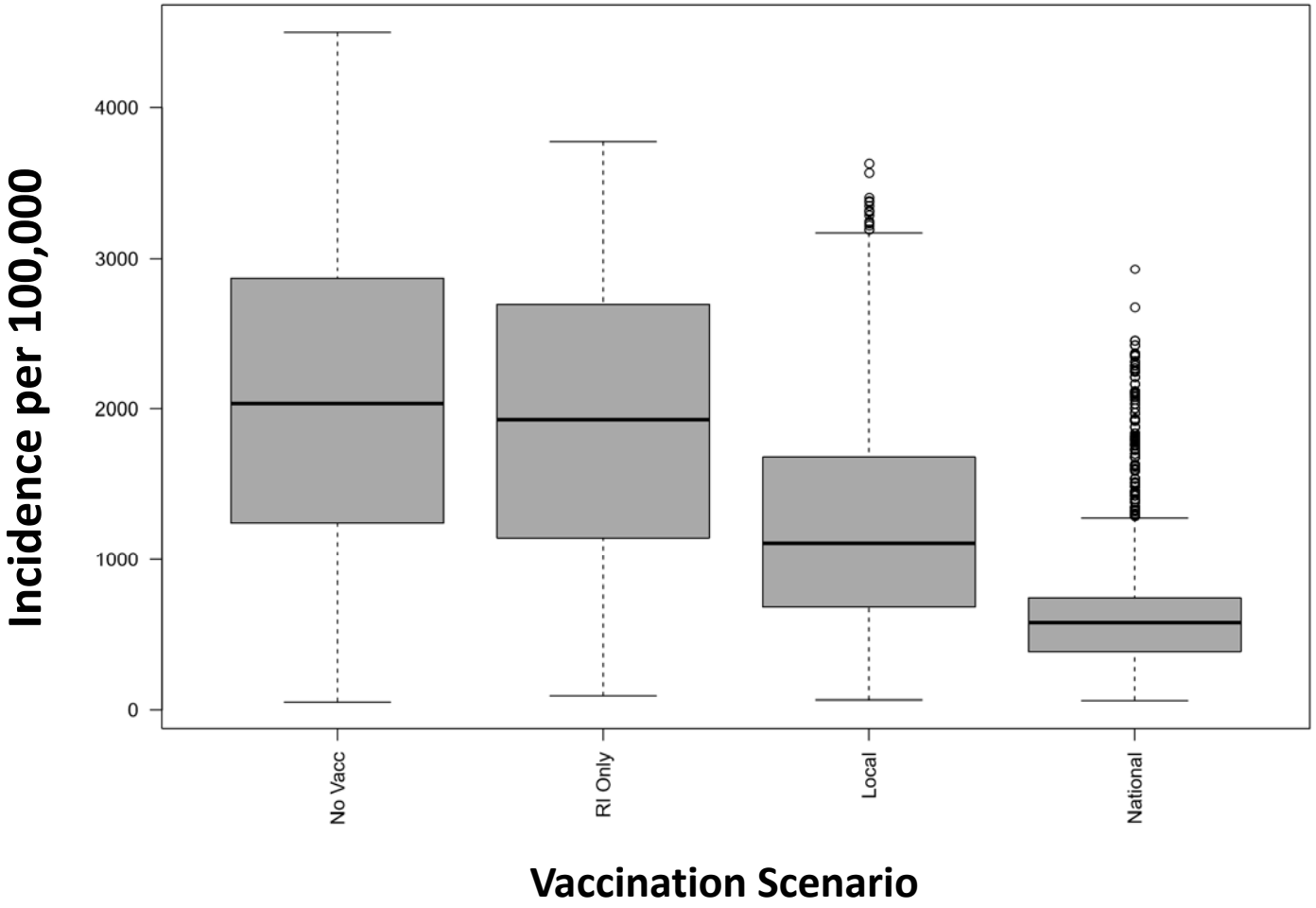
Disease incidence varies on surveillance scenarios



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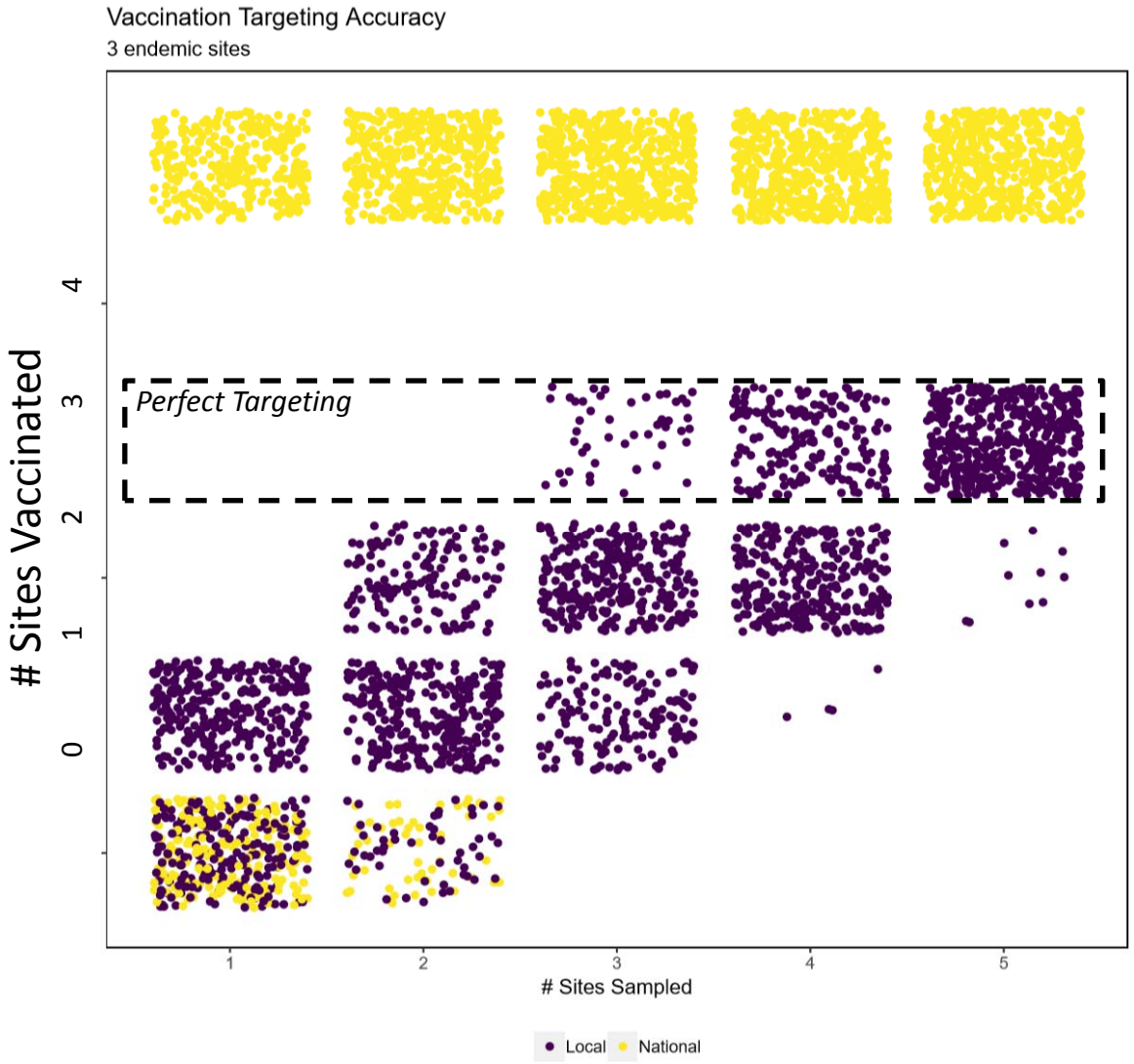
Optimal ES levels depend on the catch-up strategy



National strategy is highly responsive, vaccinating the entire country in most simulation runs.

Local strategy is more cost-efficient, but requires a large ES catchment area to ensure that it doesn't overlook/miss endemicity.

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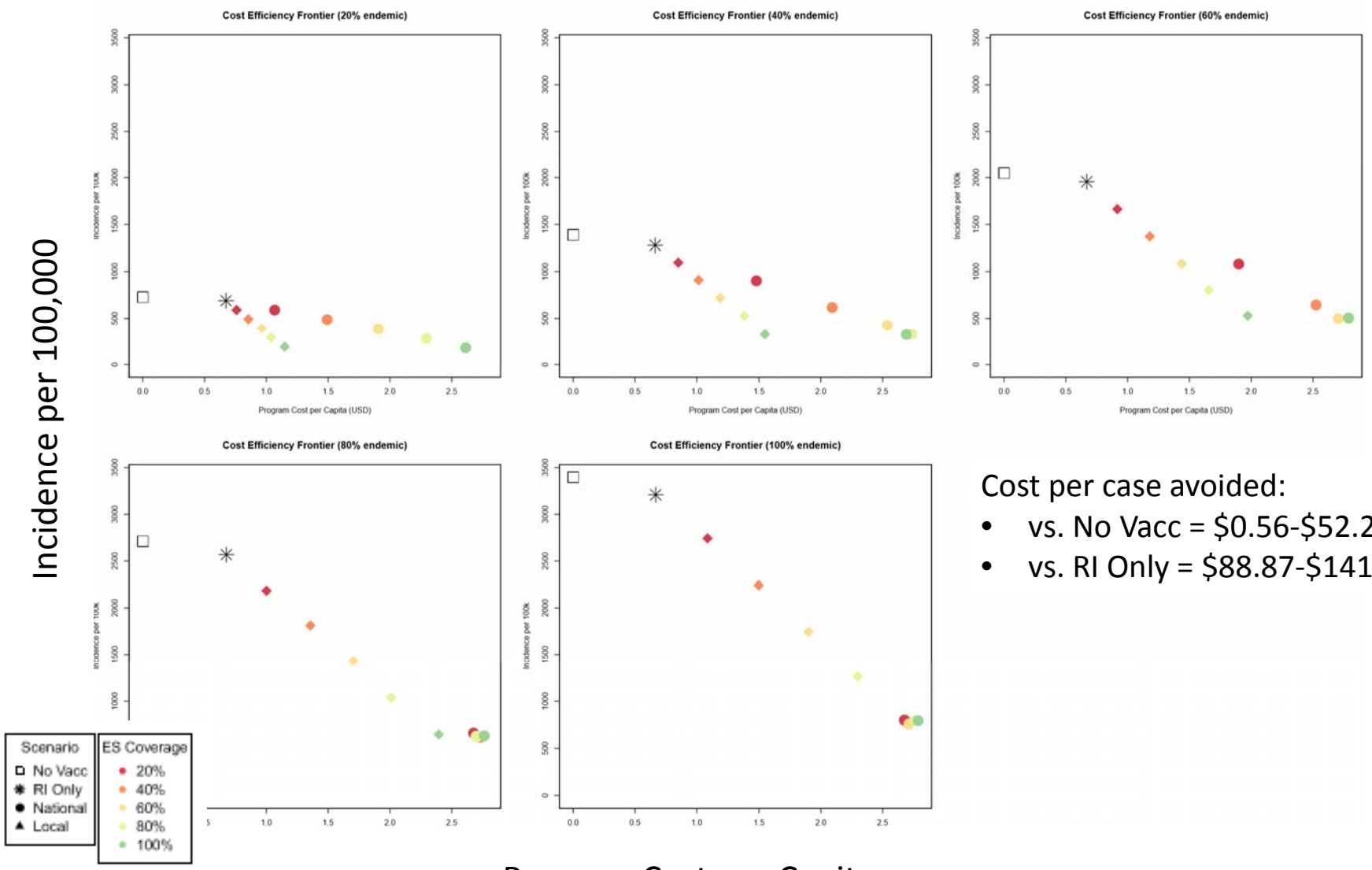
Cost-Efficient Frontier (Program Cost)

Fewer cases at lower cost



Cost per case avoided:

- vs. No Vacc = $0.56-$52.26
- vs. RI Only = $88.87-$141.25

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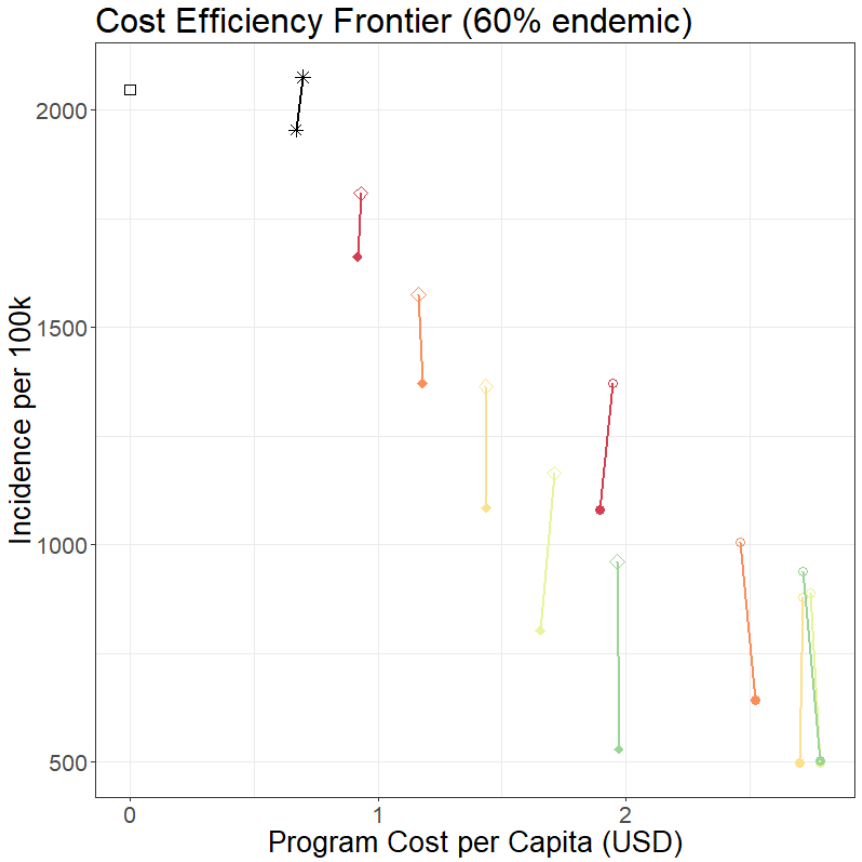
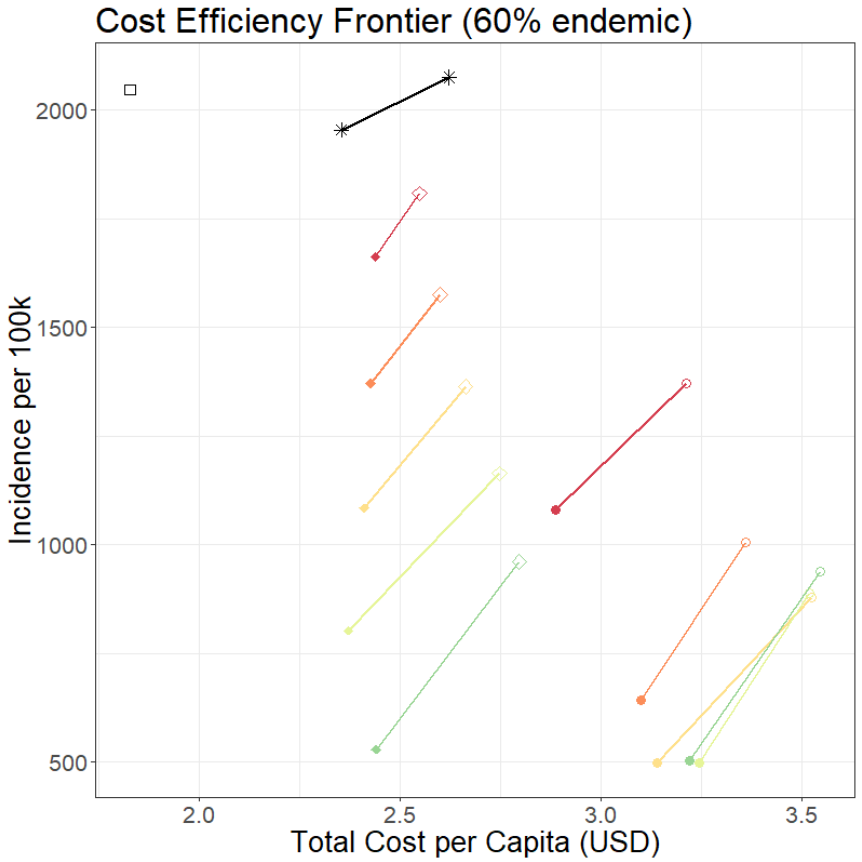
Vaccine efficacy changes the details but not the decision

Comparison of 87% vs. 55% vaccine efficacy.





Vaccine efficacy doesn't change the program strategy, so we only see an increase in incidence.

Less effective vaccination drives up total cost due to increased cases and treatment expenses.

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Costs could increase without substantial revision to the recommended strategy

Vaccination Prices

- Inclusive of the vaccine and campaign-based delivery
- Surveillance-based campaigns are superior to routine-only introduction, for a cost up to $2.93-$4.37 per person targeted (compared to $2.24 baseline)

Treatment Costs

- Multi-drug resistant (MDR) typhoid is more expensive to treat and is increasing in prevalence
- The cost of treating cases becomes ***more expensive*** than running vaccination introduction campaigns if treatment costs exceed $207-$644 per acute case
- ***Vaccination is cost-saving*** if this is the case

Key Findings

- Locally-targeted campaigns informed by ES are **cost-efficient across scenarios** explored
- National campaigns maximize burden reduction, but results in over-vaccination of low-risk populations
- **Adequate ES coverage** is necessary to ensure endemicity is not overlooked
- Quantitative ES is important in determining the appropriate response policy
- Environmental surveillance is an **inexpensive investment** for better vaccination targeting
- These patterns are true regardless of the "patchiness" of the true underlying disease prevalence

Thank You

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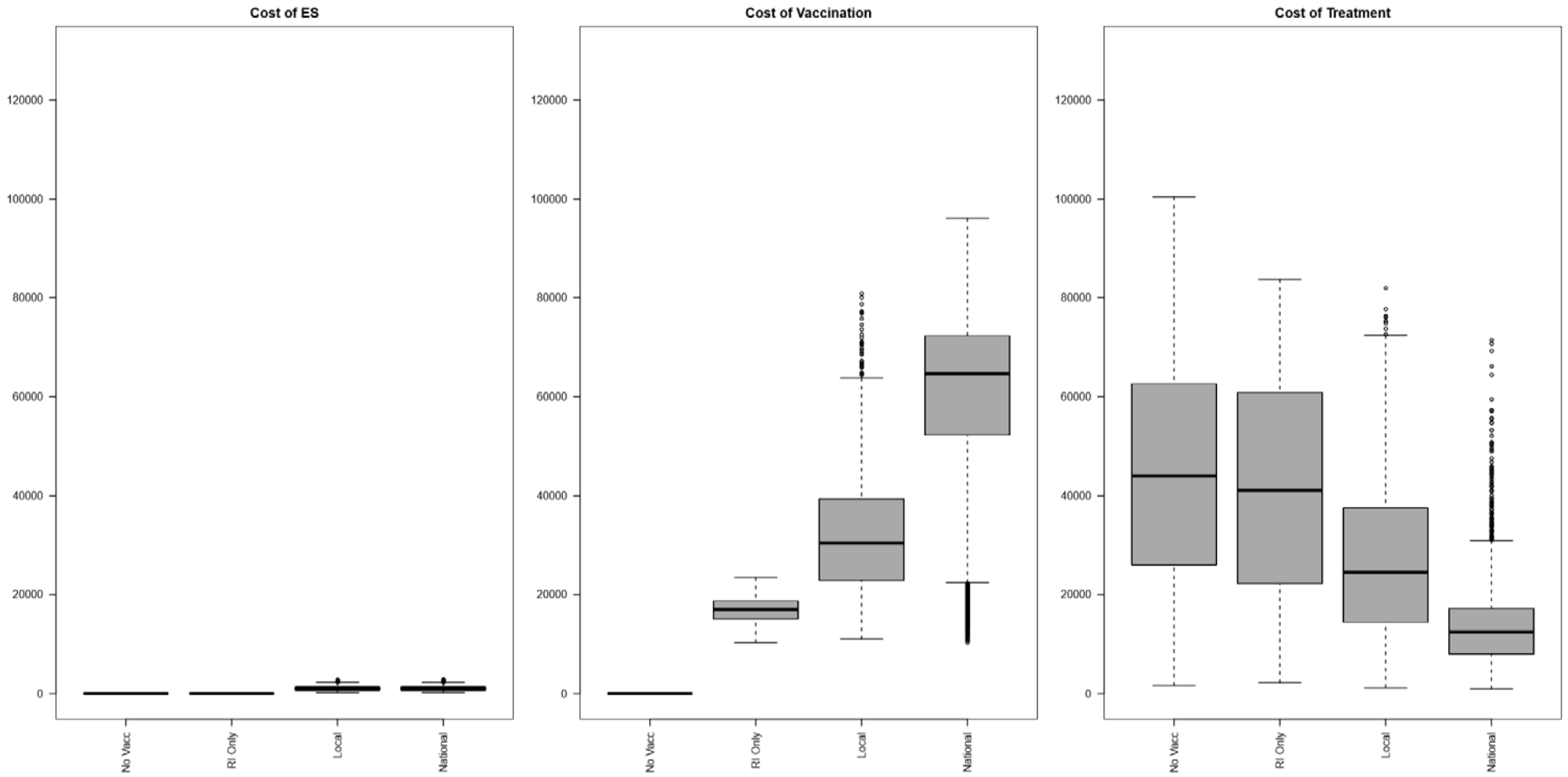
Cost Components



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