National Institute for Health and Clinical Excellence

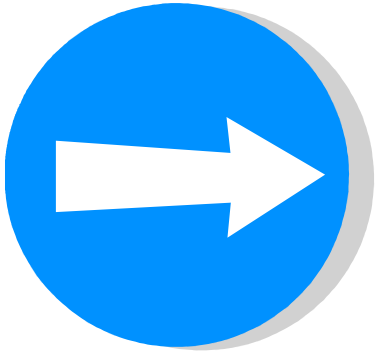
Presentation 4

Assessing cost-effectiveness – Incremental analysis and Efficiency frontiers

Standard approach to measuring cost-effectiveness

Average cost effectiveness ratio (ACER)

$$= \frac{\text{Expected cost with A}}{\text{Expected effect with A}}$$



Incremental cost effectiveness ratio (ICER)

$$= \frac{\text{Expected cost with A} - \text{Expected cost with B}}{\text{Expected effect with A} - \text{Expected effect with B}}$$

NHS
National Institute for Health and Clinical Excellence

Net benefits…

- ICERs useful and intuitive but have unfavorable statistical properties
- Fortunately we can (equivalently) express the results of a cost effectiveness analysis in terms of net health or net monetary benefit (need to specify a threshold willingness to pay…)
- NHB
  - $\Delta Effect - \Delta Costs / Threshold > 0$
- NMB
  - $Threshold \times \Delta Effect - \Delta Costs > 0$

Note: ICER decision rule → $\Delta Costs/\Delta Effects < \lambda$

Why incremental analysis ?

The sixth stool GUAIAC

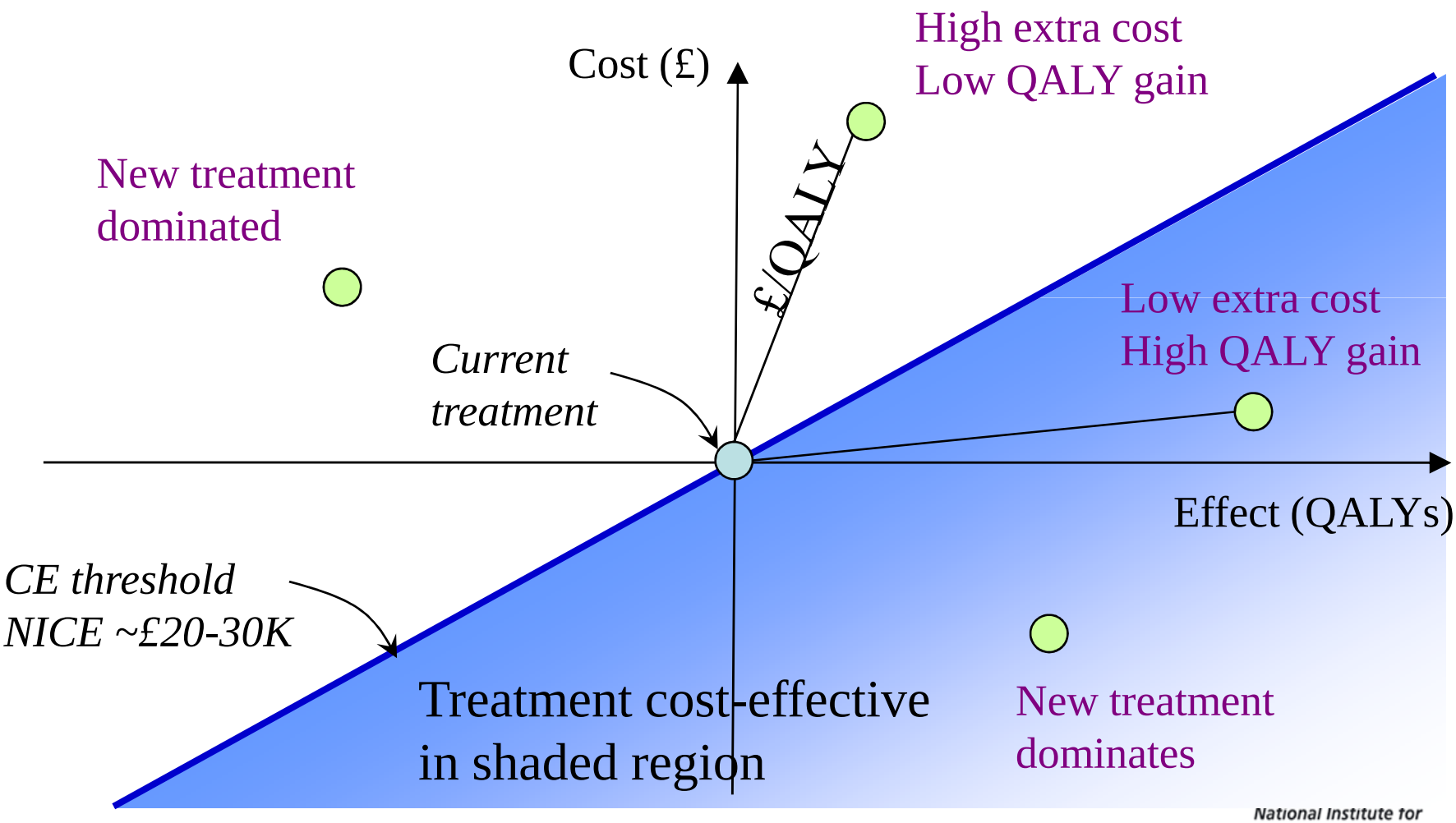
Neuhauser D & Lewicki AM. *N.Engl.J.Med.* 1975;July 31:226-8.

No. tests	*Effect (cancers detected)*	*Cost (£000s) @*	
1			
2			
3			
4			
5			
6			

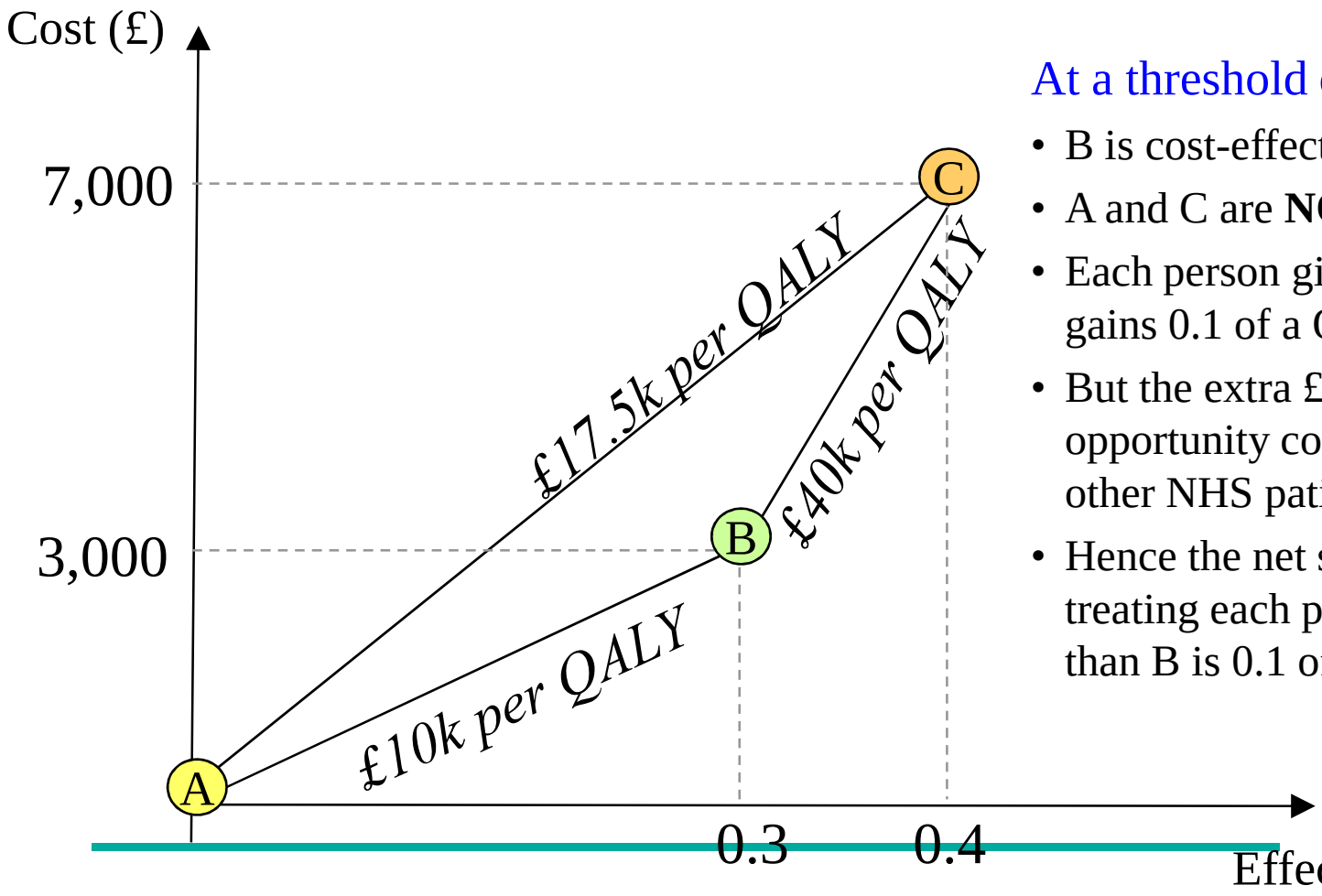
@ 1975 UK £, converted from US $ (OECD, GDP PPP, 1980)

* Assuming health system can afford to pay £20,000 per QALY

Assessing cost-effectiveness



Incremental analysis:
making the right comparisons

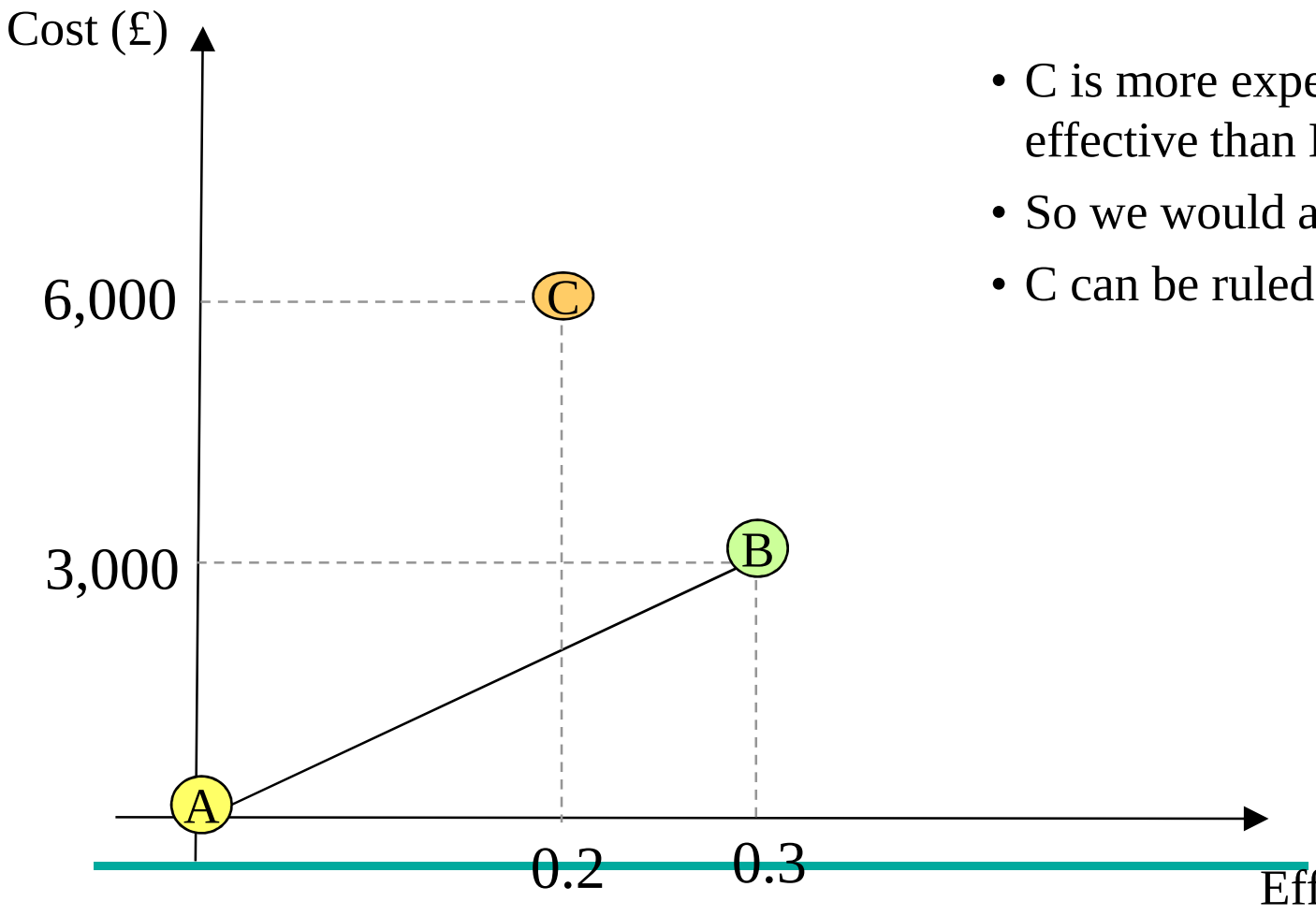


At a threshold of £20k/QALY:

- B is cost-effective
- A and C are **NOT**
- Each person given C rather than B gains 0.1 of a QALY
- But the extra £4k implies an opportunity cost of 0.2 QALYs for other NHS patients (£4k/£20k)
- Hence the net social loss for treating each patient with C rather than B is 0.1 of a QALY

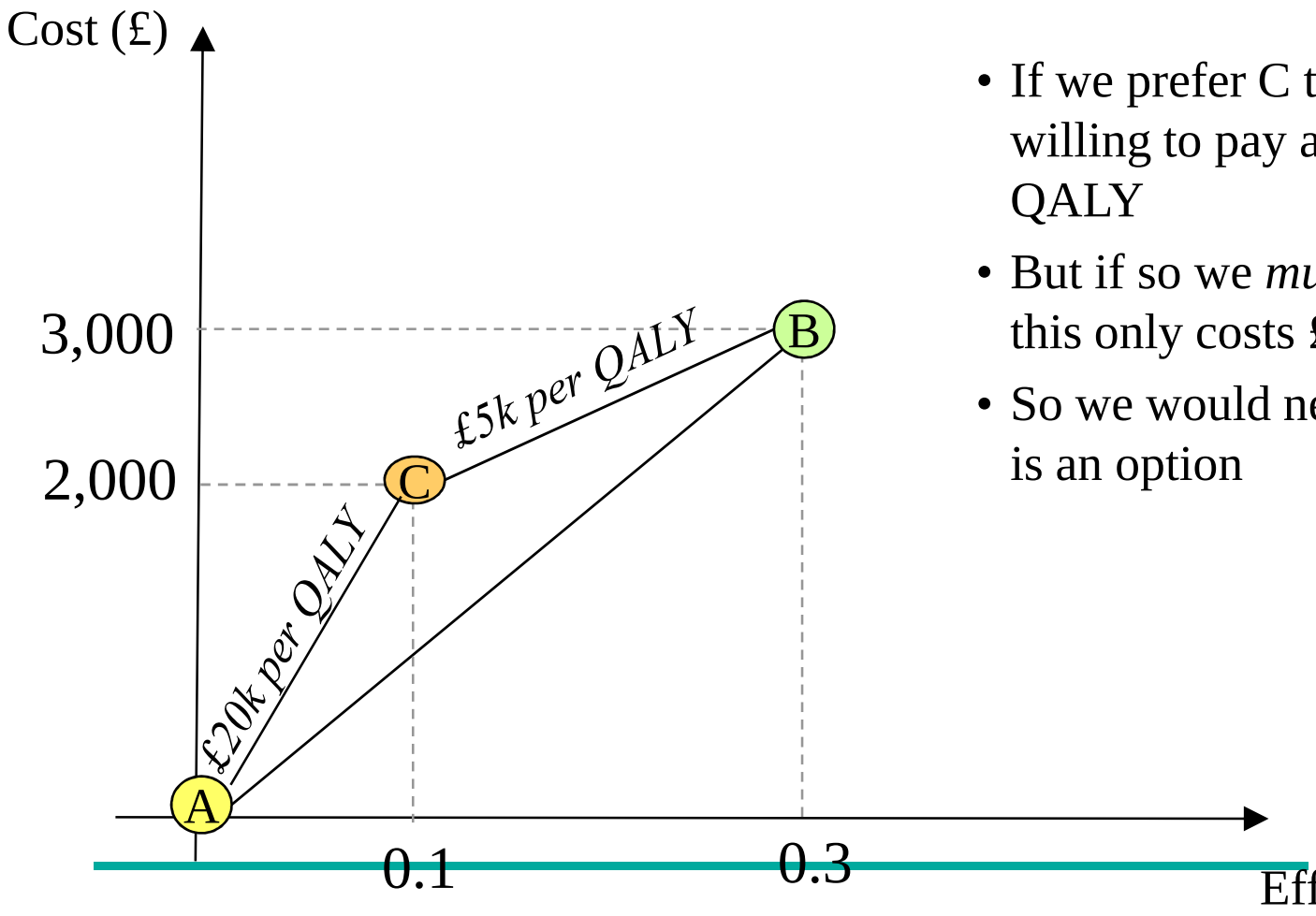
NHS
National Institute for Health and Clinical Excellence

Incremental analysis:
Simple dominance



- C is more expensive and less effective than B
- So we would always prefer B.
- C can be ruled out

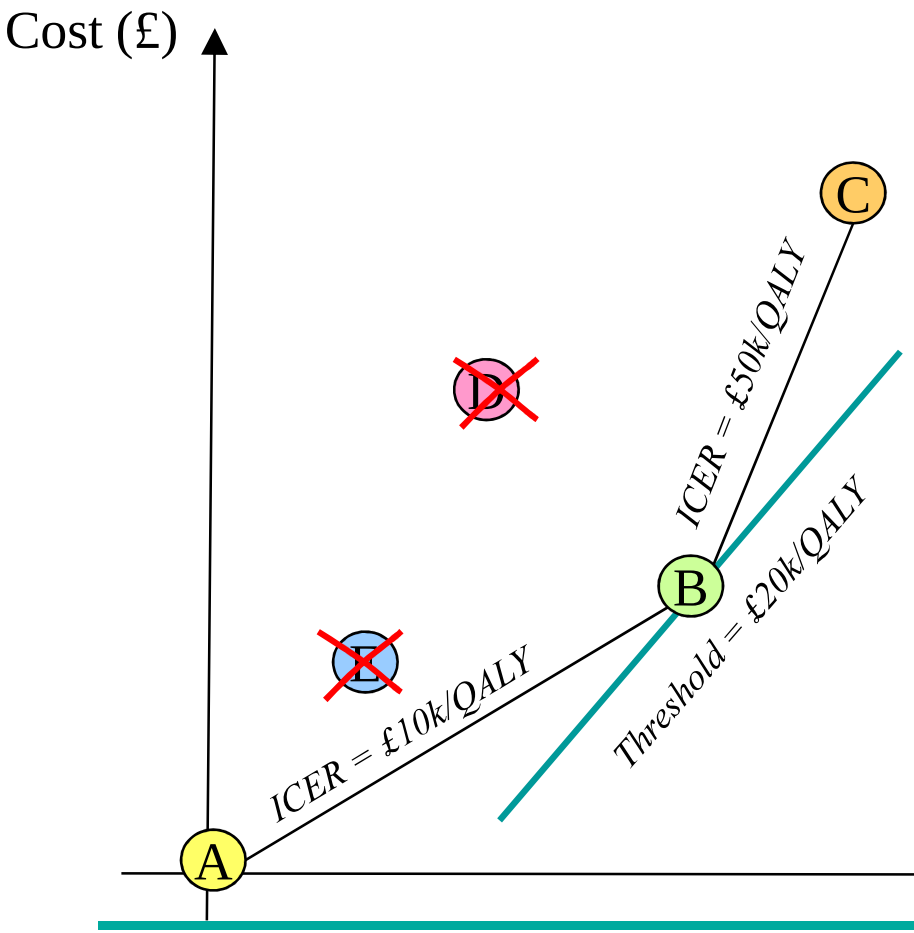
Incremental analysis:
Extended dominance



- If we prefer C to A, we must be willing to pay at least £20k per QALY
- But if so we *must* prefer B to C, as this only costs £5k per QALY
- So we would never choose C if B is an option

NHS
National Institute for Health and Clinical Excellence

Incremental analysis:
Rules for comparison of multiple options



1. Rule out any options subject to simple dominance
2. Rule out any options subject to extended dominance
3. Rank remaining options in order of increasing effect
4. Calculate ICERs between successive pairs of options
5. Identify cost-effectiveness threshold
6. Select option with highest ICER less than threshold

NHS
National Institute for Health and Clinical Excellence

Rationing and the threshold…
a brief overview

(Acknowledgements to Joanne Lord, Brunel University, UK)

HERG
Health Economics Research Group

NHS
National Institute for
Health and Clinical Excellence

How can we use cost-effectiveness to decide if we can afford it?

- Several approaches
  - Willingness to pay
  - Fixed budget
  - Using a threshold
  - Budget reallocation

- To illustrate, let's draw up a league table…

A simple league table model

1. List all possible health care interventions for all groups of patients
2. Estimate cost & health gain (e.g. QALY/DALY) for each intervention
3. Eliminate any options where an alternative costs less and gives bigger health gain
4. Rank remaining options in order of decreasing value for money (e.g. cost per QALY gained)

*(Note - This isn't really possible, but it's a useful device for thinking through the issues**)***

Example of a league table

Selected interventions	$/QALY
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and high risk for stroke	Cost-saving
Thrombolytic therapy with intracoronary streptokinase vs. conventional therapy in patients with ECG evidence of AMI and duration of symptoms < 4 hours	$4,800
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and medium risk for stroke	$8,800
Captopril therapy vs. No captopril in 60 year-old patients surviving myocardial infarction	$11,000
Thrombolytic therapy with tissue plasminogen activator vs. streptokinase in patients presenting within 6 hours after onset of symptoms of AMI	$32,000
Captopril therapy vs. No captopril in 50 year-old patients surviving myocardial infarction	$73,000
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and low risk for stroke	$410,000

https://research.tufts-nemc.org/cear

The willingness to pay approach

- Determine how much society is willing to pay for a unit of health effect (e.g. $50,000 per QALY)
- Fund everything with a cost per QALY below this figure
- This will determine how high the budget needs to be

Selected interventions	$/QALY
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and high risk for stroke	Cost-saving
Thrombolytic therapy with intracoronary streptokinase vs. conventional therapy in patients with ECG evidence of AMI and duration of symptoms < 4 hours	$4,800
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and medium risk for stroke	$8,800
Captopril therapy vs. No captopril in 60 year-old patients surviving myocardial infarction	$11,000
Thrombolytic therapy with tissue plasminogen activator vs. streptokinase in patients presenting within 6 hours after onset of symptoms of AMI	$32,000
Captopril therapy vs. No captopril in 50 year-old patients surviving myocardial infarction	$73,000
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and low risk for stroke	$410,000

WTP threshold

Healthcare budget needed

NHS
National Institute for Health and Clinical Excellence

The fixed budget approach

- Determine how much society is willing to spend on health (e.g. budget fixed by elected government)
- Start by funding projects at the top of table and continue moving down the table until the money runs out
- This will determine the ‘shadow price’ of the budget

Selected interventions	$/QALY
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and high risk for stroke	Cost-saving
Thrombolytic therapy with intracoronary streptokinase vs. conventional therapy in patients with ECG evidence of AMI and duration of symptoms < 4 hours	$4,800
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and medium risk for stroke	$8,800
Captopril therapy vs. No captopril in 60 year-old patients surviving myocardial infarction	$11,000
Thrombolytic therapy with tissue plasminogen activator vs. streptokinase in patients presenting within 6 hours after onset of symptoms of AMI	$32,000
Captopril therapy vs. No captopril in 50 year-old patients surviving myocardial infarction	$73,000
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and low risk for stroke	$410,000

Shadow price

Healthcare budget fixed

NHS
National Institute for Health and Clinical Excellence

The threshold approach

- Can assess incremental changes to current system
  - Start by *estimating* a cost-effectiveness threshold
  - Select projects for evaluation
  - Fund projects if cost per QALY below threshold

Selected interventions	$/QALY
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and high risk for stroke	Cost-saving
Thrombolytic therapy with intracoronary streptokinase vs. conventional therapy in patients with ECG evidence of AMI and duration of symptoms < 4 hours	$4,800
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and medium risk for stroke	$8,800
Captopril therapy vs. No captopril in 60 year-old patients surviving myocardial infarction	$11,000
Thrombolytic therapy with tissue plasminogen activator vs. streptokinase in patients presenting within 6 hours after onset of symptoms of AMI	$32,000
Captopril therapy vs. No captopril in 50 year-old patients surviving myocardial infarction	$73,000
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and low risk for stroke	$410,000

Estimated threshold

? Budget impact

NHS National Institute for Health and Clinical Excellence

The reallocation approach

- Or compare potential investment/disinvestment projects and reallocate funding between them

Estimated threshold

Selected interventions	$/QALY
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and high risk for stroke	Cost-saving
Thrombolytic therapy with intracoronary streptokinase vs. conventional therapy in patients with ECG evidence of AMI and duration of symptoms < 4 hours	$4,800
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and medium risk for stroke	$8,800
Captopril therapy vs. No captopril in 60 year-old patients surviving myocardial infarction	$11,000
Thrombolytic therapy with tissue plasminogen activator vs. streptokinase in patients presenting within 6 hours after onset of symptoms of AMI	$32,000
Captopril therapy vs. No captopril in 50 year-old patients surviving myocardial infarction	$73,000
Warfarin vs. aspirin in 65 year-old with nonvalvular atrial fibrillation and low risk for stroke	$410,000

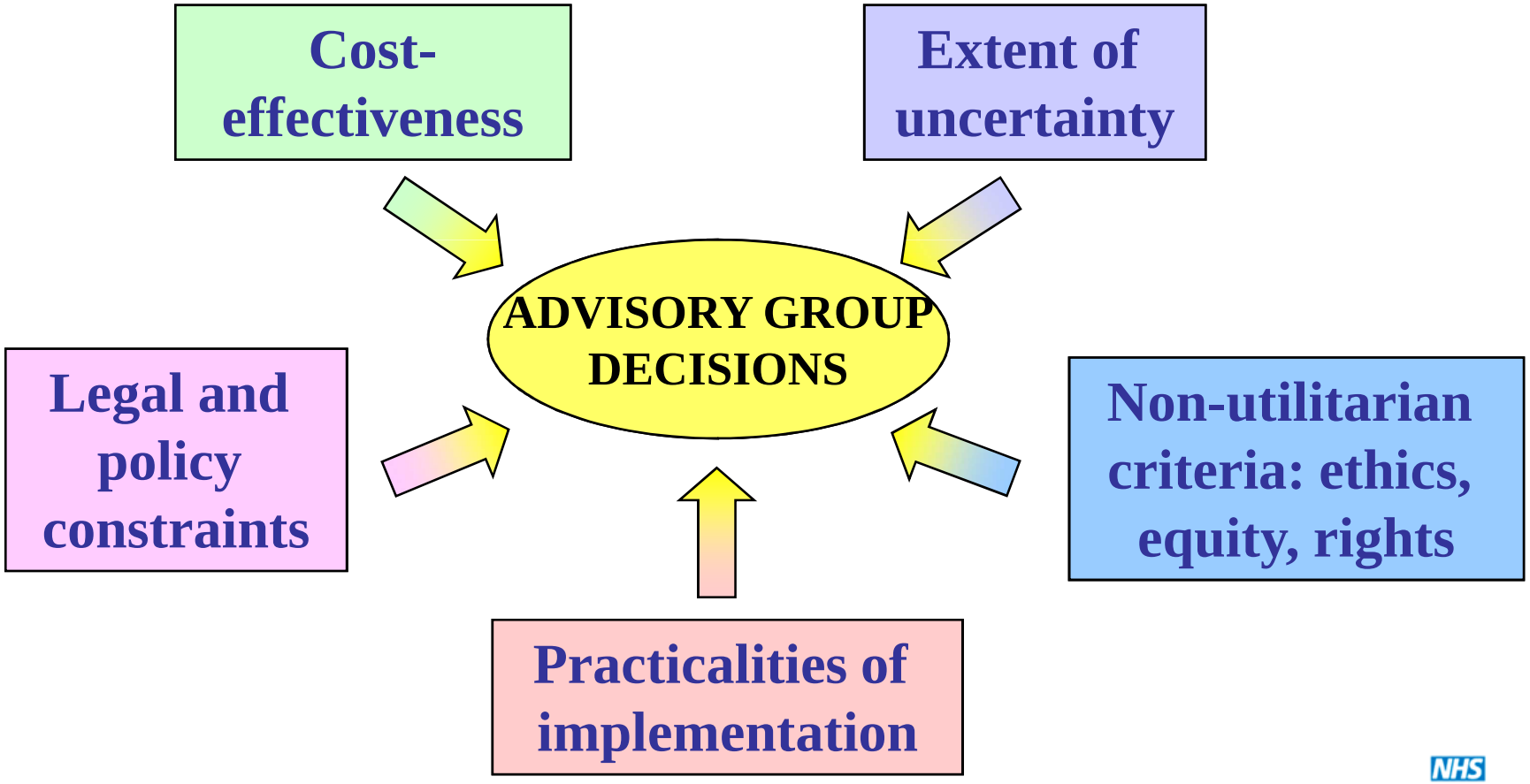
Budget neutral

NHS
National Institute for Health and Clinical Excellence

NICE as ‘threshold searcher’

- The cost effectiveness of many interventions unknown
  - Challenging to gather such information
  - Challenging to use that data to analyse optimal resource allocation
- Even if data were available, it would be impractical to dismantle the current health care system and reconstruct based on an estimated optimal allocation…
- So the estimated threshold approach may be the most pragmatic
- Important to get the threshold ‘right’
  - Too high, and more cost-effective interventions will be displaced from the health service
  - Too low, and less cost-effective strategies will continue to be funded and patients will be denied cost-effective treatments
- Need to identify ‘disinvestment’ opportunities

NICE doesn't have a fixed CE threshold… why?



The role of cost impact assessment

Cost-effectiveness vs. cost-impact – a "separation of roles" in NICE guidance

Cost-effectiveness analysis

- Cost per QALY gained
- Objective: to estimate efficiency of resource use
- Relative impact of options (per patient)
- By NCC economists during development
- Should ***inform advisory body recommendations***

Cost impact analysis

- Costs and savings (not health gain)
- Objective: planning for implementation
- Absolute impact
- NICE cost analysts during consultation on the draft guidance
- Should ***not change recommendations***

What is costed in a *guideline*?

☒ The key recommendations

☒ Every recommendation

☑ **'Significant cost impact recommendations'**

cost of optimum care ***less*** cost of current care = ***cost impact***
cost impact can be either a cost (+) or saving (-)

Types of costing tool

- Costing report – summarises the national cost estimate and discusses the assumptions made when estimating the financial impact of implementing the guidance. For technology appraisals the report is incorporated into the costing template.
- Costing template – provides users with the ability to estimate local cost impact based on their population and changing assumptions to reflect local circumstances.
- Costing statement – explains why the cost impact is not considered to be significant. When cost impact is minimal, usually no costing report or costing template is produced.

F15

CG87CostingTemplate [Read-Only] [Compatibility Mode]

Costing template for type 2 diabetes: newer agents

National Institute for Health and Clinical Excellence

Costing template

Notes		England Unit cost (£) / Percentage (%)	England Units	England Total cost (£)	Cost for selected population using standard assumptions [Enter the name of your locality here] Unit cost (£) / Percentage (%)	Cost for selected population using standard assumptions [Enter the name of your locality here] Units	Cost for selected population using standard assumptions [Enter the name of your locality here] Total cost (£)	Cost for selected population using local assumptions [Enter the name of your locality here] Unit cost (£) / Percentage (%)	Cost for selected population using local assumptions [Enter the name of your locality here] Units	Cost for selected population using local assumptions [Enter the name of your locality here] Total cost (£)
								Blue cells shoud be amended to reflect local circumstances		
	Total population		50,542,505			100,000			100,000	
*1	Males 18-24	0.02%	471		0.02%	1		0.02%	1	
*2	Males 25-34	0.21%	6,911		0.21%	14		0.21%	14	
	Males 35-44	1.04%	39,805		1.04%	79		1.04%	79	
	Males 45-54	3.23%	103,921		3.23%	206		3.23%	206	
	Males 55-64	7.08%	207,157		7.08%	410		7.08%	410	
	Males 65-74	12.19%	241,345		12.19%	477		12.19%	477	
	Males 75+	13.63%	206,261		13.63%	408		13.63%	408	
	Females 18-24	0.05%	1,143		0.05%	2		0.05%	2	
	Females 25-34	0.22%	7,358		0.22%	15		0.22%	15	
	Females 35-44	0.77%	30,127		0.77%	60		0.77%	60	
	Females 45-54	2.20%	72,255		2.20%	143		2.20%	143	
	Females 55-64	4.42%	133,844		4.42%	265		4.42%	265	
	Females 65-74	8.63%	189,004		8.63%	374		8.63%	374	
	Females 75+	10.13%	243,171		10.13%	481		10.13%	481	
	Total cases		1,482,773			2,934			2,934	
	Overall prevalence		2.9%			2.9%			2.9%	
	Current prescribing behaviour									
*3	Metformin	39.60%	587,178		39.60%	1,162		39.60%	1,162	
	Sulfonlyurea	14.75%	218,709		14.75%	433		14.75%	433	
	Pioglitazone	0.50%	7,414		0.50%	15		0.50%	15	
	Rosiglitazone	0.50%	7,414		0.50%	15		0.50%	15	
	Metformin & sulfonylurea	18.00%	266,899		18.00%	528		18.00%	528	
	Metformin & pioglitazone	1.50%	22,242		1.50%	44		1.50%	44	
	Metformin & rosiglitazone	1.50%	22,242		1.50%	44		1.50%	44	
	Metformin & sitagliptin	0.00%	-		0.00%	-		0.00%	-	
	Metformin & vildagliptin	0.00%	-		0.00%	-		0.00%	-	
	Sulfonylurea & pioglitazone	1.00%	14,828		1.00%	29		1.00%	29	
	Sulfonylurea & rosiglitazone	1.00%	14,828		1.00%	29		1.00%	29	
	Sulfonylurea & sitagliptin	0.00%	-		0.00%	-		0.00%	-	
	Sulfonylurea & vildagliptin	0.00%	-		0.00%	-		0.00%	-	
	Metformin & sulfonylurea & pioglitazone	3.00%	44,483		3.00%	88		3.00%	88	
	Metformin & sulfonylurea & rosiglitazone	3.00%	44,483		3.00%	88		3.00%	88	

Step 2. Costing template | Step 3. Costing summary | Sensitivity analysis | Pharmacological Treatments | Costs over time | Where to find the guidance

Ready

75%

Workbook Views | Show/Hide | Zoom | Window | Macros

F19 | =D19+((G19-D19)/3)*2

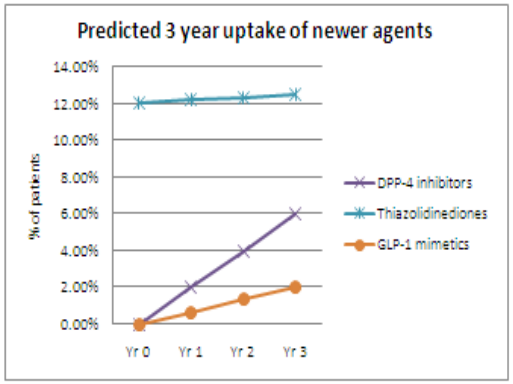
CG87CostingTemplate [Read-Only] [Compatibility Mode]

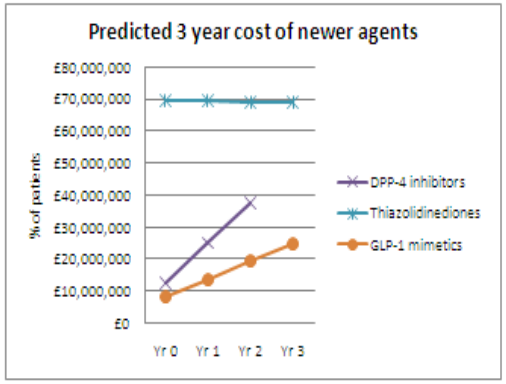
Costs over time

NHS
National Institute for
Health and Clinical Excellence

	User percentage by treatment			
	Yr 0	Yr 1	Yr 2	Yr 3
Metformin	40.00%	40.00%	40.00%	40.00%
Sulfonylurea	15.00%	15.00%	15.00%	15.00%
Pioglitazone	0.50%	0.67%	0.83%	1.00%
Rosiglitazone	0.50%	0.33%	0.17%	0.00%
Metformin & sulfonylurea	18.00%	17.67%	17.33%	17.00%
Metformin & pioglitazone	1.50%	2.00%	2.50%	3.00%
Metformin & rosiglitazone	1.50%	1.33%	1.17%	1.00%
Metformin & sitagliptin	0.00%	0.33%	0.67%	1.00%
Metformin & vildagliptin	0.00%	0.33%	0.67%	1.00%
Sulfonylurea & pioglitazone	1.00%	1.17%	1.33%	1.50%
Sulfonylurea & rosiglitazone	1.00%	0.83%	0.67%	0.50%
Sulfonylurea & sitagliptin	0.00%	0.50%	1.00%	1.50%
Sulfonylurea & vildagliptin	0.00%	0.50%	1.00%	1.50%
Metformin & sulfonylurea & pioglitazone	3.00%	3.17%	3.33%	3.50%
Metformin & sulfonylurea & rosiglitazone	3.00%	2.67%	2.33%	2.00%
Metformin & sulfonylurea & sitagliptin	0.00%	0.17%	0.33%	0.50%
Metformin & sulfonylurea & vildagliptin	0.00%	0.17%	0.33%	0.50%
Exenatide	0.00%	0.67%	1.33%	2.00%
Acarbose	0.00%	0.00%	0.00%	0.00%
NPH insulin	5.00%	4.00%	3.00%	2.00%
Long-acting insulin	9.00%	7.33%	5.67%	4.00%
Premix insulin	1.00%	1.17%	1.33%	1.50%
Total	100%	100%	100%	100%

Costs over time			
Yr 0	Yr 1	Yr 2	Yr 3
£14,092,273	£14,139,722	£14,187,171	£14,234,620
£4,592,889	£4,618,837	£4,644,786	£4,670,735
£2,098,124	£2,797,498	£3,496,873	£4,196,247
£3,113,823	£2,075,882	£1,037,941	£0
£12,010,460	£11,788,044	£11,565,628	£11,343,212
£6,828,169	£9,460,091	£12,092,013	£14,723,935
£9,875,267	£8,778,015	£7,680,763	£6,583,512
£0	£2,263,700	£4,527,400	£6,791,100
£0	£1,907,834	£3,815,669	£5,723,503
£4,507,630	£5,258,901	£6,010,173	£6,761,444
£6,539,028	£5,449,190	£4,359,352	£3,269,514
£0	£3,373,308	£6,746,617	£10,119,925
£0	£2,839,510	£5,679,020	£8,518,530
£15,658,082	£16,943,151	£18,228,221	£19,513,291
£20,684,682	£18,386,384	£16,088,086	£13,789,788
£0	£1,183,747	£2,367,494	£3,551,241
£0	£1,005,814	£2,011,629	£3,017,443
£7,999,560	£13,537,716	£19,075,873	£24,614,030
£0	£0	£0	£0
£13,715,649	£10,972,519	£8,229,389	£5,486,260
£34,696,885	£28,271,536	£21,846,187	£15,420,838
£2,743,130	£3,200,318	£3,657,506	£4,114,695
£159,155,650	£168,251,720	£177,347,791	£186,443,861





Step 2. Costing template | Step 3. Costing summary | Sensitivity analysis | Pharmacological Treatments | Costs over time | Where to find the guidance

Ready | 75%

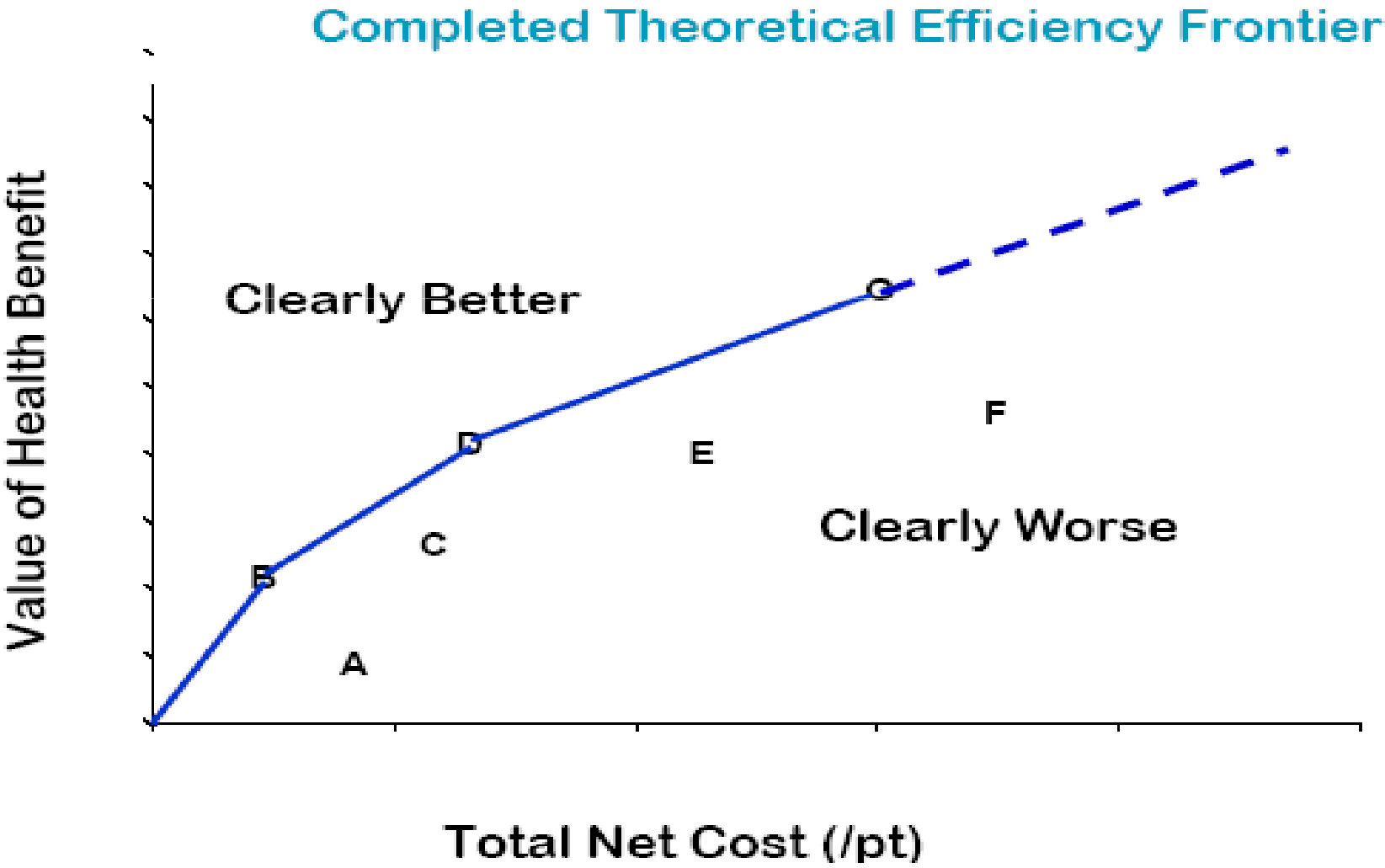
“Efficiency frontiers”

Efficiency frontiers

- An alternative approach to standard approaches for assessing the relation of benefits to costs (in the German Statutory health care system) (IQWiG, 2008)
- Focus on addressing the ceiling price at which a superior health technology *in a given therapeutic area* should be reimbursed
- Abandons cost-utility analysis – “accepted clinical measures” should be used as measure of benefit (familiarity to clinicians plus their availability from clinical trials)
- To compare costs and benefits in a particular therapeutic area, construct a diagram with costs on X-axis and ‘value’ on the Y-axis
  - Plot existing therapies as points on this graph

IQWiG's Efficiency Frontier

Source: IQWiG 2008



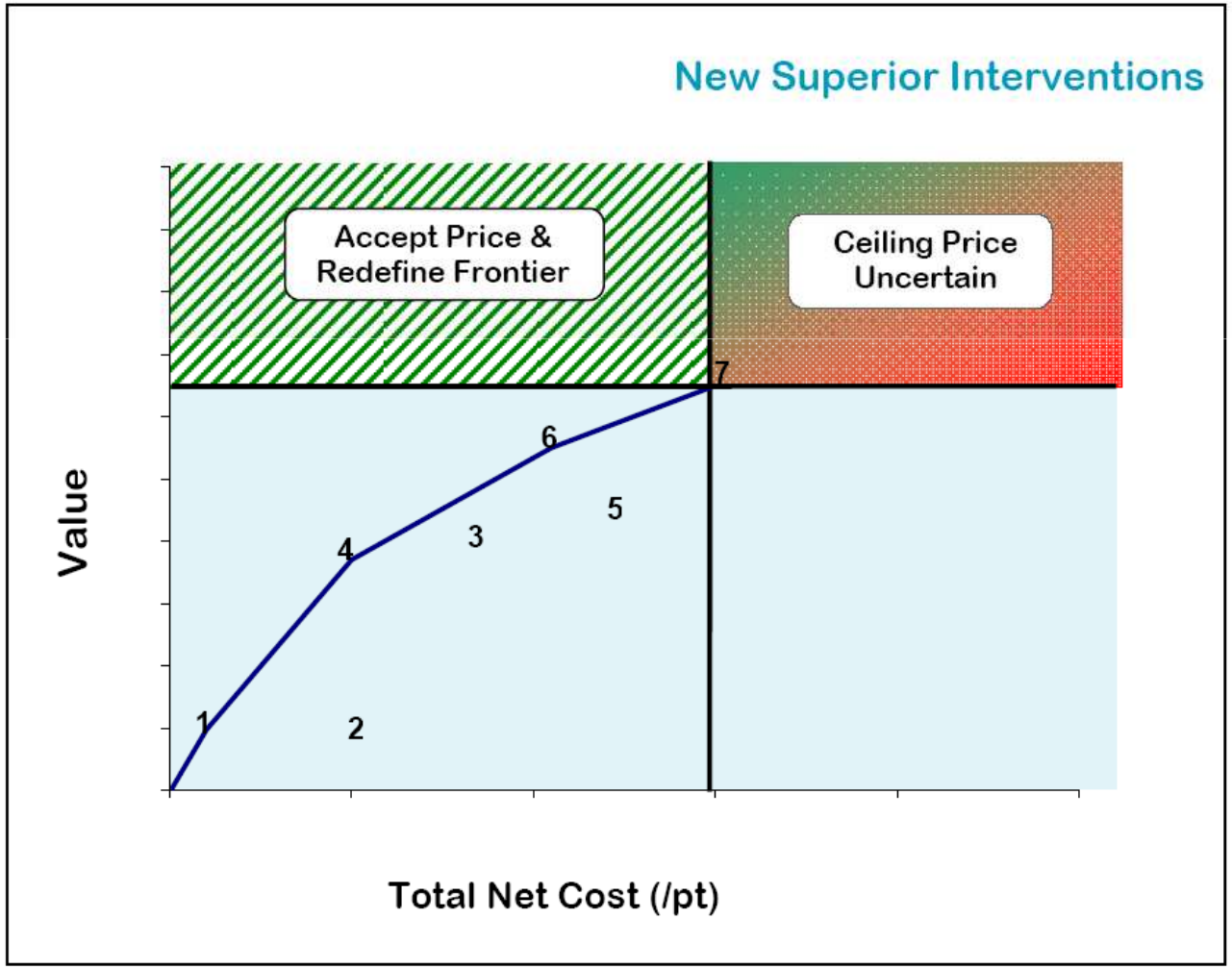
IQWiG's Efficiency Frontier – issues
(Drummond & Rutten, 2008)

- Does the measure of value capture overall benefit to patient?
- Is the measure of value based on a cardinal scale? (e.g. can you infer that for a given increase in costs there is a corresponding increase in benefit)
  - Many clinical measures do not have cardinal properties
- How up to date is the information on value and costs for a specific intervention?
- Are all relevant interventions presented?
- Do positions on the 'efficiency frontier' represent efficient decision making in the past?
- How useful is cost-effectiveness information from foreign jurisdictions (especially if published studies used a cost per QALY approach)?

Frontier approach would allow identification of inefficient strategies that may still be used in clinical practice

Using the efficiency frontier to make decisions…

Source: IQWiG 2008



Using the efficiency frontier to make decisions…

- Decision zones above the superiority boundary – not clear what rules apply when the ceiling price is uncertain
- How are decisions made when there are multiple non-aggregated dimensions of value (and hence potentially, multiple efficiency frontiers)?
- What if two therapeutic areas have a common and highly relevant measure of value, e.g. increased survival
  - It may be possible to pay more for increased survival in one therapeutic area compared to another