What happens to people in the absence of any intervention?

Modeling patient's care-seeking behavior

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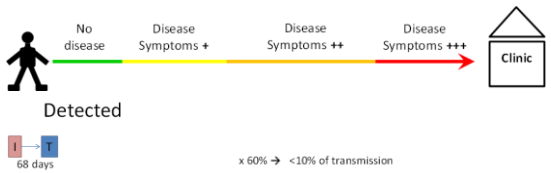
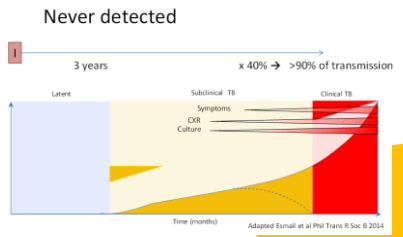
TB Modelling and Analysis Consortium

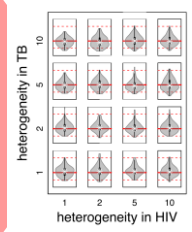
At last year's TB-MAC MRG meeting…

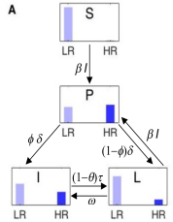




Biological & Clinical Characteristics

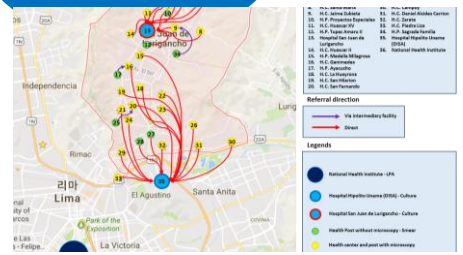
Heterogeneity





Diagnostic Tools

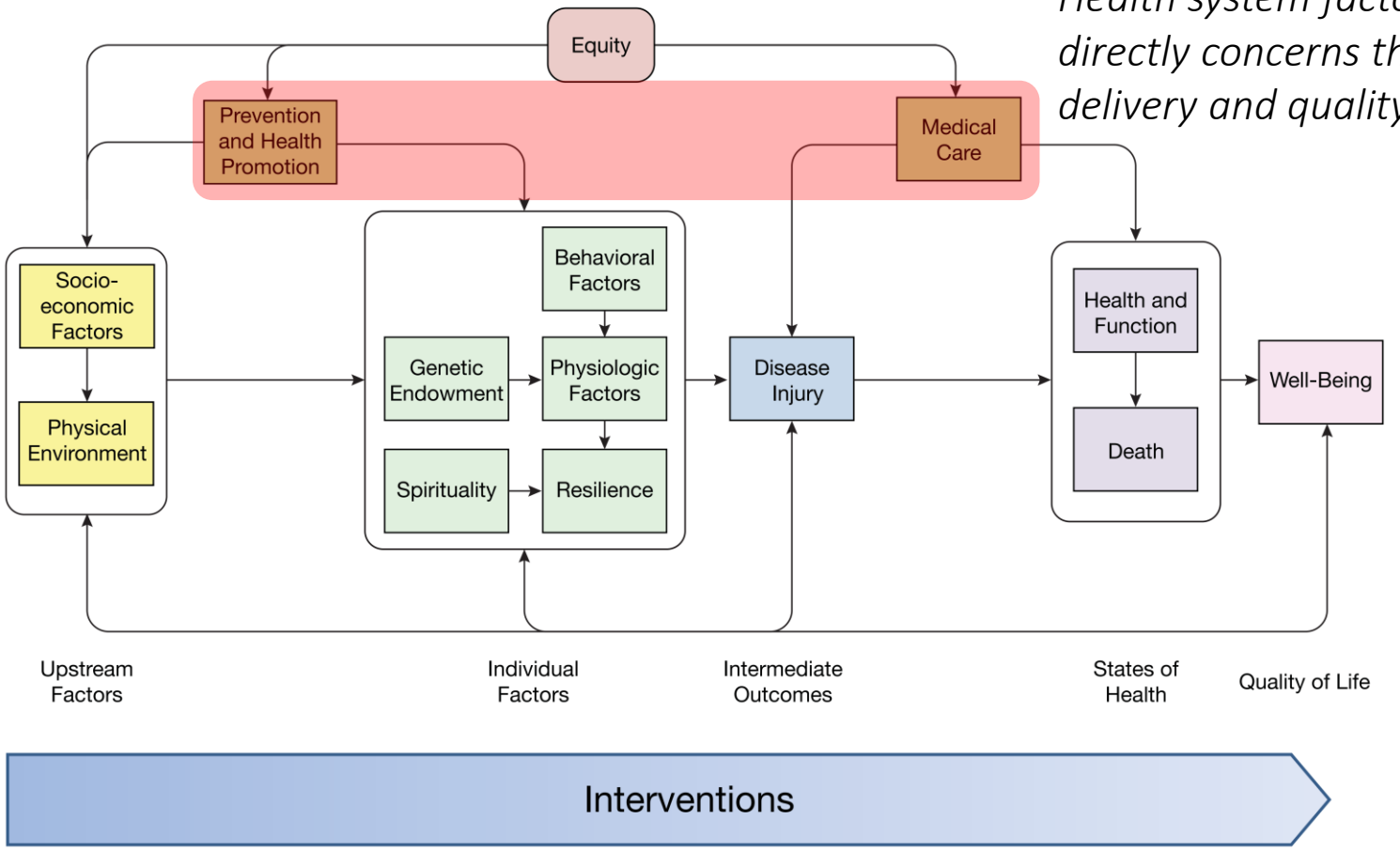
Health Systems



Economics & Financing

The pathway to promoting patient's well-being

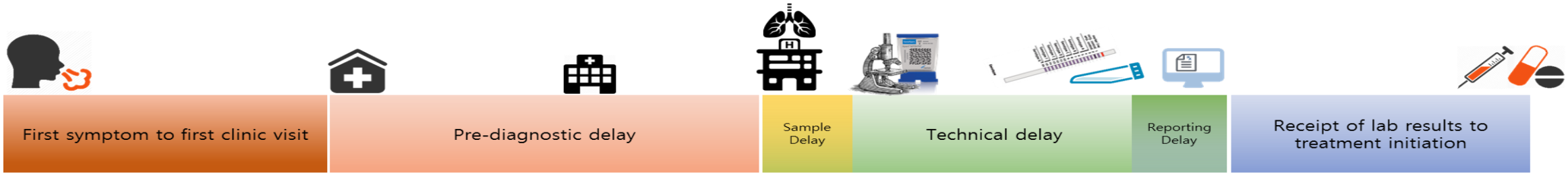
Health system factors directly concerns the delivery and quality of care



Institute for Healthcare Improvement (IHI) Composite Model of Population Health – Stoto, 2014

Added complexity: An overview of delays in TB care pathway

Dissecting causes of delays in diagnosis and treatment of TB



Patient Delay

Definition:
Time between onset of the first symptom(s) and the time when the patient first contacted any type of health care service

Time components
- Time to seeking health care

Pre-diagnostic delay

Definition
Time between patient's first contact with the health care service and specimen collection got TB diagnosis (or first visit for TB specific consultation)

Time components
- Time to TB clinic visit

Sample delay is defined as time of specimen collect to specimen arrival at the laboratory.
Reporting delay is defined as time of result at the laboratory to availability of results at the clinic. Technical delay is defined as time between sample arrival at the laboratory to test result

Diagnostic Delay

Definition
Time between specimen collection (or first TB specific visit or study recruitment) and reporting or receipt of results at the clinic.

Time components
- Sample delay
- Technical delay
- Reporting delay

Treatment Delay

Definition
Time between test result reporting and treatment decision for TB disease (or to confirm no TB)

Time components
- Time to seeking health care

Therapeutic Delay

Definition
Time between first specimen collection (for diagnosis of TB) and treatment decision for TB disease (or to confirm no TB)

Time components
- Diagnostic delay
- Treatment delay

Health Systems Delay

Definition
Time between patient's first contact with the health system to treatment decisions for TB disease

Time components
- Pre-diagnostic delay
- Diagnostic delay
- Treatment delay

How have we have thus far ‘modeled’ the impact of patient care-seeking behavior

- Impact of symptom-related patient care-seeking behavior in the cost-effectiveness of active case-finding programs
- A case of decentralization of Xpert in India

Finding cases earlier:

Value and Cost-effectiveness of Active Case-Finding

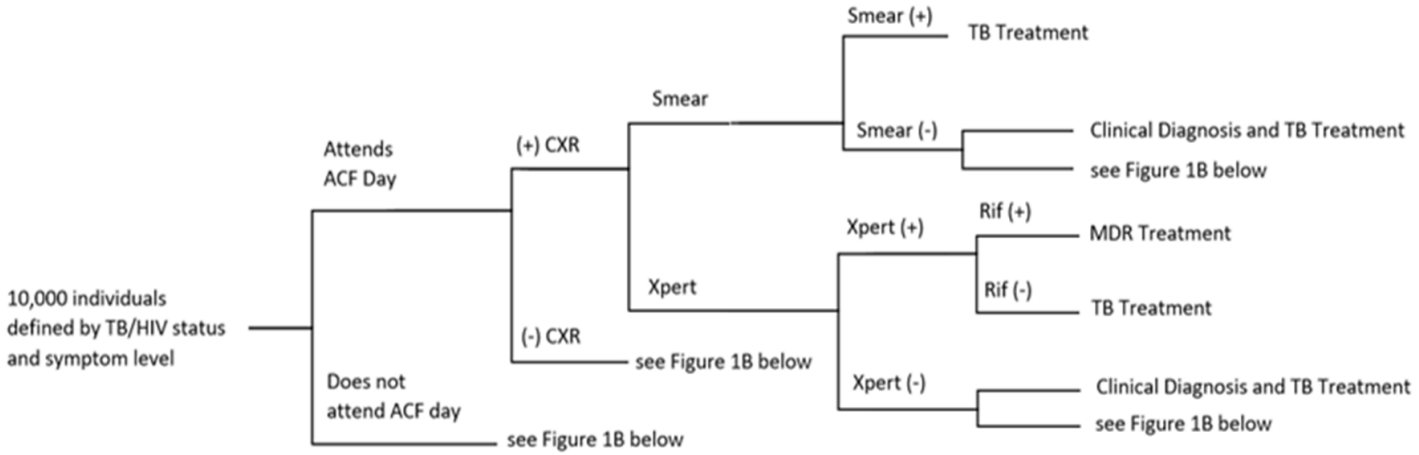


Fig 1A – ACF Day algorithm

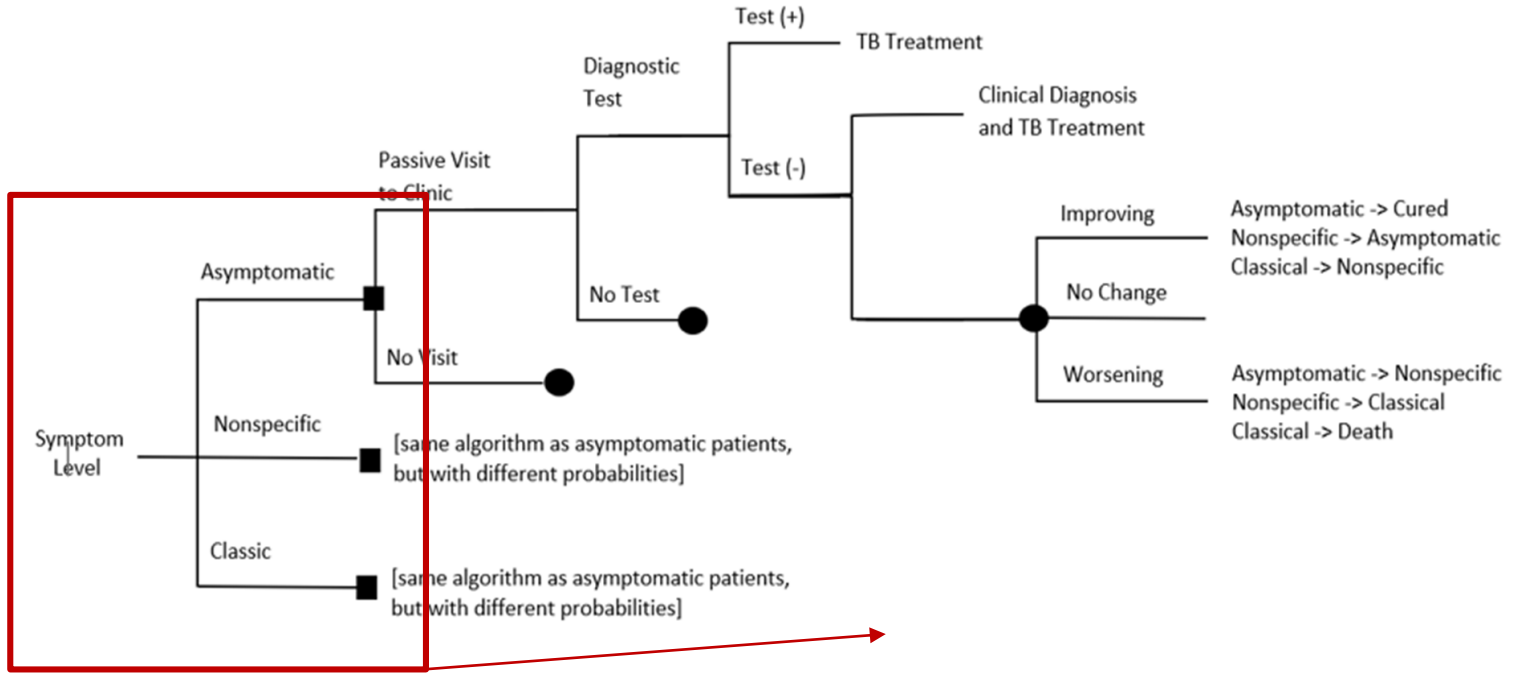
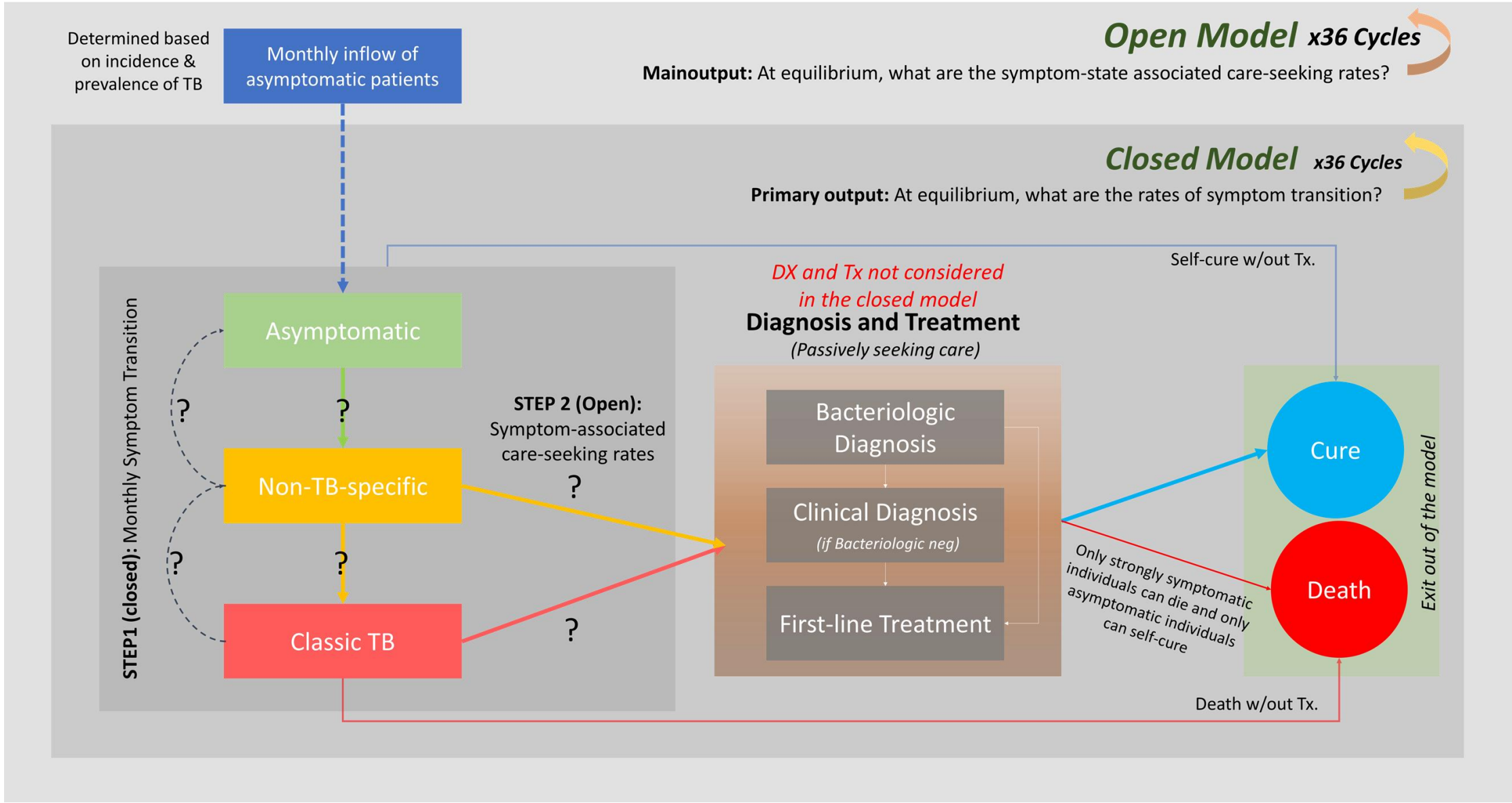


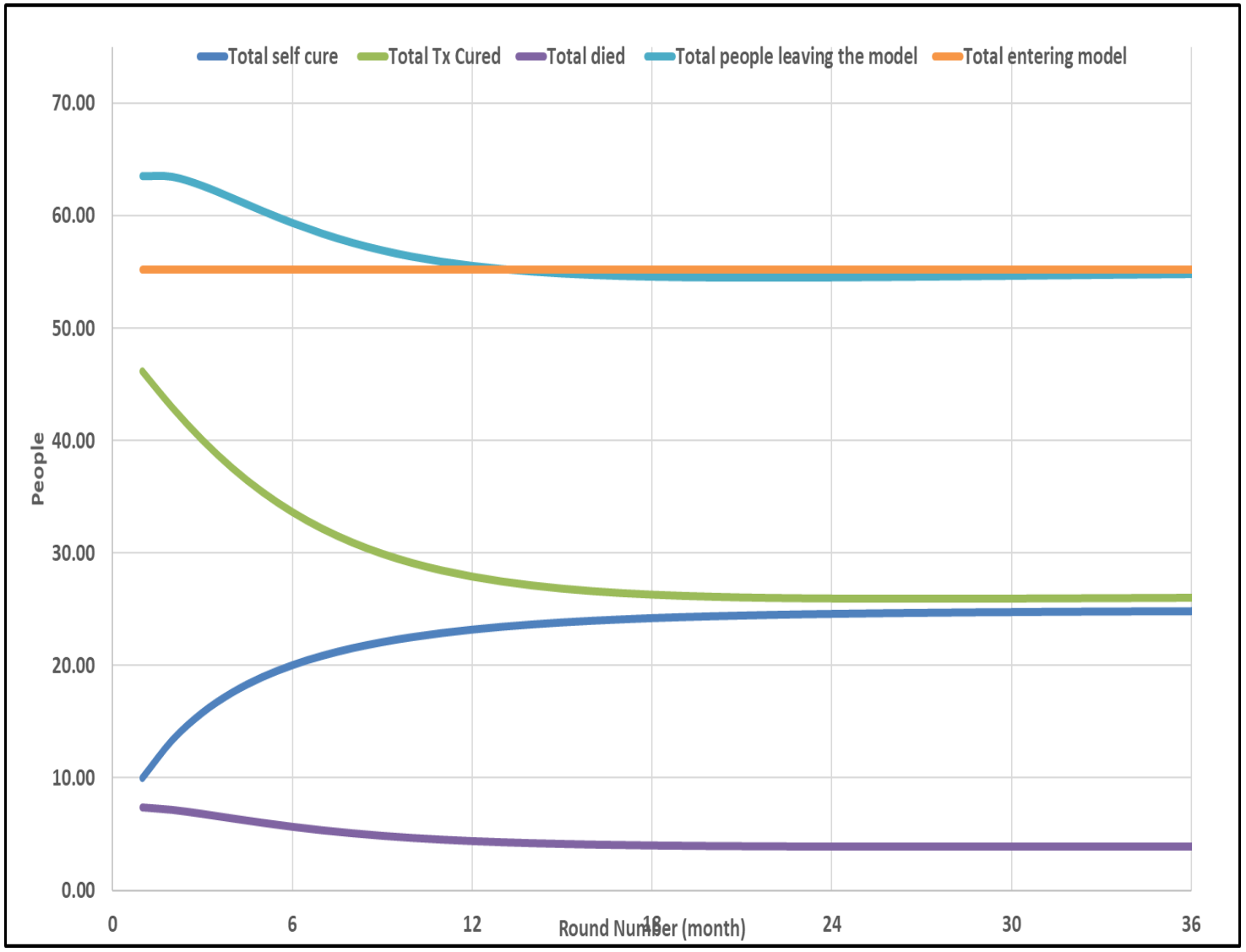
Fig 1B – Markov Model of Routine Care

Conceptual model framework of symptom-associated care-seeking



Model Parameters and calibration

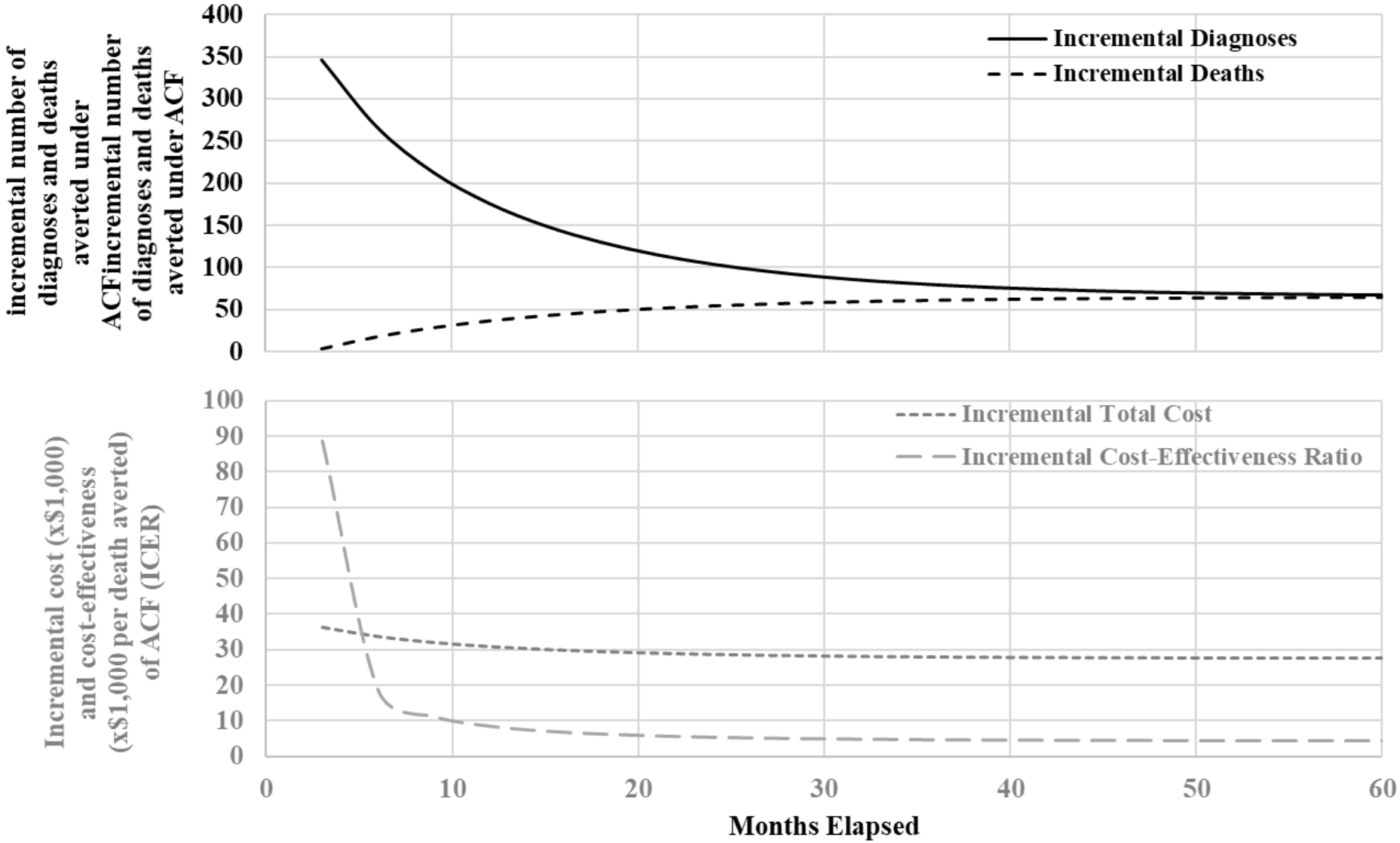
Model Parameters	
Population epidemiology	
Prevelance of TB in Cambodia yearly (660/100,000)	0.01
Incidence of Tb in Cambodia per year (437/100,000)	0.0044
Duration of disease	1.51
1/(prevelance/incidence)	0.66
Number of people enter with NoSx every year	662.12
Number of people enter with NoSx every round	55.18
number of TB+ people in model	1000.00
TB Epidemiology	
P (No Sx | TB)	0.20
P (Mild Sx | TB)	0.40
P (Strong Sx | TB)	0.40
Programatic features	
P (diagnostic test | PCF contact)	0.83
Sensitivity of diagnostic tests	0.85
P (Tx | Positive Diagnosis) [CAT1] (p_LTC_PCF)	0.70
P (Tx | Negative Diagnosis & No Sx) [Emp]	0.00
P (Tx | Negative Diagnosis & Mild Sx) [Emp]	0.50
P (Tx | Negative Diagnosis & Strong Sx) [Emp]	1.00
P(Cure | Tx)	0.93
p (Cure | NoTx & NoSx)	0.05
P (Death t+1 | Strong Sx t)	0.02
Steps for the closed model calibration	
(1) 75% faster progression than regression of symptoms	
(2) # self cure and # death is equal	
(3) Duration of no Sx is 9mo	
Steps for the open model calibration	
(1) Calibrate P(PCF contact | MildSx) and P(PCF contact | StrongSx) to the extent entry & exit reach equal in numbers at equilibrium	



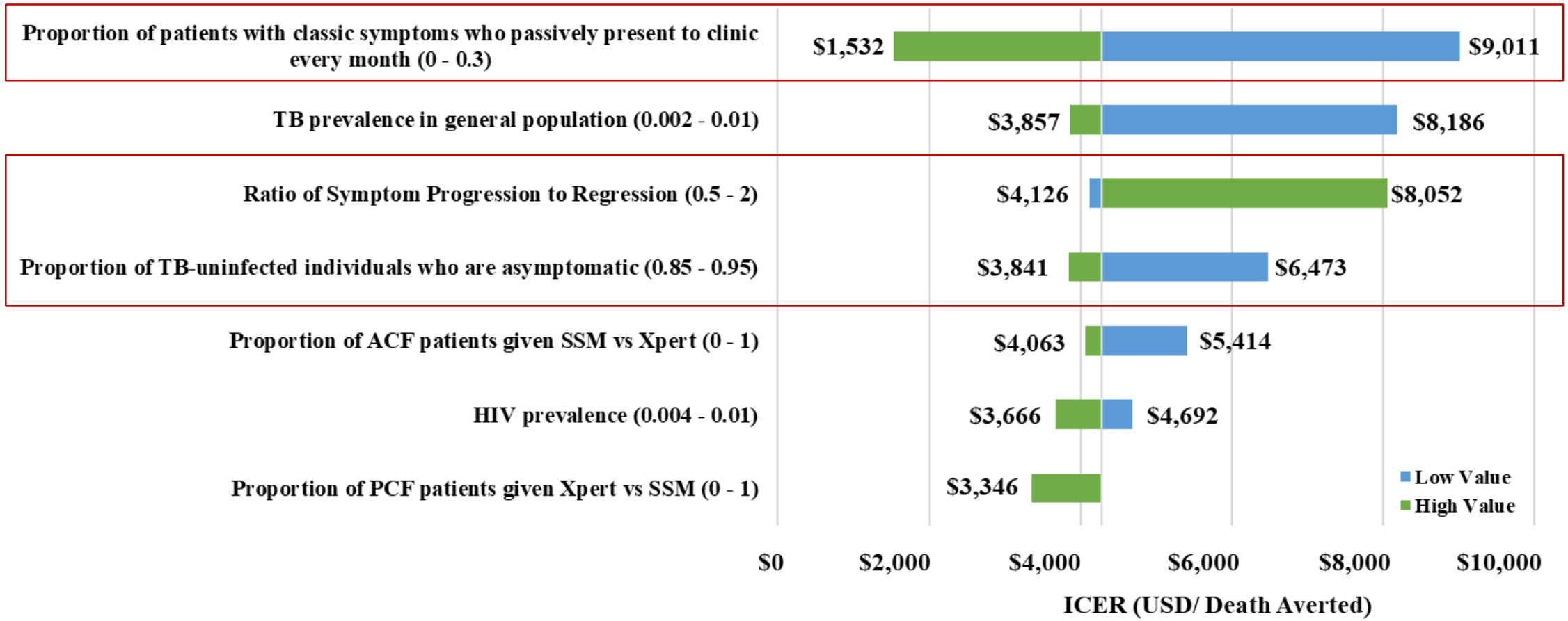
Results

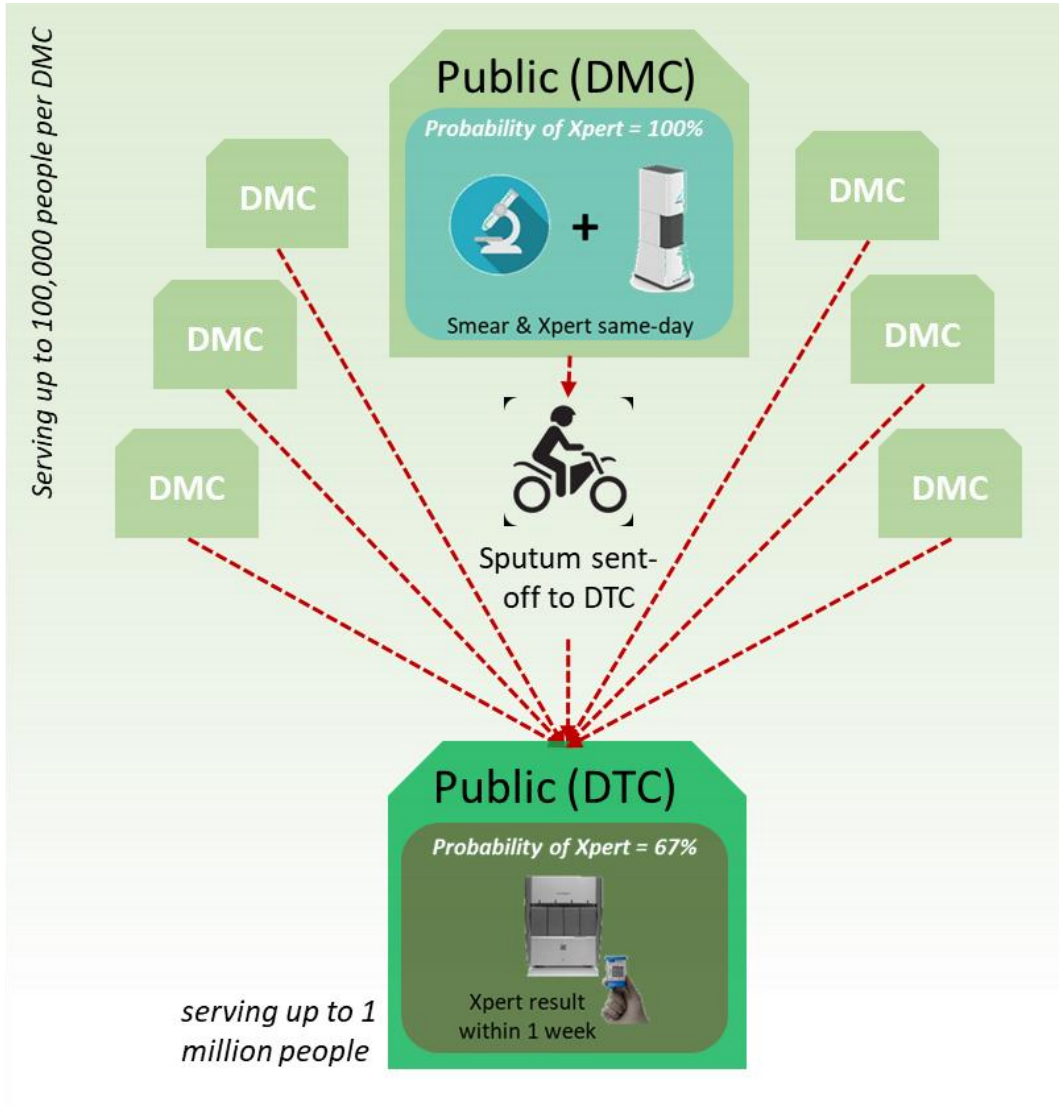
Model Parameter	Output	
	Cambodia	India
Proportion of patients having passive contact with health system by symptom levels		
Asymptomatic	0	0
Nonspecific	0.7	0.5
Classic TB	0.14	1.0
Monthly Symptom Transition Rate		
Non-specific to asymptomatic	0.120	
Non-specific to classic TB	0.158	
Asymptomatic to non-specific	0.210	
Classic TB to non-specific	0.090	

Clinical and Economic impact of ACF over time



Impact on the Cost-Effectiveness of ACF





Decenetralized Xpert in India

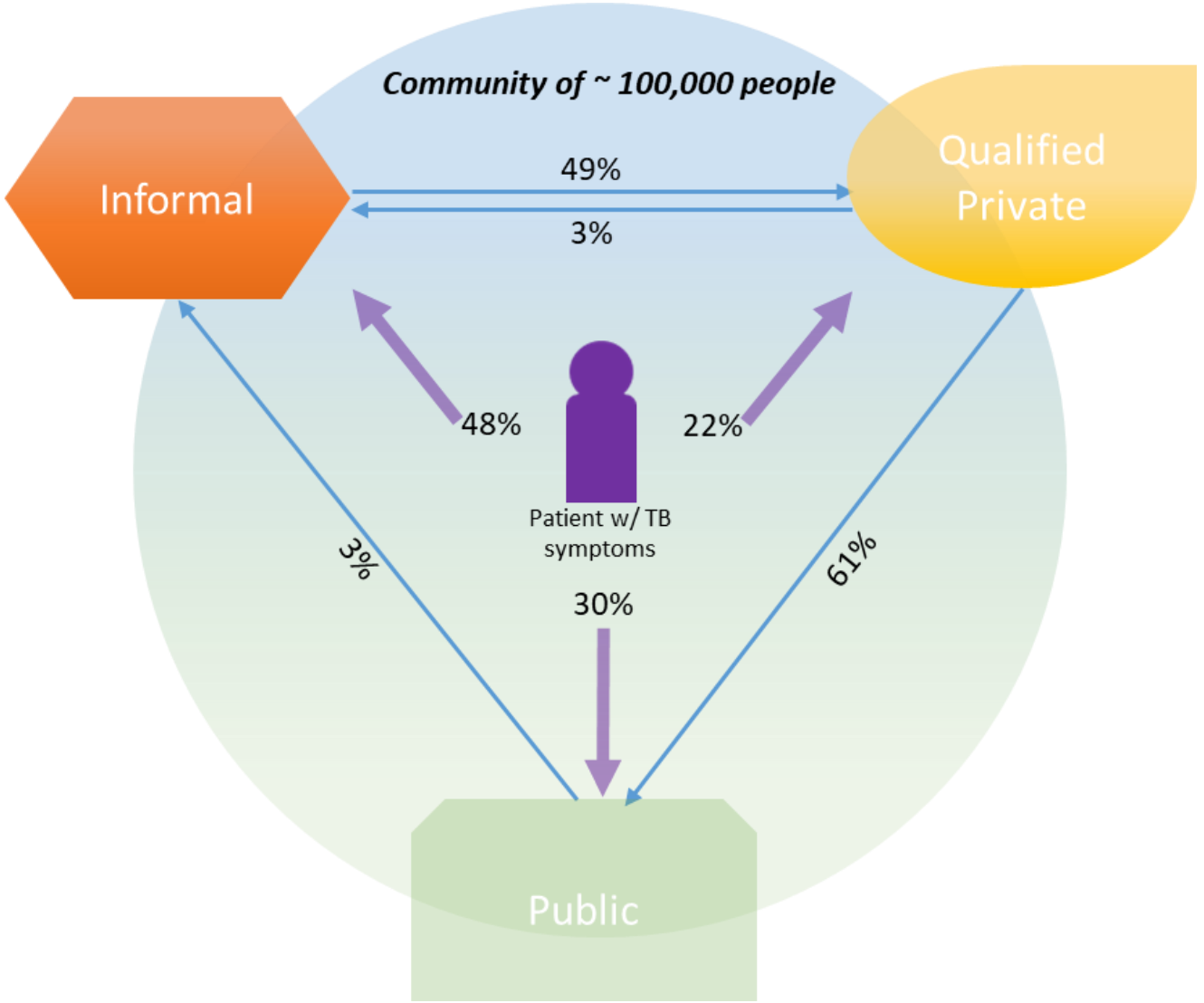
All suspected TB patients (100%) will be tested with Xpert as an upfront test in both scenarios (smear as treatment monitoring tool)

- Decentralized: on the same day during the diagnostic visit
- Centralized: on the same week of the diagnostic visit (w/ added cost of sample transport network)

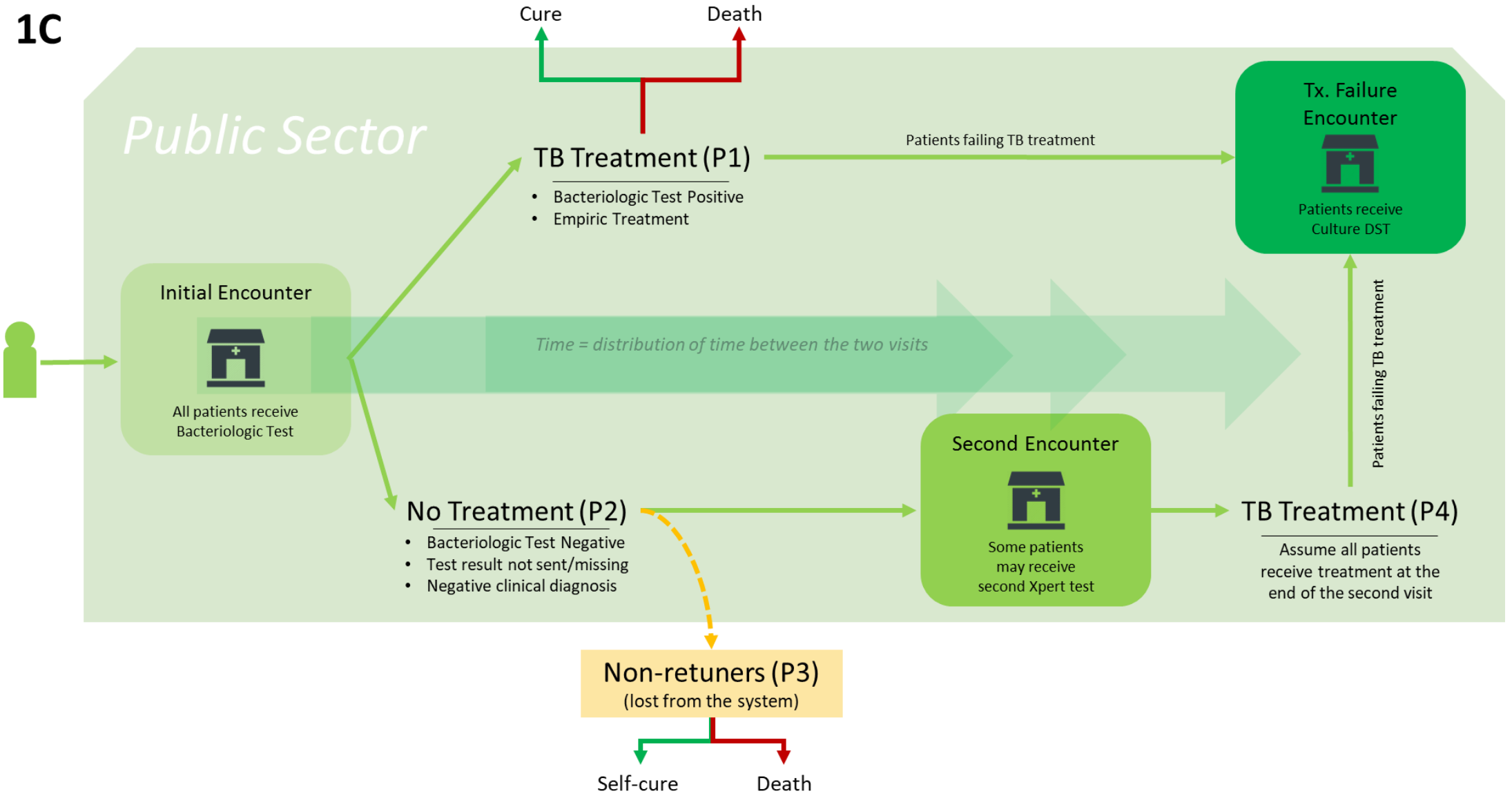
Conceptualization of care-seeking pathways

‘Private – Public’

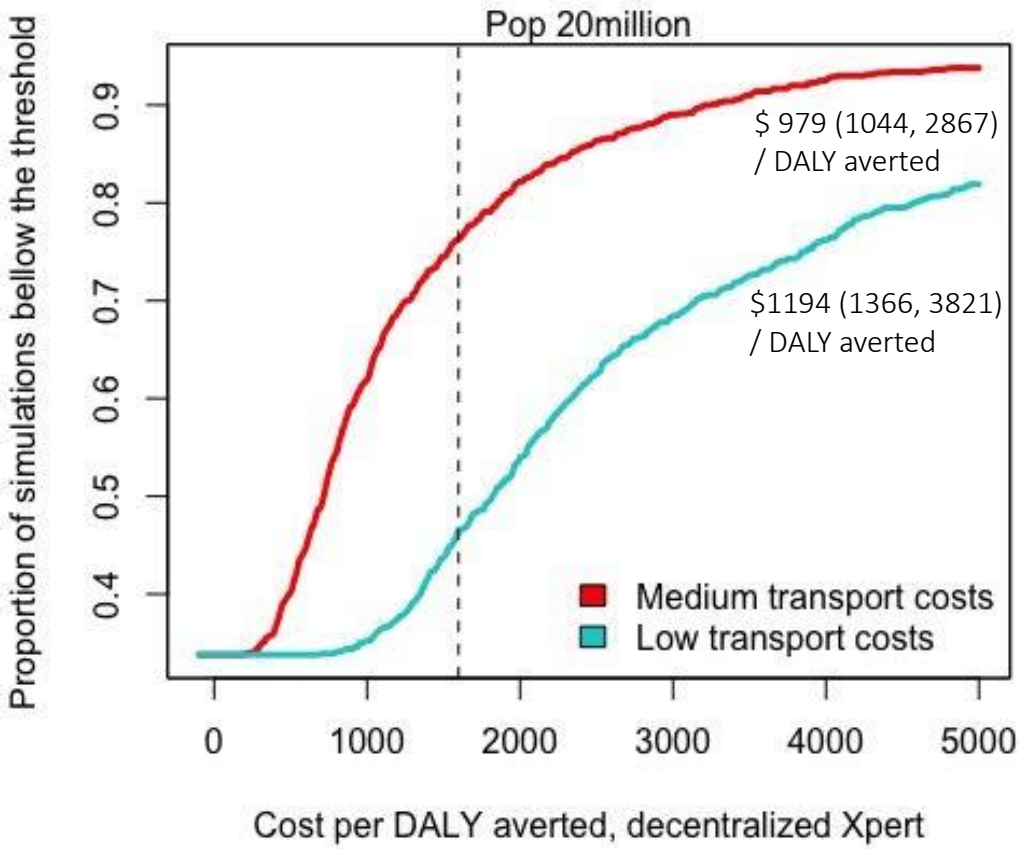
a. Probability of seeking care modeled as a function of time since infection
b. Probability seeking care via each provide depends on the previous step



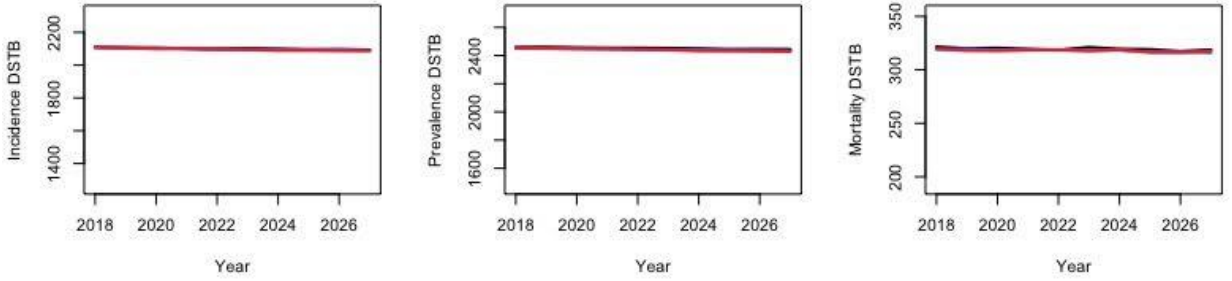
Key impact of DXP



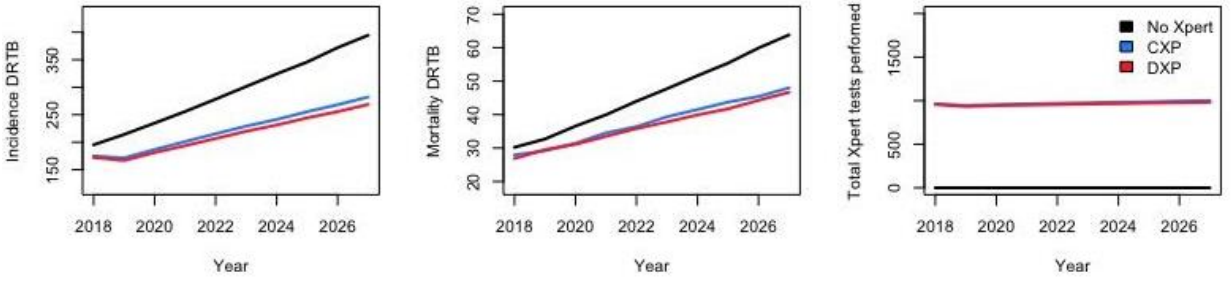
Is Xpert decentralization cost-effective?



Little or no impact in Drug-Susceptible TB prevalence



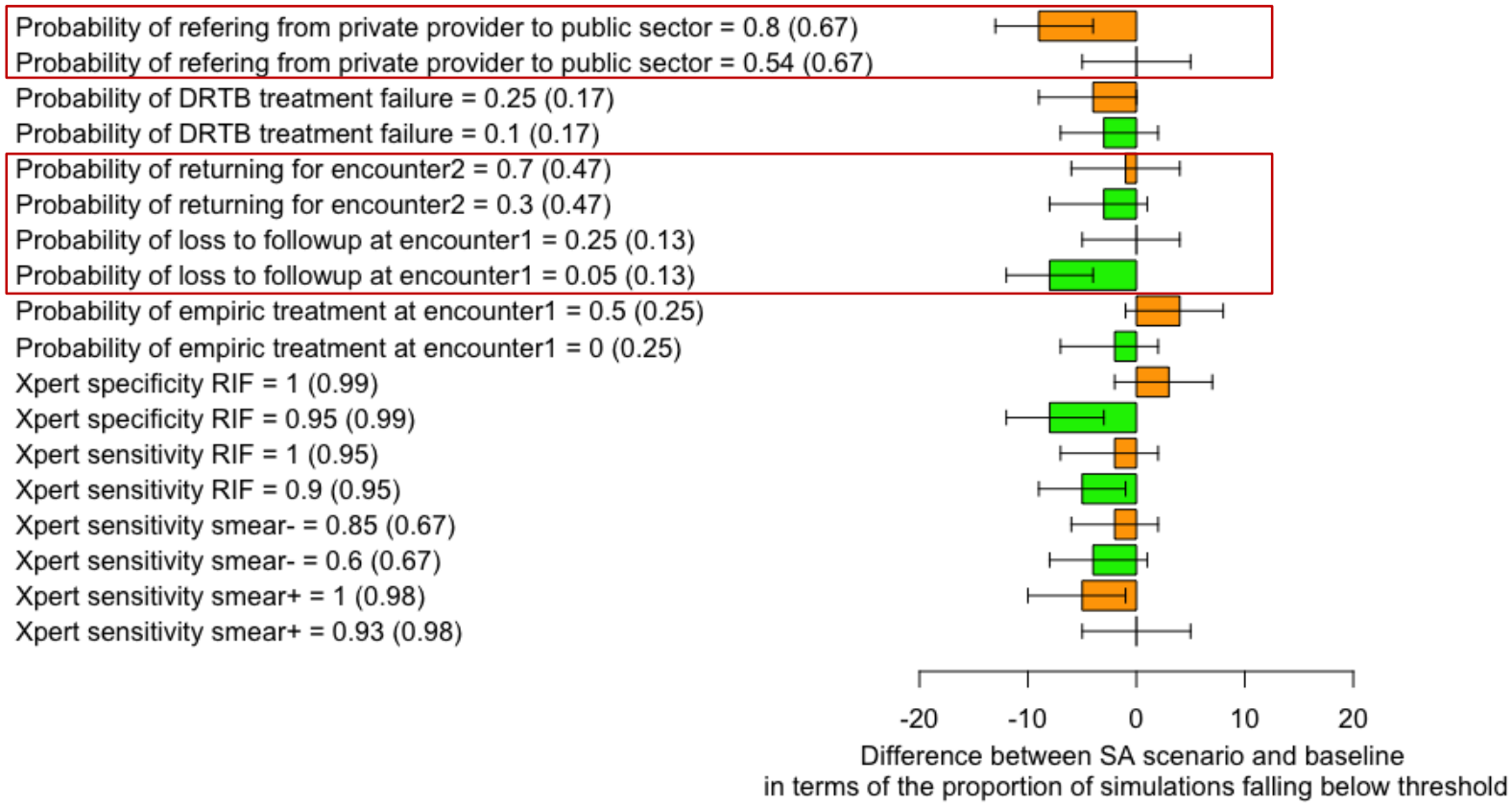
Can lower incidence and mortality due to Drug-Resistant TB, but does not change the underlying trend*



** Possibly due to the 13% lost to follow-up who are never treated and continue to transmit the disease in both scenarios*

Impact of parameters of patient care-seeking behavior

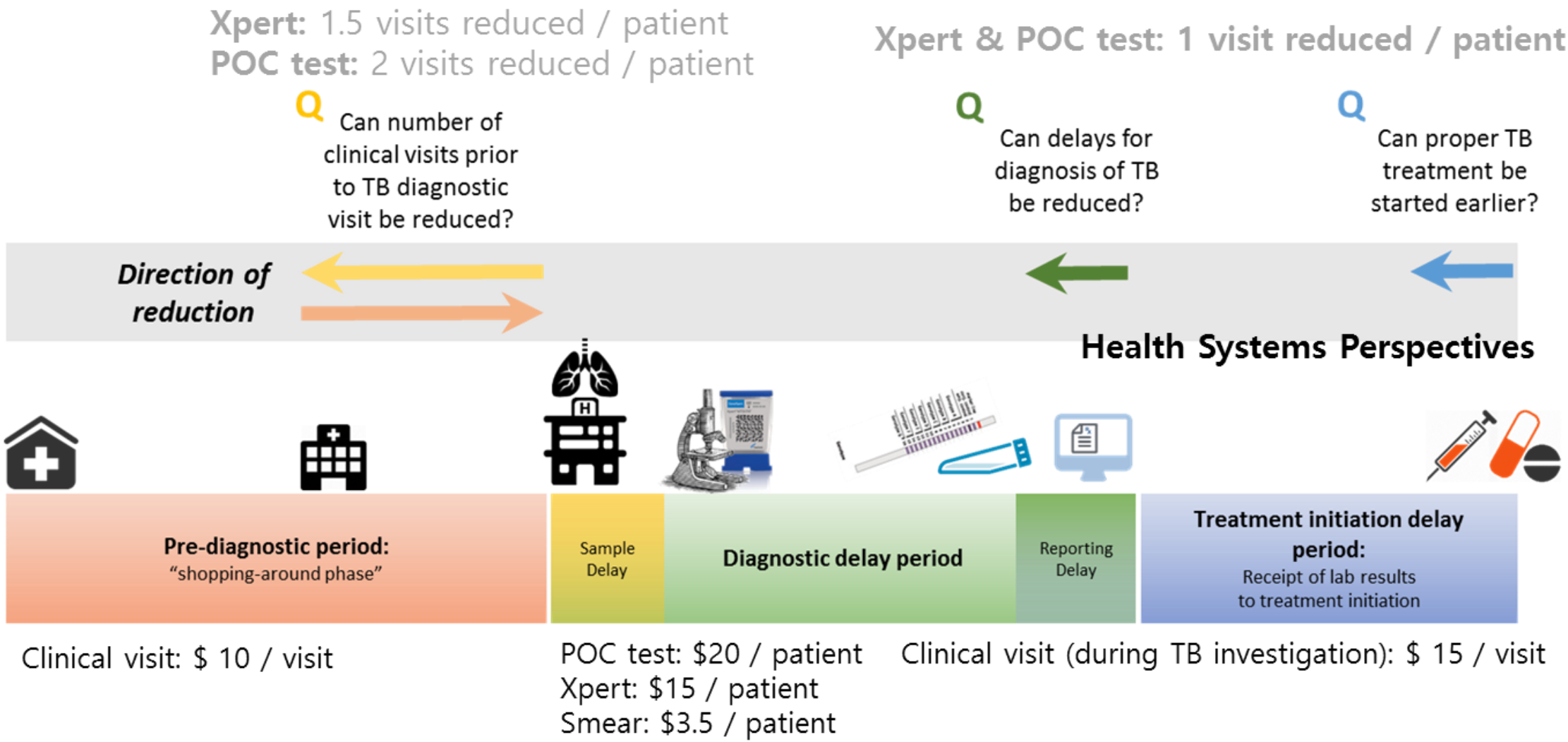
Post-calibration one-way sensitivity analyses of key parameters



Assessed as proportions of simulations falling below the ICER threshold of ~ $1600

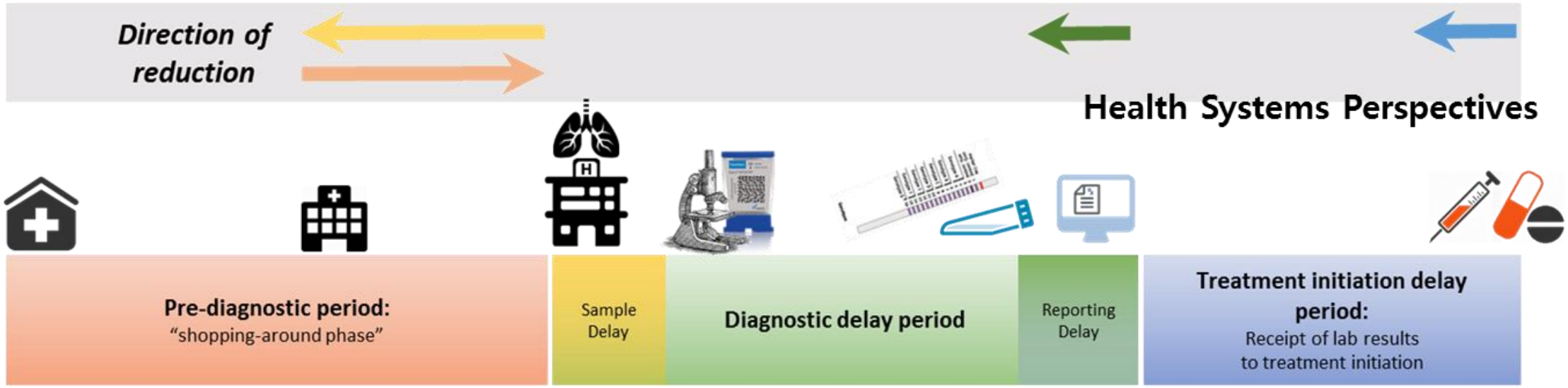
Conceptualization of how rapid diagnostics can reduce costs

Can we justify incremental cost of a diagnostic test? – A Reduced utilization of health services



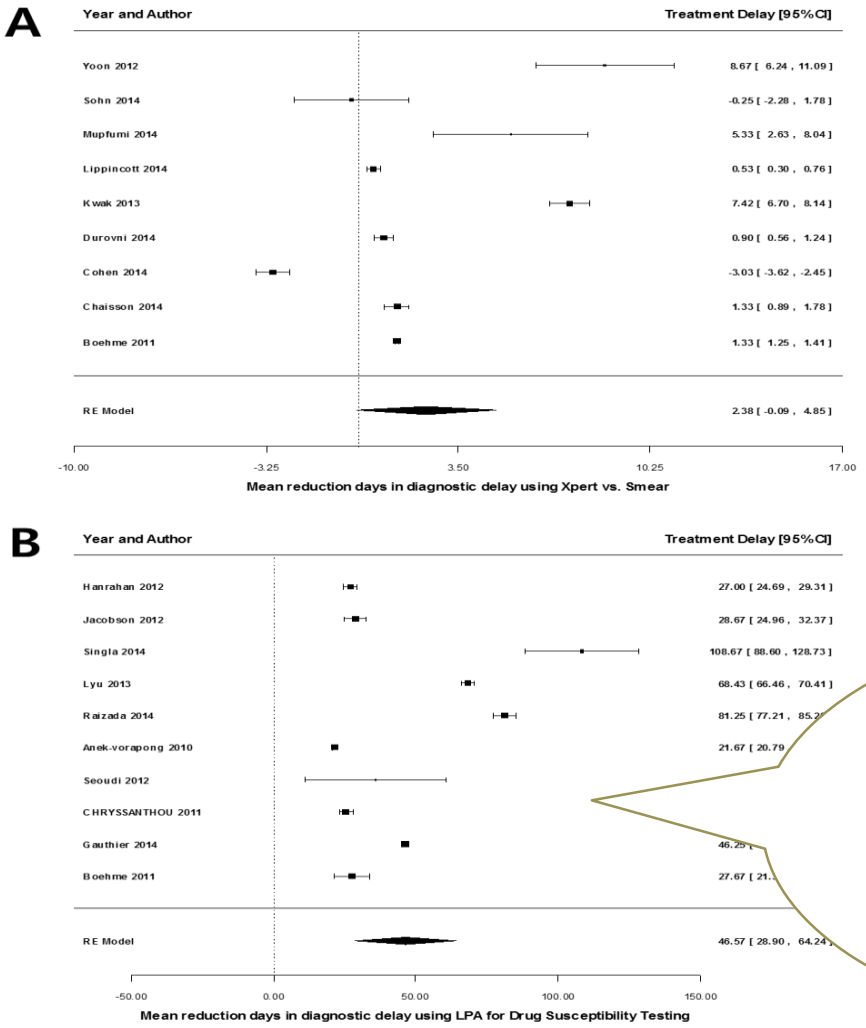
But! This depends on how patients ‘behave’

Within and outside of the health systems



Added complexity

Have rapid TB diagnostics had impact on reducing the delays?



- Screening 7,995 titles led to 39 eligible studies (21 for DS-TB w/ Xpert & 18 for DR-TB w/ LPA, where 2 were also for Xpert)
- Use of Xpert (vs. smear microscopy) reduced 2.83 days (95% CI: 0.09, 4.85) for diagnosis and 16.54 days* (95% CI 6.79, 26.35) for treatment for DS-TB

Exclusion of hypothetical studies reduced the effect to 4.75 days (95% CI 0.94, 8.57)

culture DST) reduced 45.57 days (95% CI
days (95% CI 27.72, 97.24) for
DR-TB
observed (types of study
ion of time delay components,
A)

How can a 2 hr. test end up delaying diagnosis and treatment for more than 40 days**?!

** e.g. Hanrahan & Jacobson reported overall 55 and 60 days for treatment initiation of MDR-TB using LPA results

More complexities

- Social determinants of TB
- Equity issues
- Natural history of TB disease (biological and clinical considerations)
- Health systems operations and efficiencies in program implementation & scale-up
- Political willingness
- Patient's innate behavior (underlying constructs of patient characteristics associated with the disease, symptoms, and care-seeking)

???: How much of these do can we model in understanding the impact of new diagnostic tools (and other TB interventions) ???

Dowdy Team

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- Karl Johnson (JHU Krieger School of Arts & Sciences)

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Thank you!

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