Assessing the Cost-Effectiveness of Diabetes Interventions

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Why Perform Cost-Effectiveness Analyses?

- Resources are limited
- Choices must be made
- Choices should consider costs and outcomes

Value for Money

- **How is cost-effectiveness assessed?**
- **What is the cost-effectiveness of diabetes prevention?**

How is cost-effectiveness assessed?

Essential Elements of Economic Analyses of Health-Care Programs

- Type of analysis
- Perspective
- Type and definition of costs
- Description and valuation of outcomes
- Choice of comparator
- Modeling
- Discounting
- Sensitivity analyses

Types of Economic Analyses

- Descriptive cost analysis
- Cost-benefit
- Cost-effectiveness
- Cost-utility

Perspective of Economic Analyses

- Payer
- Society

Type of Costs

- Direct medical
- Direct nonmedical
- Indirect

Direct and Indirect Costs of Diabetes, United States, 2017

Total Costs
$327 billion

Direct Costs
$237 billion

- Diabetes
- Diabetes complications
- Excess medical costs due to diabetes

Indirect Costs
$90 billion

- Illness
- Disability
- Premature mortality

ADA. Diabetes Care 41:917-928, 2018

Definition of Direct Medical Costs

- Cost of intervention
- Cost of side-effects of intervention
- Cost of outcomes
- Costs of non-intervention related medical care

Description and Valuation of Outcomes

- Beneficial outcomes produced
- Adverse outcomes averted

Outcomes

- Clinical
- Years of life
- Quality-adjusted life-years

QALY

Quality-Adjusted Life-Year

adjusts length of life for quality of life

Quality-Adjusted Life-Year

time in health state **x** **quality of life in health state**

where quality of life = health utility

1.0 = excellent health

0 = death

Calculation of QALYs

20 years of life/excellent health

20 x 1.0 = 20 QALYs

20 years of life/10 excellent health

10 with blindness

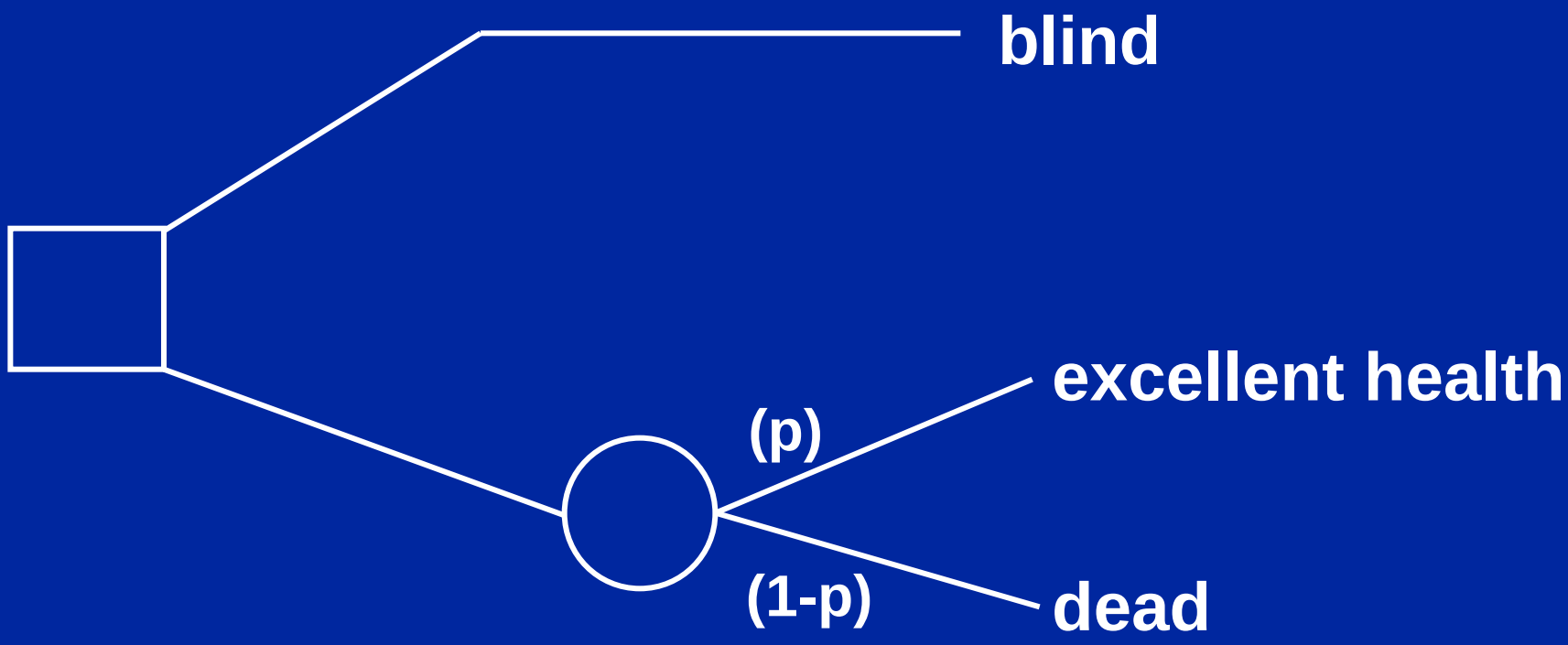
(10 x 1.0) + (10 x 0.51) = 15.1 QALYs

Approaches to Measuring Health Utilities

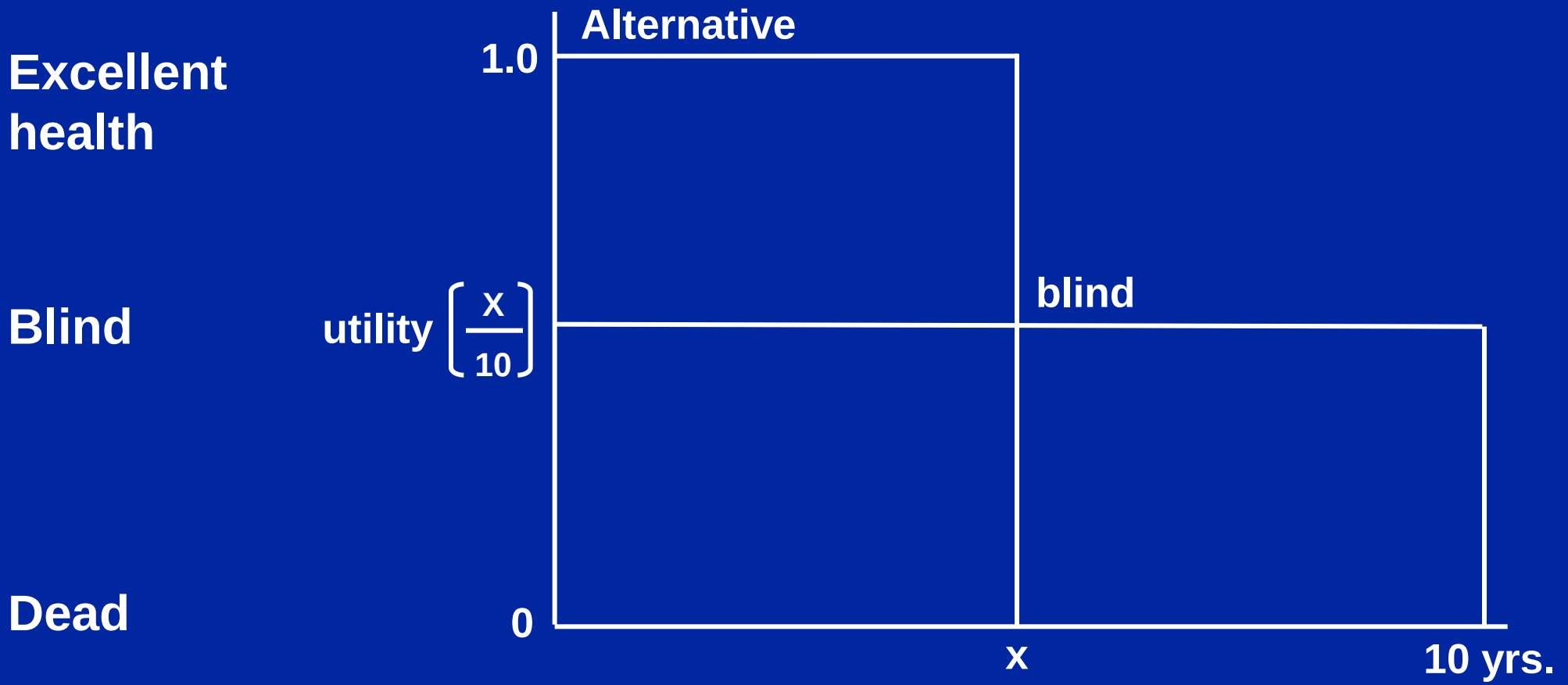
- Standard gamble
- Time trade-off
- Multiattribute utility models
- Rating scales

Standard Gamble

Choice between less desirable (but certain) health state and a gamble offering a certain probability between excellent health and death.



Time Trade-Off



Multiattribute Utility Models

- EuroQol (EQ-5D)
- Health Utilities Index (HUI)
- Quality of Well-Being Index (QWB)

Under each heading, please check the ONE box that best describes your health TODAY

MOBILITY

- I have no problems walking ❑
- I have slight problems walking ❑
- I have moderate problems walking ❑
- I have severe problems walking ❑
- I am unable to walk ❑

SELF-CARE

- I have no problems washing or dressing myself ❑
- I have slight problems washing or dressing myself ❑
- I have moderate problems washing or dressing myself ❑
- I have severe problems washing or dressing myself ❑
- I am unable to wash or dress myself ❑

USUAL ACTIVITIES *(e.g. work, study, housework, family or leisure activities)*

- I have no problems doing my usual activities ❑
- I have slight problems doing my usual activities ❑
- I have moderate problems doing my usual activities ❑
- I have severe problems doing my usual activities ❑
- I am unable to do my usual activities ❑

PAIN / DISCOMFORT

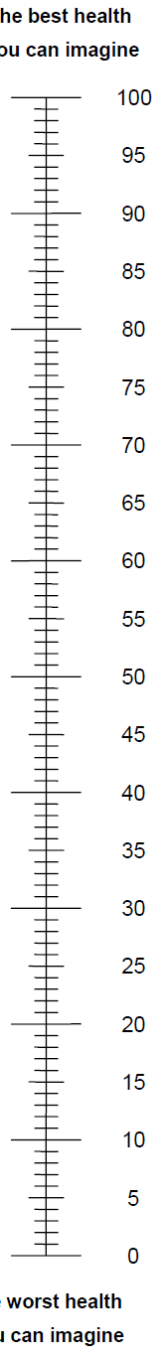
- I have no pain or discomfort ❑
- I have slight pain or discomfort ❑
- I have moderate pain or discomfort ❑
- I have severe pain or discomfort ❑
- I have extreme pain or discomfort ❑

ANXIETY / DEPRESSION

- I am not anxious or depressed ❑
- I am slightly anxious or depressed ❑
- I am moderately anxious or depressed ❑
- I am severely anxious or depressed ❑
- I am extremely anxious or depressed ❑

- We would like to know how good or bad your health is TODAY.
- This scale is numbered from 0 to 100.
- 100 means the best health you can imagine.
  0 means the worst health you can imagine.
- Mark an X on the scale to indicate how your health is TODAY.
- Now, please write the number you marked on the scale in the box below.

YOUR HEALTH TODAY = ☐



Choice of Comparator

New therapy

vs.

? all relevant alternatives?

? usual therapy?

? substandard therapy?

? placebo?

Choice of Comparator

Failure to compare a new therapy with a strong alternative will result in a deceptively favorable cost-effectiveness picture.

Modeling

- When direct empirical data are not available, methods of imputation and extrapolation are used to estimate outcomes
- No model generates new data, it merely combines existing information within an explicit framework

Types of Models

- Decision trees
- State-transition
  - Markov
  - Monte Carlo
- Complex mathematical

Discounting

- Even in a world of zero inflation, there are advantages to receiving benefits earlier and incurring costs later.
- Discounting adjusts future costs and benefits to current value.

Sensitivity Analyses

The values of one or more of the key parameters are varied singly or simultaneously to evaluate the robustness of the results to the underlying assumptions.

Example:
Cost-Utility of Diabetes Prevention

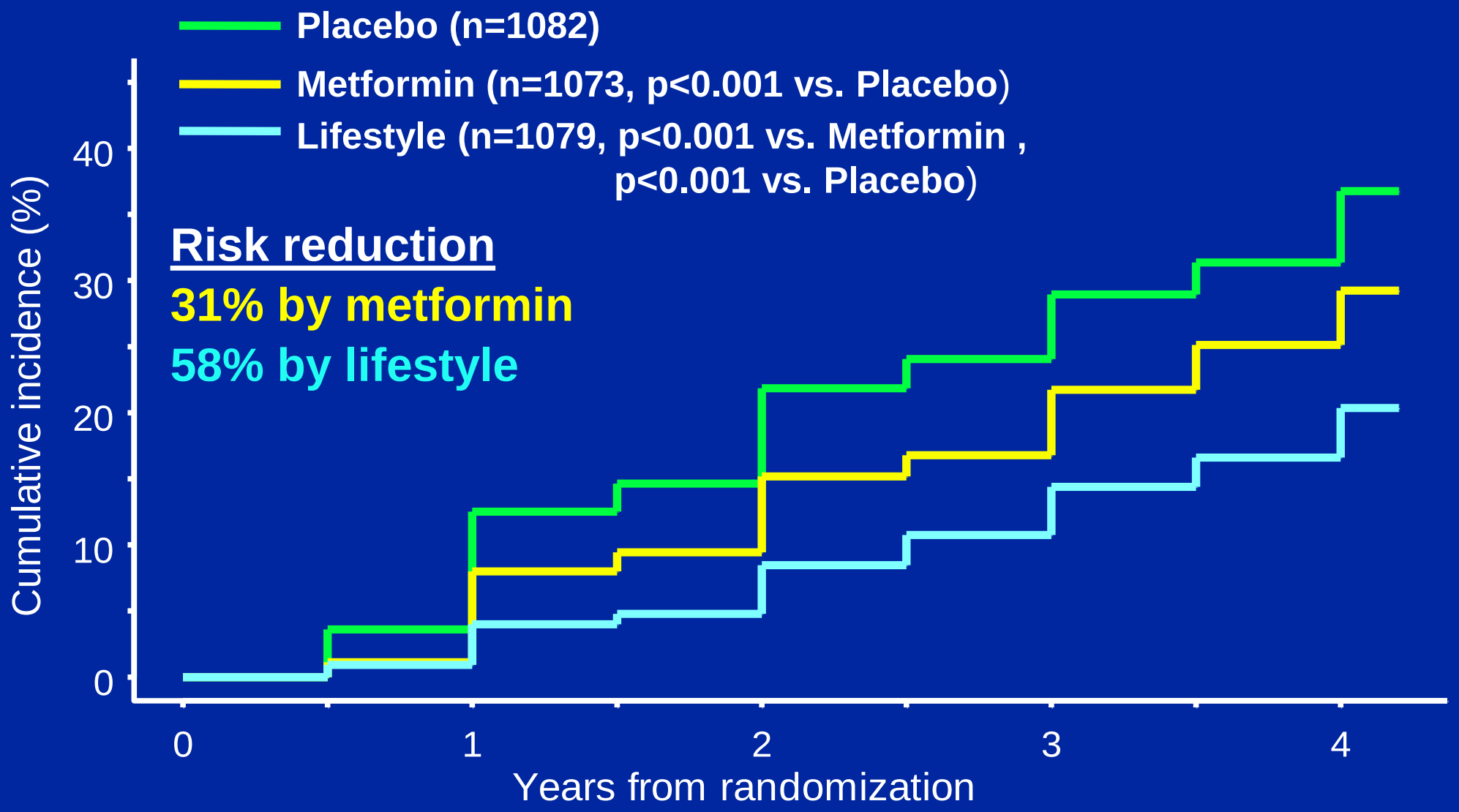
Hypothesis

The increased costs of interventions for diabetes prevention will be partially or completely offset by savings arising from delaying or preventing diabetes, its complications, and comorbidities, and by delaying or preventing diabetes-related decrements in quality-of-life.

DPP Interventions

- **Lifestyle**
  - **healthy, low-calorie, low-fat diet & physical activity of moderate intensity (brisk walking for ≥ 150 min/week) to achieve and maintain ≥ 7% loss of body weight**
  - **16 session core curriculum over 6 months then monthly follow-up**
- **Metformin**
  - **850 mg daily increasing to 850 mg twice daily**
  - **standard lifestyle recommendations**
  - **quarterly follow-up**
- **Placebo**
  - **standard lifestyle recommendations**

Incidence of Diabetes



The DPP Research Group. N Engl J Med 346:393, 2002

Simulated Lifetime Analysis

Data Sources

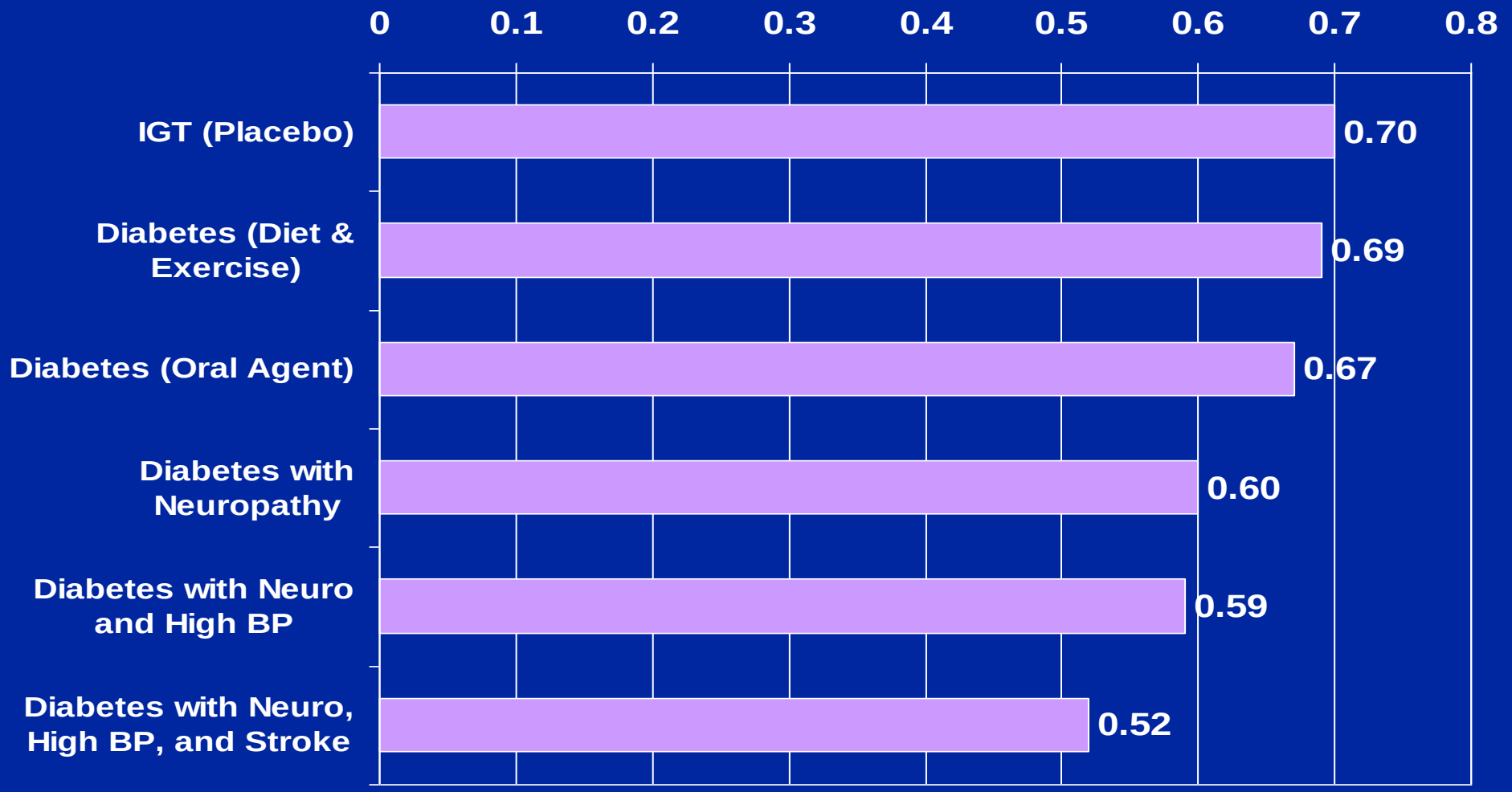
	Treatment of IGT	Treatment of Diabetes
Costs	DPP	Cost Model
Quality of Life	DPP	Quality of Life Model
Health Outcomes	DPP	Type 2 Diabetes Model

DPP. Ann Intern Med 142:323, 2005

Annual Direct Medical Costs in a Man Progressing from IGT to Diabetes with Complications

Brandle. Diabetes Care 26:2300, 2003

Health Utility Scores in a Man Progressing from IGT to Diabetes with Complications



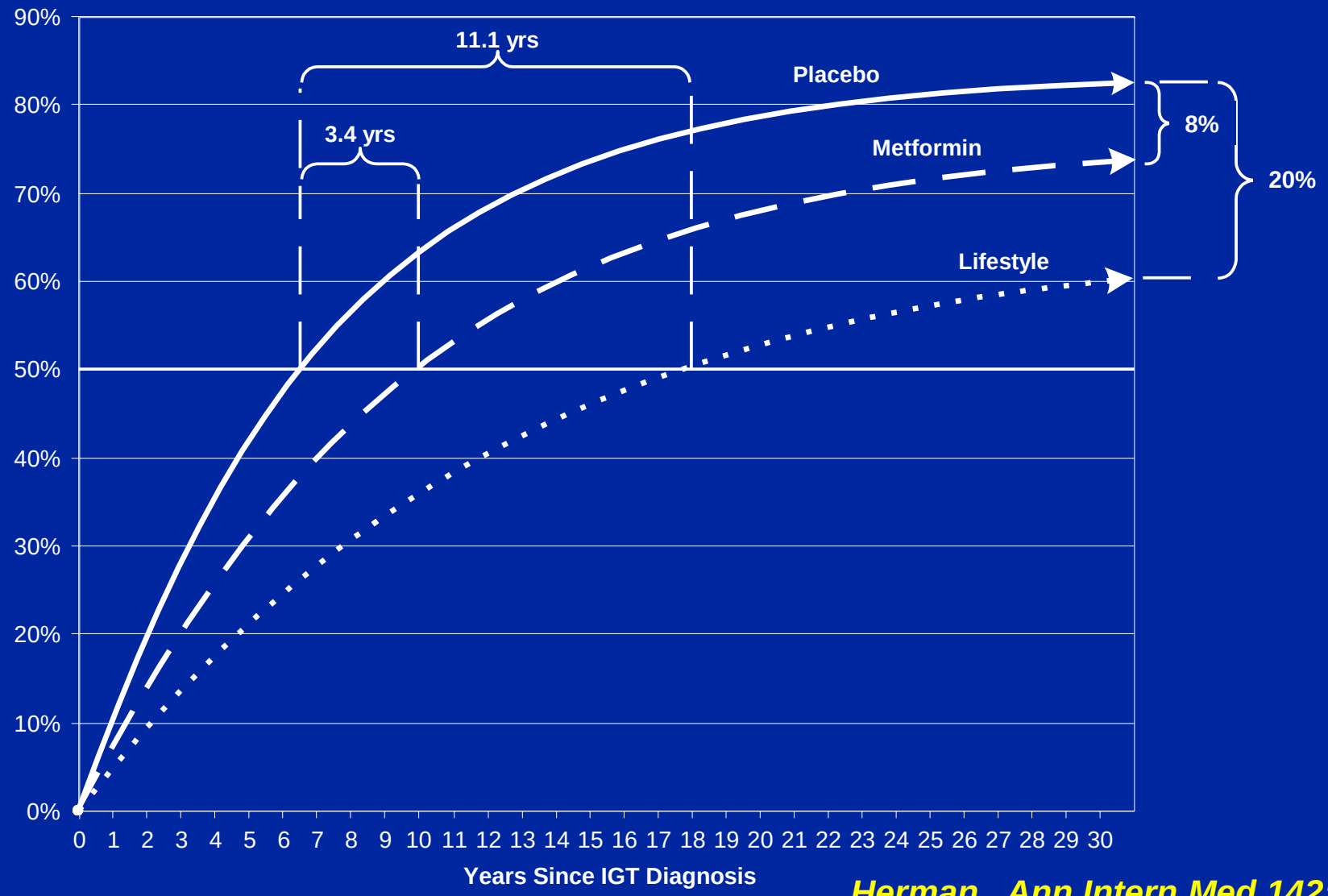
Coffey. Diabetes Care 25:2238, 2002

Diabetes Cost-Effectiveness Model

- Markov model structure
- Follows a patient cohort from diagnosis of IGT to death
- IGT transition probabilities based on DPP
- Diabetes, microvascular and macrovascular transition probabilities based on UKPDS and literature
- Tracks costs, QALYs, disease progression, 5 complications, and survival

CDC Diabetes Cost-effectiveness Group. JAMA 287:2542, 2002

Simulated Cumulative Incidence of Diabetes in the DPP



Herman. Ann Intern Med 142:323, 2005

Simulated Lifetime Clinical Outcomes in the DPP

Outcome	Lifestyle	Metformin	Placebo
Diabetes (%)	63	75	83
Blindness (%)	3	5	6
ESRD (%)	0.6	0.8	1.0
Amputation (%)	1.3	1.6	1.9
Stroke (%)	19	21	21
CHD (%)	39	41	42
Life expectancy (yrs)	24.7	24.3	24.1

Herman. Ann Intern Med 142:323, 2005

Cost-utility of Interventions over a Lifetime from a Health System Perspective*

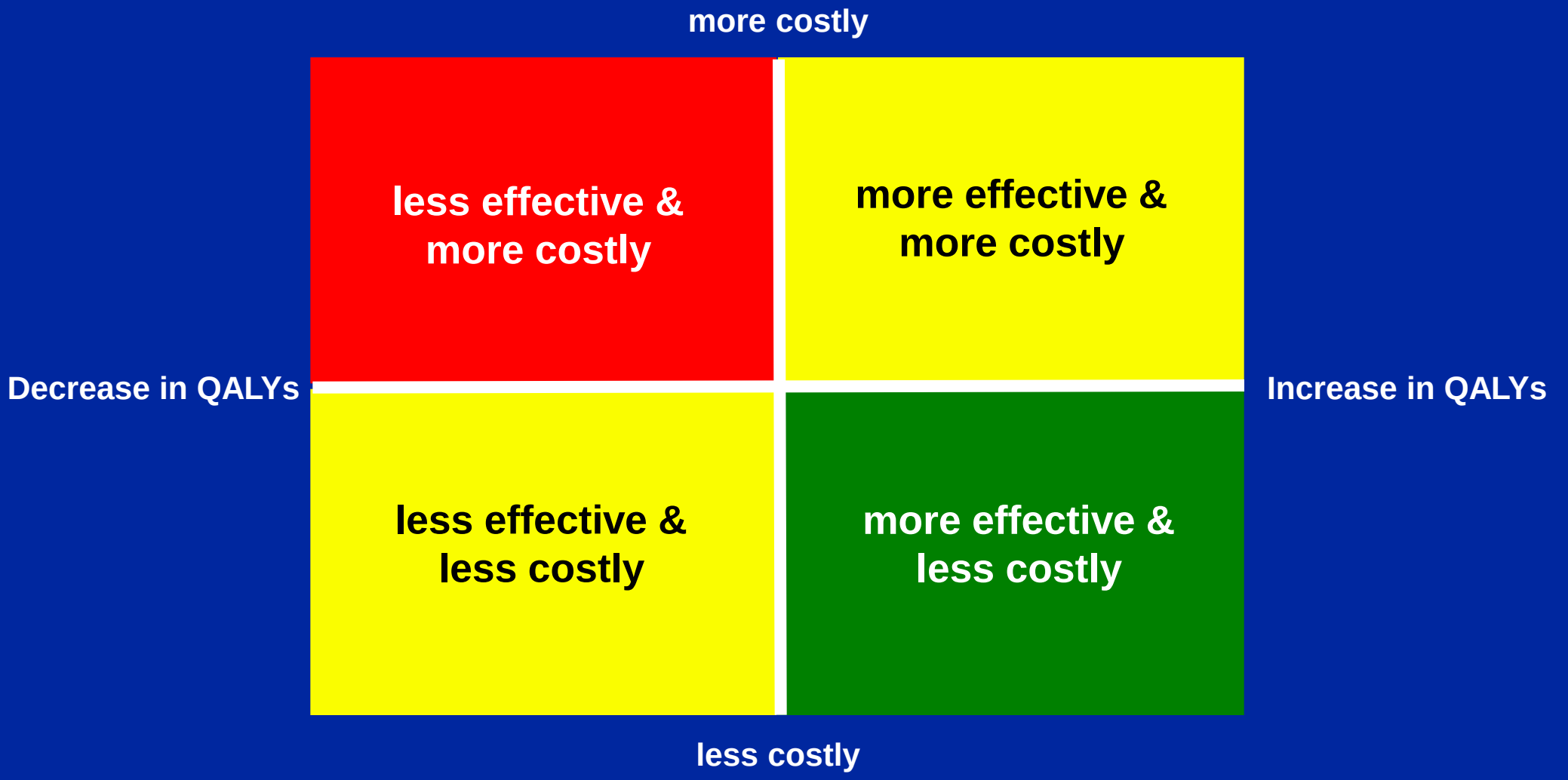
Outcome	Lifestyle	Metformin†	Placebo
Δ Cost/ Δ QALY	$1,124	$1,755	——

* costs and QALYs discounted at 3% per year

† generic pricing for metformin

Herman. Ann Intern Med 142:323, 2005

How Attractive Does a New Technology Have to be to Warrant Adoption and Utilization?

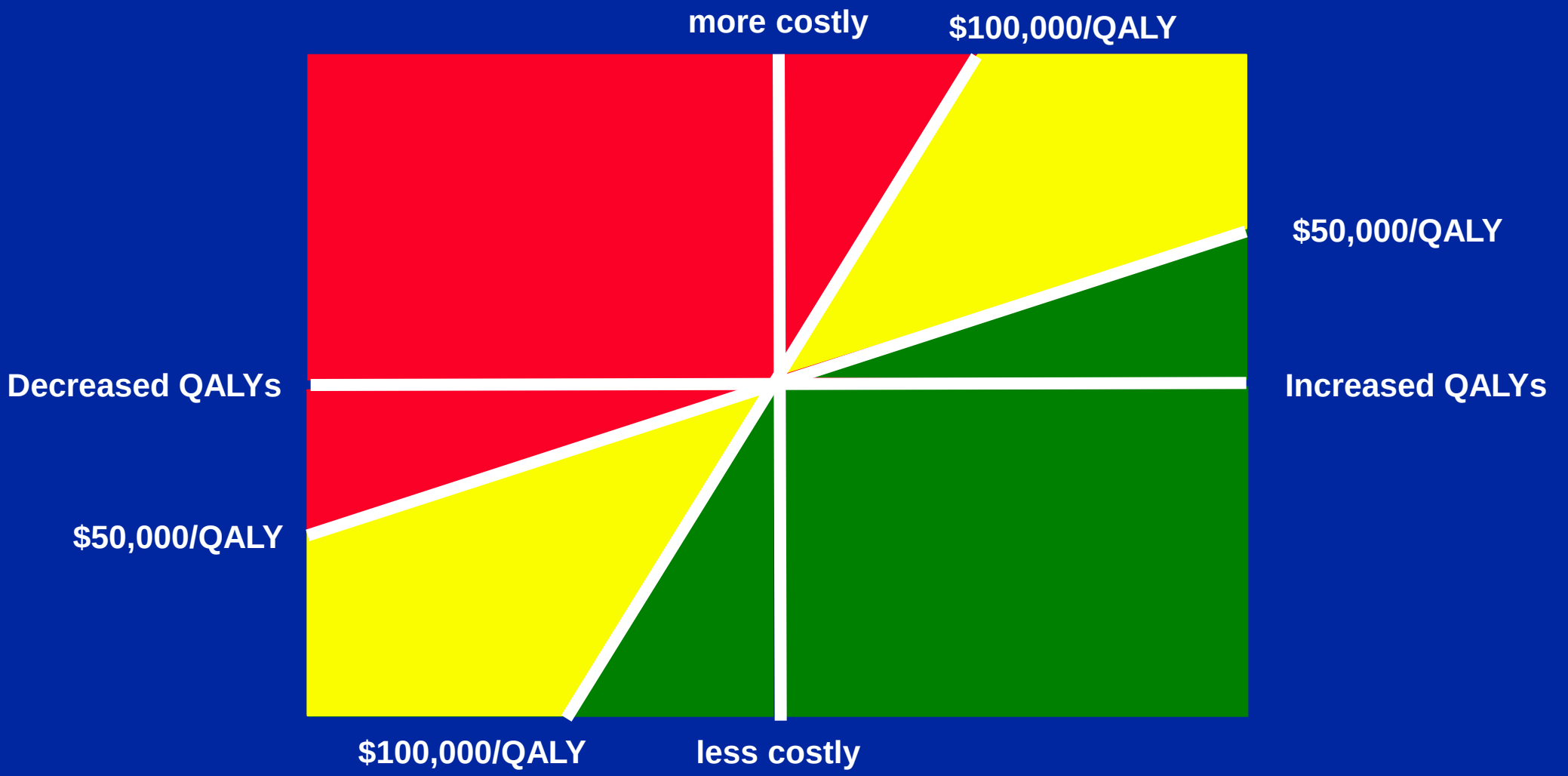


Cost-Utility of Selected Interventions in the Medicare Population

Intervention	Cost per QALY
Influenza vaccine	Cost-saving
Beta-blockers after myocardial infarction	<$10,000
Mammographic screening	$10,000-$25,000
Hypertension medication (DBP >105 mmHg)	$10,000-$60,000
Cholesterol management, as secondary prevention	$10,000-$50,000
Dialysis for end-stage renal disease	$50,000-$100,000
Left ventricular assist devices	$500,000-$1.4 million

PJ Neumann. N Engl J Med 353:1516, 2005

How Attractive Does a New Technology Have to be to Warrant Adoption and Utilization?



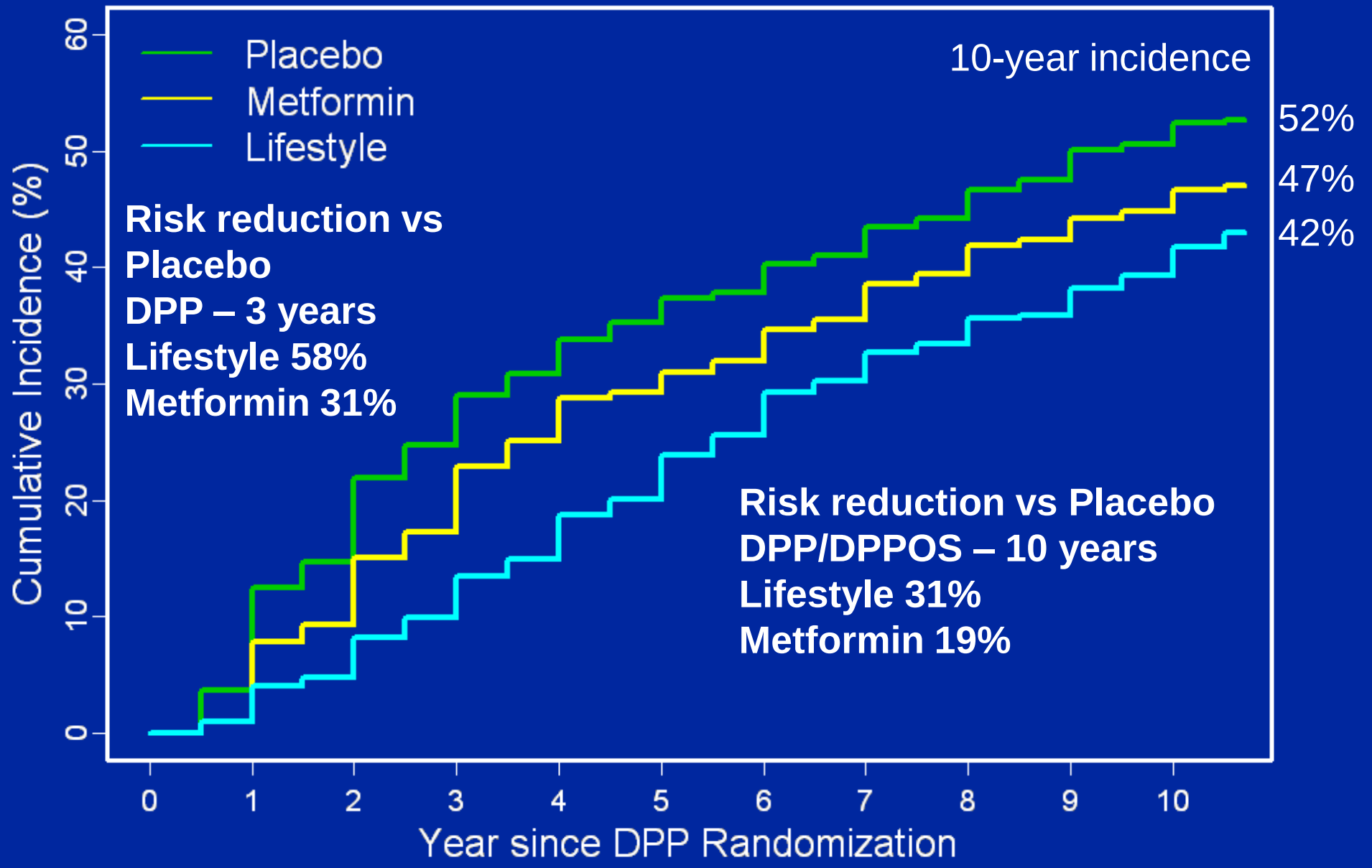
10-year within-trial economic analysis of the DPP/DPPOS

Background

- **The DPPOS followed participants for an additional 7 years during which time those in the lifestyle and metformin interventions were encouraged to continue those interventions.**
- **During DPPOS, lifestyle participants received extra lifestyle support and all participants were offered a 16 session group lifestyle intervention and 4 healthy lifestyle program sessions per year.**

DPP Research Group. Lancet 374:1677, 2009

Cumulative Incidence of Diabetes during DPP/DPPOS



DPP Research Group. Lancet 374:1677, 2009

Cost-utility of Interventions over 10 years from a Health System Perspective*

Outcome	Lifestyle	Metformin†	Placebo
Δ Cost/ Δ QALY	$10,037	cost-saving	——

* costs and QALYs discounted at 3% per year

† generic pricing for metformin

DPP. Diabetes Care 35:723, 2012

Conclusion

Lifestyle and metformin interventions as implemented in DPP/DPPOS are cost-effective for preventing diabetes

Funding

Cost-effectiveness ≠ Cost

Funding

- **The initial cost of an intervention is determined by the number of individuals to whom it is applied and the cost of the intervention**

Funding

- **When applied to a large population, an inexpensive intervention will have huge cost implications.**

Funding

Interventions for diabetes prevention are more likely to be cost-effective in developed countries where resources are available to treat diabetes, its complications, and comorbidities.

Mind the Gap!

- There are substantial costs involved in identifying people for targeted interventions
- The recruitment of highly selected subjects for clinical trials may result in overestimation of intervention effectiveness in real-world practice
- If only a small proportion of eligible people participate in an intervention, a lot of achievable benefit is not achieved

Wareham. Lancet Diabet Endo 3:160, 2015

The effectiveness and cost-utility of targeted interventions for diabetes prevention should not negate the importance of:

- Population interventions to address school health, food policy, and the built environment
- Early detection and intensive management of diabetes