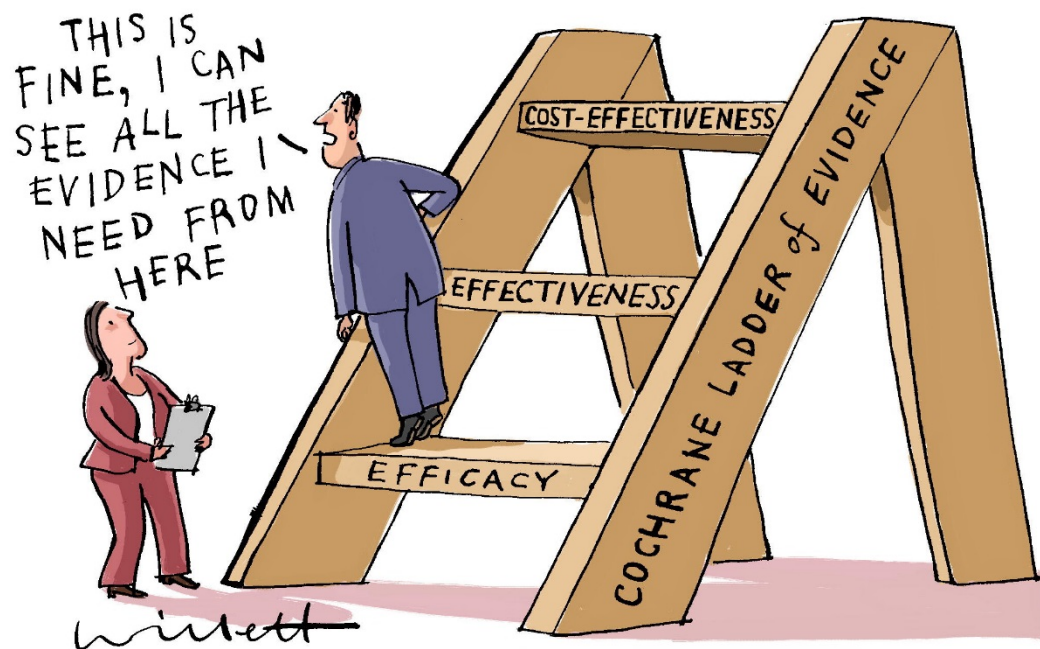


Healthcare Decision Making:

An introduction to Cost & Cost-Effectiveness Analysis



Hoon Sohn, MPH, PhD Candidate



McGill University

Agenda

- Forms & Structure of economic evaluations
- What is cost-effectiveness analysis (CEA)?
 - Measuring costs (previous lecture)
 - Measuring effectiveness
 - How do we perform CEA
 - Decision analytic model
 - Incremental Cost-effectiveness Ratio (ICER) & how we make decisions
- Relevance & Challenges of CEA in TB diagnostics
- Evaluating economic evaluation studies – important checklists

What can you make of this abstract?

OPEN ACCESS Freely available online

PLOS MEDICINE

Rapid Diagnosis of Tuberculosis with the Xpert MTB/RIF Assay in High Burden Countries: A Cost-Effectiveness Analysis

Anna Vassall^{1,2}, Sanne van Kampen¹, Hojoon Sohn³, Joy S. Michael⁴, K. R. John⁵, Saskia den Boon⁶, J. Lucian Davis⁷, Andrew Whitelaw^{8,9}, Mark P. Nicol^{8,9}, Maria Tarcela Gler¹⁰, Anar Khaliqov¹¹, Carlos Zamudio¹², Mark D. Perkins¹³, Catharina C. Boehme¹³, Frank Cobelens^{1*}

Abstract

Background: Xpert MTB/RIF (Xpert) is a promising new rapid diagnostic technology for tuberculosis (TB) that has characteristics that suggest large-scale roll-out. However, because the test is expensive, there are concerns among TB program managers and policy makers regarding its affordability for low- and middle-income settings.

A lot of jargon (e.g. DALYs, ICER, WTP, etc.), but it's basically saying Xpert is cost-effective.

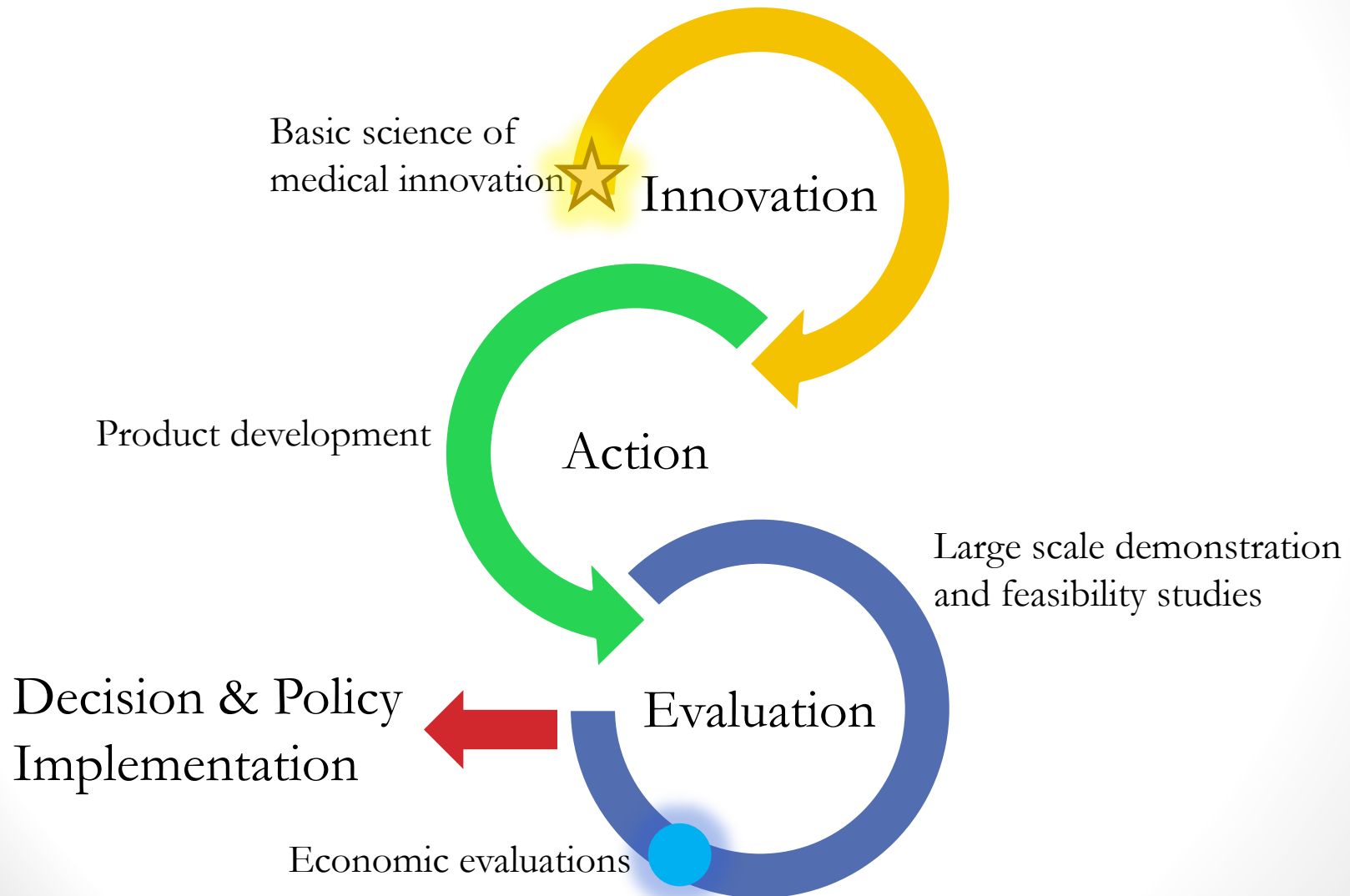
Conclusions: Our results suggest that Xpert is a cost-effective method of TB diagnosis, compared to a base case of smear microscopy and clinical diagnosis of smear-negative TB in low- and middle-income settings where, with its ability to substantially increase case finding, it has important potential for improving TB diagnosis and control. The extent of cost-effectiveness gain to TB programmes from deploying Xpert is primarily dependent on current TB diagnostic practices. Further work is required during scale-up to validate these findings.

Please see later in the article for the Editors' Summary.

By the end of the lecture, I hope...

- You will:
 - Understand how economic evaluations are planned
 - Understand the basics of economic evaluations and key elements in cost-effectiveness analysis
 - Critically appraise manuscripts and articles evaluating cost-effectiveness of an intervention

Process of medical decision making

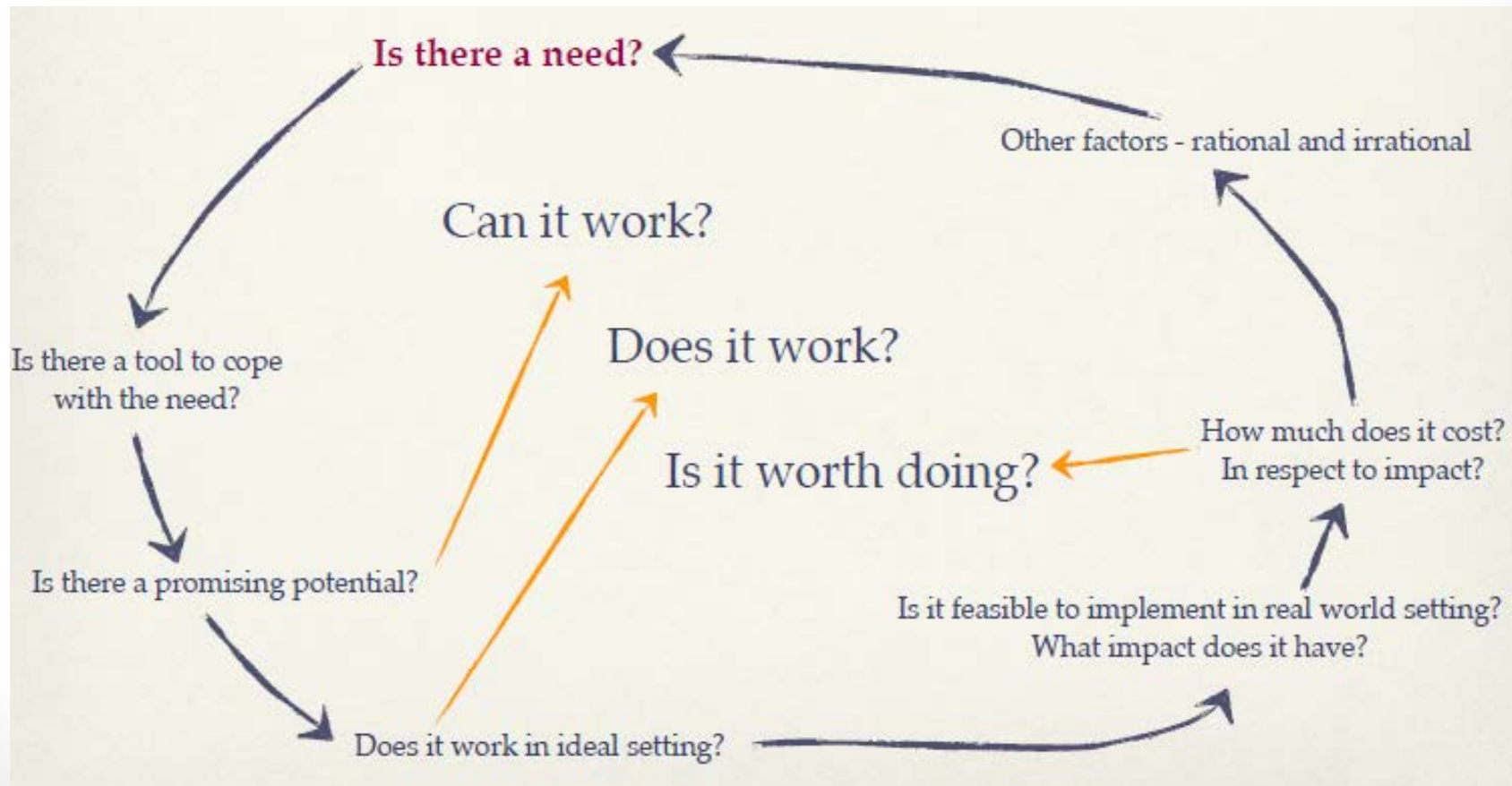


What is an economic evaluation?

- A **comparative analysis** of alternative course of action in terms of both **cost** and their **benefits**
- A tool for comparison and is used to ensure the society can receive a good return on its investments in public health

‘How do we value one thing compared to another’

Process of an Economic Evaluation



Why Economic Evaluation?

- Scarcity → choice → value of benefits (opportunity cost) → efficiency
- Economic evaluation = measuring ‘value’ of alternative course of action assessed in costs against effect measures
- Opportunity cost forces identification of relevant alternatives
- Assessment of ‘value’ makes explicit importance of viewpoints – an alternative that seems unattractive from one point of view may seem more attractive from another
 - E.g. health services vs. societal perspective
- Valuation requires value judgements to be made explicit
- Measurement enables uncertainties surrounding orders of magnitude to be assessed

A word on opportunity cost

- The cost of a good or service as measured by ‘alternative’ uses that are foregone by producing the good or service
 - Different from financial cost = what is actually paid (not including donated goods, volunteered time, distorted prices)
- A scenario of the Xpert test (as a replacement to microscopy)
 - Xpert costs \$15 (all costs combined)
 - Smear costs \$11 (\$1 consumables, \$10 labor and other factors)
 - Trade-off: Xpert ‘replaces’ smear – at what cost?
 - $\text{Cost of Xpert} - \text{Cost of smear} = \$15 - \$11 = \$4$
 - Incremental (opportunity) cost of performing Xpert is \$4

Forms of Economic Evaluations

Cost-benefit Analysis

- Monetary values (WTP)
- Considerable progress WTP, but controversial
- Human capital/stated preferences (contingent valuations)

Cost-utility Analysis

- Broader measure of benefits: utility
- Generic outcome measure (e.g. QALY, DALY)

Cost-effectiveness Analysis

- Cost per unit of effect
- Single outcome, common effect; natural units:

Cost-minimization Analysis

- Multiple outcomes in natural units
- Assumes outcomes identical/very similar
- Comparison of costs

Cost-consequence analysis

- Present in a summary table format for costs & effect outcomes
- Let the decision makers weigh the options

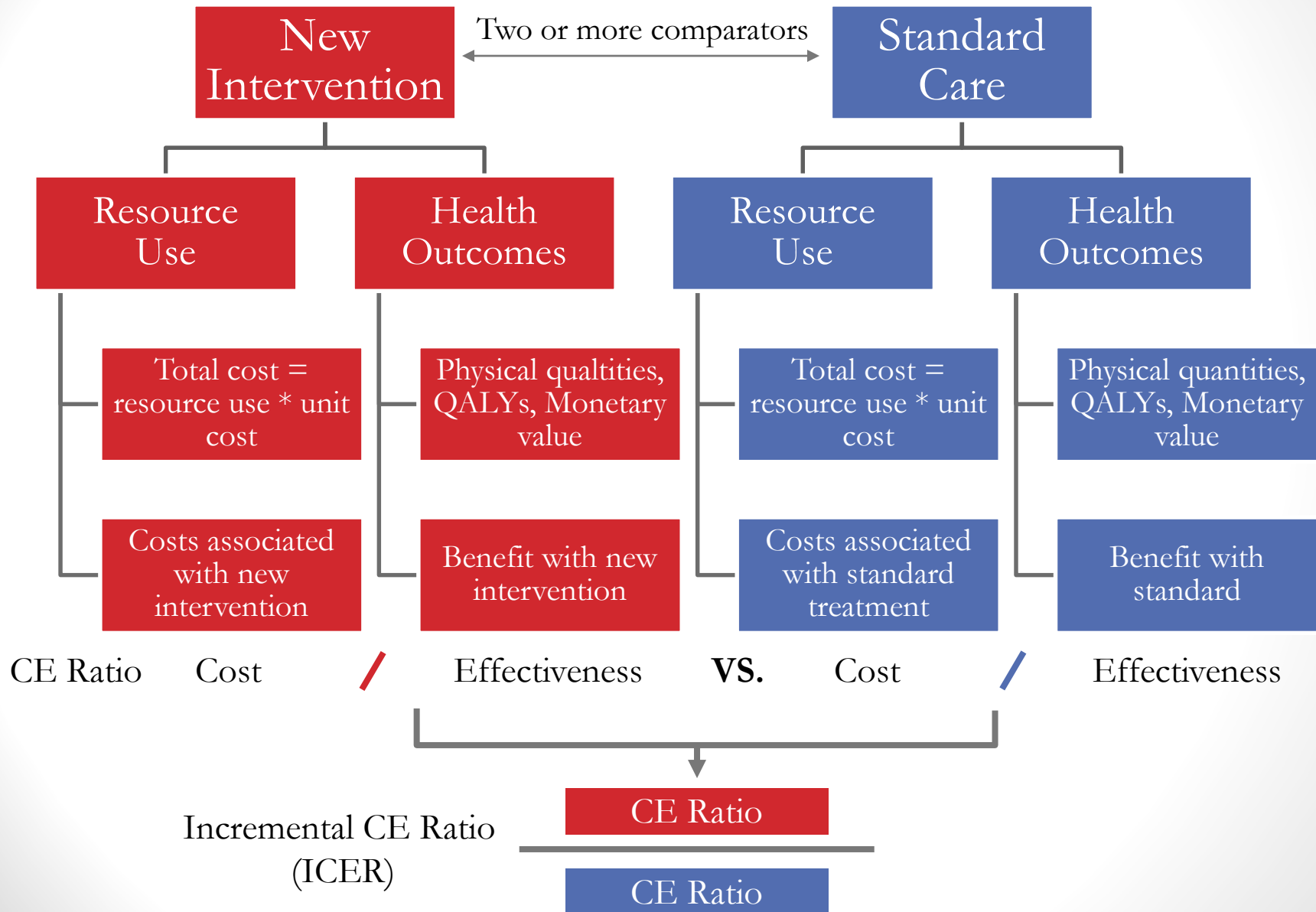
2 X 2 Table for determining the form of Economic Evaluation

2. Are at least 2 alternatives compared?

1. Are both costs (inputs) and consequences (outputs) examined?

		NO		YES	
NO		Examines only consequences	Examines only costs	2 PARTIAL EVALUATION	
		1A	1B		
		• Outcome description.	• Cost description.		
YES		3A	3B	4 FULL ECONOMIC EVALUATION	
		• Efficacy or effectiveness evaluation.	• Cost analysis.		
				• Cost-minimisation analysis. • <u>Cost-effectiveness analysis.</u> • Cost-utility analysis. • Cost-benefit analysis.	

Structure of Cost-effectiveness Analysis



Measuring Cost-Effectiveness

- Incremental Cost-effectiveness Ratio (ICER)

$$ICER = \frac{\Delta Cost}{\Delta Effects}$$

*** How much more does it **cost** to implement new strategy and what additional **effect** does it bring?***

Discrepancies in reported & actual perspective of an economic evaluation

TABLE 2. Perspective Used in Published CUAs, 1976 to 2005

	As Stated By Author	As Stated By Reviewer
Societal	473 (40.6%)	341 (29.3%)
Health care payer	382 (32.8%)	799 (68.6%)
Not stated/could not be determined	298 (25.6%)	16 (1.4%)
Other	11 (0.9%)	8 (0.7%)
Total	1164	1164

Source: Center for the Evaluation of Value and Risk in Health. Tufts Medical Center. "CEA Registry." Available at: www.cearegistry.org. Accessed May 15, 2008.¹⁹

Even the authors cannot figure out what exact perspectives used in their study!!!

Perspective of the study

- Determines **how** and **what** we measure in cost and effectiveness in our study

Recommended, but difficult

- Societal perspective
 - Aimed at capturing all costs and effectiveness relevant for the target population and the society
 - We are all members of the society, no matter who incurs costs and receives benefits
- Provider's perspective – (e.g. Health services perspective)
 - Restrict costs and effectiveness relevant in providing health services
- Patient's perspective
 - Restrict costs and effectiveness incurred by patients receiving health services (e.g. patient's health utility and out of pocket expenses in DOTS and DOTS-plus programs)

Is mandatory military service cost-effective?



Ice cream brought me so much 'utilities' during the summers



But, I lost my 'valuable' time in research, career and add an insult to the injury, I was paid \$100 per month!

In what perspective?

* Societal vs. personal *

The government thinks otherwise!



Rapid Diagnosis of Tuberculosis with the Xpert MTB/RIF Assay in High Burden Countries: A Cost-Effectiveness Analysis

Anna Vassall^{1,2}, Sanne van Kampen¹, Hojoon Sohn³, Joy S. Michael⁴, K. R. John⁵, Saskia den Boon⁶, J. Lucian Davis⁷, Andrew Whitelaw^{8,9}, Mark P. Nicol^{8,9}, Maria Tarcela Gler¹⁰, Anar Khaliqov¹¹, Carlos Zamudio¹², Mark D. Perkins¹³, Catharina C. Boehme¹³, Frank Cobelens^{1*}

Abstract

Background: Xpert MTB/RIF (Xpert) is a promising new rapid diagnostic technology for tuberculosis (TB) that has characteristics that suggest large-scale roll-out. However, because the test is expensive, there are concerns among TB program managers and policy makers regarding its affordability for low- and middle-income settings.

Methods and Findings: We estimate the impact of **1. Comparative intervention** effectiveness of TB care using decision analytic modelling, **2. Assess costs** comparing the introduction of Xpert to a base case of smear microscopy and clinical diagnosis in India, South Africa, and Uganda. The introduction of Xpert increases TB case finding in all three settings; from 72%–85% to 85%–90% of the cohort of individuals with suspected TB, compared to the base case. Diagnostic costs (including **3. Evaluate costs against effect measure** all individuals with suspected TB) also increase: from US\$28–US\$49 to US\$133–US\$146 and US\$137–US\$151 per TB case detected when Xpert is used “in addition to” and “as a replacement of” smear microscopy, respectively. The incremental cost effectiveness **4. Assess cost-effectiveness of new intervention** compared to the base case, range from US\$41–\$110 per disability adjusted life year (DALY) averted. Likewise the ICERs for using Xpert “as a replacement of” smear microscopy range from US\$52–\$138 per DALY averted. These ICERs are below the World Health Organization (WHO) willingness to pay threshold.

Conclusions: Our results suggest that Xpert is a cost-effective method of TB diagnosis, compared to a base case of smear microscopy and clinical diagnosis of smear-negative TB in low- and middle-income settings where, with its ability to substantially increase case finding, it has important potential for improving TB diagnosis and control. The extent of cost-effectiveness gain to TB programmes from deploying Xpert is primarily dependent on current TB diagnostic practices. Further work is required during scale-up to validate these findings.

Please see later in the article for the Editors' Summary.

Determining cost-effectiveness of Xpert MTB/RIF

In more detail

- Examine two mutually exclusive scenarios
 - Conventional TB diagnosis (AFB smear + culture)
 - TB diagnosis with Xpert
- Cumulative costs for each scenario
 - Costs of diagnosis (micro-costing vs. price costing), but also include...
 - Treatment costs, other testing costs?
 - Costs of patients?
 - Overhead costs? (see micro-costing lecture)
- Evaluate effectiveness indicators for each scenario
 - What and how to measure effectiveness?
 - Immediate outcomes
 - Incremental yield & detection, reduction in follow-up, % correctly diagnosed, reduction in time to diagnosis and treatment initiation, etc.
 - Outcomes further downstream of diagnosis
 - Transmission reduction, lives saved → DALYs & QALYs
 - Much harder to measure
 - Calculate ICER
 - Weigh against 'willingness to pay' (WTP) to determine whether Xpert is favorable over standard intervention
 - How do we know what WTP to use?

Costs in relation to Effectiveness

- The way we measure effectiveness and its relevant costs depends on how we frame the question for the CEA
 - Diagnosis of TB
 - Incremental correct detection & diagnosis of TB
 - Doesn't this increase costs as we are detecting more cases?
 - Reduction in diagnostic and treatment delay
 - How are reduction in time delays relevant to health outcomes?
 - Reduction in drop-out rates during diagnostic phase
 - Clinical outcomes beyond diagnosis
 - Successful treatment
 - TB deaths averted
 - Life Years (LY) gained
 - Health utilities
 - 'Adjusted' years of life where:
 - 1 = life lived in perfect health
 - 0 = Death



More difficult to measure (i.e. not observable)

Cost components in CEA

TABLE 1. Cost Components Included in Published CUAs, 1976 to 1997

Cost Components Included	n = 228
Direct health care costs	226 (99.1%)
Intervention	222 (97.4%)
Hospitalization	199 (87.3%)
Outpatient visits	167 (73.2%)
Long-term care	28 (12.3%)
Other health care	165 (72.4%)
Direct nonhealth care and time costs	38 (16.7%)
Patient time	22 (9.6%)
Transportation	11 (4.8%)
Family/caregiver time	13 (5.7%)
Social services	6 (2.6%)
Productivity costs	19 (8.3%)
Other	5 (2.2%)

Majority are health services costs!!!

Source: Stone PW, Liljas B, Chapman RC, et al. Variations in methods to estimate costs in cost-effectiveness analyses. *Int J Technol Assess Health Care*. 2000;16:111-124.³

Changes in costing methods in CEA

TABLE 3. Change Over Time in Costing Methods in Published CUAs

Item	1976–1997 (n = 227)	1998–2001 (n = 300)	2002–2005 (n = 637)	<i>P</i>
Presented the study perspective clearly	52%	74%	83%	<0.0001
Presented the study time horizon	90%	75%	87%	0.3378
Conducted and reported sensitivity analysis	88%	93%	84%	0.0147
Discounted costs and QALYs	74%	85%	84%	0.0028
Stated the year of currency for resource costs	68%	83%	85%	<0.0001

Source: Center for the Evaluation of Value and Risk in Health. Tufts Medical Center. "CEA Registry." Available at: www.cearegistry.org. Accessed May 15, 2008.¹⁹

Still, there are good number of studies failing to do proper cost assessment

Identifying and quantifying costs

What is proper costing?

Micro-costing

- ID specific cost components of interventions
- May require time and motion study (highly recommended in absence of prior standardized costs for the compared interventions)
- Establish specific unit costs for each resources utilized

Macro-costing

- ID service bundles (diagnostics, treatment, etc.)
- Pre-suppose availability of unit costs for these service bundles
- Use of database and payment transactions (i.e. price of an equipment, drugs, diagnostic kits, etc.)



More detailed and accurate



Less time consuming

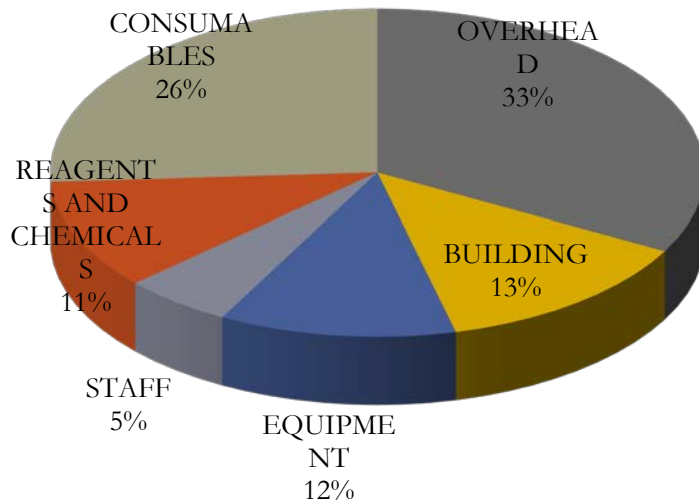
When in doubt, do & use results from micro-costing studies!

- Especially for new interventions
 - Identify cost drivers
 - Allows us to structurally think about how resources are used
- CEA in itself is already full of assumptions and uncertainties
 - Any small changes in unit costs can easily flip the analysis results
 - We want to make sure we get costs right!
- Micro-costing in itself provides a lot of information for decision making
 - Examples in next few slides

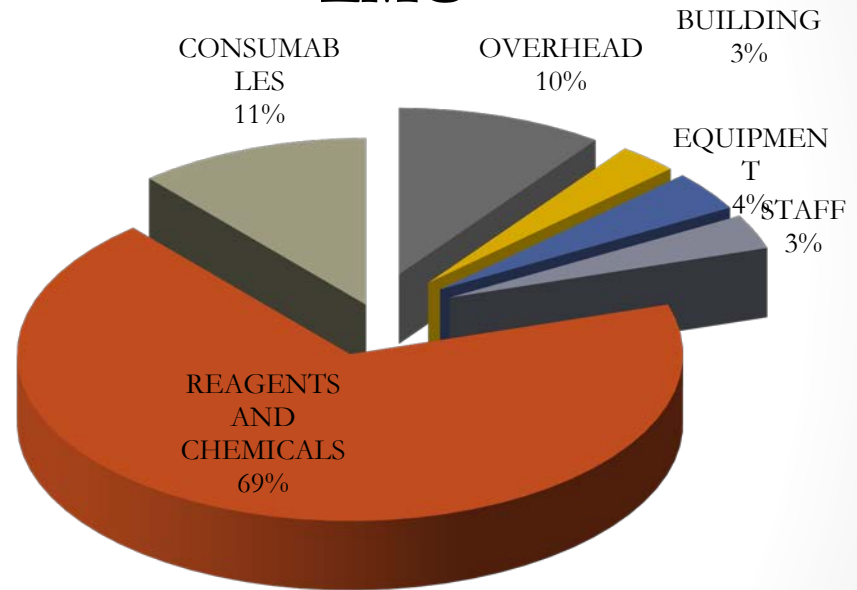
Identifying cost drivers

solid vs. liquid culture

SMC



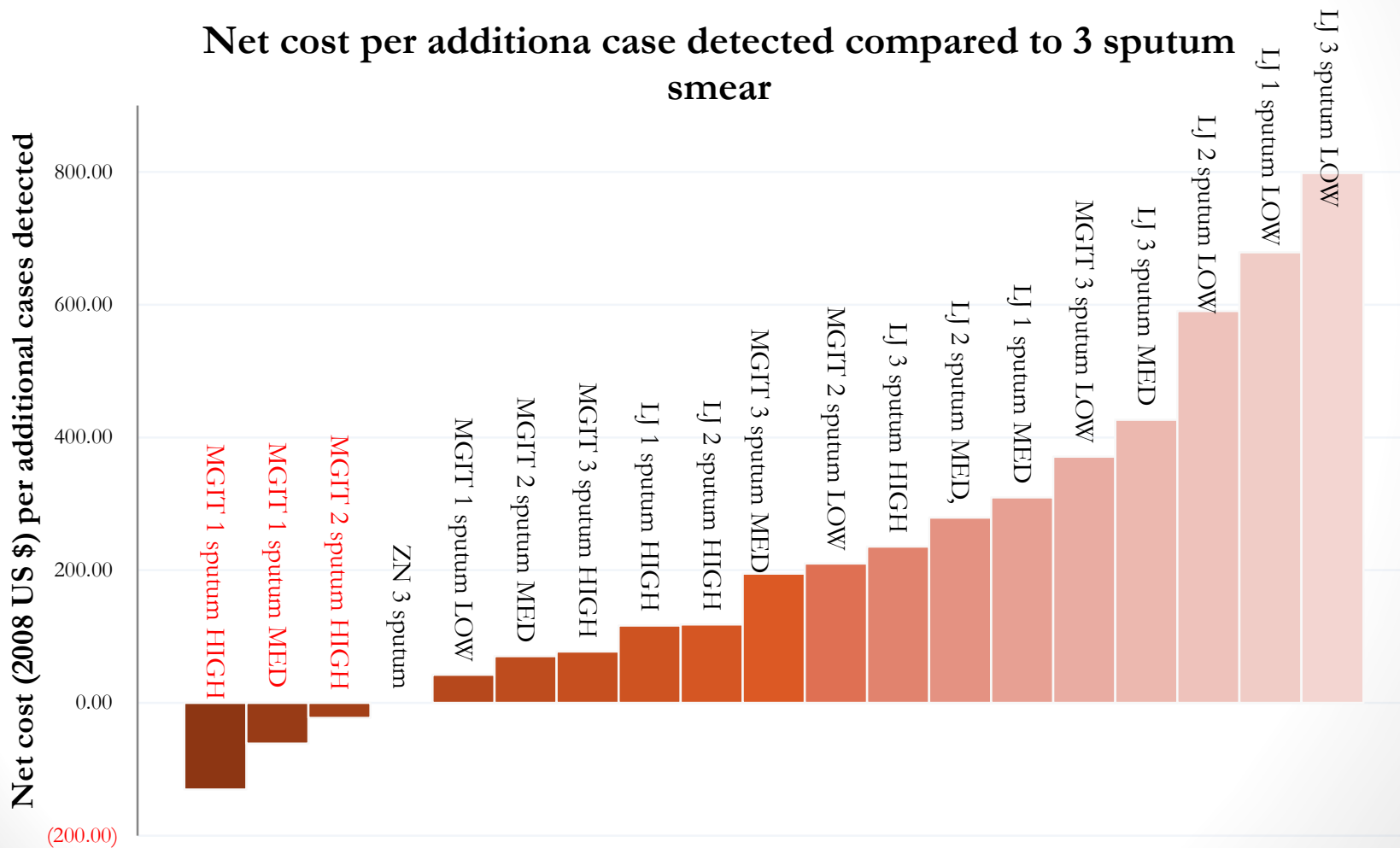
LMC



SMC – solid media culture

LMC – liquid media culture

Costs associated per additional TB cases detected with 3 sputum smear as base-case scenario



Assessing cost of MIGHT culture against various pricing and laboratory workload



Cost-Effectiveness Comparison of Genechip and Conventional Drug Susceptibility Test for Detecting Multidrug-Resistant Tuberculosis in China

Yu Pang^{1*}, Qiang Li^{1*}, Xichao Ou^{1*}, Hojoon Sohn², Zhiying Zhang³, Junchen Li³, Hui Xia¹, Kai Man Kam⁴, Richard J. O'Brien⁵, Junying Chi¹, Shitong Huan⁶, Daniel P. Chin^{6*}, Yan-En Zhao^{1*}

Abstract

Background: Genechip (CapitalBio, Beijing, China) is a system for diagnosing resistance to rifampin and isoniazid, which shows high efficiency in detecting drug-resistant tuberculosis. Here, we firstly evaluated the costs of Genechip for detecting the drug susceptibility of *Mycobacterium tuberculosis*, compared to conventional drug susceptibility test (DST) in laboratories in China.

Methodology/Principal Findings: Data on the costs of the two tests were collected at four hospitals. Costs were calculated using the essential factor cost calculation method. The costs of diagnosing a single case of multidrug-resistant tuberculosis (MDR-TB) using Genechip and DST were US\$22.38 and \$53.03, respectively. Taking into account the effect on costs from failure of a certain number of tests to accurately diagnose MDR-TB, the costs of Genechip and DST increased by 17.65% and 5.22%, respectively. The cost of both tests decreased with the increasing prevalence of MDR-TB disease, and the cost of Genechip at a sensitivity of more than 50% was lower than that of DST. When price of Genechip was varied to 50%, 80%, 150%, and 200% of the original price, the cost of Genechip at sensitivities of more than 30%, 40%, 60%, and 70%, respectively, was also lower than that of DST.

Conclusions/Significance: This study showed that Genechip was a more cost-effective method of diagnosing MDR-TB compared to conventional DST.

*** Cost per (correctly) diagnosed MDR-TB case assessed by varied sensitivity and disease prevalence ***

Cost-Effectiveness Analysis of Introduction of Rapid, Alternative Methods to Identify Multidrug-Resistant Tuberculosis in Middle-Income Countries

Carlos Acuna-Villaorduna,^{1,5} A
Nora Morcillo,⁷ Juan Saravia,
and Eduardo Gotuzzo¹²

This particular study compared 5 different DST methods & used detailed micro-costing combined with decision analytic model

¹Instituto de Medicina Tropical Alexander Von Humboldt, ²Universidad Peruana Cayetano Heredia, ³Instituto Nacional de Salud, and ⁴Dirección de Salud Lima Norte, Lima, Peru; ⁵Internal Medicine Department, Washington Hospital Center, Washington, DC; ⁶Royal Tropical Institute, Amsterdam, The Netherlands; ⁷Antonio Cetrángolo Hospital, Buenos Aires, Argentina; and ⁸Foundation for Innovative New Diagnostics and ⁹Tropical Disease Research, World Health Organization, Geneva, Switzerland

Background. Resistance to commonly used antituberculosis drugs is emerging worldwide. Conventional drug-susceptibility testing (DST) methods are slow and demanding. Alternative, rapid DST methods would permit the early detection of drug resistance and, in turn, arrest tuberculosis transmission.

Methods. A cost-effectiveness analysis of 5 DST methods was performed in the context of a clinical trial that compared rapid with conventional DST methods. The methods under investigation were direct phage-replication assay (FASTPlaque-Response; Biotech), direct amplification and reverse hybridization of the *rpoB* gene (INNO-LiPA; Innogenetics), indirect colorimetric minimum inhibitory concentration assay (MTT; ICN Biomedicals), and direct proportion method on Löwenstein-Jensen medium. These were compared with the widely used indirect proportion method on Löwenstein-Jensen medium.

Results. Assessing Cost-effectiveness against varied disease prevalence health care interventions. DST multidrug-resistant tuberculosis. Excluding the effects of transmission, the direct proportion method on Löwenstein-Jensen medium was the most cost-effective alternative DST method for patient groups with prevalences of multidrug-resistant tuberculosis of 2%, 5%, 20%, and 50% (cost in US\$2004, \$94, \$36, \$8, and \$2 per disability-adjusted life year, respectively).

Conclusion. Alternative, rapid methods for DST are cost-effective and should be considered for use by national tuberculosis programs in middle-income countries.

Comparative cost and performance of light-emitting diode microscopy in HIV–tuberculosis-co-infected patients

A. Whitelaw^{*,#,,##}, J. Peter^{†,##}, H. Sohn⁺, D. Viljoen^{*}, G. Theron[†], M. Badri[§], V. Davids[†], M. Pai⁺ and K. Dheda^{†,f,***}

TABLE 2 Average unit cost per acid-fast bacilli (AFB) smear on sputum sample/slide for light-emitting diode (LED) with auramine O versus Ziehl–Neelsen (ZN) light microscopy

Type of microscopy	Cost per AFB smear US\$						
	Overhead [#]	Building space [†]	Equipment ⁺	Staff [§]	Reagents and chemicals ^f	Consumables ^{##}	Total
LED	0.81	0.01	0.08	0.47	0.04	0.22	1.63
ZN	1.06	0.01	0.08	0.69	0.04	0.22	2.10

[#]: maintenance, running, management and supervision costs; [†]: cost relating to the use of specific physical (laboratory space) for procedures relevant for microscopy; ⁺: costs based on annualised cost of laboratory equipment, inclusive of procurement costs; [§]: complete staff hands-on time from the receipt of specimen to dispatch and filing of the result forms; ^f: based on costs of ready-made staining reagents procured by National Health Laboratory Services and ~3 mL of use per slide for each staining reagent; ^{##}: cost associated with the use of general consumables such as sputum collection cups, gloves, glass slides, etc.

Fluorescence microscopy is less expensive than Ziehl-Neelsen microscopy in Thailand

H. Sohn,* C. Sinthuwattanawibool,[†] S. Rienthong,[‡] J. K. Varma^{†§}

Table Average unit cost (US\$) per AFB smear on one sample: FM with auramine vs. ZN light microscopy

Microscopy	Type of cost						Total
	Over-head	Building space	Equipment	Staff	Reagents and chemicals	Consumables	
FM	0.15	0.01	0.08	0.14	0.25	0.40	1.03
ZN	0.21	0.01	0.02	0.19	0.33	0.40	1.16

AFB = acid-fast bacilli; FM = fluorescent microscopy; ZN = Ziehl-Neelsen.

Multicentre evaluation of Ziehl-Neelsen and light-emitting diode fluorescence microscopy in China

H. Xia,* Y-Y. Song,* B. Zhao,* K-M. Kam,[†] R. J. O'Brien,[‡] Z-Y. Zhang,[§] H. Sohn,^{||} W. Wang,[#] Y-L. Zhao*

Table 5 Average unit cost of low, medium and high workload laboratories

Slide volume/day	Breakdown of variable costs per test (US\$)						Total mean $\pm$ SD	t	P value
	Overhead	Building	Equipment	Labour	Reagents	Consumables			
Low: 1–15									
ZN	0.77	0.01	0.05	0.70	0.42	0.67	2.62 $\pm$ 0.40	0.94	0.35
LED-FM	0.77	0.01	0.06	0.74	0.43	0.72	2.73 $\pm$ 0.98		
Medium: 16–30									
ZN	0.68	0.01	0.04	0.62	0.30	0.51	2.16 $\pm$ 0.33	6.61	<0.05
LED-FM	0.49	0.01	0.03	0.44	0.35	0.58	1.90 $\pm$ 0.37		
High: $\geq$ 31									
ZN	0.59	0.00	0.02	0.48	0.43	0.29	1.81 $\pm$ 0.73	2.50	0.13
LED-FM	0.47	0.00	0.03	0.38	0.34	0.36	1.58 $\pm$ 0.57		
Average									
ZN	0.69	0.01	0.04	0.61	0.37	0.50	2.20 $\pm$ 0.58	5.08	<0.05
LED-FM	0.54	0.01	0.04	0.48	0.36	0.54	1.97 $\pm$ 0.71		

SD = standard deviation; ZN = Ziehl-Neelsen; LED-FM = light-emitting diode fluorescence microscopy.

How do we do micro-costing?

EXPERT
REVIEWS

TB diagnostic tests: how do we figure out their costs?

Expert Rev. Anti Infect. Ther. 7(6), 723–733 (2009)

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Tuberculosis continues to be a major global health problem. Lack of accurate, rapid and cost-effective diagnostic tests poses a huge obstacle to global TB control. While several new diagnostic tools are being developed and evaluated for TB, it is important that new tools are introduced for widespread use only after careful validation of accuracy, impact as well as cost-effectiveness in real-world settings. While there are large numbers of studies on the accuracy of TB diagnostic tests, there are few studies that are focused on cost and cost-effectiveness. There are currently no widely accepted standards on how to evaluate costs of a TB test. In this review, we describe the basic approach for computing the costs of TB diagnostic tests, and provide templates for various data elements and parameters that go into the costing analysis. We hope this will pave the way for a standardized methodology for costing of TB diagnostic tests. Such a tool would enable improved and more generalizable costing analyses that can provide a strong foundation for more sophisticated economic analyses that evaluate the full economic and epidemiological impact resulting from the implementation and routine use of performance-verified new and innovative diagnostic tools. This, in turn, will facilitate evidence-based adoption and use of new diagnostics, especially in resource-limited settings.

How do we do micro-costing?

1. Planning cost-analysis

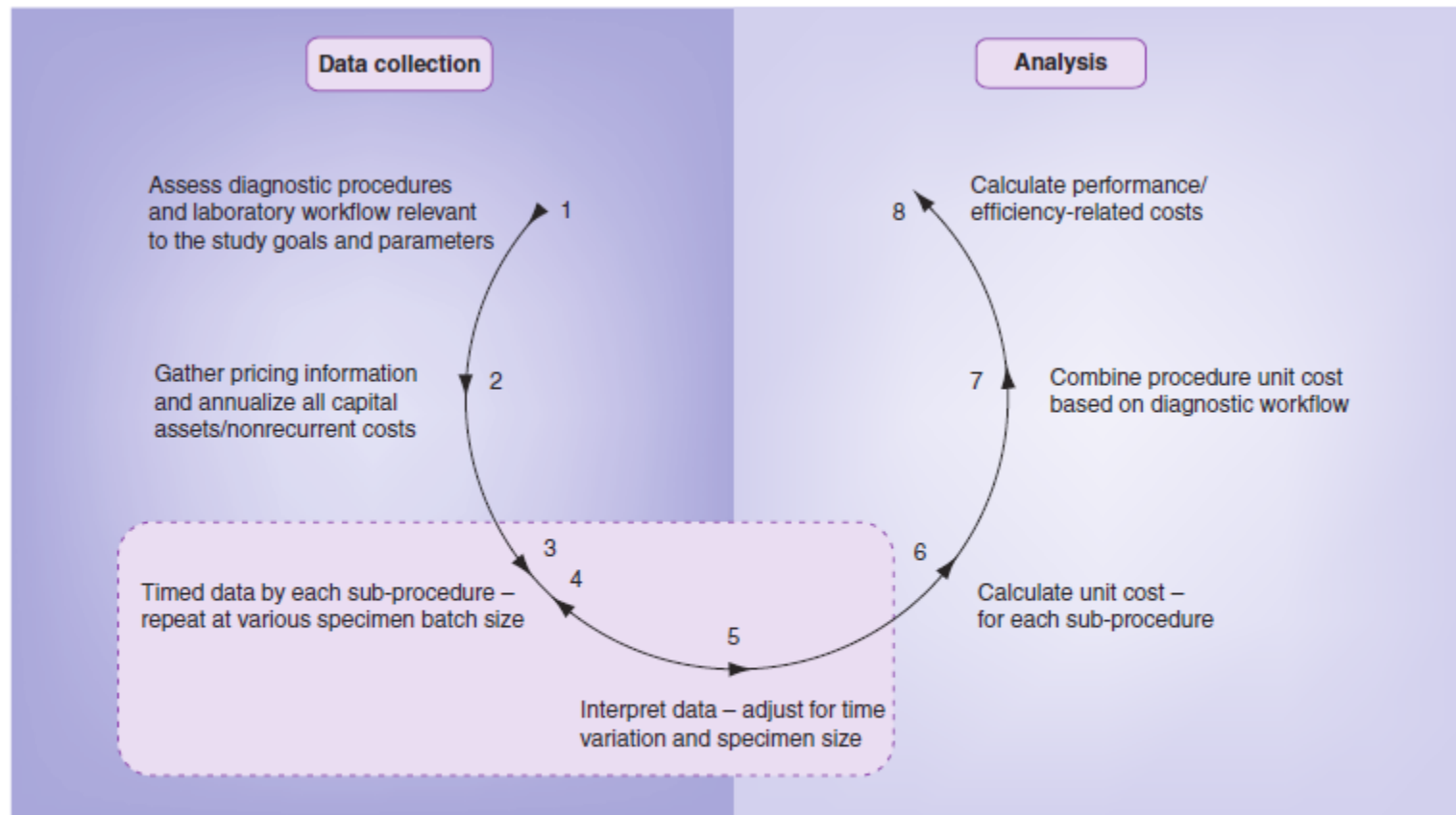


Figure 1. Planning for cost analysis in TB laboratory diagnostics. This diagram provides a step by step plan for cost analysis in evaluating TB diagnostic tests in various study settings. Steps 3, 4 and 5 should be undertaken for all the methods evaluated and relevant sub-procedures and repeated to capture data variations caused by specimen loads (and/or specimen batch size). In step 7, the investigator should consult laboratory experts regarding diagnostic workflow to reflect local laboratory practice in combining procedure unit costs.

How do we do micro-costing?

2. Assess diagnostic scenarios

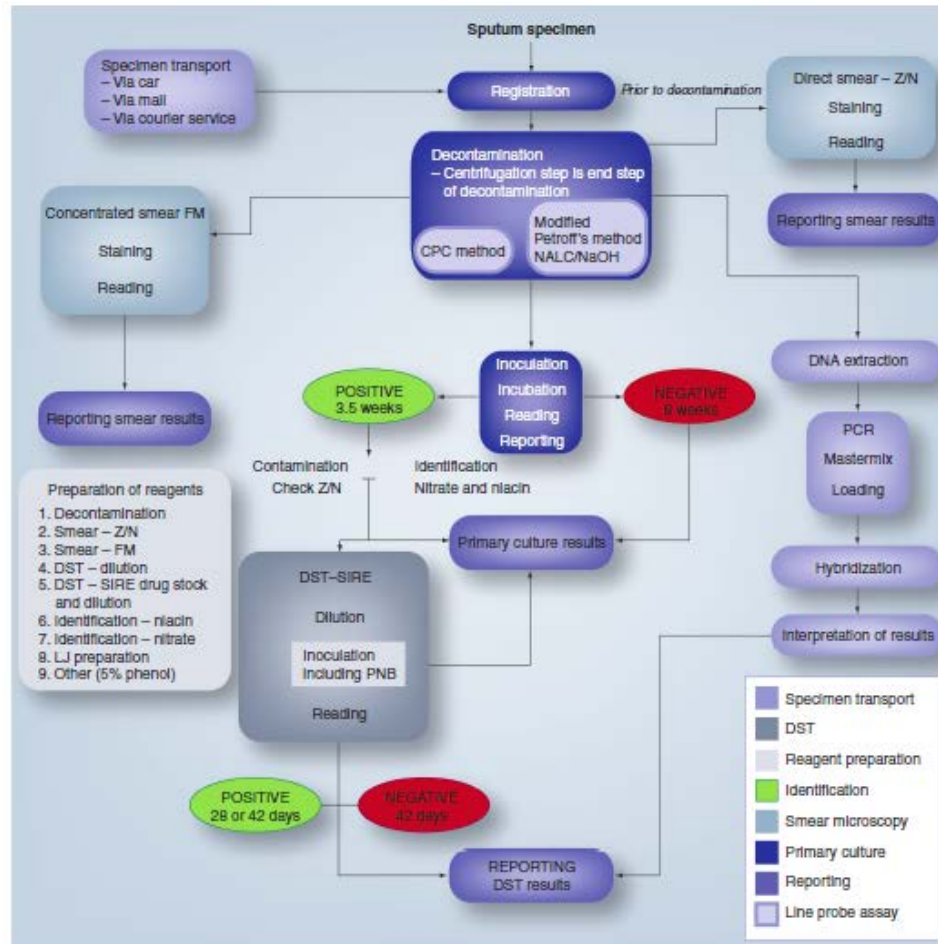


Figure 2. Example of diagnostic workflow of a TB culture laboratory with molecular diagnostic capacity. When first planning for a costing study, evaluating diagnostic workflow is essential in capturing all aspects of laboratory activities that need to be evaluated for costs. Shown is a generalized workflow observed in a laboratory where molecular testing for MDR-TB using a line probe assay is being evaluated against the conventional culture method using LJ in a demonstration study. Actual workflow at different laboratories may vary.
CPC: Cetylpyridinium chloride; DST: Drug susceptibility testing; FM: Fluorescent microscopy; LJ: Löwenstein Jensen; MDR: Multidrug resistance; NALC: N-acetyl-L-cysteine; Z/N: Ziehl-Neelsen.

How do we do micro-costing?

3. Determine cost components and source of data

Table 2. Cost data elements for cost analysis of TB diagnostics and suggested data sources.		
Data element	Cost items	Suggested sources of data
Physical infrastructure	Construction	Construction contractors/government estates and building planning office/recent laboratory construction budget
	Maintenance contracts for all laboratory equipment requiring periodic maintenance	Laboratory financial records/laboratory or hospital accounts office/service contractors
Chemicals and reagents, and consumables	All types of chemicals and reagents utilized for diagnostic methods evaluated	Laboratory financial records/manufacturer catalog (must include all costs associated with procurement, usually at 25% of the catalog price)
	All types of general laboratory consumables (e.g., latex gloves, micropipette tips)	Laboratory financial records/manufacturer catalog (must include shipping costs)
Human resources	Laboratory staff salaries	Government salary scale/laboratory or hospital accounts office
	Laboratory staff allowances and benefits	Government salary scale/laboratory or hospital accounts office
	Staff training off-site	Laboratory records/interview
Training and quality assurance	Orientation training for new staff	Laboratory staff records
	External QA/QC for various laboratory diagnostic activities	Pricing/cost available through laboratory/hospital accounts office. List of QA/QC programs can be found in the general SOP
	Internal QA/QC	Cost can be evaluated as part of the general cost analysis using 'ingredients' approach. The full list of internal QA/QC procedures can be found in the general SOP
Specimen transport	Cost of a vehicle used for specimen transport – evaluated as purchased 'new'	Accounting office/autodealer
	Average distance traveled – annual figure	List of locations referring specimens to the laboratory
	Average driver salary	Accounting office
	Quantity of fuel used	Accounting office
	Fuel price	General market research, accounting office
	Insurance of vehicle	Accounting office
	Other consumables used in specimen transport	Accounting office

QA: Quality assurance; QC: Quality control; SOP: Standard operating procedure.

How do we do micro-costing?

4. Collect data & calculate unit costs

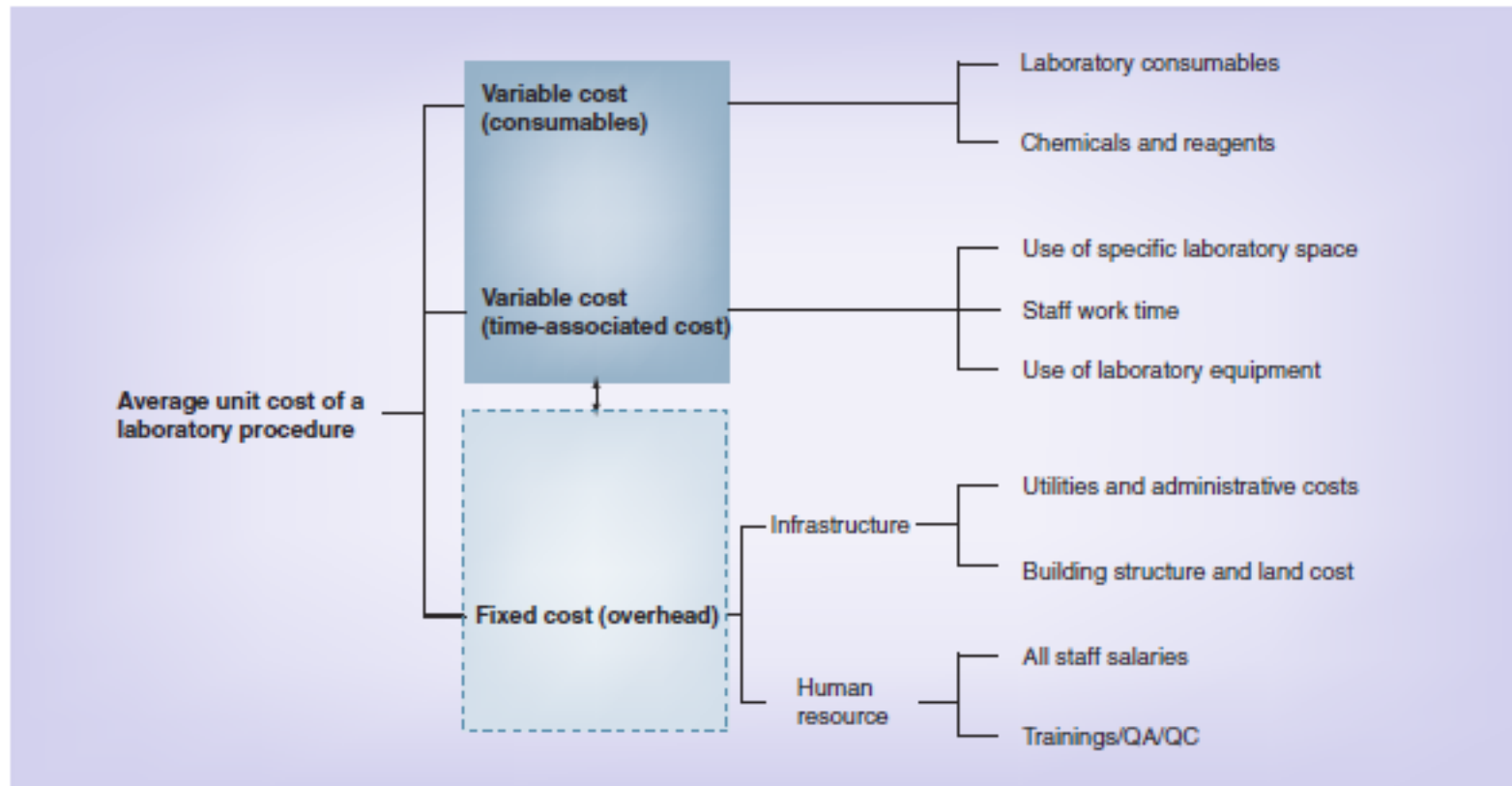


Figure 3. Component of unit cost figure of a laboratory procedure. Costs associated with training/QA/QC are assessed independently as per activity cost and allocated into average unit cost based on staff timing associated with the relevant laboratory procedure. For example, test specific training/QA/QC (e.g., culture and molecular testing hands-on training) should be allocated only into test specific unit cost, whereas period QA/QC for general laboratory activities should be allocated into all of the laboratory procedures/activities calculated for unit cost.

QA: Quality assurance; QC: Quality control.

Important considerations in calculating costs

- Inflation & discounting
 - Inflation: \$100 that we have now holds less value in the future
 - Important to specify the year of costs & currency
 - Assume you know that this \$100 will be worth a certain amount in the following year (discounting)
 - Normally we evaluate a discount rate of 3%
 - \$100 now is equivalent to \$103 next year
- Capital vs. recurrent costs
 - “up-front” costs are required for some items (e.g. equipment, building)
 - These items last certain expected time (expected life years)
 - (same for the health utilities! – we will discuss this later)
 - A \$20,000 Xpert machine is expected to last 10 years, but this is not equivalent of dividing \$20,000 into 10 equal costs spread over 10 years
 - Inflation & discounting

Important considerations in calculating costs

- Fixed vs. variable costs
 - Cost per Xpert test:
 - Lab space (Xpert machine?) – same costs regardless of # of tests performed
 - Xpert cartridge – dependent on the # of tests
 - Staff time – depends on the # of tests
 - So, unit cost of a test should:
 - Variable costs (consumables) + fixed costs (overhead & equipment)
- Perspectives
 - We've discussed earlier that what perspective we take in our evaluation will determine what costs we assess
 - E.g. costs that are relevant to the laboratory may not be so relevant in the clinical setting
 - Perspectives of scaling-up diagnosis capacity is generally different from the ideal societal perspective

Important considerations in calculating costs

- Issues of currency
 - Generally \$US is accepted as a ‘standard’ currency, but...
 - It depends on the perspectives of programs
 - In UK, HTA assesses in GBP, and other country level programs evaluate costs in their own currency
 - If we were to compare programs in multiple countries, we need to ‘standardize’ reporting currency
 - Issues of currency conversion
 - Exchange rates
 - Use average exchange rates over the entire evaluation year rather than point conversion rate
 - Issue of local “purchasing power” – Big Mac analogy
 - Important to specify currency used in the analysis
 - “International \$” = based on purchasing power parity
 - “US\$” – based on exchange rates

Cost Analysis Tool - demonstration

Laboratory Overhead Summary					
ENTER OVERHEAD DATA BELOW					
	COUNTRY				
1. CURRENCY	South Africa	India	Uganda	China	
Currency multiplication factor (USD/local currency)				0.15	
Local Currency/USD				6.80	
2. General Facts	Lab 1 China	Lab 2 China	Lab 3 China	Lab 4 China	Lab 4 - A China
Country	China	China	China	China	China
Town	Lian Yun Gang	KaiFeng	Hohhot	ChongQing	YongChuan
Year of Assessment	2010	2010	2010	2010	2010
Name of the laboratory	Fourth Hospital	Second Hospital	Fourth Hospital	CDC	Second Hospital
Approximate Annual Operational Minutes	101400	111540	109200	117000	117000
Approximate Annual Operational days	260	286	260	260	260
% workload for TB (laboratory)	100.00%	100.00%	100.00%	100.00%	100.00%
Number of Laboratory Staff	4	4	4	4	4
3. Physical Dimensions					
Approximate total size of building	12000	8500	5000	3500	68456
Approximate building cost (USD) per m2 Unsealed Lab	US\$514.71	US\$514.71	US\$514.71	US\$1,102.94	US\$500.00
Approximate building cost (USD) per m2 Sealed Lab	US\$777.63	US\$698.53	NA	NA	NA
Total # of rooms	9	9	11	6	12
Average Room Size (m ²)	23.41	21.67	11.75	12.96	10.47
4. Annual Overhead Cost Summary					
Total Annual Building & Maintenance Costs per Room	US\$614.85	US\$568.97	US\$308.60	US\$729.18	US\$267.00
Total Annual Utilities Costs	US\$2,001.44	US\$2,769.81	US\$1,083.59	US\$1,071.51	US\$1,482.21
Total Annual Cleaning & Securities Costs	US\$1,788.69	US\$374.25	US\$1,649.01	US\$555.36	US\$549.64
Total Furniture & Equipment Assets	US\$1,380.91	US\$858.63	US\$839.15	US\$672.35	US\$971.22
Total Annual Administrative Costs	US\$25,975.84	US\$18,905.57	US\$24,011.16	US\$8,292.07	US\$20,331.62
Total Annual Management & Staff Costs	US\$24,176.47	US\$17,941.18	US\$22,058.82	US\$23,529.41	US\$51,911.76
EQA 1	US\$5,106.00	US\$3,162.44	US\$3,769.22	US\$2,546.49	US\$2,673.90
EQA 2	US\$2,432.10	US\$2,673.90	US\$2,673.90	US\$2,673.90	US\$2,673.90
5. Overhead Unit Cost (per operational minutes)					
Total Annual Building & Maintenance Costs per Room	US\$0.00606	US\$0.00510	US\$0.00283	US\$0.00623	US\$0.00228
Total Annual Utilities Costs	US\$0.00084	US\$0.00115	US\$0.00084	US\$0.00071	US\$0.00121
Total Annual Cleaning & Securities Costs	US\$0.00075	US\$0.00015	US\$0.00128	US\$0.00037	US\$0.00045
Total Furniture & Equipment Assets	US\$0.00340	US\$0.00770	US\$0.00768	US\$0.00575	US\$0.00830
Total Annual Administrative Costs	US\$0.06404	US\$0.04237	US\$0.05497	US\$0.01772	US\$0.04344
Total Annual Management & Staff Costs	US\$0.05961	US\$0.04021	US\$0.05050	US\$0.05028	US\$0.11092
EQA 1	US\$0.01259	US\$0.00709	US\$0.00863	US\$0.00544	US\$0.00571
EQA 2	US\$0.00600	US\$0.00599	US\$0.00612	US\$0.00571	US\$0.00571

Key components

OH_SUMMARY

OH_CALC

OH_BUILDING

OH_STAFF

TRANSPORT

DECON

Equipment

Chemicals and Reagents

Consumables

- OH_SUMMARY
 - General info about the laboratory, set currency exchange, etc.
- OH_CALC
 - Allocation of overhead costs into each specific procedure costs
- OH_BUILDING
 - Assessment of building costs
- OH_STAFF
 - HR and operational costs
- TRANSPORT
 - Costs relevant to transportation of samples, patients, etc.
- DECON
 - One example of laboratory procedure – how data is entered and calculated
- Equipment, Chemicals & Reagents, Consumables sheets
 - Library of equipment costs
 - Ability to calculate upto 4 different pricings & currency

Challenges in collecting cost data

- Obtaining information on prices and overhead costs
 - Need to go through multiple levels of approval to obtain cost data
 - Even with the approval, sometimes cost data are unavailable at the laboratories
- Detailed assessment & observation of procedures that require multiple measurements
 - Single measurement of procedural time and use of resources does not reflect true operations in the laboratory (e.g. batching of specimen)
- Lack of standardization and tools for cost analysis
- Variations in perspectives taken for cost and cost-effectiveness analysis
 - Very difficult to cross-compare and examine the results within and across disease interventions

Other cost analysis considerations

- Laboratory costs are only a small component
 - Clinical and treatment costs are often greater than laboratory costs
 - Patient's out of pocket and economic costs are even greater

THE NEW ENGLAND JOURNAL of MEDICINE

SPECIAL ARTICLE

Domestic Returns from Investment in the Control of Tuberculosis in Other Countries

Kevin Schwartzman, M.D., M.P.H., Olivia Oxlade, M.Sc.,
R. Graham Barr, M.D., Dr.P.H., Franque Grimard, Ph.D., Ivelisse Acosta, M.D.,
Jeannette Baez, M.D., Elizabeth Ferreira, M.D., Ricardo Elías Melgen, M.D.,
Willy Morose, M.D., Arturo Cruz Salgado, D.D., M.P.H., Vary Jacquet, M.D.,
Susan Maloney, M.D., Kayla Laserson, Sc.D., Ariel Pablos Mendez, M.D., M.P.H.,
and Dick Menzies, M.D.

INT J TUBERC LUNG DIS 12(8):928-935
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Cost of tuberculosis diagnosis and treatment from the patient perspective in Lusaka, Zambia

A. Aspler,^{††} D. Menzies,^{*} O. Oxlade,^{*} J. Banda,[‡] L. Mwenge,[‡] P. Godfrey-Faussett,^{*} H. Ayles^{††}

BMC Public Health



Research article

Open Access

Impact of DOTS expansion on tuberculosis related outcomes and costs in Haiti

Vary Jacquet^{†1}, Willy Morose^{†1}, Kevin Schwartzman^{†2}, Olivia Oxlade^{†2},
Graham Barr^{†3}, Franque Grimard^{†4} and Dick Menzies^{*†2}

Tool(s) for assessing patient costs

Assessing Patient Costs due to Tuberculosis (TB)

Questionnaire 1-2 months treatment

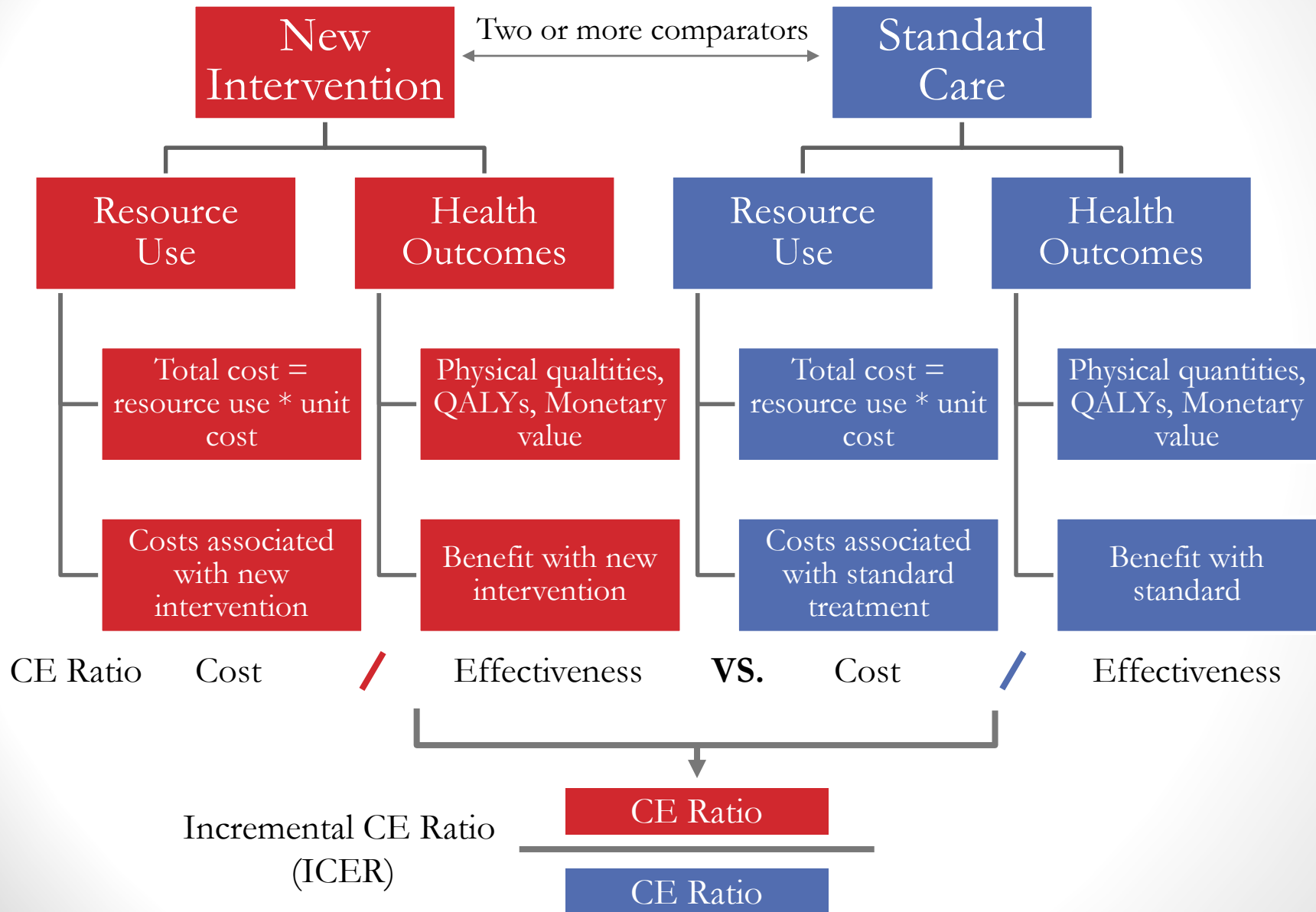
Principal Investigator: Dr Dick Menzies
Respiratory Epidemiology Unit
McGill University, Montreal

Funded by: The Canadian Institute for Health Research
January 2007

COFFEE BREAK



Structure of Cost-effectiveness Analysis



Measuring Cost-Effectiveness

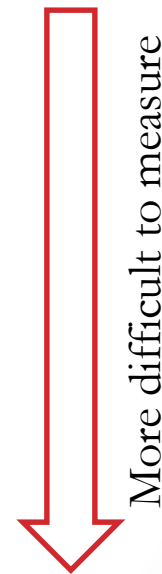
- Incremental Cost-effectiveness Ratio (ICER)

$$ICER = \frac{\Delta Cost}{\Delta Effects}$$

*** How much more does it **cost** to implement new strategy and what additional **effect** does it bring?***

What are the 'effectiveness' measurements?

- It can be any outcomes that we assess, but depend on the perspective of the analysis
 - Health services perspective
 - Incremental yield
 - # of correctly diagnosed TB
 - Reduction in lost to follow-up
 - Reduction in diagnostic and treatment delay
 - Societal perspective
 - Changes in health utilities
 - Changes in expected life years (LY) – life years gained or lost



Measuring Health Utilities

- Standard Gamble

“If you win the bet, you live in perfect health, otherwise you die”

- Just like any gambling tactics –Based on your current state of health (e.g. likelihood of dying is 1 in 10, 20, 100, or 1000, etc.)
- Assess whether or not an individual is willing to risk ‘death’ for a chance for full health state

- Time-Trade off

- How many years of life are you willing to ‘trade’ for X number of years in full health?

- Visual Analogue Scale

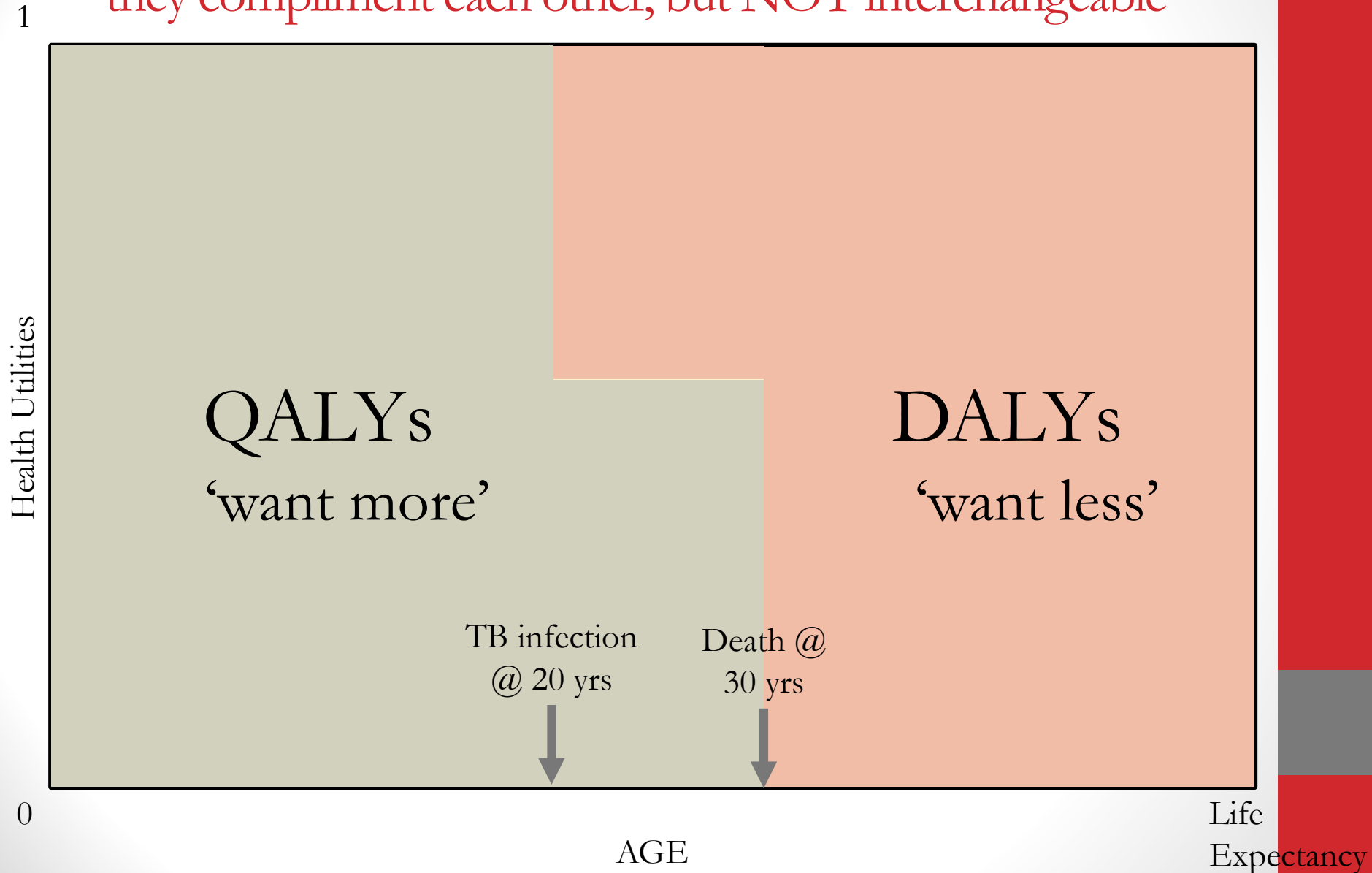
- A scale from 0 to 100 to assess your current quality of life

DALYs & QALYs

- DALY: Disability-Adjusted Life Year
 - “Disability weights” (1-utility) is assigned using standard scenarios
 - Do not change from one setting to another
 - Age & sex can be incorporated, also discounting, but nothing else
 - Calculate as years of life lost (YLL) + years of life with disability (YLD)
 - DALYs are bad = want to avert them!
- QALY: Quality-Adjusted Life Year
 - More of a ‘pure’ utility measure
 - Ask people in your cohort (or people similar to the cohort) to answer traditional utility questions for each health state (SF-36, SF-12, SF-6D, EQ-5D questionnaires)
 - Each year in a particular health state is weighted by this value
 - Takes into account all external factors that weigh into decisions

DALYs vs. QALYs

‘they compliment each other, but NOT interchangeable’



A word of caution – DALYs vs. QALYs

- Graphically, they compliment one another, but are NOT interchangeable – Why?
- Measurement is done on different instruments
 - Standardized scenarios (DALYs) vs. Local preference surveys (QALYs)
 - Standardized age and discount weights in DALYs whereas QALYs depend on responses at local level (e.g. same questions answered by individuals in Canada will be different from those in India!)
 - Globally standardized (DALYs) vs. Local specific (QALYs)
 - QALYs is not dependent on life-expectancy whereas DALYs do
 - Expert's valuation (DALYs) vs. Individual patient's valuation (QALYs) – issue of subjectivity and transparency
 - Societal preference is to give more weight to those with worse initial health states

Effect of measurement instrument on health utility measure

A comparison of the EQ-5D and SF-6D across seven patient groups

John Brazier^{a,*}, Jennifer Roberts^a, Aki Tsuchiya^{a,c} and Jan Busschbach^{b,c}

^aSheffield Health Economics Group, University of Sheffield, Sheffield, UK

^bInstitute for Medical Technology Assessment (iMTA), Erasmus University, Rotterdam, The Netherlands

^cThe EuroQol Group

Comparison of the minimally important difference for two health state utility measures: EQ-5D and SF-6D

Stephen J. Walters & John E. Brazier

Health Economics and Decision Science, School of Health and Related Research, University of Sheffield, UK

(E-mail: S.J.Walters@sheffield.ac.uk)

Comparing Cost-Utility Estimates

Does the Choice of EQ-5D or SF-6D Matter?

Tracey H. Sach, PhD,*†‡ Garry R. Barton, PhD,† Claire Jenkinson, BSc,† Michael Doherty, MD,§

Anthony J. Avery, MD,† and Kenneth R. Muir, PhD†

- Each instrument incorporates different health dimensions/domains and number of health states
- Results are discrepant based on what population is being questioned

The impact of tuberculosis on health utility: a longitudinal cohort study

Melissa Bauer · Sara Ahmed · Andrea Benedetti · Christina Greenaway ·
Marek Lalli · Allison Leavens · Dick Menzies · Claudia Vadeboncoeur ·
Bilkis Vissandjée · Ashley Wynne · Kevin Schwartzman

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0 = death
1 = perfect health

Abstract

Purpose To estimate health utility derived from the Short Form-36 (SF-36) questionnaire and Standard Gamble instrument for persons diagnosed and treated for tuberculosis (TB) disease, those diagnosed and treated for latent TB infection (LTBI), and those screened but not treated for TB disease or LTBI over the year following their diagnosis/initial assessment.

Methods Participants were recruited at two Montreal hospitals (2008–2011) and completed the SF-36 and Standard Gamble at baseline and at follow-up visits 1, 2, 4, 6, 9, and 12 months thereafter. SF-6D health utility scores were derived from SF-36 responses. Linear mixed models

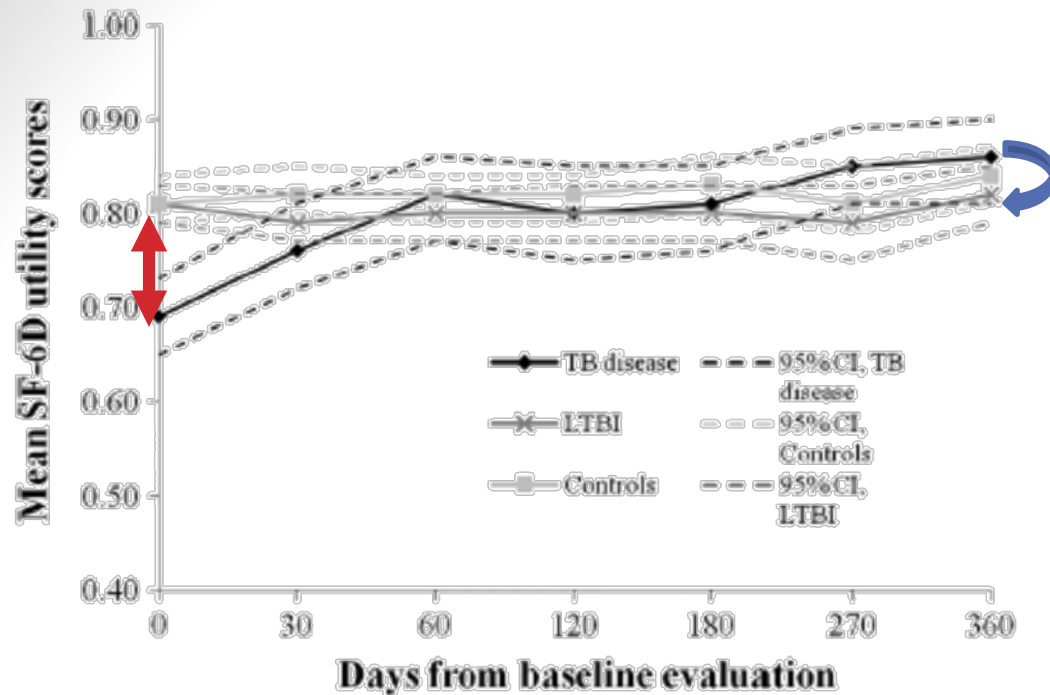
were used to compare mean health utility at each evaluation and changes in health utility between participants treated for TB disease, those treated for LTBI, and those in the control group.

Results Of the 263 participants, 48 were treated for TB disease, 105 for LTBI, and 110 were control participants. Fifty-four percent were women, mean age was 35 years, and 90 % were foreign-born. Participants treated for TB disease reported worse health utility compared with control participants at the baseline visit (mean SF-6D: 0.69 vs. 0.81; mean Standard Gamble: 0.64 vs. 0.96). They reported successive improvement at months 1 and 2 that was then sustained throughout follow-up. Health utility reported by participants treated for LTBI and control participants was comparable throughout the study.

Conclusion Treatment for TB disease had a substantial negative impact on health utility, particularly during the first 2 months of treatment. However, treatment for LTBI did not have a substantial impact.

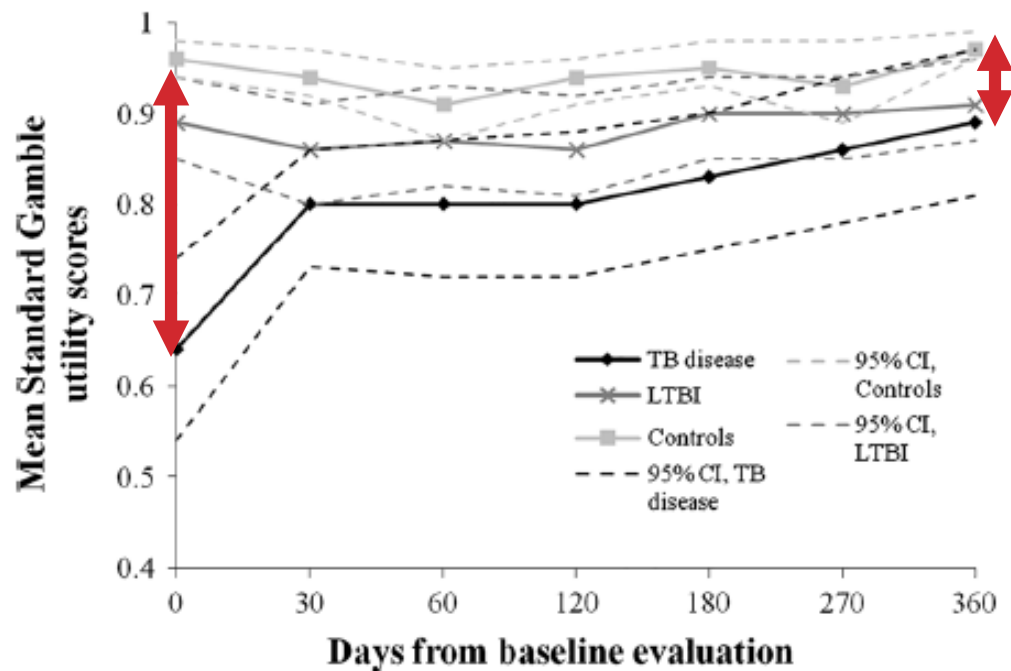
Electronic supplementary material The online version of this article (doi:10.1007/s11136-014-0858-6) contains supplementary material, which is available to authorized users.

M. Bauer · A. Benedetti · M. Lalli · A. Leavens · D. Menzies ·



Health quality is flipped at the end of TB treatment

Differences in health quality between the control and TB patient is consistent, but reduced over time



Decision Analytic Models

- Mathematical prediction of health events based on sequence of decision events
- Usually compare mutually exclusive interventions for a specific set of patient population/group
- Events are link to costs and health outcomes (w/ probabilities of such outcome)
- Data inputs and parameters are synthesized from various sources
 - Clinical trial data
 - Published estimates
 - Assumptions
- Many sources of uncertainty – but the goal is to predict and describe major cost and effectiveness drivers that determines CE of an intervention
- Trade-off between clinical and economically important outcomes

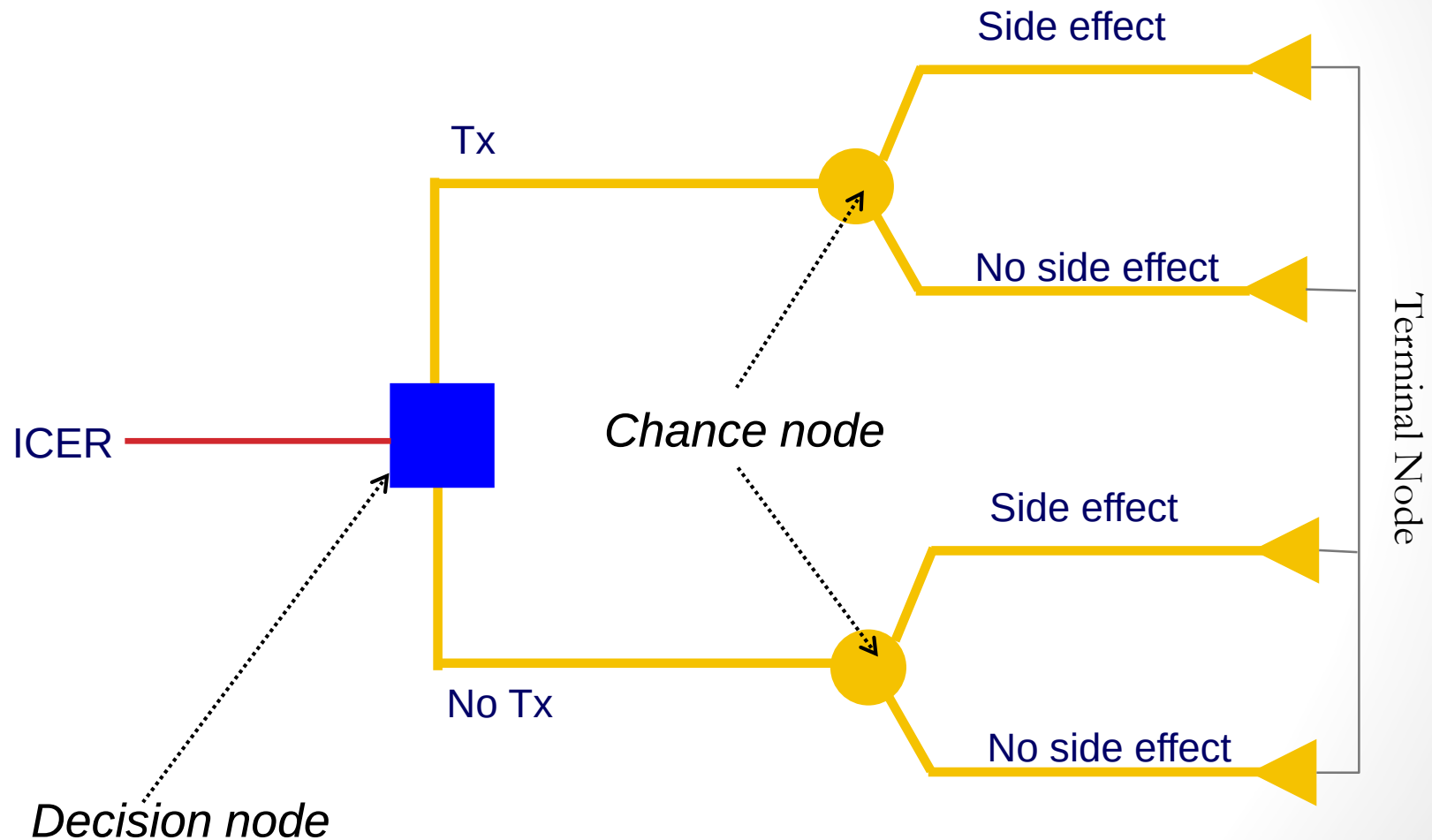
Key elements of models

- Models are MUCH simplified versions of reality
 - But, we want to reflect a model that represents reality as close as possible
 - Otherwise, we lose credibility
- Thus, we must allow:
 - Comparison of all feasible alternative interventions/strategies
 - Exploration of full range of clinical policies and actual practice
 - Test for a range of patient sub-groups
 - Systemic combination of evidence from variety of sources

Data sources for modeling

Type of parameter	Source
Baseline event rates / Prevalence	Observational studies / Trials / National Report & Surveys
Relative treatment effects	Trials
Long-term prognosis	Longitudinal observation studies
Resource use	Observations studies/ Trials
Quality of life weights (utilities)	Cross sectional surveys / Trials

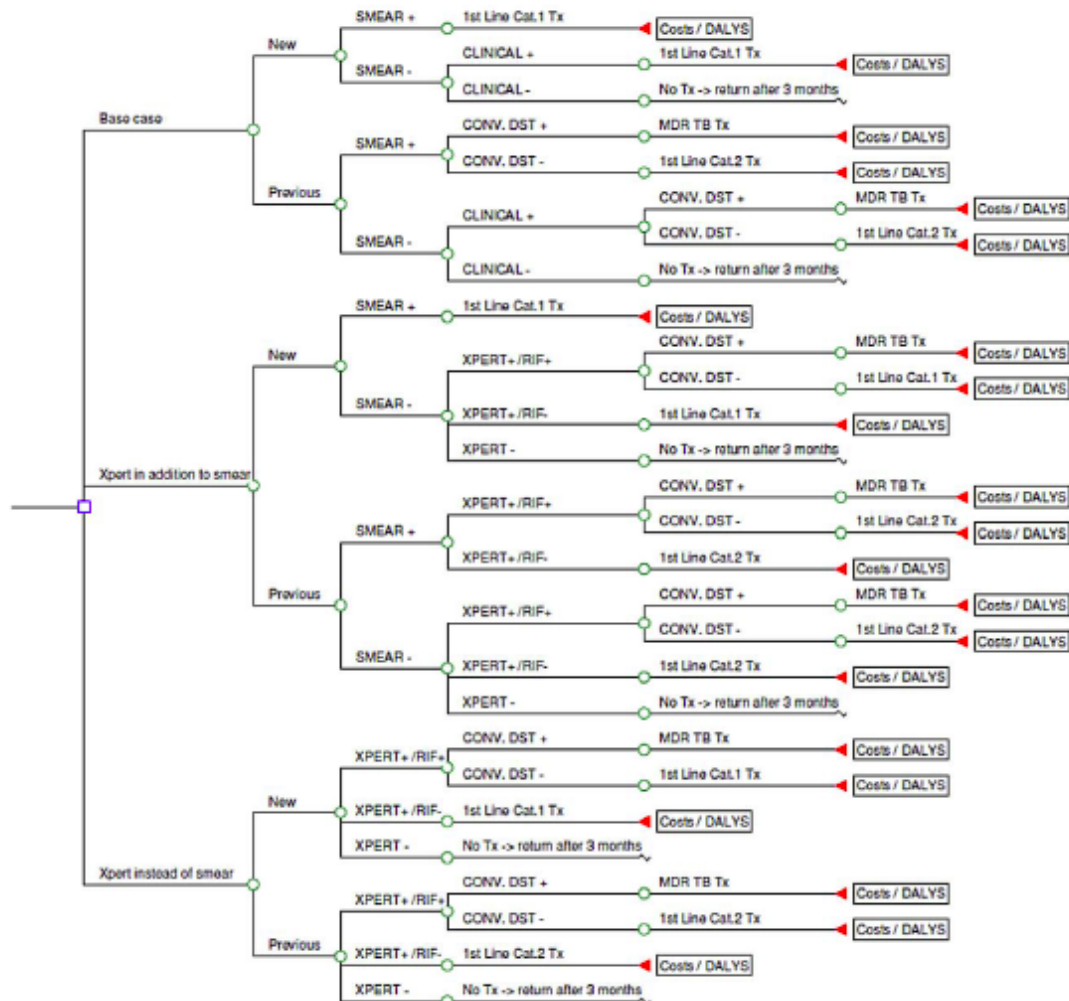
Explaining a decision tree model



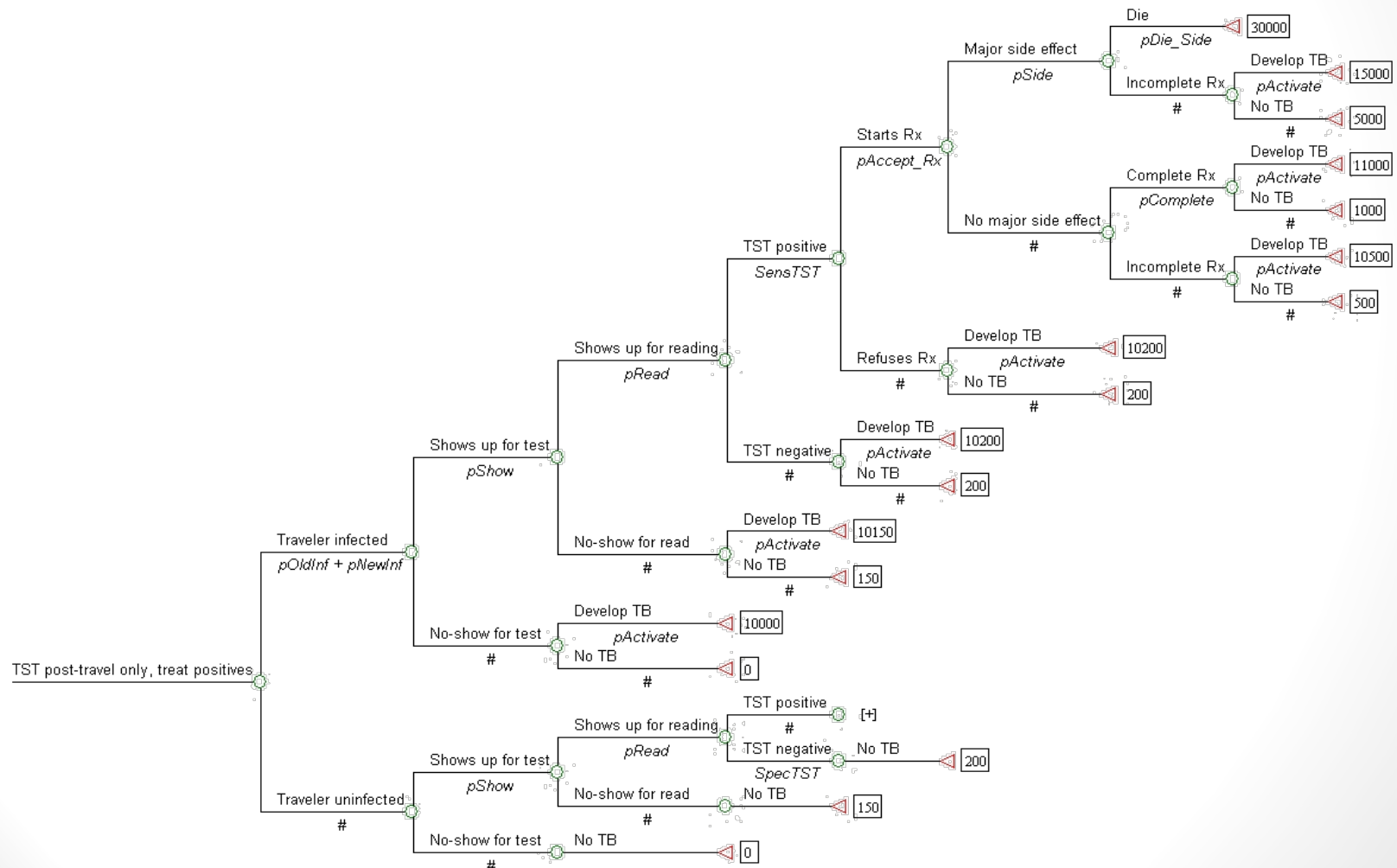
When constructing the tree, we need to...

- Structure the decision problem
 - Specify target group/setting
 - Specify time-frame for events modeled
 - Select appropriate end-points (e.g. disease diagnosis, death, etc.)
- Assign values to outcome
- Assign probabilities of each event downstream of the decision node

Complex tree structure



Complex tree structure



CEA example – CE of Rapid DST vs. baseline test

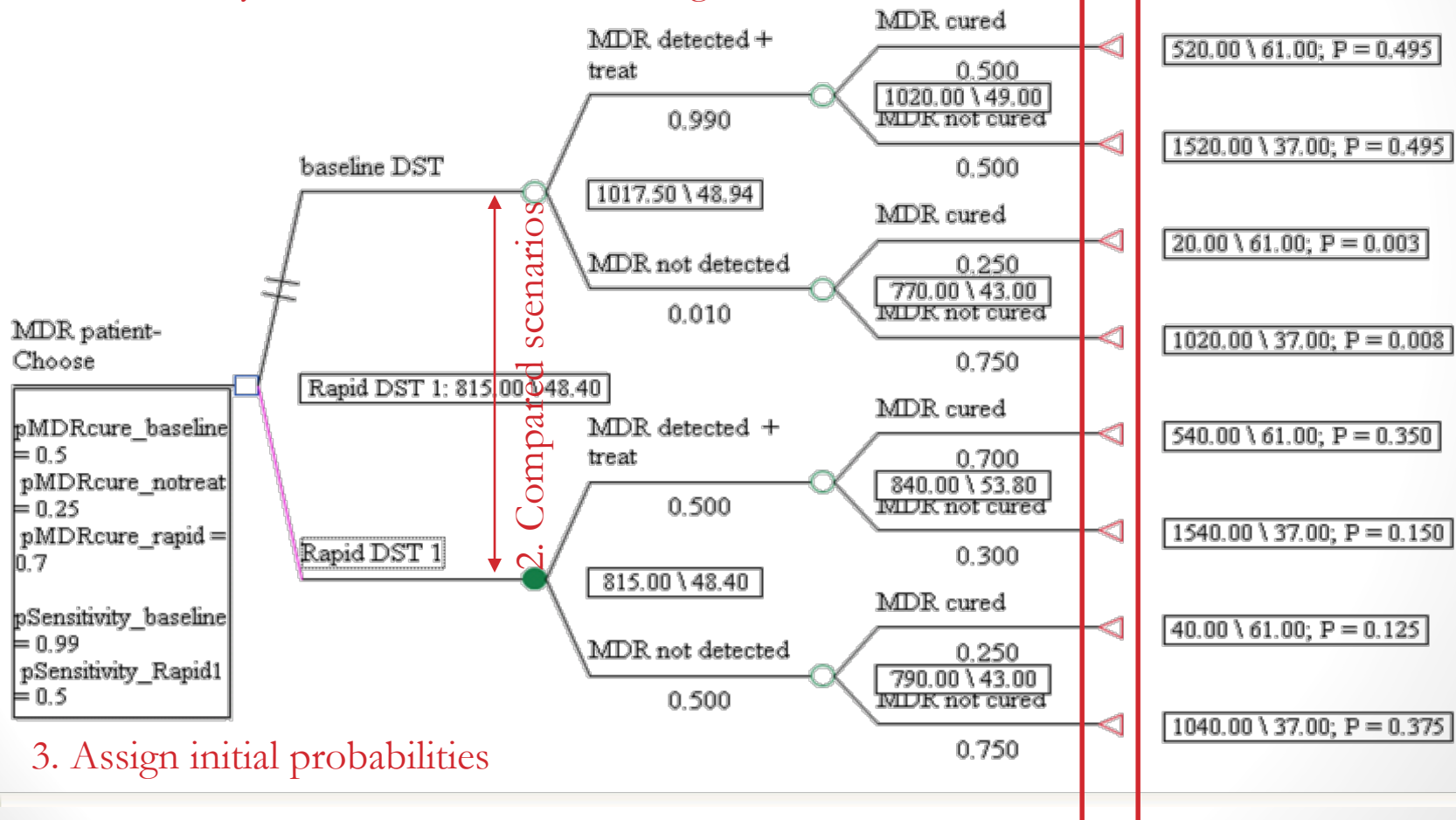
Two different strategies for DST: Baseline test vs. Rapid test

Parameters	Compared scenarios	
	Baseline DST	Rapid DST
Sensitivity to detect MDR	99%	50%
MDR Cure	50% (assumes delay in dx)	70% (assumes no delay in dx)
Initial cost (test cost)	\$ 20	\$ 40
Cost of MDR-TB Tx: \$ 500 Additional cost of incurred by patients not cured: \$ 500 N.B. Hypothetical figures for demonstrative purposes only		

Constructing the decision tree model

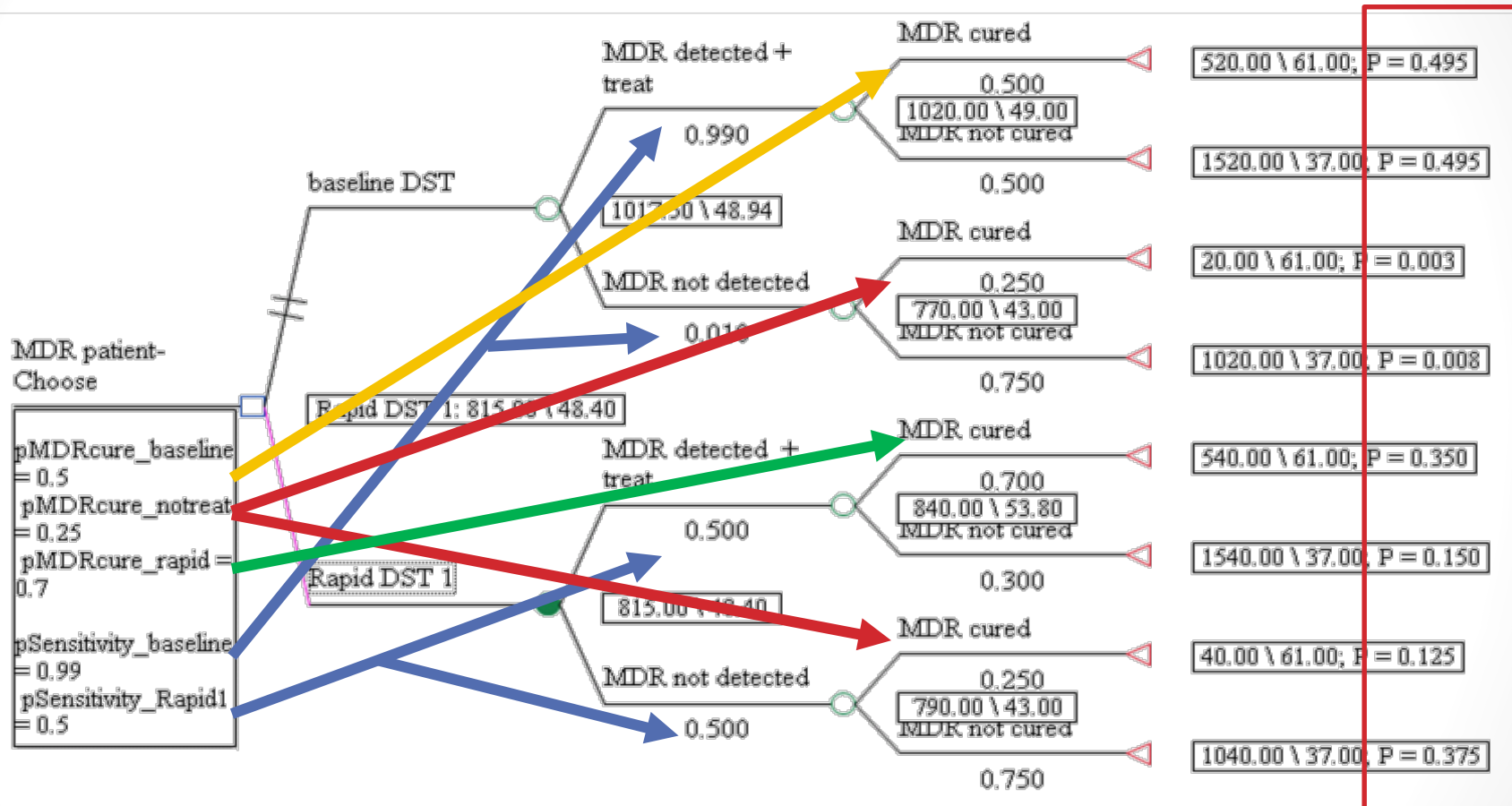
Structuring the decision problem

1. Define key events downstream of diagnosis



4. Assigning values to the outcomes

3. Assign initial probabilities



Outcome probabilities determined

Assigning values to the outcome

2. Calculating cost

Baseline DST:

- Cured patient: Dx cost + Tx cost = \$20 + \$500 = \$520
- Not cured patient: Dx cost + Tx cost + additional cost
= \$20 + \$500 + \$500 = \$1020

$$\begin{aligned}\text{Expected Cost} &= \sum P(\text{event}) * \text{cost}(\text{event}) \\ &= (520 * 0.495) + (1520 * 0.495) + (20 * 0.003) + (1020 * 0.008) = \$1017.50\end{aligned}$$

Rapid DST:

- Cured patient: Dx cost + Tx cost = \$40 + \$500 = \$540
- Not cured patient: Dx cost + Tx cost + additional cost
= \$40 + \$500 + \$500 = \$1040

$$\begin{aligned}\text{Expected Cost} &= (540 * 0.35) + (1540 * 0.15) + (40 * 0.125) + (1040 * 0.375) \\ &= \$815\end{aligned}$$

Assigning values to the outcomes

1. Calculating DALYs

Assume in this example:

- Life expectancy is 61 years
- MDR diagnosed at 35 years
- MDR disease lasts 2 years
- Untreated MDR=death

	DALYs by health state
Disease Free	1 /yr
MDR	0.729/yr
Die	0/yr

Patient with cured MDR = $((35*1)+(0.729*2)+(24*1))=61$ **DALYs**

Patient with uncured MDR = $((35*1)+(0.729*2)+(24*0))=37$ **DALYs**

Assigning values to the outcome

3. Calculating effect measure (DALY)

Baseline DST:

$$\begin{aligned}\text{Expected Effectiveness} &= (61 * 0.495) + (37 * 0.495) + (61 * 0.003) + (37 * 0.008) \\ &= 48.94 \text{ DALYs}\end{aligned}$$

Rapid DST:

$$\begin{aligned}\text{Expected Effectiveness} &= (61 * 0.35) + (37 * 0.15) + (61 * 0.125) + (37 * 0.375) \\ &= 48.40 \text{ DALYs}\end{aligned}$$

Interpreting the results - ICER

	Cost (per person)	Incremental Cost (Δ cost)	Effectiveness (DALYs)	Incremental Effectiveness (Δ effectiveness)	ICER (Δ cost/ Δ effectiveness) (per person)
Rapid DST	\$815.00	-	48.40	-	
Baseline DST	\$1017.50	\$202.5	48.94	0.54	\$375

- Baseline is more effective than rapid DST by about 0.5 DALY averted
- It comes at an added cost of \$202.5
- Thus, ICER = \$375 per DALY averted
 - It means for each DALY averted using baseline DST test, it costs additional \$375 compared to Rapid DST
- Lower ICERs correspond to better value (i.e. lower cost per unit of additional effectiveness)
- Another way to say is 'Rapid DST is NOT Cost-Effective'

What does it mean?

- \$375 / DALY averted – what does this mean?
 - Literally,
 - “ it will cost ‘us’ (differs based on the perspective we take) \$375 more to diagnose patients with routine DST to reduce 1 year of disabled (imperfect) life”
- That’s great! But, what does it really mean to us? – How are we going to decide?
 - Is increased effect ‘worth’ increased cost?
 - Can we ‘afford’ (pay) \$375 for each disable year averted?
 - Are we willing to pay \$375 for each disable year averted?
 - How is this figure relevant (compare) to other interventions across different diseases?

How do we decide?

1. ICER Plane

	Less Effective	More Effective
More Cost	Do not adopt	Is the increased in effect worth the cost?
Less Cost	Is decreased in effect worth the savings?	Definitely Choose

CE decision rule

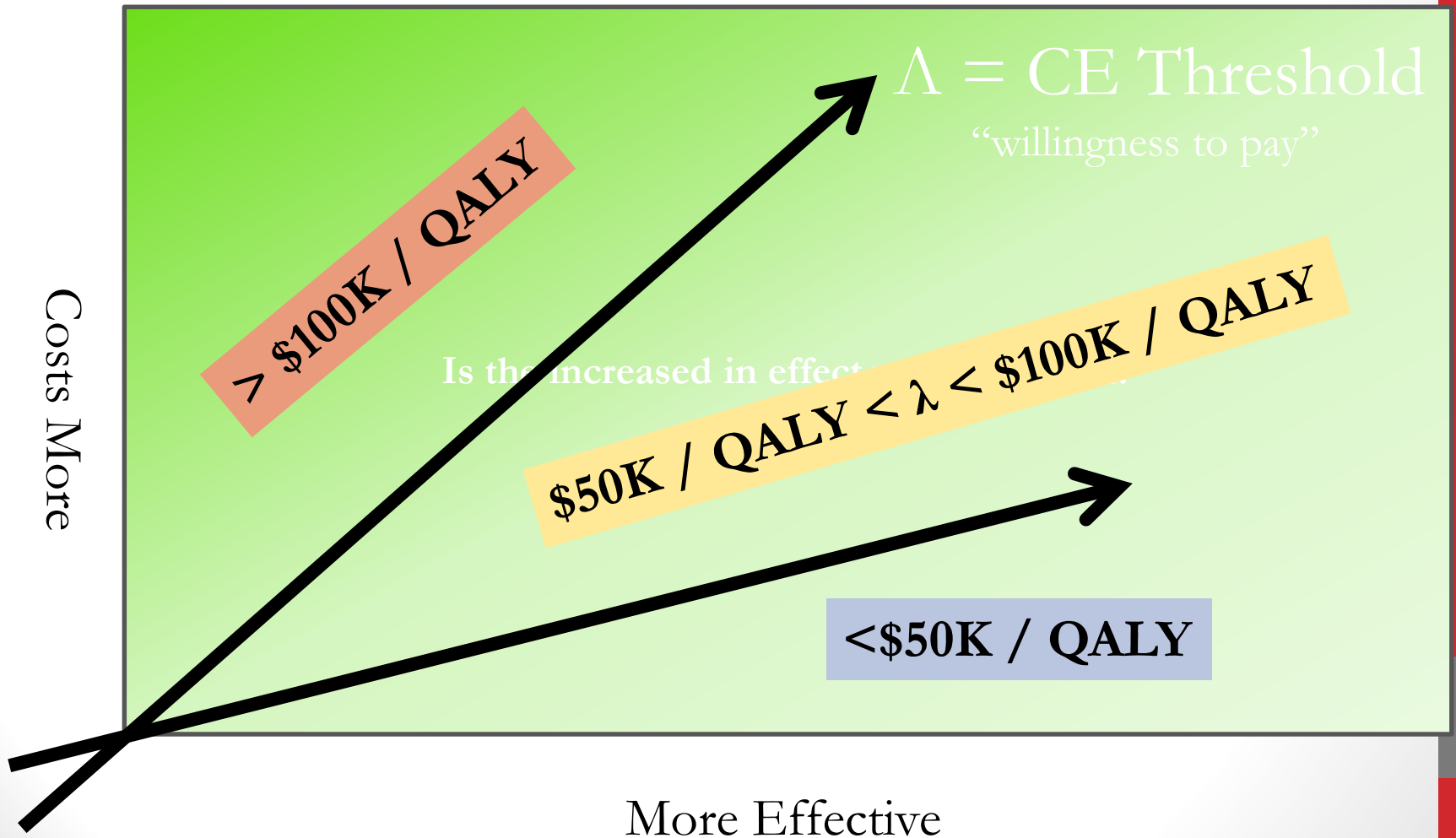
Choose new intervention (n) if:

$$ICER = \frac{\Delta Cost}{\Delta Effects} < \lambda$$

*** where λ = willingness to pay

Making decisions based on ICER

Depends on the “willingness to pay”



What is Cost-Effectiveness?

A question of Willingness to Pay

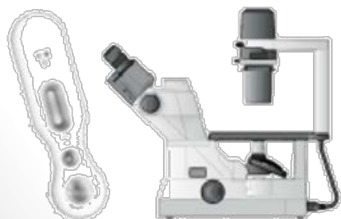
- Refers to how much more we are willing to spend in order to achieve certain benefit
- Differs based on effect measure and perspective of the analysis
- Generally, we view it as a societal perspective and costs are weighed against health outcome measure (e.g. health utilities such as QALYs and DALYs)
- Allows comparisons for how cost-effective an intervention will be in respect to other disease interventions
- Generally, 3 times the GDP per QALY gained is accepted as Cost-effective (extreme end)
- Use of Cost-Effectiveness League tables
- It is generally established that ICER below \$50,000 / QALY or 20-30K GBP is considered CE
 - Based on dialysis studies with no supporting data

Cost-effectiveness League Table

Intervention	Cost per QALY (£Aug 1990)
Cholesterol testing and diet therapy only (all adults, aged 40-69)	220
Neurosurgical intervention for head injury	240
GP advice to stop smoking	270
Neurosurgical intervention for subarachnoid haemorrhage	490
Anti-hypertensive therapy to prevent stroke (ages 45-64)	940
Pacemaker implantation	1,100
Hip replacement	1,180
Valve replacement for aortic stenosis	1,140
Cholesterol testing and treatment	1,480
CABG1 (left main vessel disease, severe angina)	2,090
Kidney transplant	4,710
Breast cancer screening	5,780
Heart transplantation	7,840
Cholesterol testing and treatment (incrementally) of all adults Aged 25-39 years	14,150
Home haemodialysis	17,260
CABG1 (1 vessel disease, moderate angina)	18,830
CAPD2	19,870
Hospital haemodialysis	21,970
Erythropoietin treatment for anaemia in dialysis patients (assuming a 10% reduction in mortality)	54,380
Neurosurgical intervention for malignant intracranial tumours	107,780
Erythropoietin treatment for anaemia in dialysis patients (assuming no increase in survival)	126,920

TB diagnostic willingness to pay

Willingness to use and pay for a new diagnostic test for active tuberculosis in HIV-positive and HIV-negative individuals:
Results from Benin, Peru, and Tanzania



Submitted to:
Bill and Melinda Gates Foundation
Seattle, WA 98102

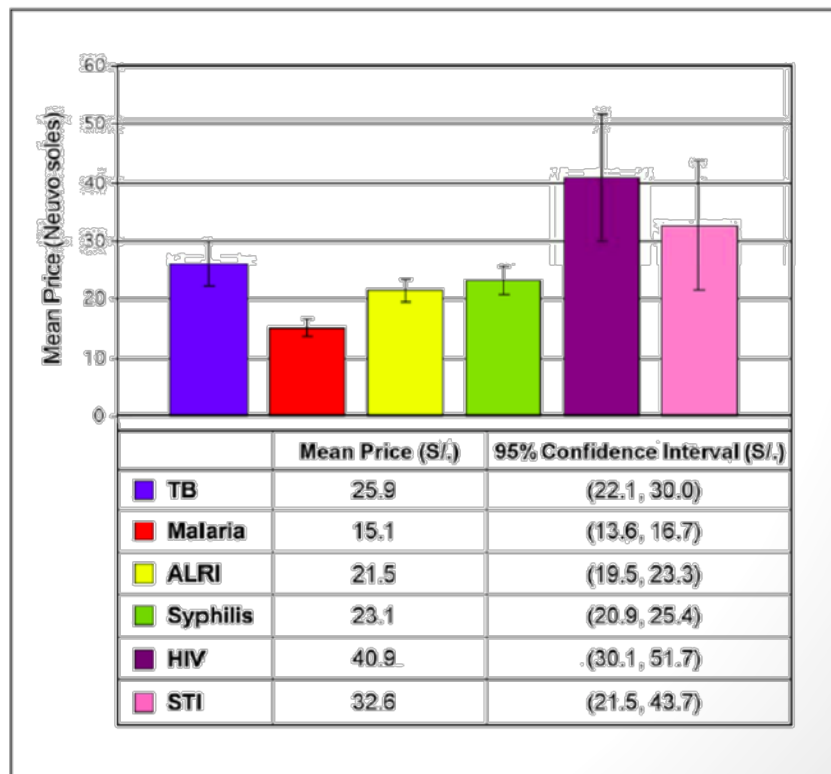
Prepared by:
Eric Rose/MBS
John Helly/MEA/MSPH
Howard Chang/MBS
and Steven A. Harvey/PHD

CHS CENTER FOR HUMAN SERVICES

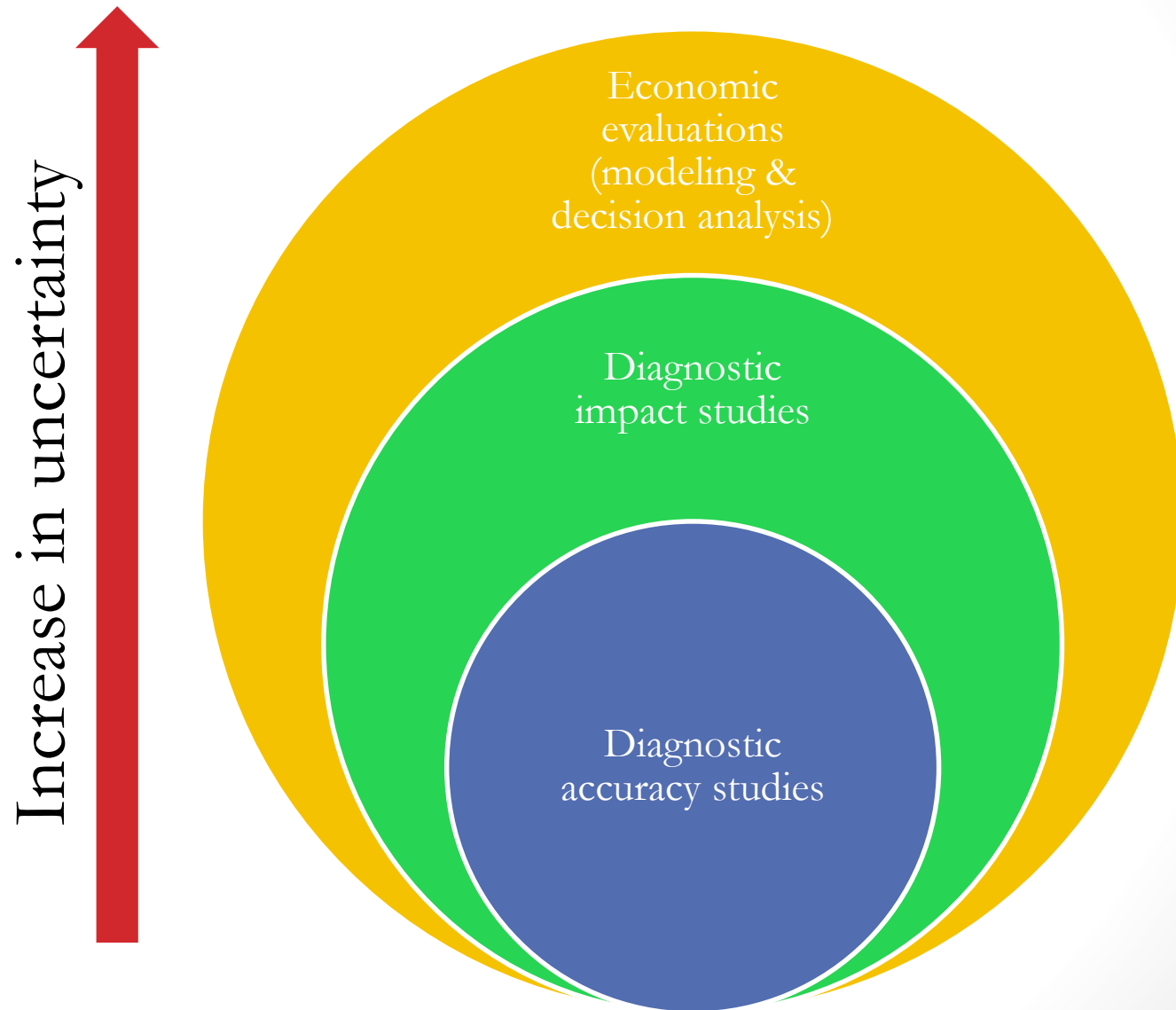
Table 1: High and low ranges of maximum willingness to pay

	Lowest Price Range	% WTP	Highest Price Range	% WTP
Benin	>0 - \$1.19	86%	>\$11.87	4%
Tanzania	>0 - \$0.43	89%	>\$4.24	11%
Peru	>0 - \$1.84	90%	>\$18.37	10%

Figure 9. Peru: Average prices consumers were willing to pay for diagnostic tests



Challenges – margin of uncertainty



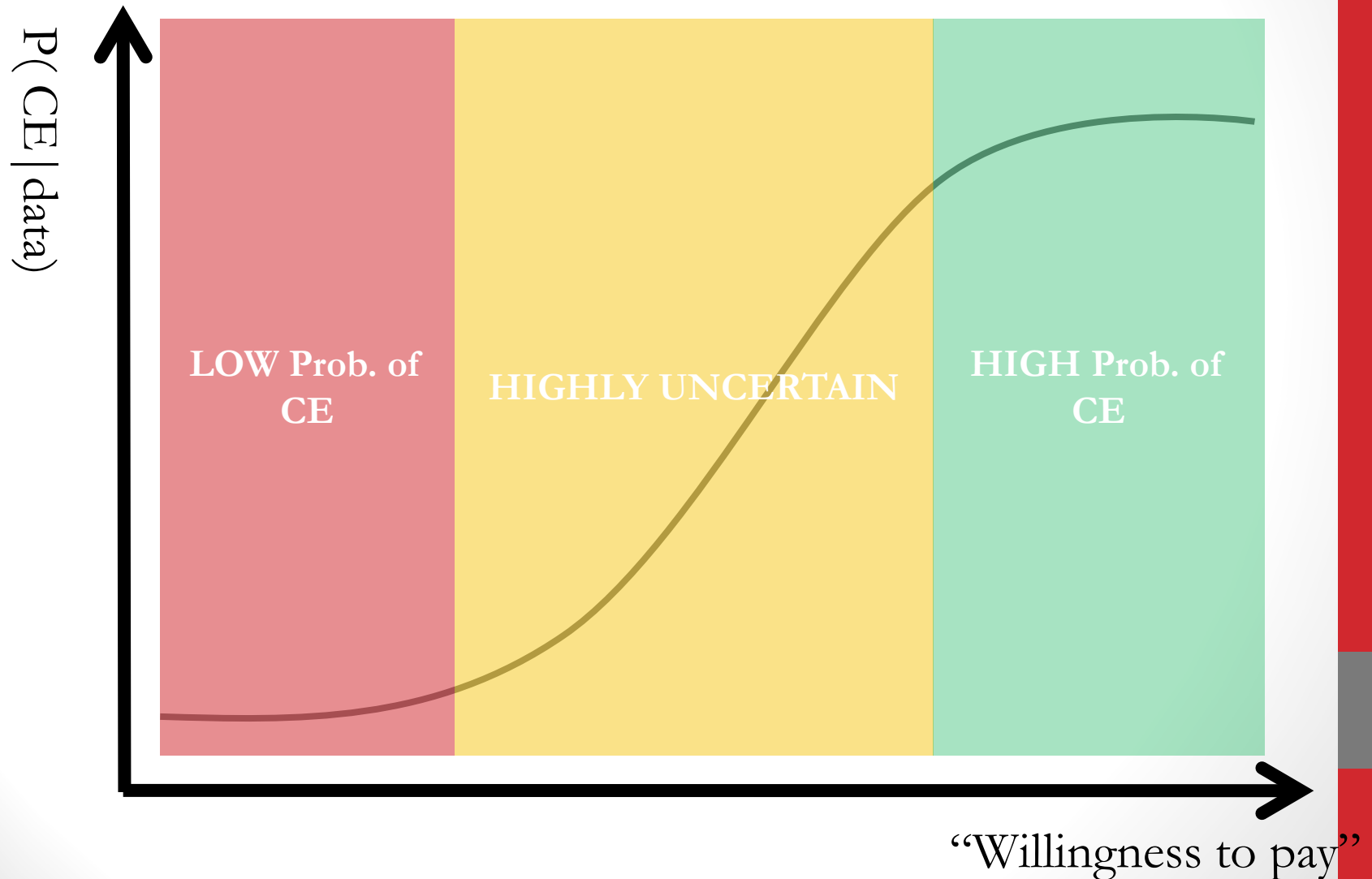
Issues in CEA of TB diagnostics

- Proper representation of diagnostic process
 - Most models are static and assumes diagnosis and treatment as one package
 - Does not account for delays, losses to follow-up, technical Dx issues
 - May risk in over-simplifying the model
- Translation of diagnosis into changes in health outcomes
 - It is generally Tx that improves overall health quality of a patient, not Dx
 - Linkage from Dx to Tx is vastly unknown
- Issue of transmission
 - Transmission models are developed on a different mathematical platform than CEAs
 - Dx does not mean Tx; thus, does not accurately predict early diagnosis = reduction in transmission

How do we improve?

- Develop models that capture realities as close as possible
- Use proper discounting to capture costs and effects that are further downstream of initial diagnosis
- Use Markov process to deal with recursive probabilities
- Adopt and stick to explicit analytic perspective (societal, health systems, patient, etc.) chosen for the analysis
- Rigorous and extensive use of sensitivity analysis
 - Test for a range of alternate probabilities and costs
 - Use of Cost-effectiveness Acceptability curve to overcome the problems of WTP
- Empirical CEA – Patient/Person-level CEA

Cost-effectiveness Acceptability Curve (CEAC)



A checklist for evaluating CEAs in healthcare

- Was the research question properly asked?
- Were alternative programs adequately described?
- Has the program's effectiveness been validated?
- Were all important & relevant costs and effects identified?
- Was an appropriate analytical perspective and analysis undertaken?
- Were comparisons between programs properly adjusted?
- Were the biases and direction of biases identified?
- Who paid for the study and were there any conflicts of interests?
- What actually went into evaluating the CE?
- How does the context of the study resemble and differ from your context?
- What is driving the costs and the model results?
- Were proper sensitivity analysis done to test for uncertainty of parameters?

Take away message

- CEA is a mere prediction of what will be cost-effective and is a 'predicted' representation of reality
- CEA is useful in identifying key drivers of costs and effectiveness of an intervention over the comparator
- Critical appraisal of CEA study in combination of various evidences (e.g. diagnostic accuracy) is necessary in decision making process
 - Never take CE analysis results for granted!
- We should be diligent about collecting and analysis data that we can be certain
 - Rigorous cost-analysis in itself can provide a lot of valuable information for decision making process

Thank you!

THE BEST YEARS OF YOUR LIFE



Is my life a
cost-
effective
one?



... hopefully, with
Increasing salaries?