EACS HIV Summer School 2018

Modelling and Health Economics

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Conflict of Interests

No conflict of interests to declare.

Outline

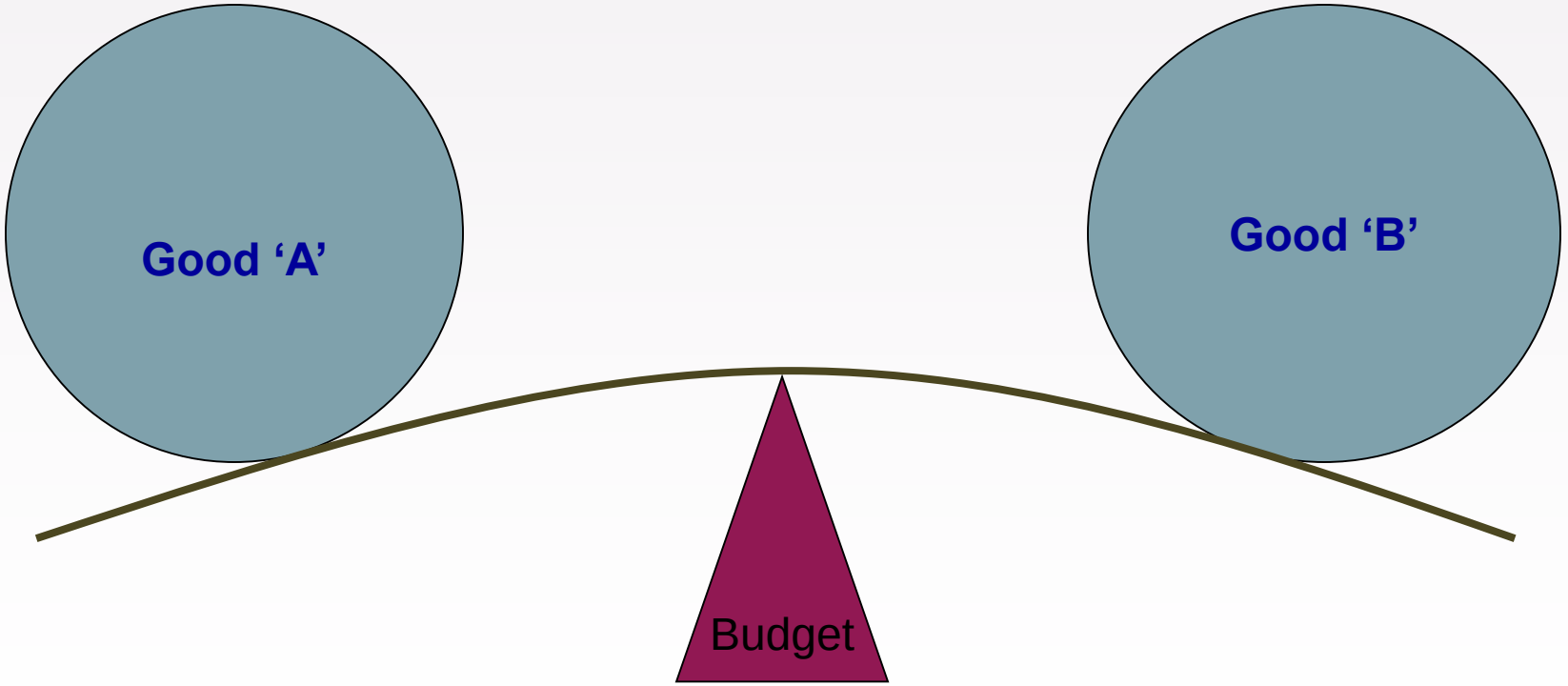
- What is (health) economics?
- Types of decisions economic evaluations (EE) inform
- why are EE performed?
- why modelling is needed in most EE?
- Example

What is (health) economics?

Economics is about

- Limited resources
- Unlimited “wants”
- ***Choosing*** between which ‘wants’ we can ‘afford’ given our resource ‘budget’

Economics is about choice



Personal choice

For lunch I could have a…

Whopper meal deal (small)

Tall latte and Chocolate Cherry Muffin (to go)

Roasted falafel & spinach wrap and cracked pepper crisps

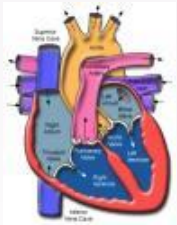
Nicaragua filter coffee and chicken club sandwich

Government choice

National Health Service could fund one IVF (US$4,500/ €3,850/ £3,500) course or…

a. 1/3 of a cochlear implant

b. 1 heart bypass operation



c. 11 cataract removals

d. 150 MMR vaccinations

e. 1/1000 of a Challenger 2 tank

Economics is the study of…

*"…how society **manages** its **scarce resources**"* (Mankiw, 2001, p.4)

*"[Economics is the] social science that studies the **choices** that individuals, businesses, governments, and entire societies make as they cope with **scarcity**"* (Bade and Parkin, 2002, p.5)

"…economies, at both the level of individuals and of society as a whole" (Krugman and Wells, 2004, p.2)

*"…how human beings **coordinate** their wants and desires, given the **decision-making** mechanisms, social customs, and political **realities** of the society"* (Colander, 2006, p.4)

*"…human behavior, with a particular focus on human **decision making**"* (Gwartney, Stroup, Sobel, and MacPherson 2006, p.5)

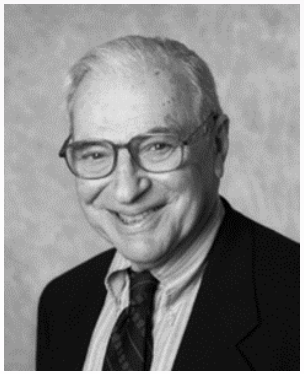
Economics

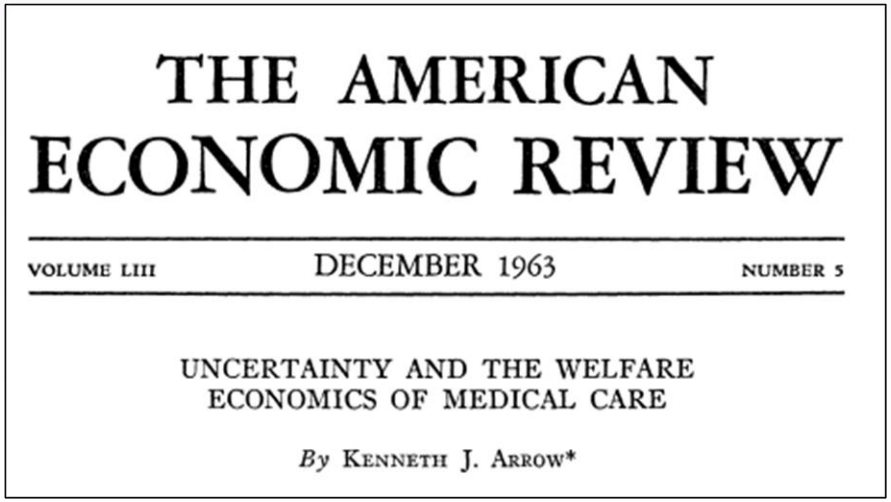
- NOT just practiced by economists
- NOT (necessarily) concerned with saving money
- Economics IS concerned with…
  - **Understanding choices**
  - Benefits
  - **Costs (resource use)**
  - Efficiency
    - ‘do the benefits outweigh the costs?’

What is Health Economics?

"Health economics is the application of economic theory, models and empirical techniques to the analysis of decision-making by individuals, health care providers and governments with respect to **health and health care***"*

(Morris, Devlin and Parkin, 2007)





THE AMERICAN ECONOMIC REVIEW

VOLUME LIII DECEMBER 1963 NUMBER 5

UNCERTAINTY AND THE WELFARE ECONOMICS OF MEDICAL CARE

By KENNETH J. ARROW*

What is an economic evaluation and what types of decision does it inform?

INDEPENDENT

Lifestyle › Health & Families › Health News

NHS accused of delaying access to 'highly tolerable' hepatitis C drugs over cost concerns

NHS England claimed Sofosbuvir's cost is prohibitive and not 'affordable'

Paul Gallagher | @PMGallagher1 | Tuesday 16 June 2015 | 0 comments

The NHS has been accused by leading health charities of attempting to "severely limit" the introduction of new drugs to treat hepatitis C because they are too expensive – despite the cost of them being cleared by officials.

The Telegraph

HOME » NEWS » HEALTH » HEALTH NEWS

Breast cancer drug is too expensive for the NHS: Nice

A breast cancer drug that can extend life by almost six months has been turned down for use on the NHS because it is too expensive.

1 0 0 1 Email

Acupuncture for low back pain no longer recommended for NHS patients

New advice represents a u-turn in treatment for back pain, which affects one in 10 people, after evidence review showed acupuncture no better than a placebo

THE TIMES

NHS fights obesity epidemic with fat super-camps

Sarah-Kate Templeton, Health Editor

July 31 2016, 12:01am, The Sunday Times

Matt Capehorn, an anti-obesity doctor, holds a 5lb lump of fat
PAUL TONGE

Obese patients will be sent to specialist centres that offer psychological counselling on "comfort" eating, medication to lose weight, fitness training,

What is an economic evaluation?

"The comparative analysis of alternative courses of action in terms of their costs and consequences"

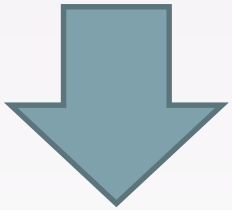
(Drummond et al 2005)

"Based on the common sense notion that a decision to do or not to do something should depend on weighing up the advantages (benefits) and disadvantages (costs)"

(Morris et al 2007)

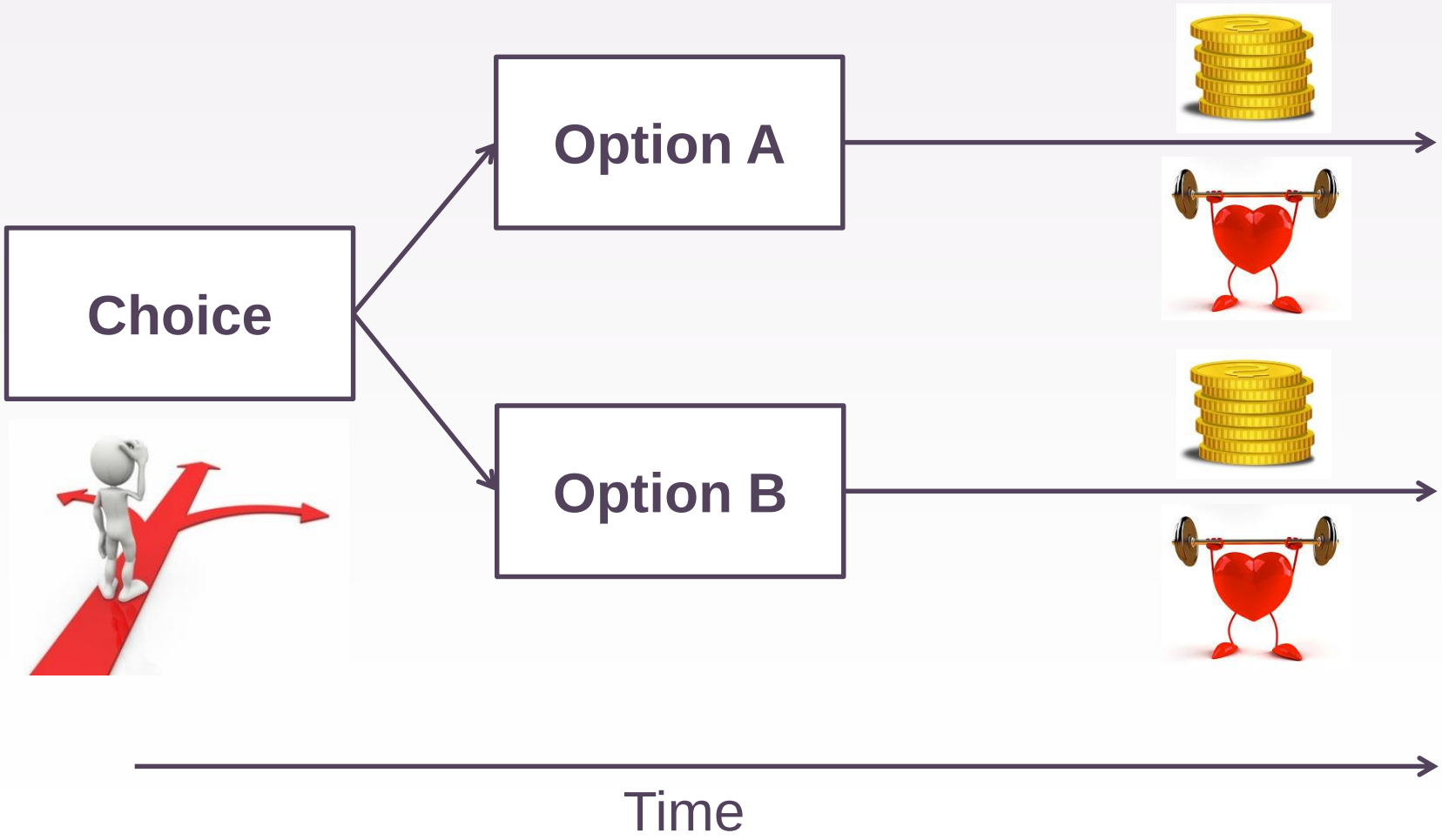
Economic evaluation

Purpose: To inform decisions



Key input: Evidence about the effects of alternative courses of action

Economic evaluation



Types of economic evaluation

Type of EE	Costs	Outcomes	Results
Cost minimization analysis (CMA)	Money	Identical	Least cost alternative
Cost effectiveness analysis (CEA)	Money	Single effect of interest common to both alternatives: Life years gained, deaths averted (natural units)	Cost per unit of consequence eg. cost per LY gained.
Cost utility analysis (CUA)	Money	Single or multiple effects not necessarily common. Valued as “utility” eg. QALY	Cost per unit of consequence eg. cost per QALY.
Cost benefit analysis (CBA)	Money	valued in money (also can include non-health aspects)	Net £ cost: benefit ratio

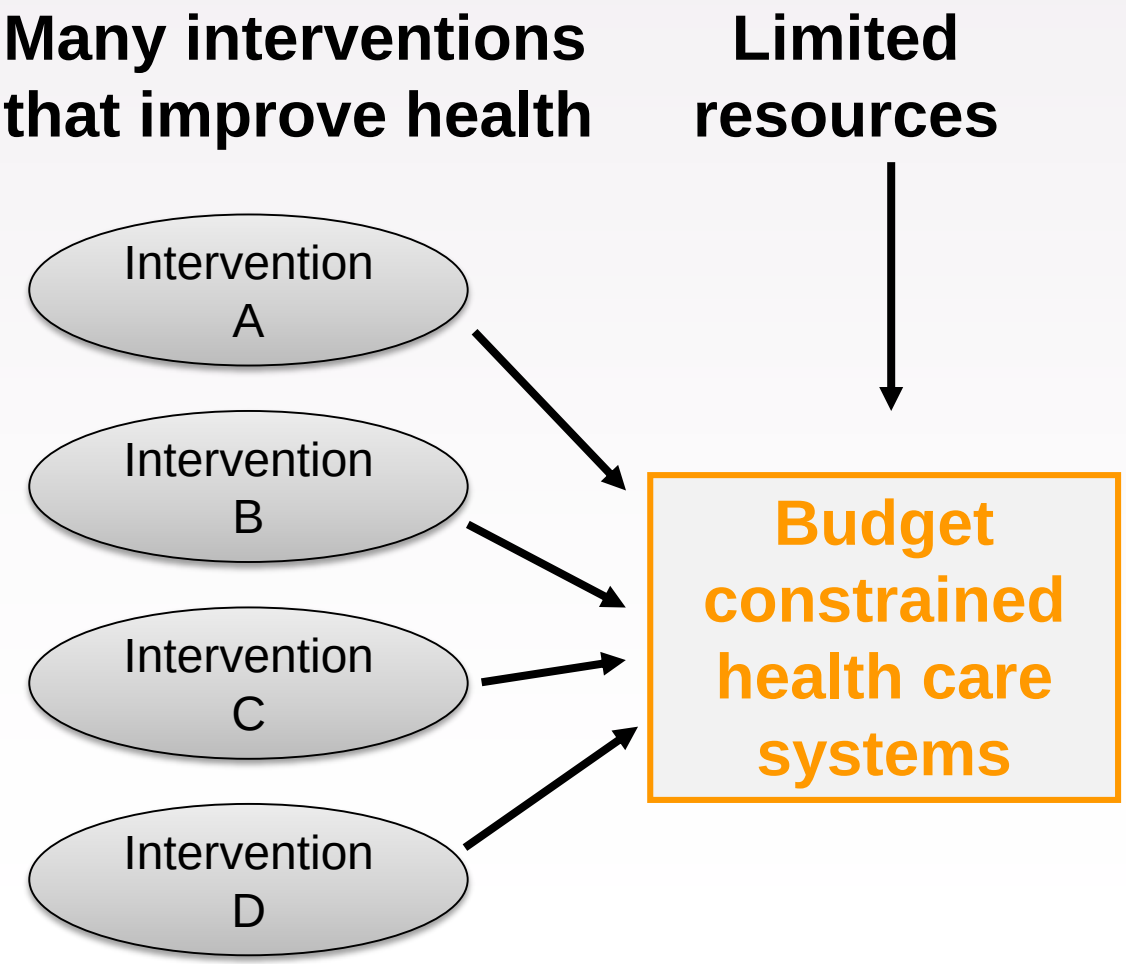
Why are economic evaluation performed?

Cost-utility and cost-effectiveness analyses

Limited resources

Budget constrained health care systems

Cost-utility and cost-effectiveness analyses

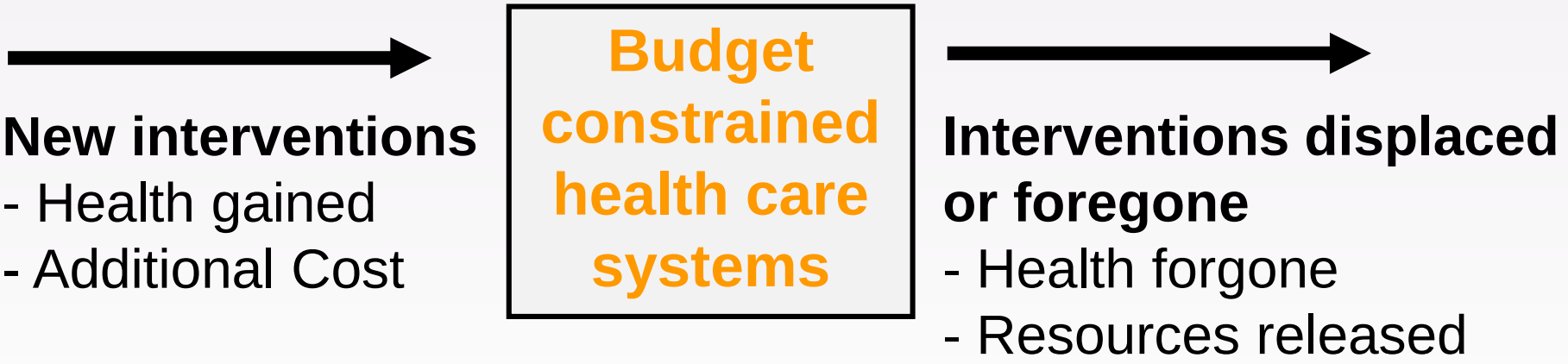


Cost-utility and cost-effectiveness analyses

New interventions
- Health gained
- Additional Cost

Budget constrained health care systems

Cost-utility and cost-effectiveness analyses



Cost-utility and cost-effectiveness analyses

Goal: maximize health of the population

Cost-utility and cost-effectiveness analyses

Goal: maximize health of the population

New interventions
- Health gained
- Additional Cost

Budget constrained health care systems

Interventions displaced or foregone
- Health forgone
- Resources released

"Is the new intervention cost-effective?

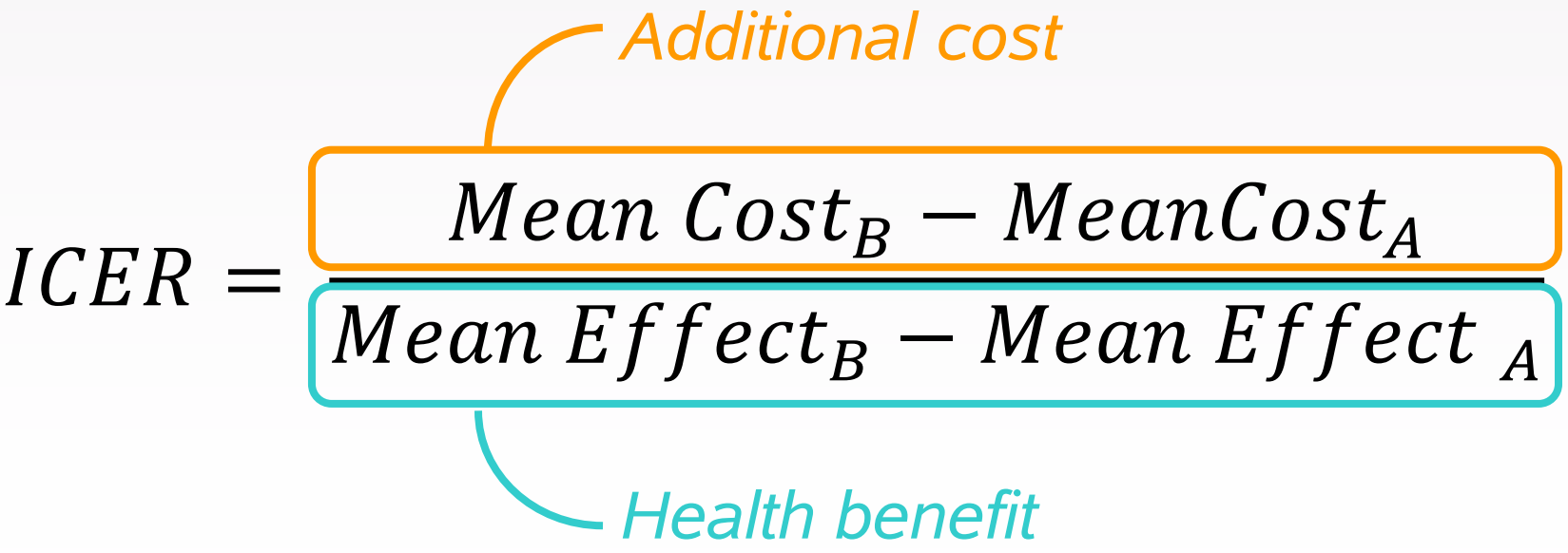
=

Is the health gain from the new intervention likely to be greater than the health foregone?

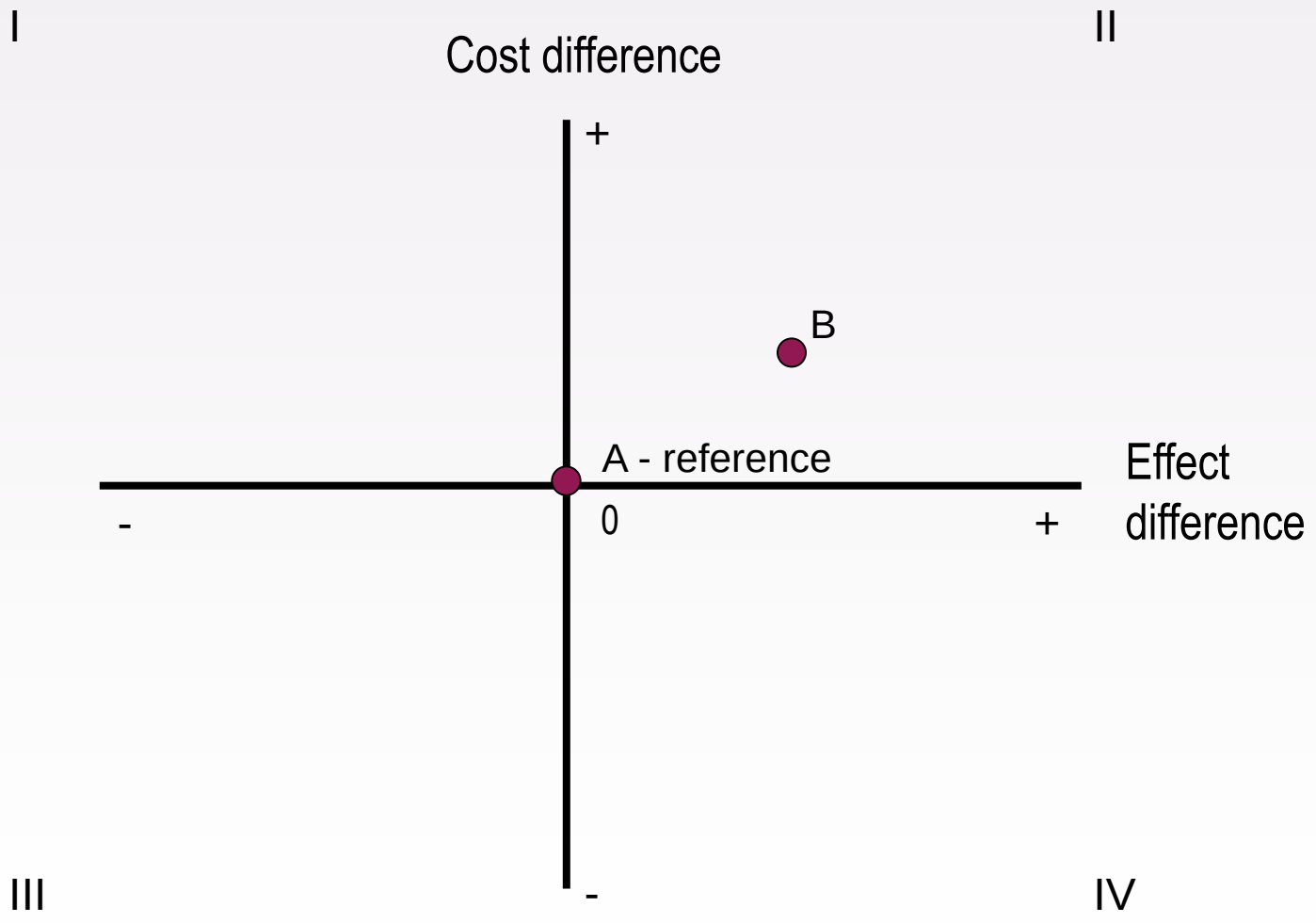
Incremental cost-effectiveness ratio (ICER)

It is they key (traditional) metrics when conducting an economic evaluation

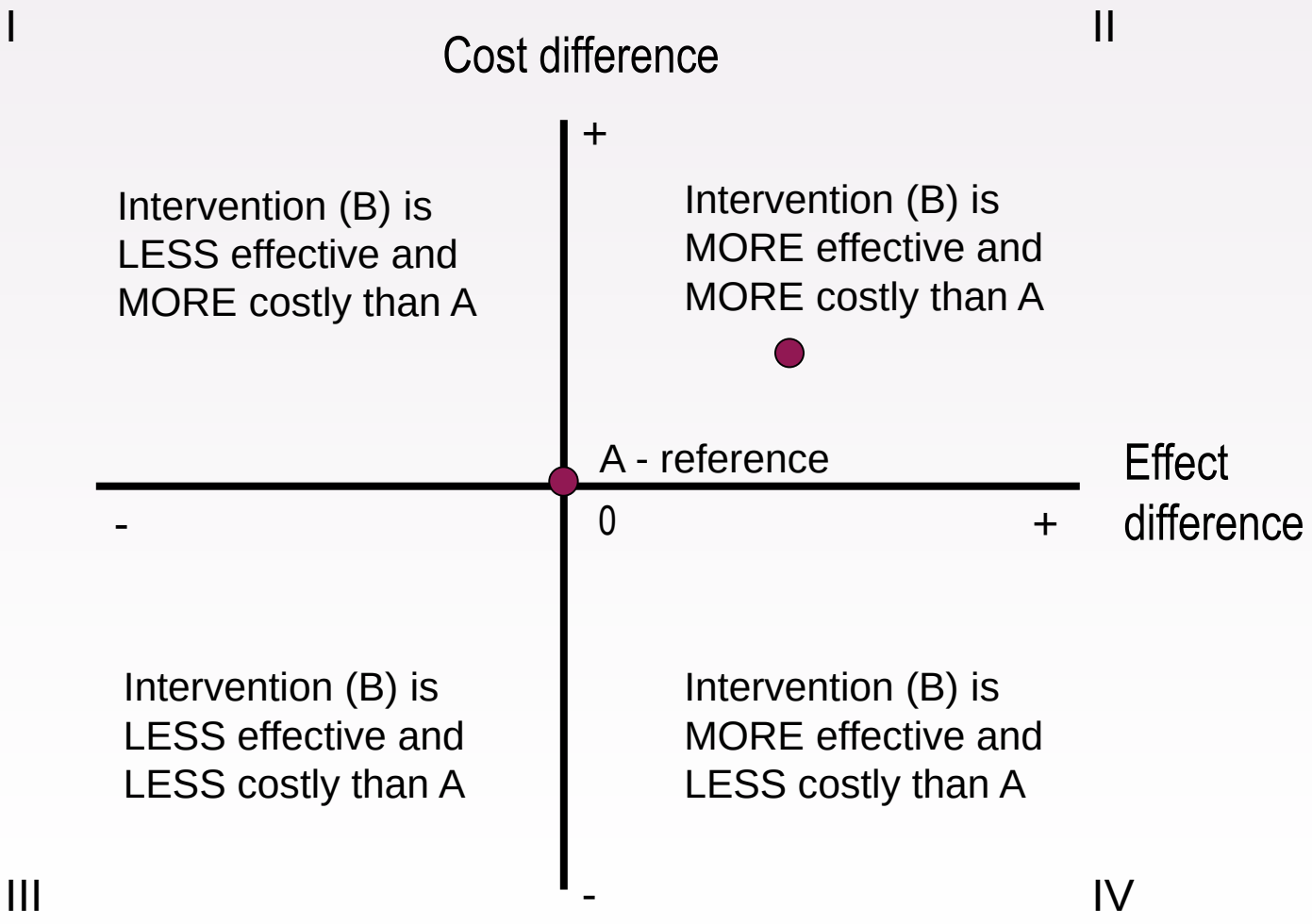
It compares costs and health outcomes over time



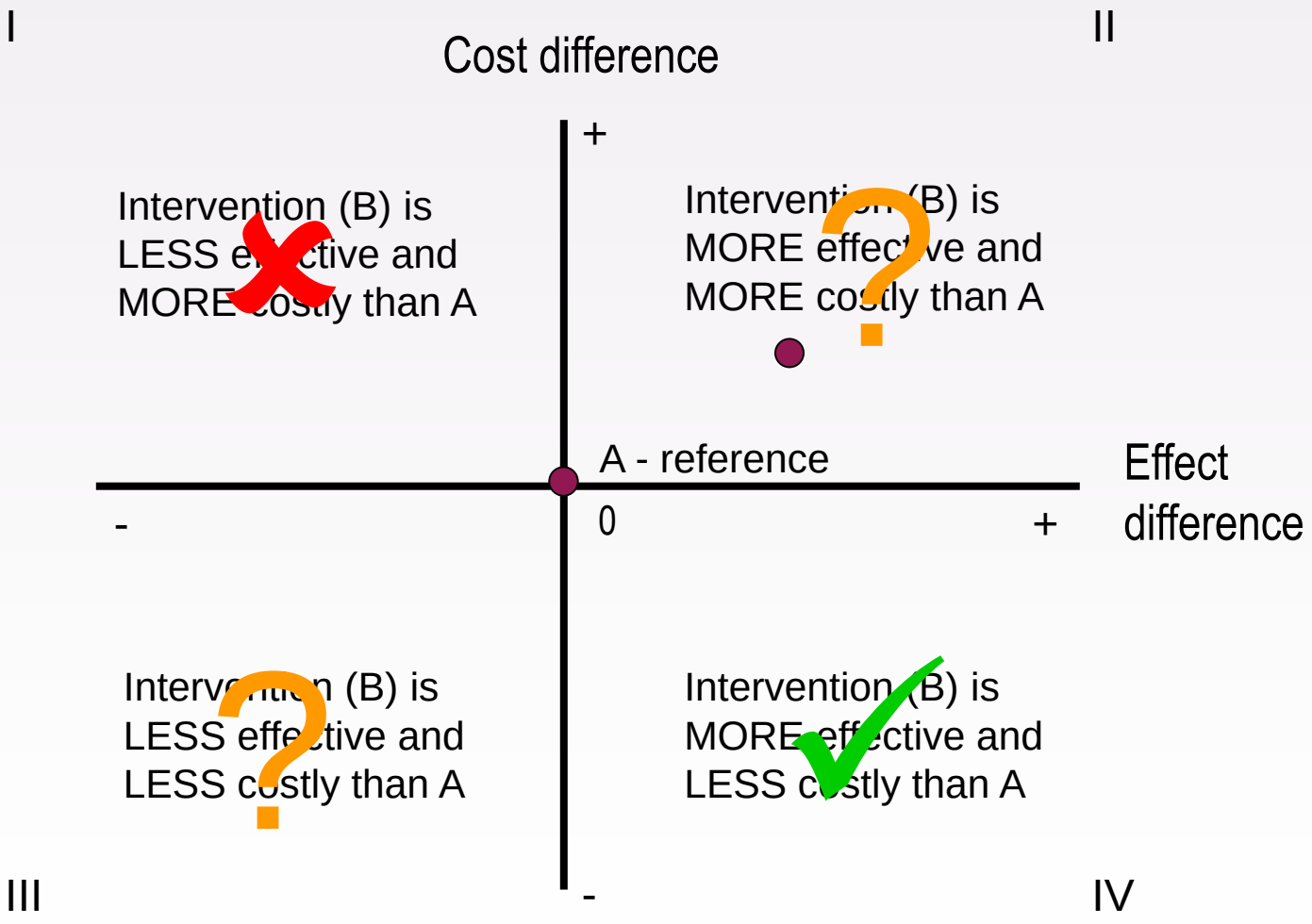
Cost-effectiveness plane



Cost-effectiveness plane



Cost-effectiveness plane



Comparison of the ICER(s) to a cost-effectiveness threshold

Greater than cost effectiveness threshold

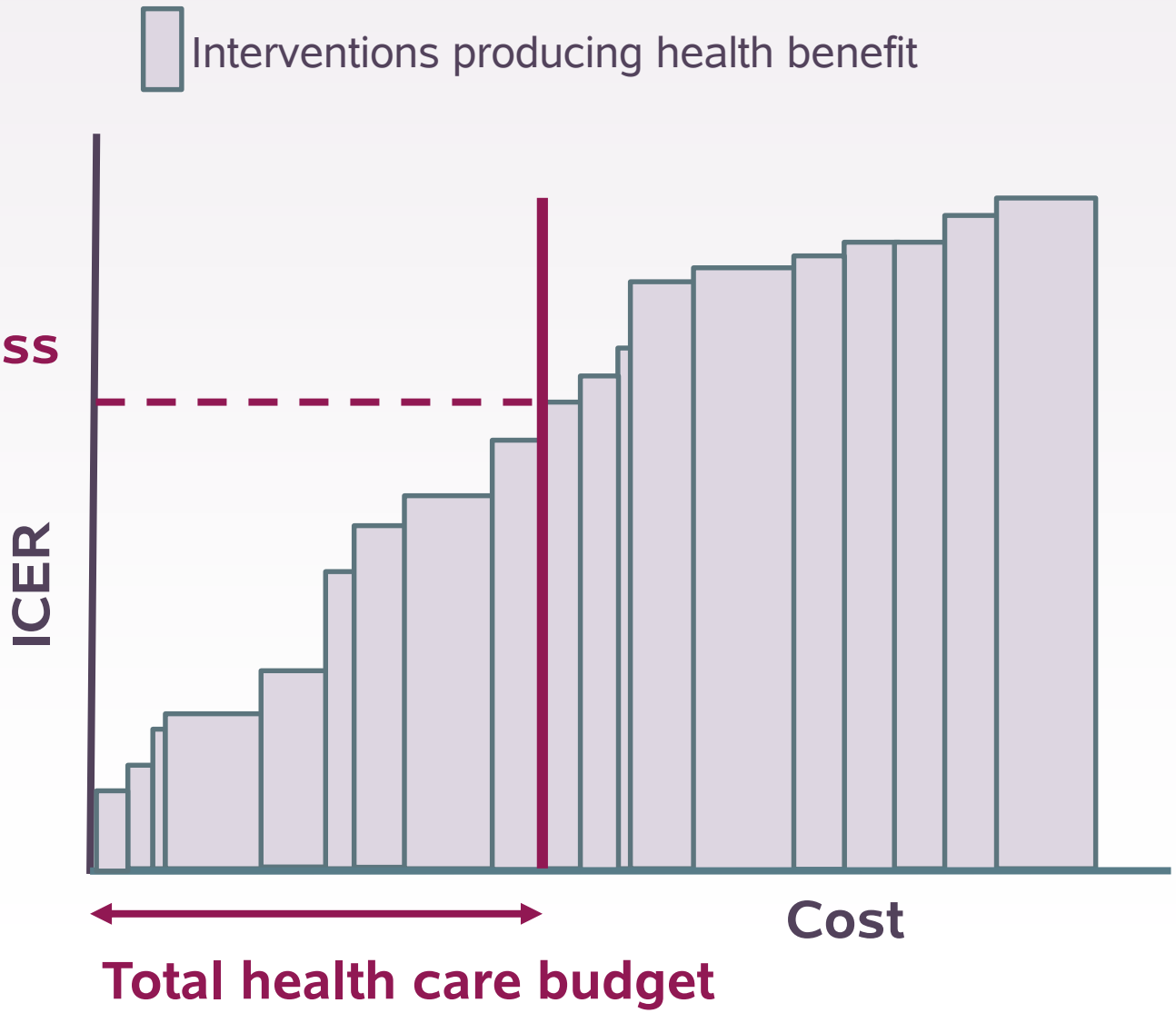
Not cost-effective

Cost-effectiveness threshold represents the **opportunity cost,** the value of the alternative that is foregone.
In the UK the threshold is around £20,000/QALY gained.

Less than cost effectiveness threshold

Cost-effective

Concept of cost-effectiveness threshold – ideal scenario



Width of bar indicates total cost of implementing the intervention in a country

Example

Example – PrEP among MSM in the UK

Cost-effectiveness of pre-exposure prophylaxis for HIV prevention in men who have sex with men in the UK: a modelling study and health economic evaluation

Valentina Cambiano, Alec Miners, David Dunn, Sheena McCormack, Koh Jun Ong, O Noel Gill, Anthony Nardone, Monica Desai, Nigel Field, Graham Hart, Valerie Delpech, Gus Cairns, Alison Rodger, Andrew N Phillips

Summary

Background In the UK, HIV incidence among men who have sex with men (MSM) has remained high for several years, despite widespread use of antiretroviral therapy and high rates of virological suppression. Pre-exposure prophylaxis (PrEP) has been shown to be highly effective in preventing further infections in MSM, but its cost-effectiveness is uncertain.

Methods In this modelling study and economic evaluation, we calibrated a dynamic, individual-based stochastic model, the HIV Synthesis Model, to multiple data sources (surveillance data provided by Public Health England and data from a large, nationally representative survey, Natsal-3) on HIV among MSM in the UK. We did a probabilistic sensitivity analysis (sampling 22 key parameters) along with a range of univariate sensitivity analyses to evaluate the introduction of a PrEP programme with sexual event-based use of emtricitabine and tenofovir for MSM who had condomless anal sexual intercourse in the previous 3 months, a negative HIV test at baseline, and a negative HIV test in the preceding year. The main model outcomes were the number of HIV infections, quality-adjusted life-years (QALYs), and costs.

Findings Introduction of such a PrEP programme, with around 4000 MSM initiated on PrEP by the end of the first year and almost 40 000 by the end of the 15th year, would result in a total cost saving (£1·0 billion discounted), avert 25% of HIV infections (42% of which would be directly because of PrEP), and lead to a gain of 40 000 discounted QALYs over an 80-year time horizon. This result was particularly sensitive to the time horizon chosen, the cost of antiretroviral drugs (for treatment and PrEP), and the underlying trend in condomless sex.

Interpretation This analysis suggests that the introduction of a PrEP programme for MSM in the UK is cost-effective and possibly cost-saving in the long term. A reduction in the cost of antiretroviral drugs (including the drugs used for PrEP) would substantially shorten the time for cost savings to be realised.

Funding National Institute for Health Research.

Lancet Infect Dis 2017

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Institute for Global Health (V Cambiano PhD, N Field PhD, A Rodger PhD, A N Phillips PhD) **and Faculty of Population Health Sciences** (G Hart PhD), **University College London, London, UK; Department of Health Services Research and Policy, London School of Hygiene & Tropical Medicine, London, UK** (A Miners PhD); **MRC Clinical Trials Unit at UCL, London, UK** (D Dunn PhD, S McCormack FRCP); **HIV and STI Department, Public Health England, London, UK** (K J Ong MSc, O N Gill FFPH, A Nardone PhD, M Desai MRCP, V Delpech PhD); **and NAM Publications, London, UK** (G Cairns MA)

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Introduction

Sex between men is the predominant mode of HIV transmission in Europe and other high-income settings.[1] In the UK, HIV incidence among men who have sex with

cost-effective from a health-system perspective (ie, the National Health Service [NHS] in the UK) and its budgetary impact. The aim of this study is to evaluate the cost-effectiveness of introducing event-based PrEP

Aim

To evaluate the **cost-effectiveness** of introducing a **PrEP** programme with **sexual event-based PrEP** among **MSM in the UK.**

In order to receive the intervention they needed to attend a genitourinary medicine clinics.

We took a health-care perspective (ie, the National Health Service [NHS] in the UK).

Scenarios/Options compared

PrEP is not available

Sexual event-based PrEP is introduced in April 2016 for MSM who present for a clinical risk assessment (i.e. GUM clinic) who:

- Have had CLAI in the previous 3 months (unless the only partner they had condomless sex with was a long-term partner virologically suppressed on ART);
- Are anticipated to have CLAI in the next 3 months [in the model they will use PrEP only if actually having CLAI]
- Have had a negative HIV test at PrEP initiation and an additional in the past year

PrEP programme is interrupted once HIV incidence is below 1/1000 person-years.

Why do we need a mathematical model?

- Think about what needs to be estimated?
- And why a clinical study (randomized controlled trial, RCT) type framework might be limited?
  - Mean costs and benefits of all relevant options
  - Over a relevant time horizon
  - Outcomes expressed in relevant units such as QALYs / DALYs
  - Using all relevant evidence (Other RCTs might already exist)
  - Others…….

Buxton et al. 1997 Health Economics 6(3):217-227

Combining modelling with cost data for CEA

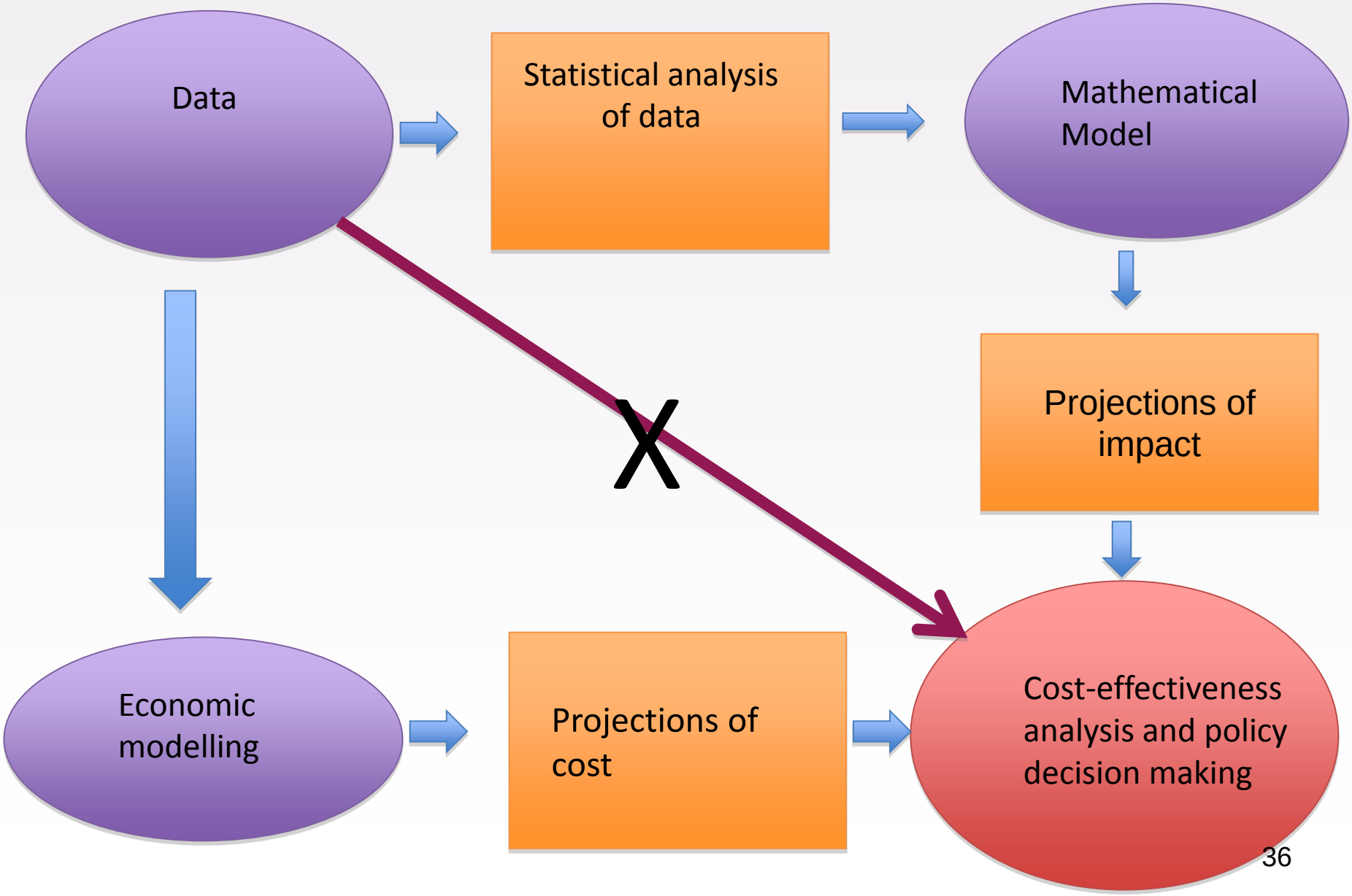
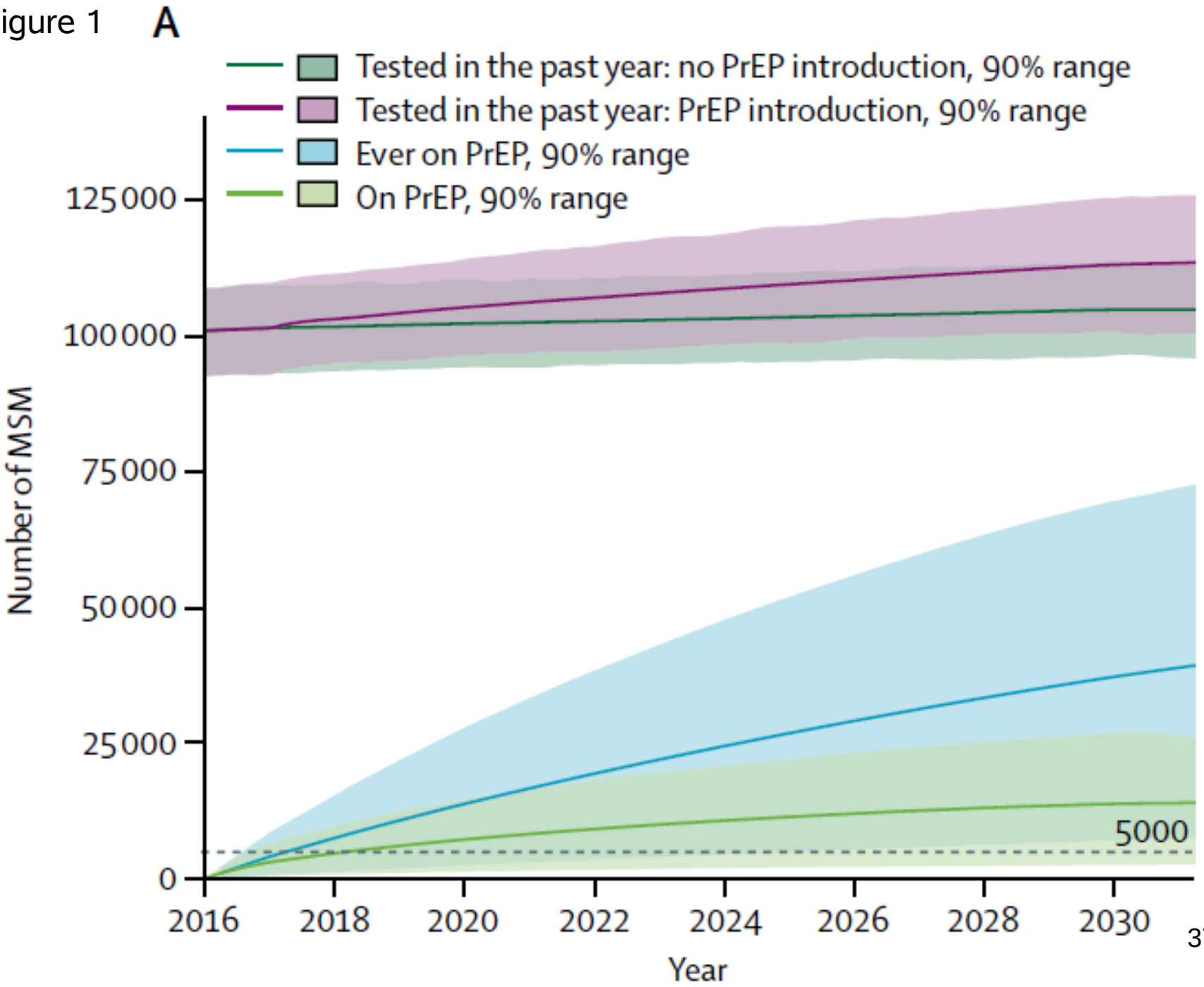


Figure 1


A
Tested in the past year: no PrEP introduction, 90% range
Tested in the past year: PrEP introduction, 90% range
Ever on PrEP, 90% range
On PrEP, 90% range
125 000
100 000
75 000
50 000
25 000
0
Number of MSM
5000
2016
2018
2020
2022
2024
2026
2028
2030
Year

	No PrEP	PrEP introduction
Cumulative mean number of HIV infections	178 900 (81 100 to 323 300)	134 600 (61 700 to 264 300)
Number of HIV infections averted	..	44 300 (3300 to 97 600)
Proportion of HIV infections averted (%)	..	25%
QALYs (in 1000s)*	55 590 (55 030 to 55 990)	55 810 (55 290 to 56 120)
QALYs gained (in 1000s)*	..	220 (20 to 430)
Discounted† QALYs (in 1000s)*	18 410 (18 330 to 18 490)	18 450 (18 360 to 18 510)
Discounted† QALYs* gained (in 1000s)	..	40 (4 to 70)

Mean (90% range) data shown; range across means of simulations with the same combination of probabilistic sensitivity analysis parameter tertiles. MSM=men who have sex with men. PrEP=pre-exposure prophylaxis. QALYs=quality adjusted life-years. *In all MSM (HIV-positive and HIV-negative). †Discounted at 3·5% per year. ‡Considering a cost-effectiveness threshold of £13 000 per QALY gained.

***Table*: Epidemiological impact on HIV infections, QALYs, and cost among MSM in the UK over an 80-year time horizon (2016–96)**

Overall cost of ART and on PrEP

1 year **on ART** (CD4>200 cells/mm^3):

£6,288 ART (FOI request)
£4,063 Healthcare
£ 164 (£41x4) CD4 measurements
£ 276 (£69x4) VL measurements
[£ 238 resistance test at ART initiation]

~£10,800

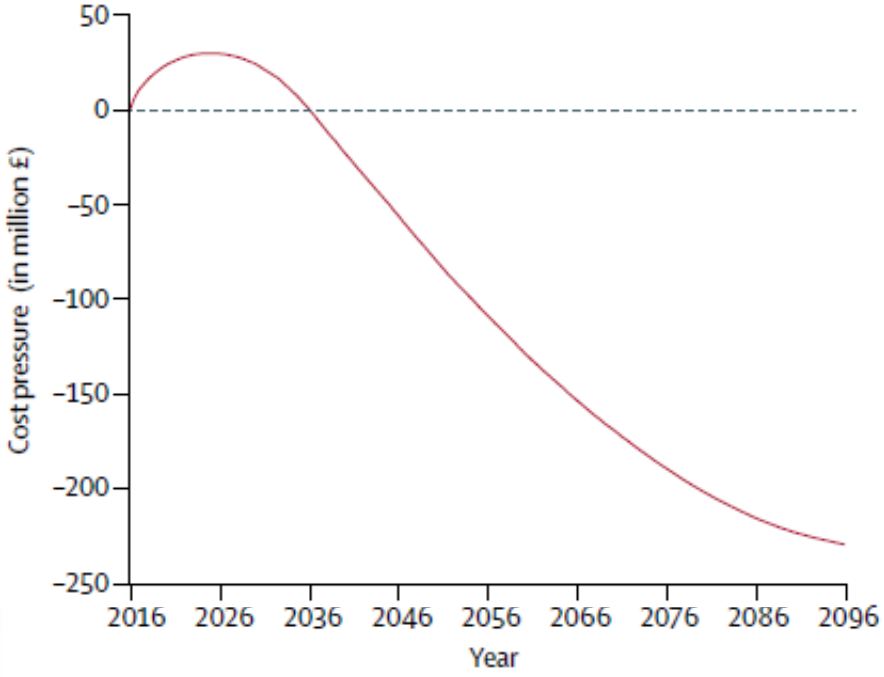
1 year **on PrEP** (following the first year):

£4,331 Truvada (BNF 2015)
£ 156 (£39x4) HIV tests
£ 94 Additional cost of monitoring people on PrEP compared to people at similar risk not on PrEP

~£4,600

Difference in budget impact

Current cost of ARVS for treatment and PrEP



Cost of ARVS for treatment and PrEP reduced by 50%

	No PrEP	PrEP introduction
Cumulative mean number of HIV infections	178 900 (81 100 to 323 300)	134 600 (61 700 to 264 300)
Number of HIV infections averted	..	44 300 (3300 to 97 600)
Proportion of HIV infections averted (%)	..	25%
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Discounted† QALYs (in 1000s)*	18 410 (18 330 to 18 490)	18 450 (18 360 to 18 510)
Discounted† QALYs* gained (in 1000s)	..	40 (4 to 70)
Cost (in million £)*	64 460 (24 070 to 141 890)	56 440 (23 910 to 126 050)
Discounted† cost* (in million £)	20 640 (11 080 to 36 220)	19 630 (11 390 to 33 690)
Difference in discounted† cost* (in million £)	..	−1000 (−4900 to 1230)
Net monetary benefit‡ (in million £)	..	1490 (−1360 to 6580)

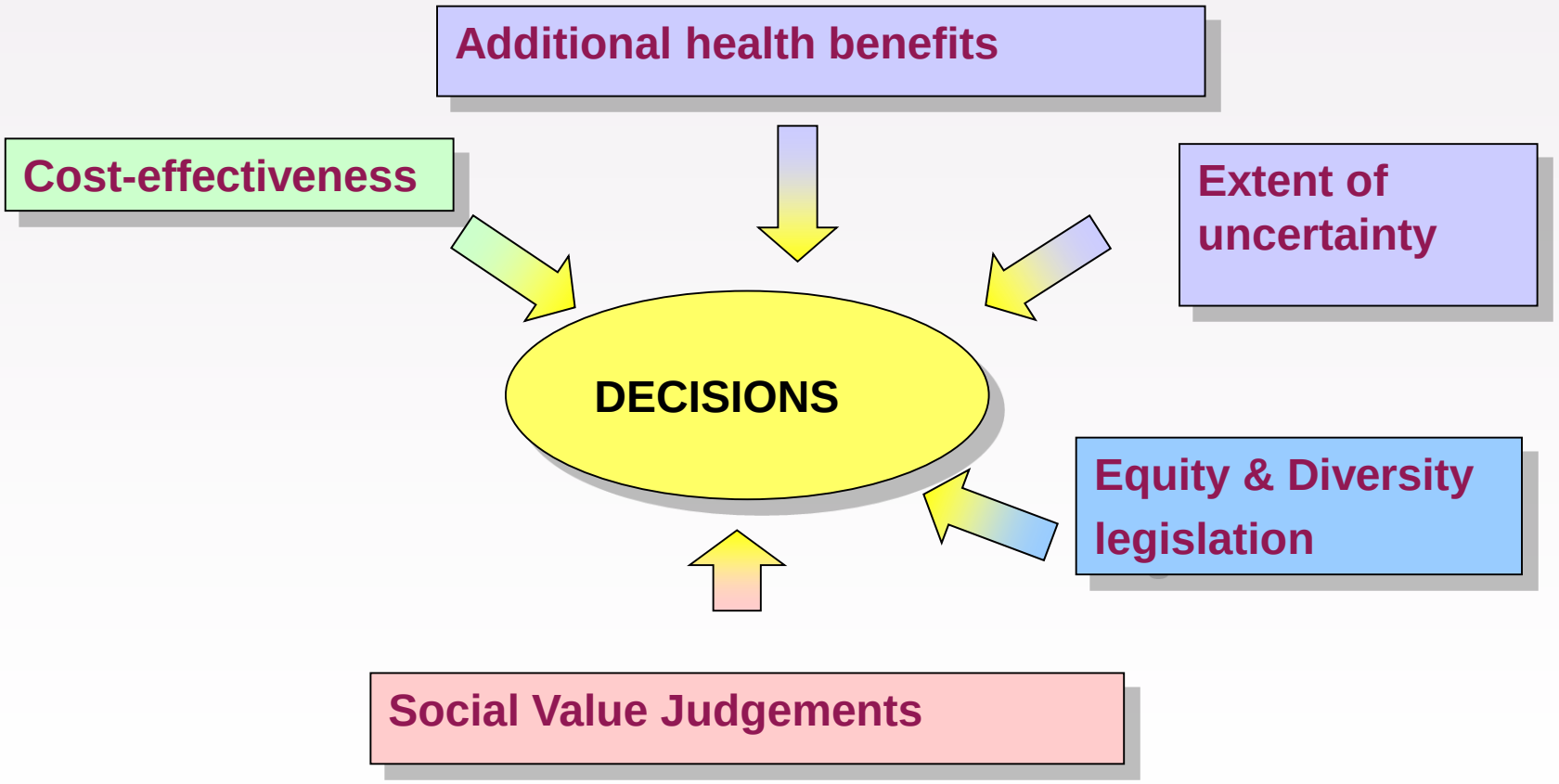
Mean (90% range) data shown; range across means of simulations with the same combination of probabilistic sensitivity analysis parameter tertiles. MSM=men who have sex with men. PrEP=pre-exposure prophylaxis. QALYs=quality adjusted life-years. *In all MSM (HIV-positive and HIV-negative). †Discounted at 3·5% per year. ‡Considering a cost-effectiveness threshold of £13 000 per QALY gained.

***Table*: Epidemiological impact on HIV infections, QALYs, and cost among MSM in the UK over an 80-year time horizon (2016–96)**

Example conclusions

- the introduction of event-based PrEP among MSM in the UK with the eligibility criteria proposed is cost-saving and leads to health benefits, caused by a substantial reduction in HIV incidence among MSM.
- Our results are robust to substantial variations in the main assumptions.
- However, there are increases in budget for the first 20 years in our main results and it takes 40 years for the incremental cost-effectiveness ratio to reach less than £13 000 per QALY gained.

What Factors Are Taken Into Account when making a decision?



PrEP Impact Trial

A pragmatic health technology assessment of PrEP and implementation

Home | The PrEP Impact Trial | FAQs | Join the Trial | Contact

ABOUT THE PrEP IMPACT TRIAL

We know from previous studies that PrEP can effectively reduce the risk of HIV infection. Several countries have implemented PrEP programmes to provide the drug to individuals at high risk of HIV. To plan a PrEP programme in England, NHS England and Local Authorities need to know how many people need PrEP, how many will want to take it and for how long. In order to find this out, we are conducting this research. This study does not involve a placebo, so everyone who is enrolled in the trial will have access to PrEP.

The PrEP Impact trial will answer three important questions:

1. How many people attending sexual health clinics need PrEP?

2. How many of these start PrEP?

3. How long do they need PrEP for?

10,000 people will be recruited to the trial over three years. HIV negative people attending sexual health clinics in England will have their risk of acquiring HIV checked by the clinic staff. If the clinic staff consider an individual meet the eligibility criteria for the

Participant Information Sheet

For further information about what is involved in taking part in the trial please read the current version of the participant information sheet. If you choose to participate you will need to read this information

Thank you

Questions?