HEALTH ECONOMICS AND OUTCOMES STUDIES IN RAPID DIAGNOSTICS

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DISCLOSURE

- The views expressed here do not necessarily reflect the views of the US Department of Veterans Affairs

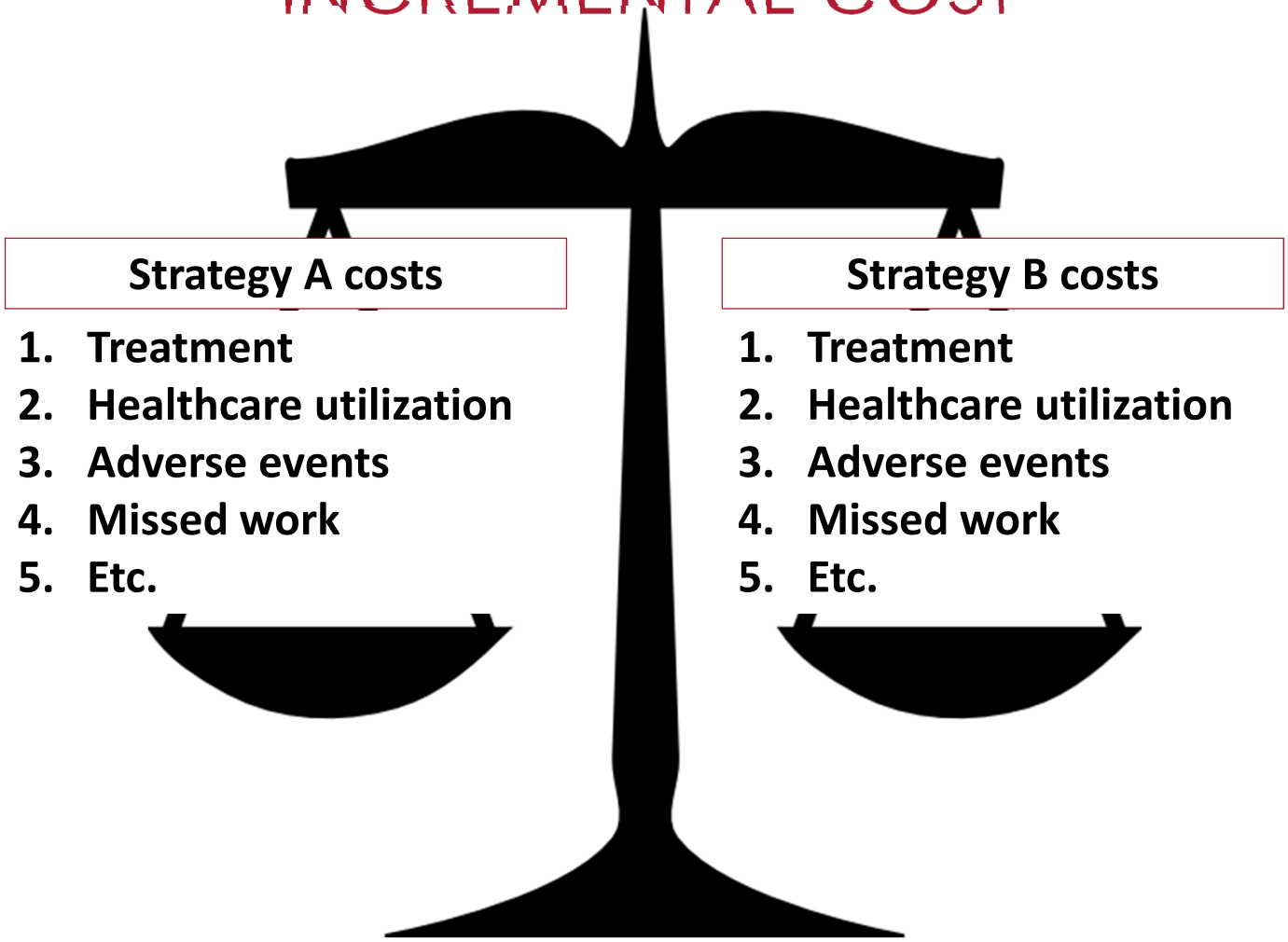
DEFINITION OF ECONOMICS

- "Economics examines economic events and arrangements through the lens of economic theory"
- The study of how individuals, governments, firms, and nations allocate scarce resources to satisfy their unlimited wants
- The study of choices

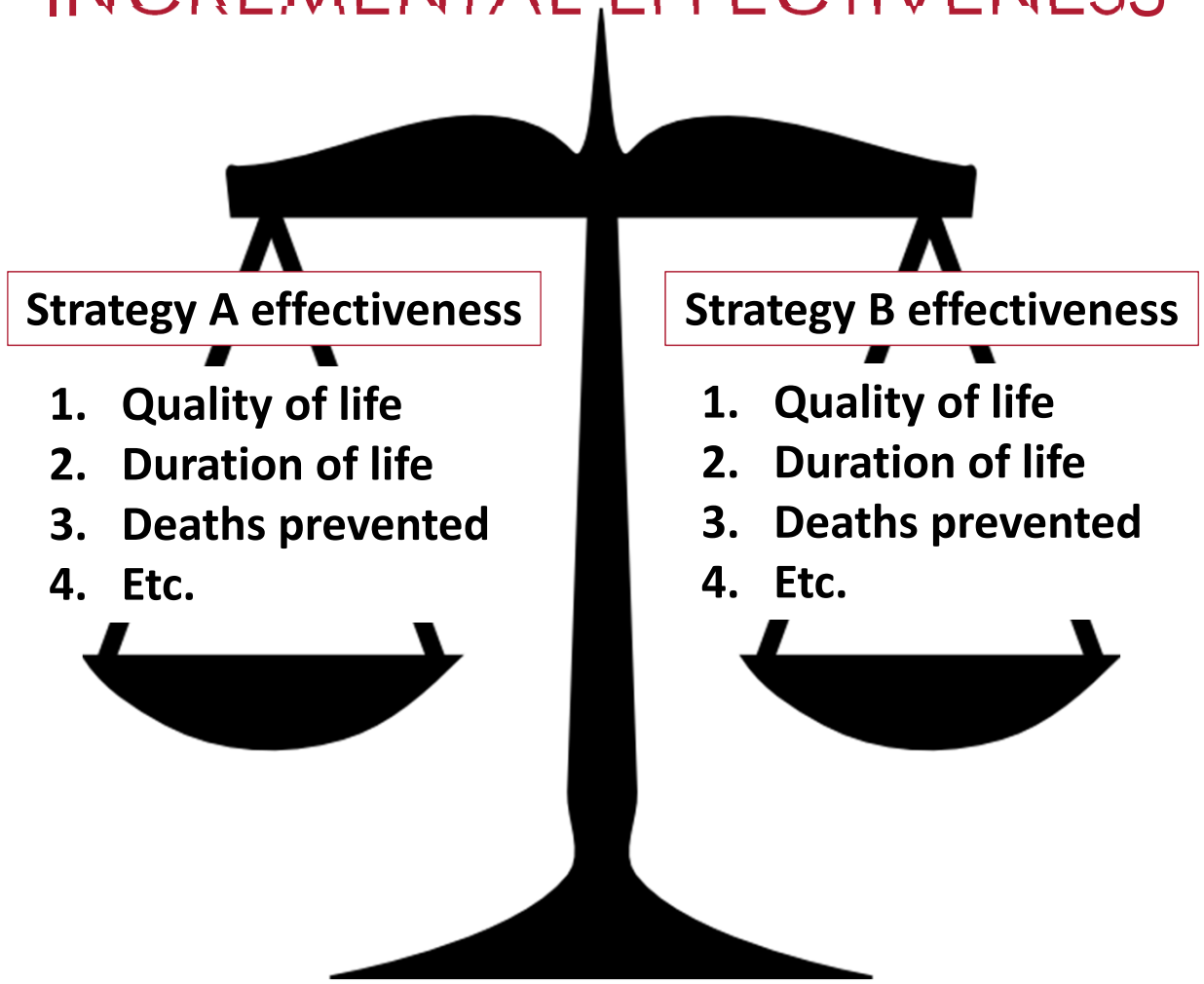
COST-EFFECTIVENESS ANALYSIS

- One of many types of economic evaluation
- Tool for making treatment decisions based on multiple metrics
  - Both cost and effectiveness
  - Each could be measured in a number of different ways
  - Calculate “bang for buck”

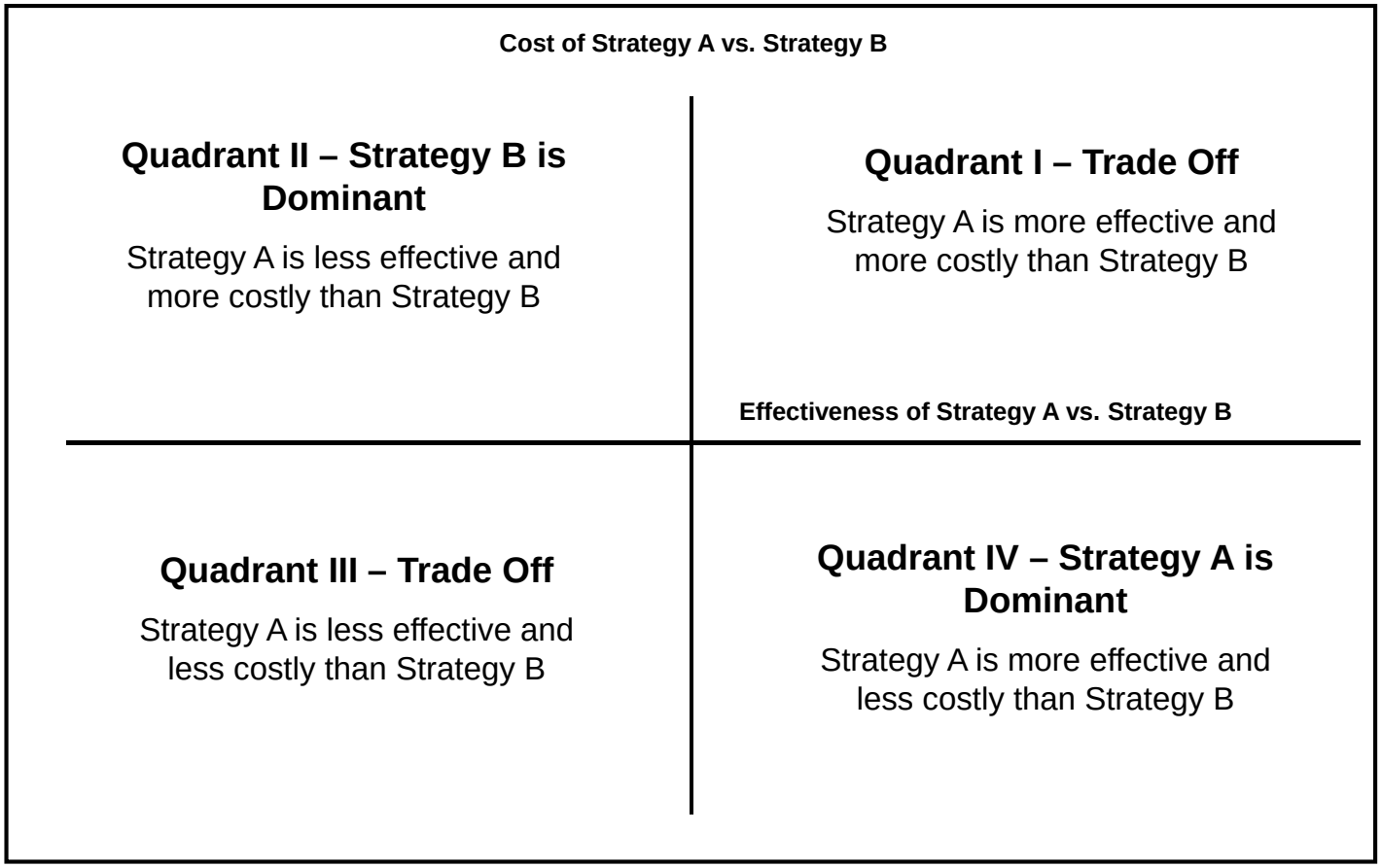
INCREMENTAL COST



INCREMENTAL EFFECTIVENESS



COST EFFECTIVENESS PLANE



COST-EFFECTIVENESS ANALYSIS

MEASURING COST-EFFECTIVENESS

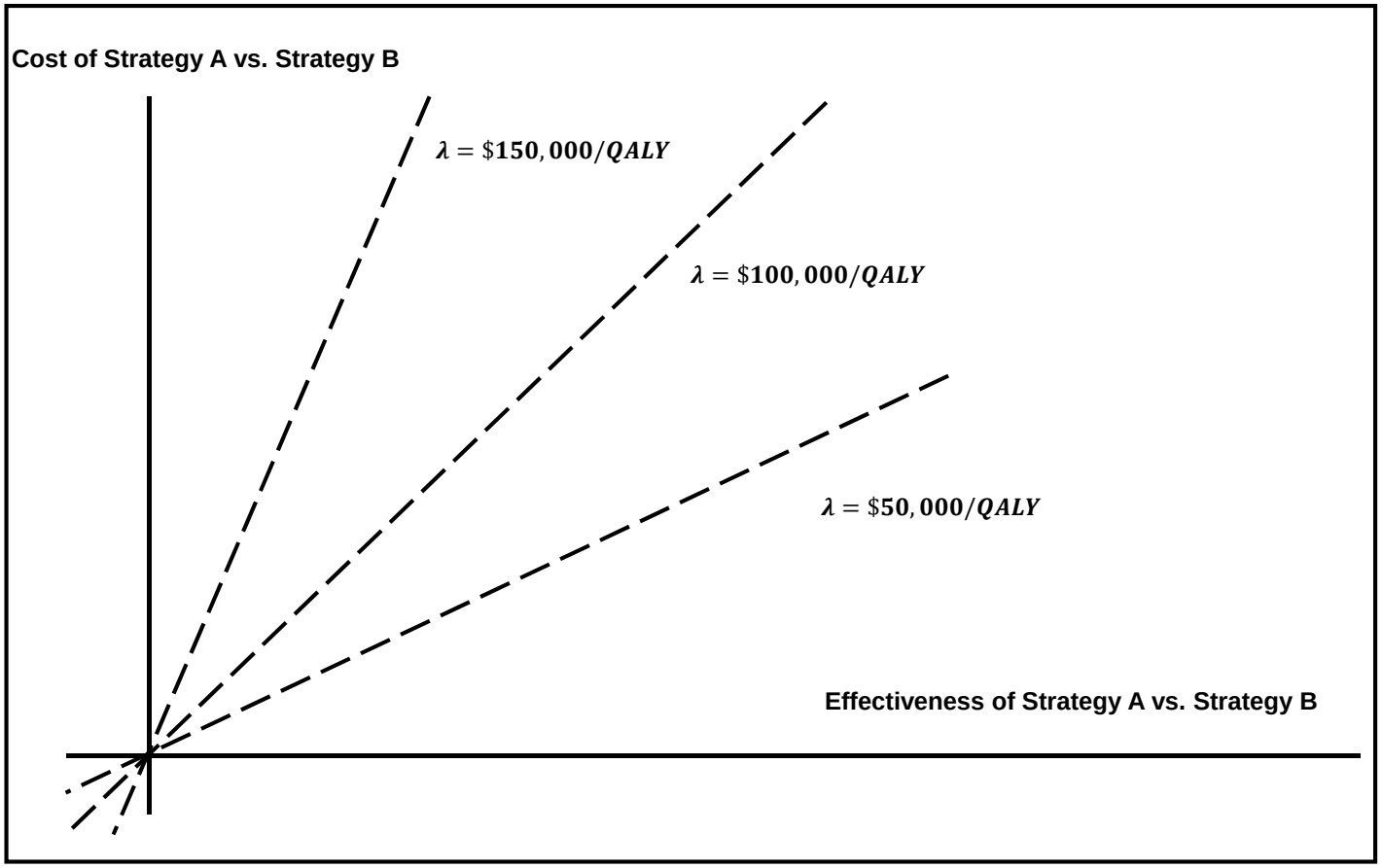
- Incremental cost-effectiveness ratio
  - $ICER = \frac{Cost_A - Cost_B}{Effectiveness_A - Effectiveness_B}$
  - Interpretation = how much it costs to get one more unit of effectiveness

WILLINGNESS TO PAY

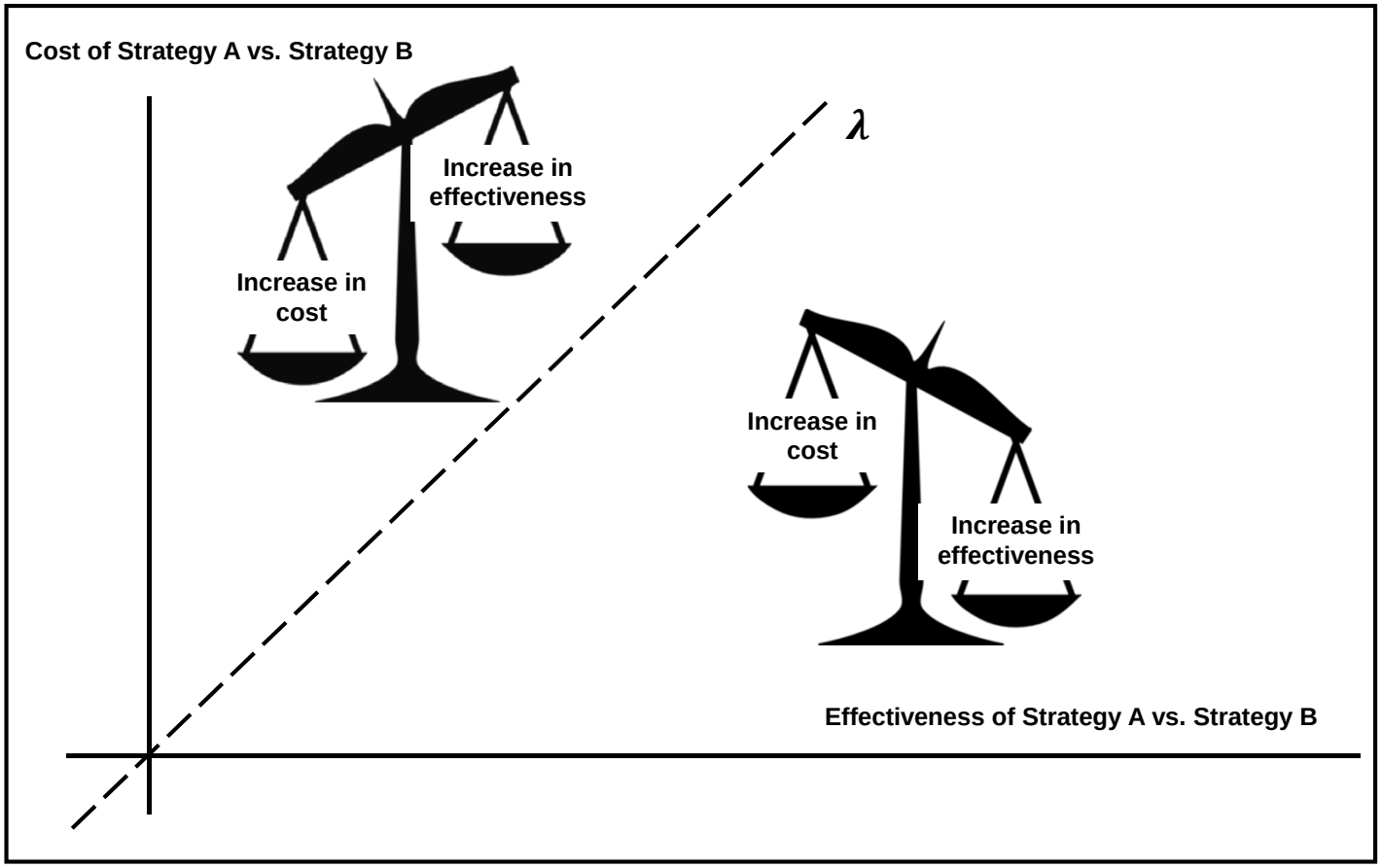
- What is a good price to pay for a QALY?
  - $50,000? Historical threshold
  - $100,000? Suggested thresholds
  - $150,000?

Grosse *Expert Rev Pharmacoecon utcomes Res* (2009); Neuman et al *NEJM* (2014)

COST EFFECTIVENESS PLANE



COST EFFECTIVENESS PLANE



SIMULATION MODELS

- Mathematical model of complex system or process
- Hypothetical patients
- Efficient way to take into account many factors
- Simplifies and organizes real-world processes

TYPES OF SIMULATION MODELS

- Static
  - Decision tree
  - Markov model
- Dynamic
  - Compartmental model
  - Agent-based simulation

INPUT PARAMETERS

- Probabilities/rates
  - Sensitivity and specificity
  - Treatment based on test results
  - Adverse effect of treatment
- Effectiveness
  - Infections prevented
  - Life-years gained
  - QALYs gained
- Costs
  - Cost of intervention
  - Cost of downstream events

HOW TO GET INPUT PARAMETERS

	Patient-level data	Literature
Advantages	Specific to your intervention	Peer reviewed
	Can get "exactly" what you need	Potentially more generalizable
	Subgroups	Faster
Disadvantages	Time-consuming	The parameter you need may not exist
	May not have what you need	Error in analysis
	You could make errors in analysis	May actually be less generalizable

CEA EXAMPLE

Economic Analysis of Rapid and Sensitive Polymerase Chain Reaction Testing in the Emergency Department for Influenza Infections in Children

Richard E. Nelson, PhD,† Chris Stockmann, MSc,‡ Adam L. Hersh, MD, PhD,‡ Andrew T. Pavia, MD,‡ Kent Korgenksi, MS,§ Judy A. Daly, PhD,¶ Marc R. Couturier, PhD,¶‖ Krow Ampofo, MD,‡ Emily A. Thorell, MD,‡ Elizabeth H. Doby, MD,‡ Jeff A. Robison, MD,‡ and Anne J. Blaschke, MD, PhD‡*

The Pediatric Infectious Disease Journal • Volume 34, Number 6, June 2015

CEA EXAMPLE

- Identification of influenza in ED can be difficult
  - Overlapping, non-specific clinical symptoms
- Testing options for diagnosis of respiratory infections
  - Fast
    - Rapid influenza test
  - Accurate
    - Polymerase chain reaction (PCR)
    - Direct fluorescent-antibody staining (DFA)

CEA EXAMPLE

- Rapid multiplex PCR
  - Fast turnaround
    - Roughly 1 hour
  - Can test for wide range of pathogens
  - Accurate
    - High sensitivity and specificity
  - 3-5 times more expensive than alternative methods

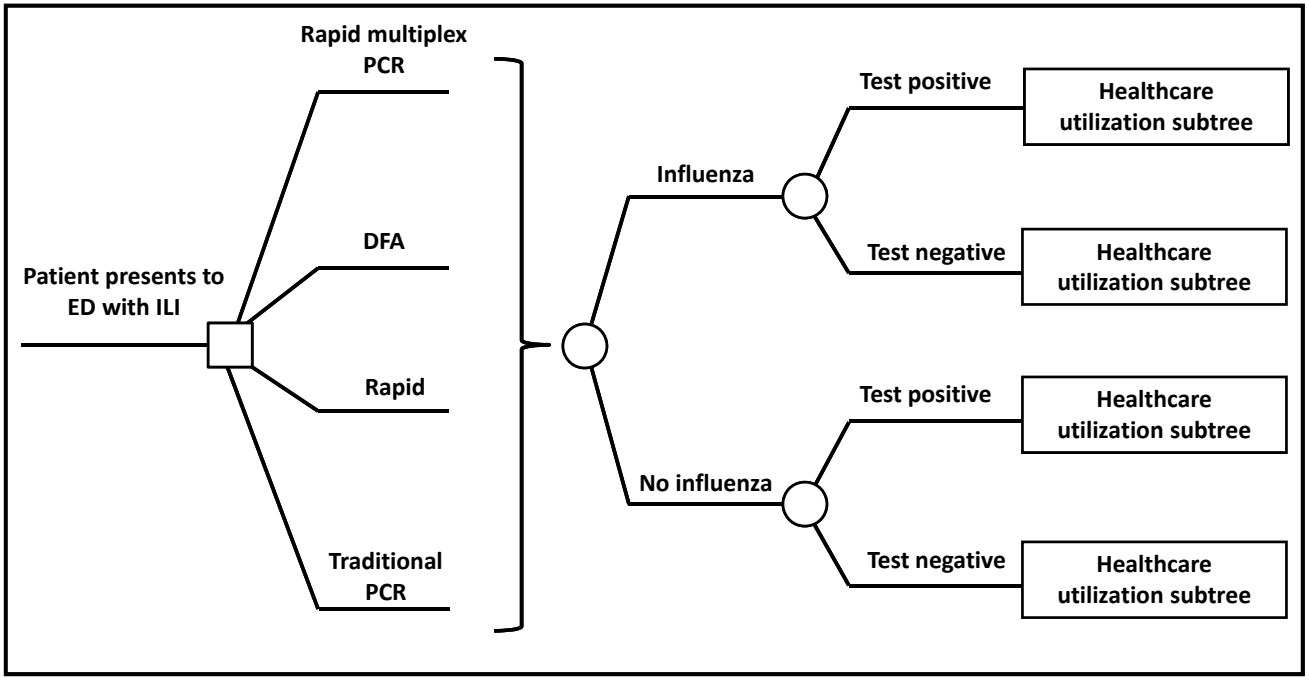
CEA EXAMPLE

- Research questions
  - Does fast, accurate information influence decision-making in the ED?
  - Is it worth the extra expense?

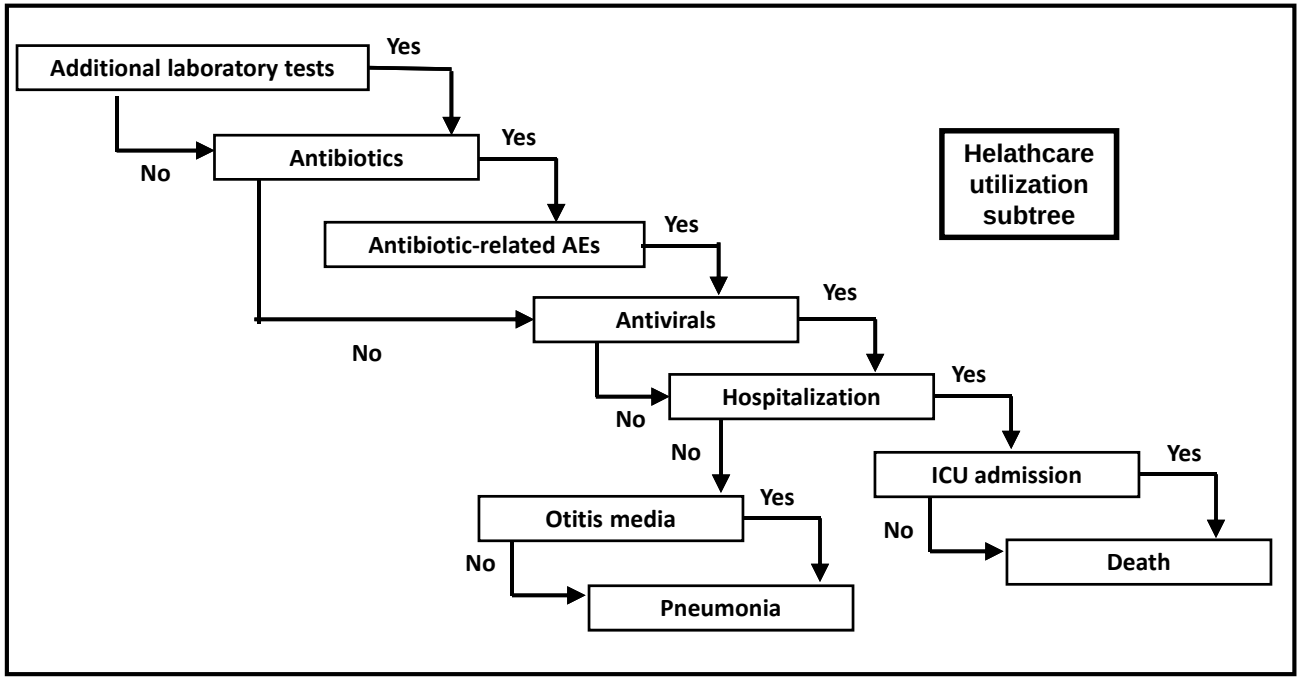
CEA EXAMPLE

- Comparisons
  - **Rapid multiplex PCR**
  - Traditional PCR
  - Rapid flu
  - DFA
- Inputs
  - Published literature
  - Local data
- Perspective
  - Hospital
- Effectiveness
  - QALYs

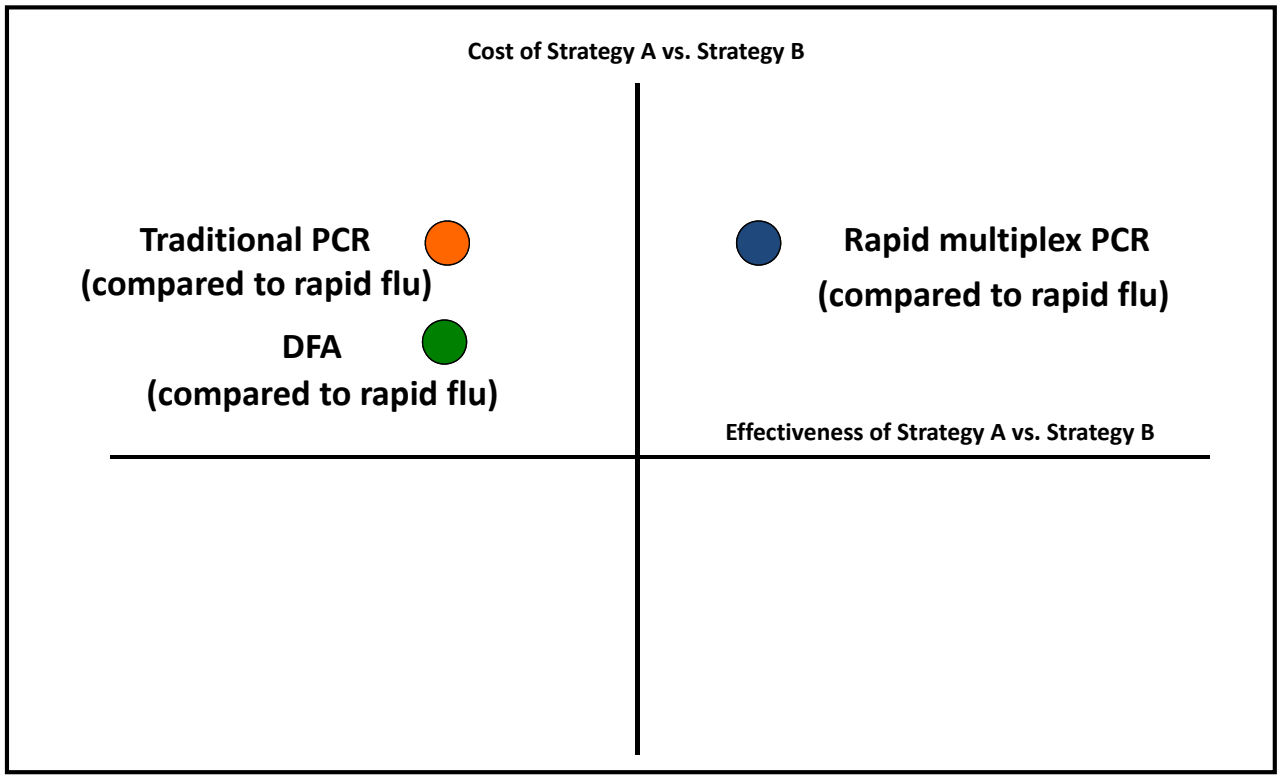
CEA EXAMPLE



CEA EXAMPLE



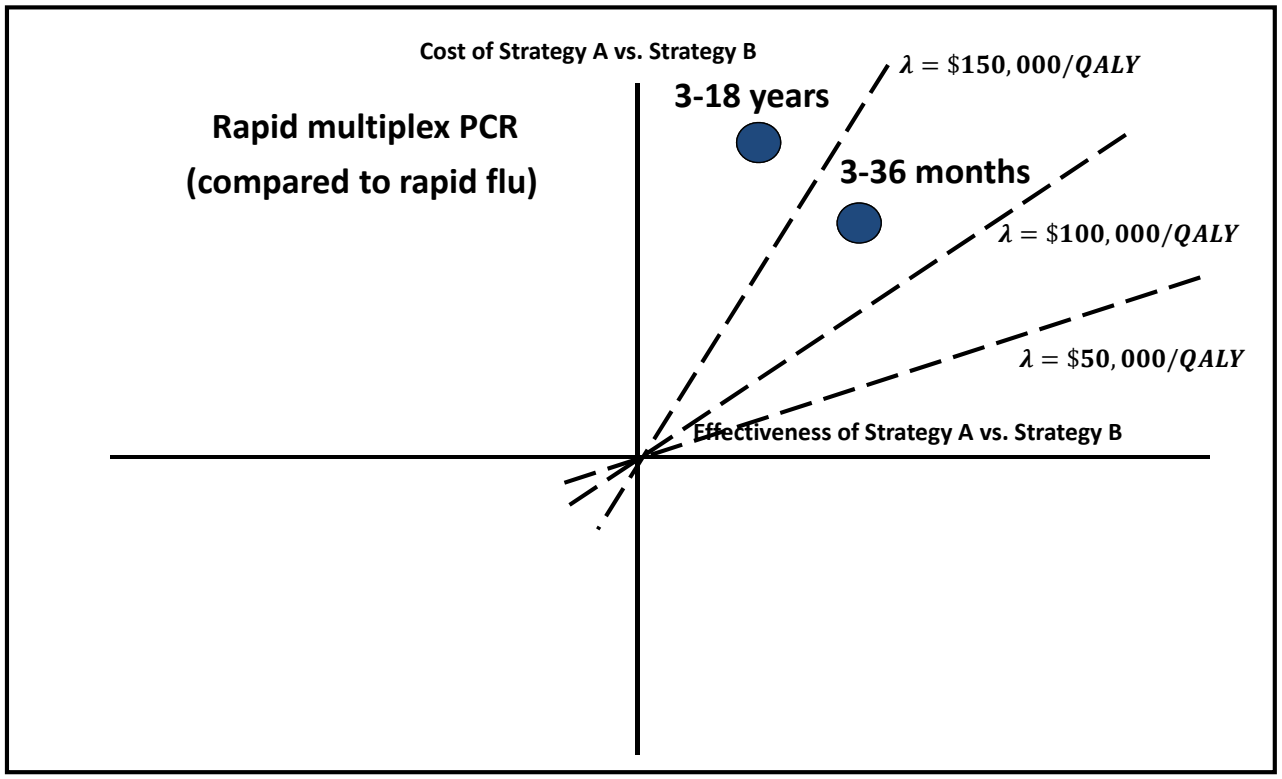
RESULTS

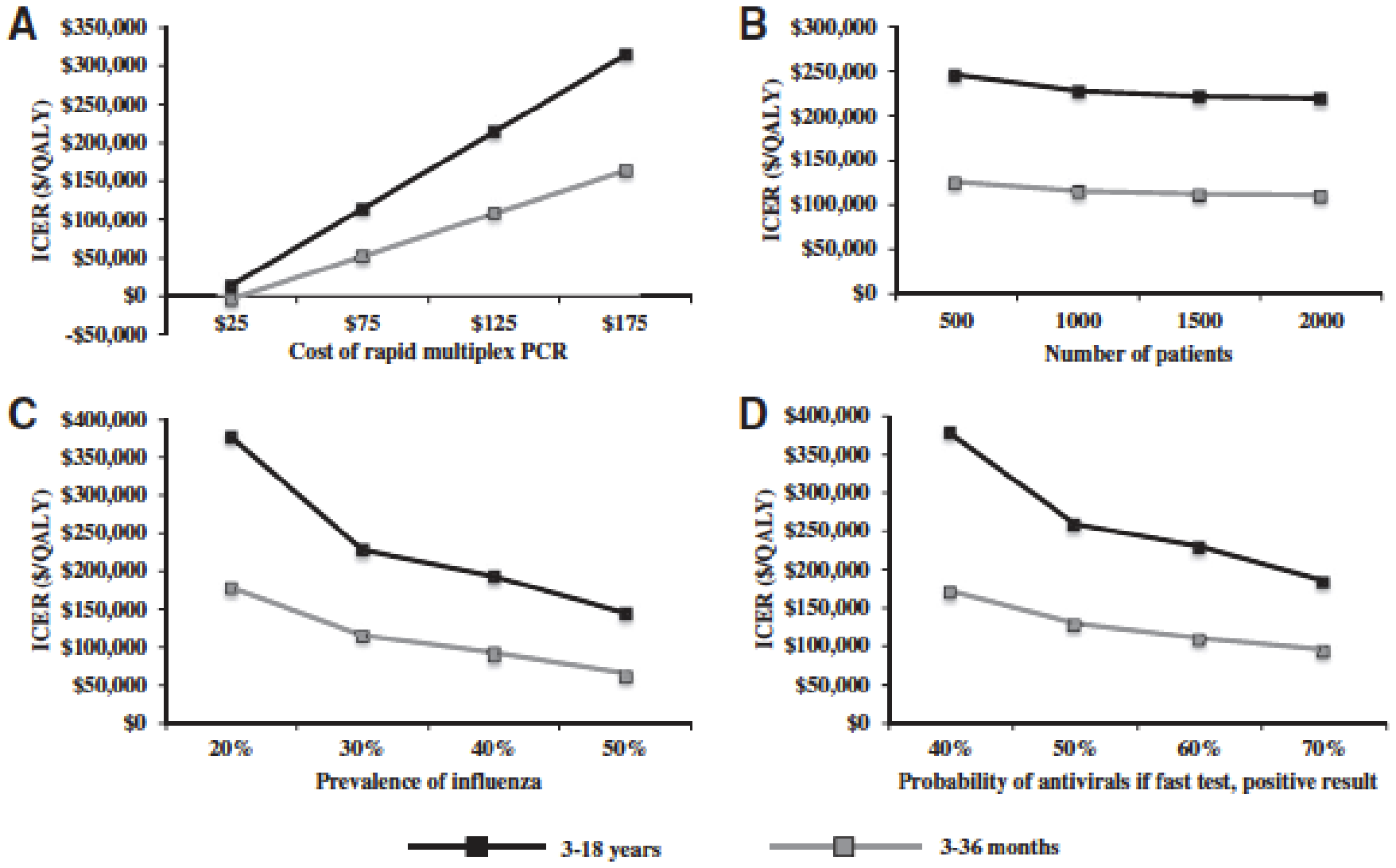


RESULTS

	3-36 months			3-18 years		
	Costs	**QALYs**	**ICER**	**Costs**	**QALYs**	**ICER**
Rapid flu (ref)	$273	28.7918	-	$118	28.7956	-
DFA	$299	28.7910	Dominated	$163	28.7952	Dominated
Traditional PCR	$344	28.7910	Dominated	$208	28.7952	Dominated
Rapid multiplex PCR	$377	28.7927	$115,556	$232	28.7961	$228,000

RESULTS




A
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
-$50,000
ICER ($/QALY)
$25
$75
$125
$175
Cost of rapid multiplex PCR
B
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
ICER ($/QALY)
500
1000
1500
2000
Number of patients
C
$400,000
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
ICER ($/QALY)
20%
30%
40%
50%
Prevalence of influenza
D
$400,000
$350,000
$300,000
$250,000
$200,000
$150,000
$100,000
$50,000
$0
ICER ($/QALY)
40%
50%
60%
70%
Probability of antivirals if fast test, positive result
3-18 years
3-36 months

CHALLENGES

- Finding evidence of the value of knowledge from rapid test
  - Local data
    - A number of obstacles
  - Published literature

HELPFUL STUDIES

PEDIATRICS®

OFFICIAL JOURNAL OF THE AMERICAN ACADEMY OF PEDIATRICS

Impact of the Rapid Diagnosis of Influenza on Physician Decision-Making and Patient Management in the Pediatric Emergency Department: Results of a Randomized, Prospective, Controlled Trial

Aleta B. Bonner, Kathy W. Monroe, Lynya I. Talley, Ann E. Klasner and David W. Kimberlin

Pediatrics 2003;112;363-367

HELPFUL STUDIES

TABLE 2. Tests Performed, Associated Charges, Prescriptions, and Time to Discharge for All Participants

	MD Aware FluOIA-Positive (N = 96)	MD Unaware FluOIA-Positive (N = 106)	P Value	MD Aware FluOIA-Negative (N = 97)	MD Unaware FluOIA-Negative (N = 92)	P Value
Complete blood count	0	13	<.001	13	7	.196
Blood culture	0	11	<.001	12	6	.172
Urine dipstick	4	7	.543	7	7	.918
Urinalysis	2	12	.011	10	8	.706
Urine culture	3	14	.011	12	5	.096
Cerebrospinal fluid studies/culture	0	2	.499	3	2	.695
Chest radiograph	7	26	.001	22	23	.708
Mean charge/patient (laboratory and radiograph)	$15.65	$92.37	<.001	$93.07	$68.91	.871
Antibiotic prescriptions	7	26	<.001	27	27	.818
Antiviral prescriptions	18	7	.02	0	2	.236
Mean time in minutes: (from patient examined by attending to discharge)	25	49	<.001	45	42	.549

HELPFUL STUDIES

JOURNAL OF THE
Pediatric Infectious Diseases Society

A National Study of the Impact of Rapid Influenza Testing on Clinical Care in the Emergency Department

Anne J. Blaschke,[1] Daniel J. Shapiro,[2,3] Andrew T. Pavia,[1] Carrie L. Byington,[1] Krow Ampofo,[1] Chris Stockmann,[1,4] and Adam L. Hersh[1]

[1]Division of Pediatric Infectious Diseases, Department of Pediatrics, University of Utah School of Medicine, Salt Lake City; [2]Department of Pediatrics and [3]Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco; and [4]Department of Pharmacology and Toxicology, University of Utah College of Pharmacy, Salt Lake City

HELPFUL STUDIES

Table 3 Clinical Care Associated With Influenza Diagnosis and Use of RIDT

Patient Group	Weighted Proportion of Visits in Which Ancillary Testing Was Performed[a]	Rate Difference (95% CI) Compared with Group 1	*P* Value
RIDT performed/ Influenza diagnosis (RIDT + /INF+)	45%	Reference	NA
RIDT not performed/ influenza diagnosis (RIDT – /INF+)	53%	8% (–8%, 24%)	.33
RIDT performed/no influenza diagnosis (RIDT + /INF–)	60%	15% (0%, 30%)	.04

Abbreviations: ARTI, acute respiratory tract infection; CI, confidence interval; NA, not applicable; RIDT, rapid influenza diagnostic tests.
[a]Ancillary testing includes blood culture, complete blood count, urinalysis, and chest x-ray.
[b]Antibiotics include penicillins, cephalosporins, macrolides, quinolones, lyncomycin derivatives, tetracyclines, sulfonamides, aminoglycosides, and carbapenems.
[c]Antivirals included oseltamivir, zanamivir, amantadine, and rimantadine.
[d]Estimates are based on fewer than 30 observations and may not be reliable.

HELPFUL STUDIES

Table 3 Clinical Care Associated With Influenza Diagnosis and Use of RIDT

	Frequency of Ancillary Testing and Medication Use					
Patient Group	Weighted Proportion of Visits in Which Ancillary Testing Was Performed[a]	Rate Difference (95% CI) Compared with Group 1	*P* Value	Weighted Proportion of Visits in Which Antibiotic(s) Were Prescribed[b]	Rate Difference (95% CI) Compared with Group 1	*P* Value
RIDT performed/ Influenza diagnosis (RIDT + /INF+)	45%	Reference	NA	11%[d]	Reference	NA
RIDT not performed/ influenza diagnosis (RIDT – /INF+)	53%	8% (–8%, 24%)	.33	23%	12% (0%, 23%)	.05
RIDT performed/no influenza diagnosis (RIDT + /INF–)	60%	15% (0%, 30%)	.04	47%	36% (25%, 46%)	<.0001

Abbreviations: ARTI, acute respiratory tract infection; CI, confidence interval; NA, not applicable; RIDT, rapid influenza diagnostic tests.
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HELPFUL STUDIES

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RIDT performed/ Influenza diagnosis (RIDT + /INF+)	45%	Reference	NA	11%[d]	Reference	NA	56%	Reference	NA
RIDT not performed/ influenza diagnosis (RIDT – /INF+)	53%	8% (–8%, 24%)	.33	23%	12% (0%, 23%)	.05	19%	–37% (–52%, –22%)	.002
RIDT performed/no influenza diagnosis (RIDT + /INF–)	60%	15% (0%, 30%)	.04	47%	36% (25%, 46%)	<.0001	2%[d]	–54% (–68%, –40%)	<.0001

Abbreviations: ARTI, acute respiratory tract infection; CI, confidence interval; NA, not applicable; RIDT, rapid influenza diagnostic tests.
[a]Ancillary testing includes blood culture, complete blood count, urinalysis, and chest x-ray.
[b]Antibiotics include penicillins, cephalosporins, macrolides, quinolones, lyncomycin derivatives, tetracyclines, sulfonamides, aminoglycosides, and carbapenems.
[c]Antivirals included oseltamivir, zanamivir, amantadine, and rimantadine.
[d]Estimates are based on fewer than 30 observations and may not be reliable.

CHALLENGES

- Incorporating other pathogens
  - Even less evidence of how providers use this information for pathogens other than influenza
  - Also, not clear what the right thing to do would be

JAMA | Special Communication

Recommendations for Conduct, Methodological Practices, and Reporting of Cost-effectiveness Analyses

Second Panel on Cost-Effectiveness in Health and Medicine

Gillian D. Sanders, PhD; Peter J. Neumann, ScD; Anirban Basu, PhD; Dan W. Brock, PhD; David Feeny, PhD; Murray Krahn, MD, MSc; Karen M. Kuntz, ScD; David O. Meltzer, MD, PhD; Douglas K. Owens, MD, MS; Lisa A. Prosser, PhD; Joshua A. Salomon, PhD; Mark J. Sculpher, PhD; Thomas A. Trikalinos, MD; Louise B. Russell, PhD; Joanna E. Siegel, ScD; Theodore G. Ganiats, MD

REPORTING

- Increased emphasis on transparency
  - Enough detail to allow for replication
    - Structured abstract
    - Reporting checklist
    - Impact inventory
    - Intermediate outcomes
    - Disaggregated results
    - Technical appendix

Basu et al *Med Decis Making* (2015)

RESOURCES

- ISPOR-SMDM Best Practices Publications
- Tufts CEA registry
- 2nd Panel of CEA book
- VA Health Economics Resource Center CEA course
- Talk to your friendly health economist and/or mathematical modeler

QUESTIONS?

HEALTH OUTCOMES STUDY

- Observational data
  - EMR
  - Claims data
- Outcomes
  - Mortality
  - Cost
  - Clinical effectiveness of treatment

HEALTH OUTCOMES STUDIES IN CLINICAL MICROBIOLOGY

- "Does there exist objective evidence that new technologies in clinical microbiology … actually contribute positively to the care of patients with infection?"
- The ultimate measure of how successful a new technology is:
  - The effect on patient outcomes

Doern (2014) *J Clin Micro*, TeKippe (2017) *J Clin Micro*

HEALTH OUTCOMES STUDIES IN CLINICAL MICROBIOLOGY

- Decrease in turnaround time for pathogen identification leads to
  - Earlier optimal antimicrobial treatment?
  - Shorter hospital and ICU LOS?
  - Improved patient outcomes?
  - Lower overall hospital costs?

Doern (2014) *J Clin Micro*, TeKippe (2017) *J Clin Micro*