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Assessing intervention impact on costs

Some basic principles of economic evaluation

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Declaration

No financial interests to declare

This Section (~40 mins)

Objective: To discuss and illustrate key concepts in cost analysis: why do we do it, choice of dependent variable, choice of timeframe, 'meaning of results'

Overview:

1. Introduction
2. Dependent variable in cost analysis (May & Normand, JPSM, 2016)
3. Timeframe (Greer at al, JPM, 2016)
4. Concluding remarks

1. **Introduction**
2. Dependent variable in cost analysis (May & Normand, JPSM, 2016)
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1. Introduction

Why economic evaluation?

Formally, we are interested in utilization analysis because:

- Health demands are infinite
- Resources to provide healthcare are finite
  - "Scarcity": decisions in allocation to be made

In practice the reason is the same as for any other type of study:

- Ensuring that the most effective care is made available

Economic perspective is often useful (& typically essential at a systems/policy level)

1. Introduction

What is economic evaluation?

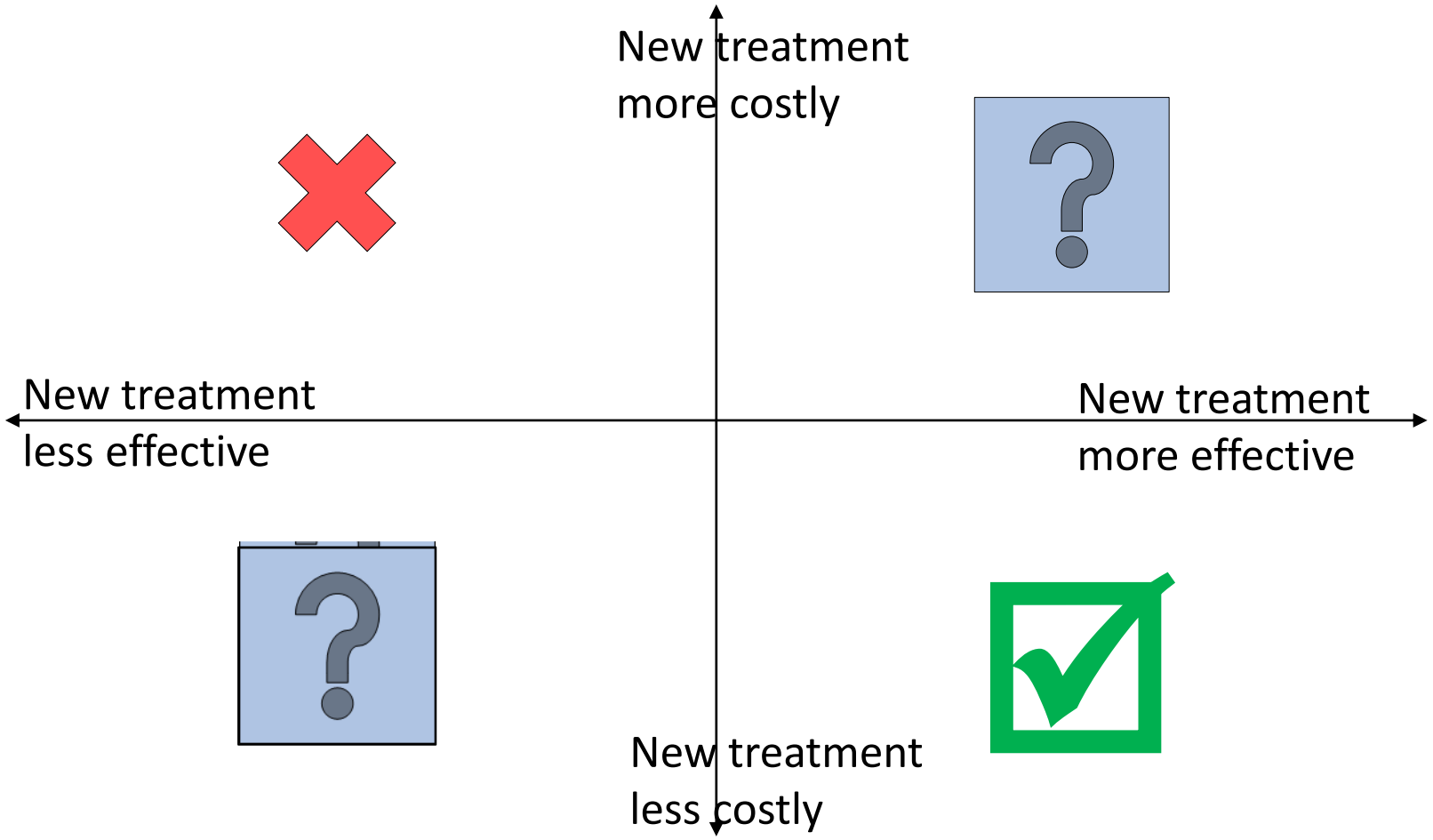
'Full' economic evaluation has two components:

- Measuring treatment effect on costs
- Measuring treatment effect on outcomes
  - 'Cost-consequence' analysis

'Cost-consequence' is an umbrella term covering cost-effectiveness analysis, cost-benefit analysis, cost-utility analysis…

1. Introduction

Cost-consequence analysis



1. Introduction

What is economic evaluation?

One of the two components is essential:

- **Measuring treatment effect on costs**
- ~~Measuring treatment effect on outcomes~~

But the 'consequence' part can be fudged through a 'non-inferiority' assumption

- i.e. that outcomes for intervention group patients are at least no worse than those for comparison group patients

➢ Cost analysis (or cost-minimisation analysis)

Often a practical approach; standard in economics of palliative care

1. Introduction

What is economic evaluation?

In the long run, ‘cost-consequence’ analysis is essential for the evidence base on palliative care, and we will talk about this a bit later in the session

For this section we will focus on

- **Measuring treatment effect on costs**
- ~~Measuring treatment effect on outcomes~~

What do we mean when we talk about ‘cost-savings’?

Spectrum of precision

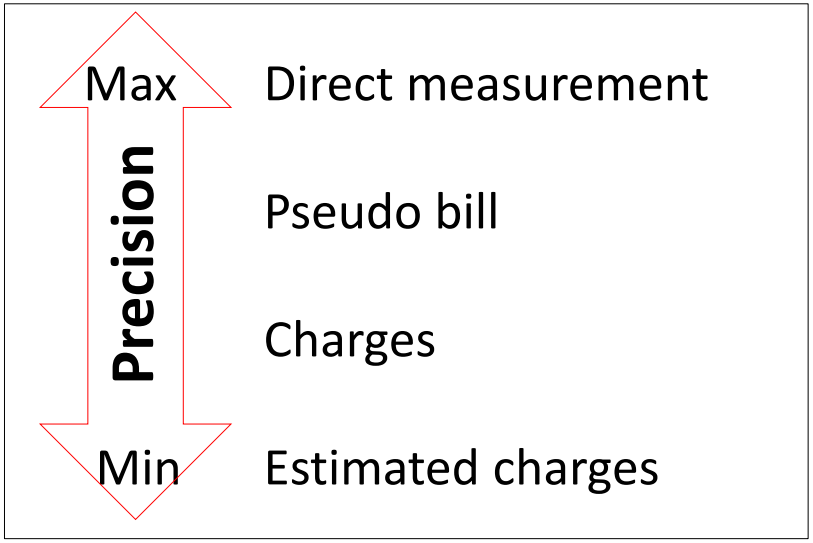
Understanding your dependent variable

Count utilization data are self-explanatory:

- (Re)admissions (how many); length of stay (days)

$$$ data are more complicated:

the cost of *what*?



Spectrum of precision

Understanding your dependent variable

Key point:

- All measures on the spectrum have pros and cons.
  - » Direct measurement is most accurate but most burdensome and not universally available
  - » Pseudo-bill trades accuracy for user-friendliness in a conservative way
  - » Charges as a proxy for costs make the same trade in a more speculative way. **Charges ≠ Costs**.

Further reading:

www.herc.research.va.gov/include/page.asp?id=determining-costs

1. Introduction
2. **Dependent variable in cost analysis (May & Normand, JPSM, 2016)**
3. Timeframe (Greer at al, JPM, 2016)
4. Concluding remarks

2. Dependent variable in cost analysis

Measuring treatment effect on *what*?

Taking the example of hospital cost analysis, three dependent variables are widely used in literature:

1. *Cost of hospital admission* for treatment group patients versus comparators
2. *Mean daily cost of hospital admission* (=Cost of hospital admission/LOS) for treatment group patients versus comparators
3. *Change in dy/dx* for treatment group patients before and after receipt of intervention

- Different approaches yield different results and mean different things (May & Normand, JPSM, 2016)

2. Simplified example

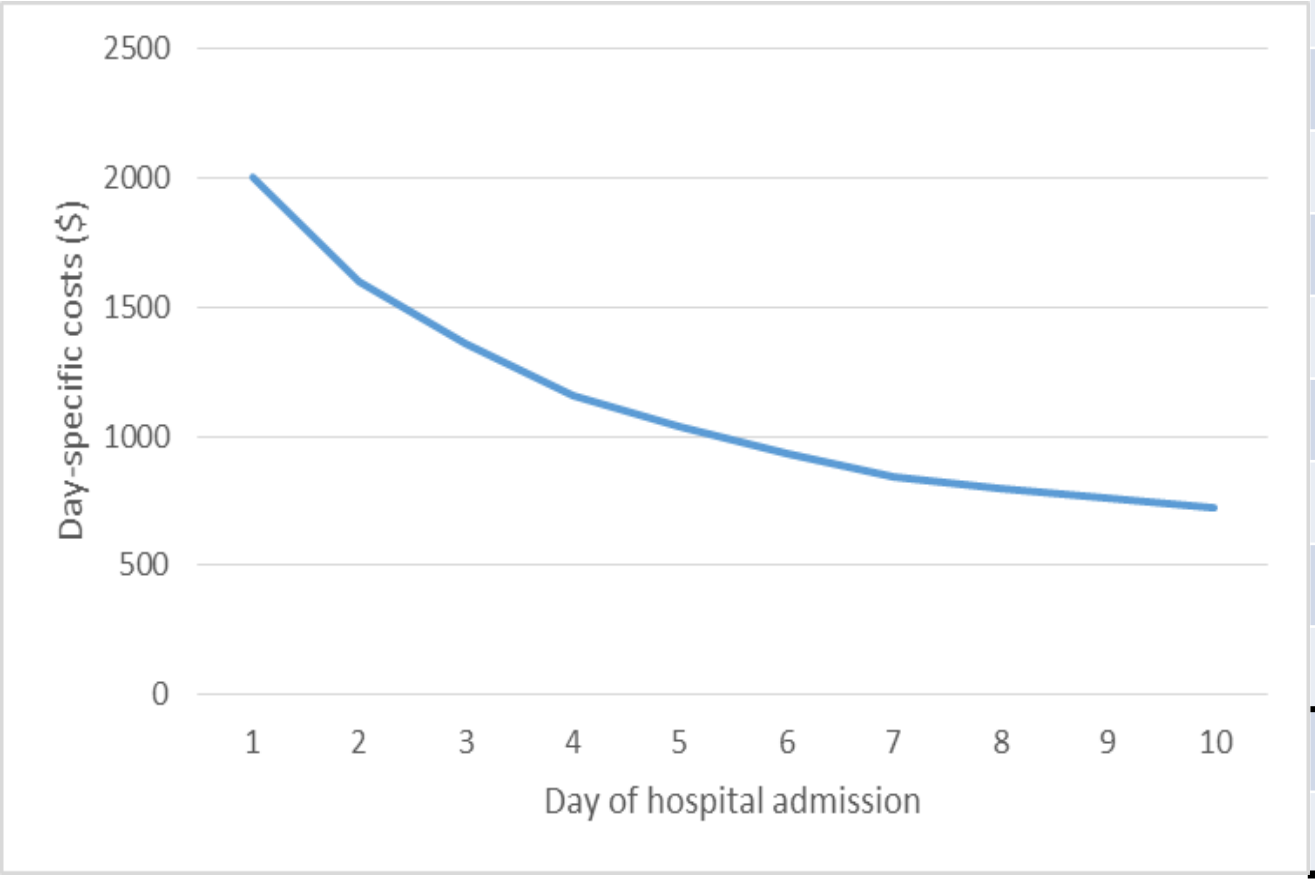
From May & Normand, 2016

Patient UC:

- Is admitted to hospital for 10 days and receives usual care only
- Has high initial costs ($2000, 18% of cost of hospitalization, on first day of admission), followed by a substantive drop, followed by reductions of diminishing magnitude
- Accrues $11219 in costs, $1122 in mean daily costs
- Costs taken from hospital database so reflect actual $ cost of care provided

Day	Cost ($)
1	2000
2	1600
3	1360
4	1156
5	1040
6	936
7	843
8	801
9	761
10	723
Σ	11219
Σ/LOS	1122

Hospital costs for Patient ‘UC’



Day	Cost ($)
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Σ	11219
Σ/LOS	1122

2. Simplified example

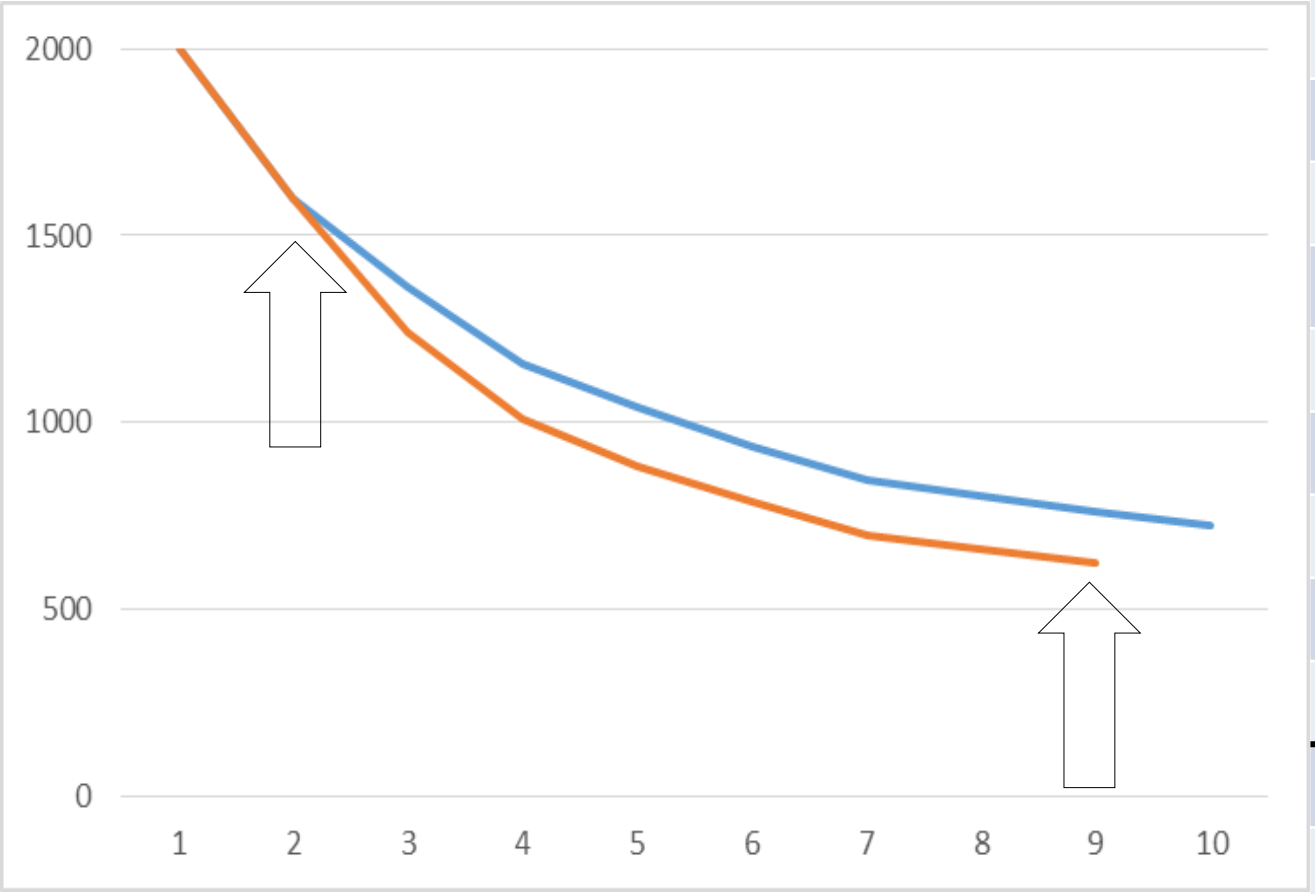
From May & Normand, 2016

Patient PC:

- Is identical to Patient UC at baseline
- Receives an intervention on day 2 that:
  - reduces day-to-day costs
  - reduces LOS by one day
- accrues $9497 in costs, $1055 in mean daily costs

Day	UC Cost ($)	PC Cost ($)
1	2000	2000
2	1600	1600
3	1360	1240
4	1156	1008
5	1040	882
6	936	785
7	843	698
8	801	660
9	761	624
10	723	
Σ	11219	9497
Σ/LOS	1122	1055

Hospital costs for ‘UC’ & ‘PC’



Day	UC Cost ($)	PC Cost ($)
1	2000	2000
2	1600	1600
3	1360	1240
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Σ	11219	9497
Σ/LOS	1122	1055

2. Calculating effects

Impact on cost of hospital admission

Research Question: What is the impact of the PC intervention on costs?

2. Calculating effects

Impact on cost of hospital admission

Research Question: What is the impact of the PC intervention on costs?

1. Cost of admission
2. Mean daily cost of admission
3. Change in dy/dx

2. Calculating effects

Impact on cost of hospital admission

1. Cost of hospital admission for treatment group patient versus comparator:

9497-11219= **- $1722**

(-1722/11219)*100 = **-15%**

Day	UC	PC
1	2000	2000
2	1600	1600
3	1360	1240
4	1156	1008
5	1040	882
6	936	785
7	843	698
8	801	660
9	761	624
10	723	d/c
Σ	11219	9497
Σ/LOS	1122	1055

2. Calculating effects

Impact on cost of hospital admission

2. Mean daily cost of hospital admission for treatment group patient versus comparator:

1055-1122= **- $67**

(-67/1122)*100 = **-6%**

$67*LOS=-$670 overall cost-effect

Day	UC	PC
1	2000	2000
2	1600	1600
3	1360	1240
4	1156	1008
5	1040	882
6	936	785
7	843	698
8	801	660
9	761	624
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2. Calculating effects

Impact on cost of hospital admission

3. Change in dy/dx for treatment group patient before and after receipt of intervention

Costs before intervention:

(2000+1600)/2= $1800 per day

Costs after intervention:

(1240+1008+…+624)/7= $842 per day

So change in dy/dx is:

((842-1800)/1800)*100 = **-53%**

Day	UC	PC
1	2000	2000
2	1600	1600
3	1360	1240
4	1156	1008
5	1040	882
6	936	785
7	843	698
8	801	660
9	761	624
10	723	d/c
Σ	11219	9497
Σ/LOS	1122	1055

2. Calculating effects

Impact on cost of hospital admission

y	$ effect on y	$ effect on Y	Estimated saving
Cost of hospitalization	-$1722	-$1722	= 15%
Mean daily costs	-$67	-$670	= 6%
Change in dy/dx	???	???	= 53%

Key conclusion:

Intervention appears to be cost-saving but for $ estimates to be credible for policy purposes they must be robust

Different methods yield different results and they can't all be right

Key question (still):

What is the impact of the intervention on costs?

2. Dependent variable in cost analysis

What is the impact of the intervention on costs?

Briefly, the answer is:

- We are interested in **resource use**: by definition, overall cost of admission reflects the resources used in treating the patient: -$1722 (a 15% cost-saving) is the true effect
- Mean daily cost (the ratio of overall cost to LOS) does not reliably approximate to total resource use: 6% ($67 or $670 overall) under-estimates true cost-saving (bias in favour of longer hospital LOS)
- Change in dy/dx is seldom a good primary outcome measure because it is impossible to measure overall impact on resource use: 53% overestimates true cost-saving (estimates are distorted as dy/dx is never constant. Also takes no account of ***timing***, which is crucial to impact on utilization)

For a full explanation, see May & Normand (2016)

2. Dependent variable in cost analysis

Measuring treatment effect on *what*?

In order to be useful, economic evaluation must be concerned with **impact on resource use, expressed in $ (or € or £ or…)**

Therefore:

- Overall cost of care is the best cost measure for an economic research question: What is the impact of the intervention on cost of healthcare?
- Creating a ratio of mean daily costs seldom answers a good economic research question (though may be a secondary analysis, e.g. for hospital CEOs)
- Change in dy/dx does not answer a good economics research question because it does not reliably calculate impact on resource use

The example was concerned with hospital costs but the same principles apply in all settings: overall costs reflect resource use; mean daily costs and change in dy/dx do not.

1. Introduction
2. Dependent variable in cost analysis (May & Normand, JPSM, 2016)
3. **Timeframe (Greer at al, JPM, 2016)**
4. Concluding remarks

3. Timeframe

Looking backwards and forwards

Two distinct approaches to time are commonplace in the economics of palliative care literature:

- **Forward-counting**, i.e. conventional research that evaluates an intervention and comparator from start of study for a specified period of time
- **Backward-counting**, where a cohort of decedents are compared for utilisation prior to death for a time period specified by the investigator (Langton et al. (2014))
    - Often treated as interchangeable…but they are **not**

3. Timeframe

Looking backwards and forwards

Interesting illustration provided recently by Greer (2016):

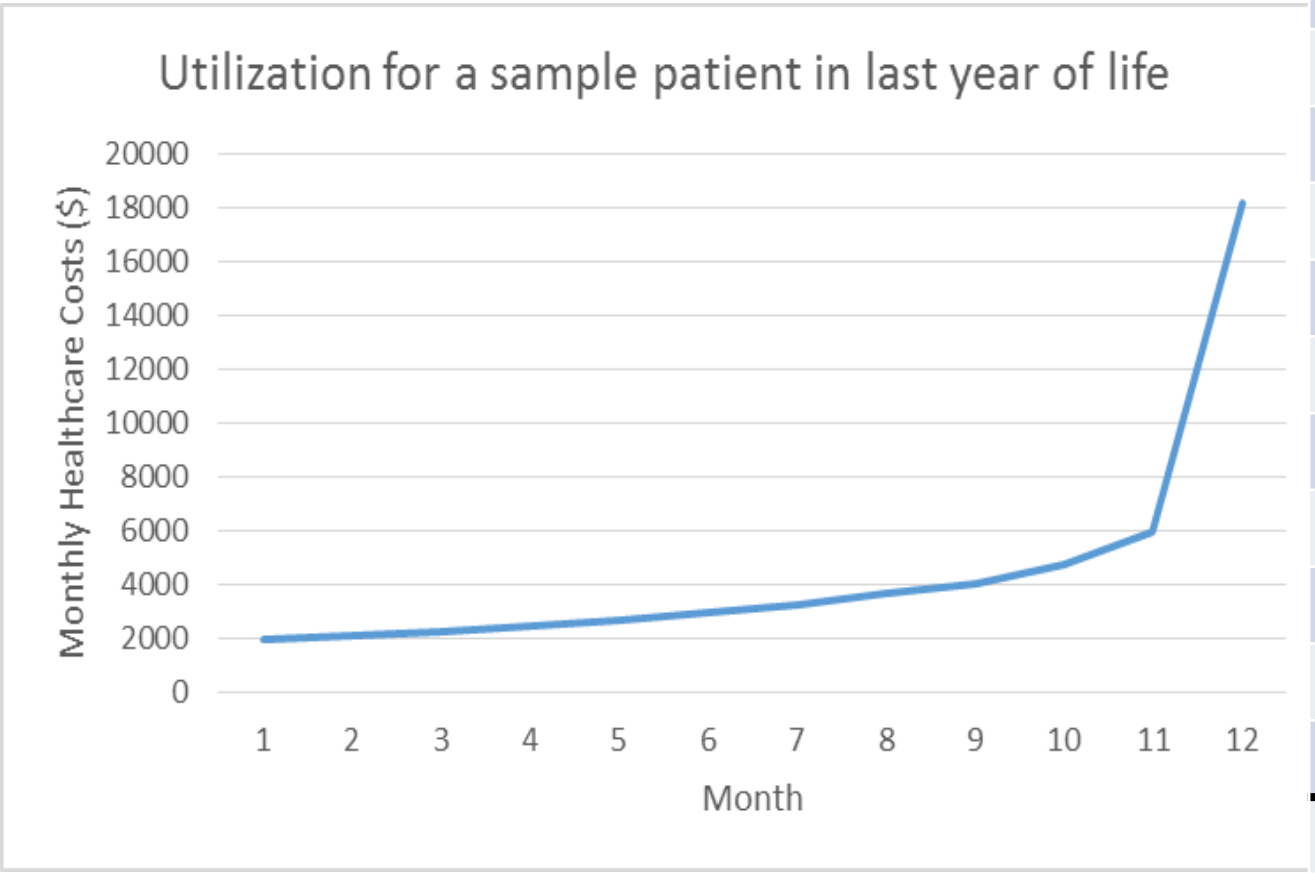
- **Forward-counting**: Over the whole study period, IG patients were on average $11,260 more expensive.
- **Backward-counting**: In the last month of life (LMOL), IG patients had $2,527 lower mean costs.
    - Clearly, methods are not interchangeable

What are the important differences between two approaches?

How can an intervention reduce costs at end of life yet be associated with higher costs overall? (Hint: Temel. 2010. *N Eng J Med*)

3. Timeframe

Costs in the Last Year of Life (LYOL) for Patient UC



Patient UC	
Month	Cost ($)
1	2000
2	2140
3	2290
4	2496
5	2721
6	2965
7	3292
8	3654
9	4056
10	4786
11	5982
12	18190
Σ	54569

3. Timeframe

Looking backwards and forwards

Now let's examine two counterfactuals for Patient UC and comparing forward- and backward-counting methods per Greer et al (2016):

(i) An intervention that reduces costs in LMOL by 10% and has no other relevant impact

(ii) An intervention that reduces costs in LMOL by 10% and extends survival

3. Timeframe

Looking backwards and forwards

Now let's examine two counterfactuals for Patient UC and comparing forward- and backward-counting methods per Greer et al (2016):

(i) **An intervention that reduces costs in LMOL by 10% and has no other relevant impact**

(ii) An intervention that reduces costs in LMOL by 10% and extends survival

Counterfactual (i)

I reduces LMOL cost by 10%, no other impact

Counterfactual (i):

Patient PC is identical to Patient UC.

Patient PC receives an intervention with 10 months to live.

Intervention is cost neutral until the last month of life, when it reduces cost of healthcare utilisation by 10%.

Intervention has no other relevant impact.

Month	Patient UC ($)	Patient PC ($)
1	2000	2000
2	2140	2140
3	2290	2290
4	2496	2496
5	2721	2721
6	2965	2965
7	3292	3292
8	3654	3654
9	4056	4056
10	4786	4786
11	5982	5982
12	18190	16371

Counterfactual (i)

I reduces LMOL cost by 10%, no other impact

Backward-counting methods: What is the intervention impact on costs in the LMOL?

16371-18190=-$1819 (i.e. 10%)

Month	Patient UC ($)	Patient PC ($)
1	2000	2000
2	2140	2140
3	2290	2290
4	2496	2496
5	2721	2721
6	2965	2965
7	3292	3292
8	3654	3654
9	4056	4056
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11	5982	5982
12	18190	16371

Counterfactual (i)

I reduces LMOL cost by 10%, no other impact

Backward-counting methods: What is the intervention impact on costs in the LMOL?

16371-18190=-$1819 (=10% of 18190)

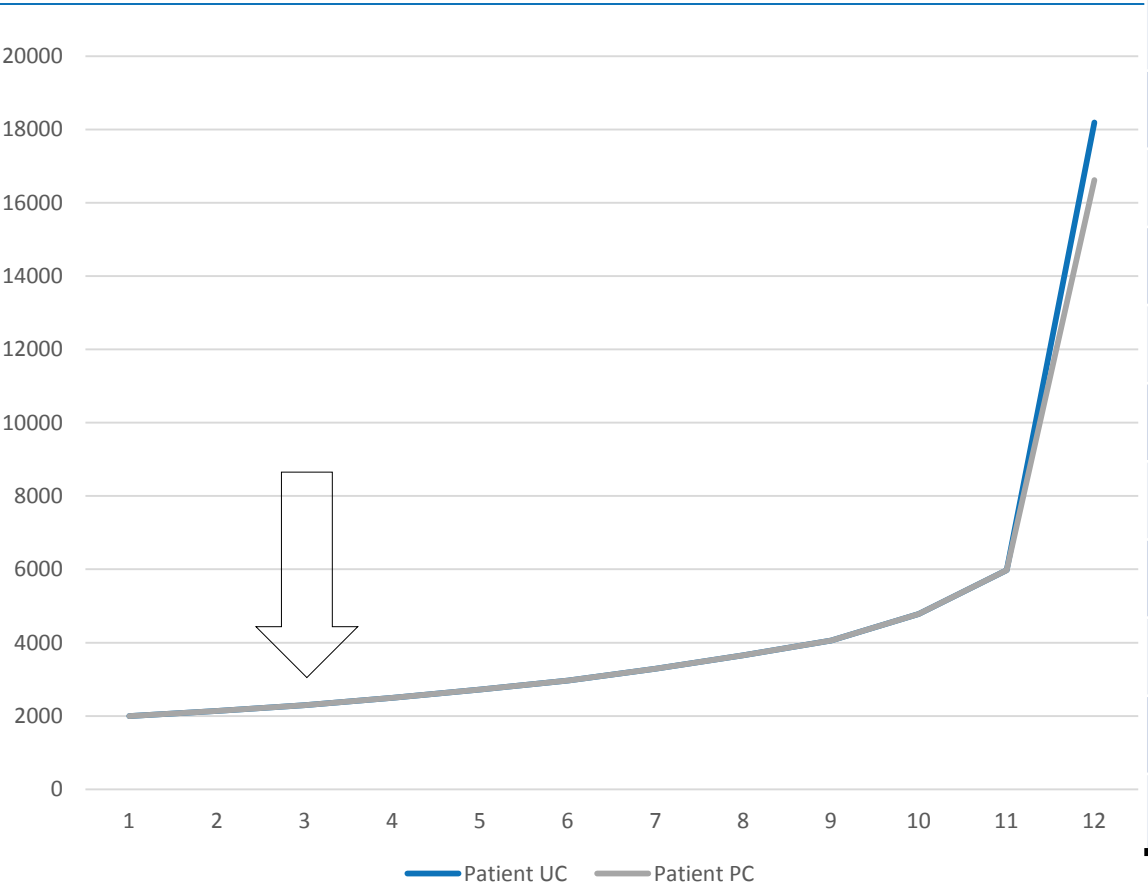
Forward-counting methods: What is the intervention impact on costs from point of intervention (Month 3)?

48613-50432=-$1819 (=4% of 50432)

	Patient UC ($)	Patient PC ($)
1	2000	2000
2	2140	2140
3	2290	2290
4	2496	2496
5	2721	2721
6	2965	2965
7	3292	3292
8	3654	3654
9	4056	4056
10	4786	4786
11	5982	5982
12	18190	16371
Σ	50432	48613

Counterfactual (i)

I reduces LMOL cost by 10%, no other impact



	Patient UC ($)	Patient PC ($)
1	2000	2000
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9	4056	4056
10	4786	4786
11	5982	5982
12	18190	16371

Counterfactual (i)

I reduces LMOL cost by 10%, no other impact

Verdict:

- Both forward- and backward-counting methods give the same answer (-$1819) but different percentages (4% or 10%)
- 'True' treatment effect is exaggerated by backward-counting methods because timeframe is not clear
- Forward-counting from intervention look at overall resource use
- More generally, be wary of 'the most important' period of last 30 days:
  - From an economic perspective, LMOL is the most costly but still only ~5% of lifetime health costs

3. Timeframe

Looking backwards and forwards

Now let's examine two counterfactuals for Patient UC and comparing forward- and backward-counting methods per Greer et al (2016):

(i) An intervention that reduces costs in LMOL by 10% and has no other relevant impact

(ii) **An intervention that reduces costs in LMOL by 10% and extends survival by one month**

3. Counterfactual (ii)

I reduces LMOL cost by 10%, extends survival

Counterfactual (ii):

- Patient PC receives an intervention that
  - Reduces LMOL costs by 10%
  - Extends life by one month
  - Has no other relevant impact

Month	Patient UC ($)	Patient PC ($)
Last month of life	18190 ⟷	16371

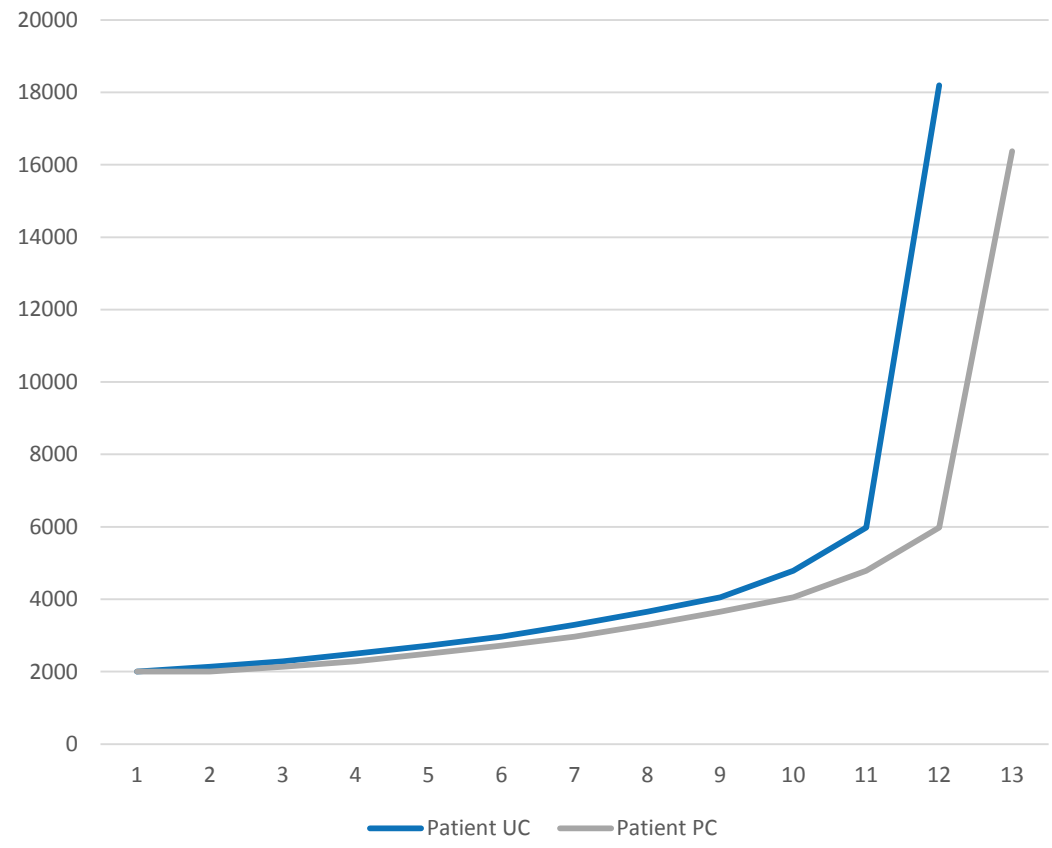
A calculation of cost effect for the last month shows the same cost reduction as previously:

16371-18190=$1819 (i.e. 10%)

- But the wider context is more complex…

3. Counterfactual (ii)

I reduces LMOL cost by 10%, extends survival



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3	2290	2140
4	2496	2290
5	2721	2496
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7	3292	2965
8	3654	3292
9	4056	3654
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11	5982	4786
12	18190	5982
13	-	16371

Counterfactual (i)

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Backward-counting methods: What is the intervention impact on costs in the LMOL?

16371-18190=-$1819 (i.e. 10% saving)

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8	3654	3292
9	4056	3654
10	4786	4056
11	5982	4786
12	18190	5982
13	-	16371
Σ	54569	54751

Counterfactual (i)

I reduces LMOL cost by 10%, no other impact

Backward-counting methods: What is the intervention impact on costs in the LMOL?

16371-18190=-$1819 (i.e. 10% saving)

Forward-counting methods: What is the intervention impact on costs from point of intervention (Month 3)?

(50753-50432)/50432=+$172 (~1% increase)

Month	Patient UC ($)	Patient PC ($)
1	2000	2000
2	2140	2000
3	2290	2140
4	2496	2290
5	2721	2496
6	2965	2721
7	3292	2965
8	3654	3292
9	4056	3654
10	4786	4056
11	5982	4786
12	18190	5982
13	-	16371
Σ	50432	50753

3. Counterfactual (ii)

I reduces LMOL cost by 10%, extends survival

Verdict:

- If there is a survival effect in either direction then an emphasis on utilisation in the 'last x of life' does not meaningfully relate to overall resource use
- This explains the 'discrepancy' in Greer 2016: Dying is expensive but living is not cheap either!

Month	Patient UC ($)	Patient PC ($)
1	2000	2000
2	2140	2000
3	2290	2140
4	2496	2290
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11	5982	4786
12	18190	5982
13	-	16371
Σ	54569	54751

3. Timeframe

Summary

- Backward counting costs originates in futile care, e.g. chemo in last few weeks of life, where timeframe is a given
- These methods can still be useful where costs/utilization are simply a proxy for quality of life and death
- These methods only examine overall resource use (and therefore answer an economic question) on assumption of treatment futility and other timeframe assumptions
- In practice, high-quality evidence on economic impact of treatment requires forward-counting evaluation

See also Bach (2004); Teno (2005), Earle (2006)

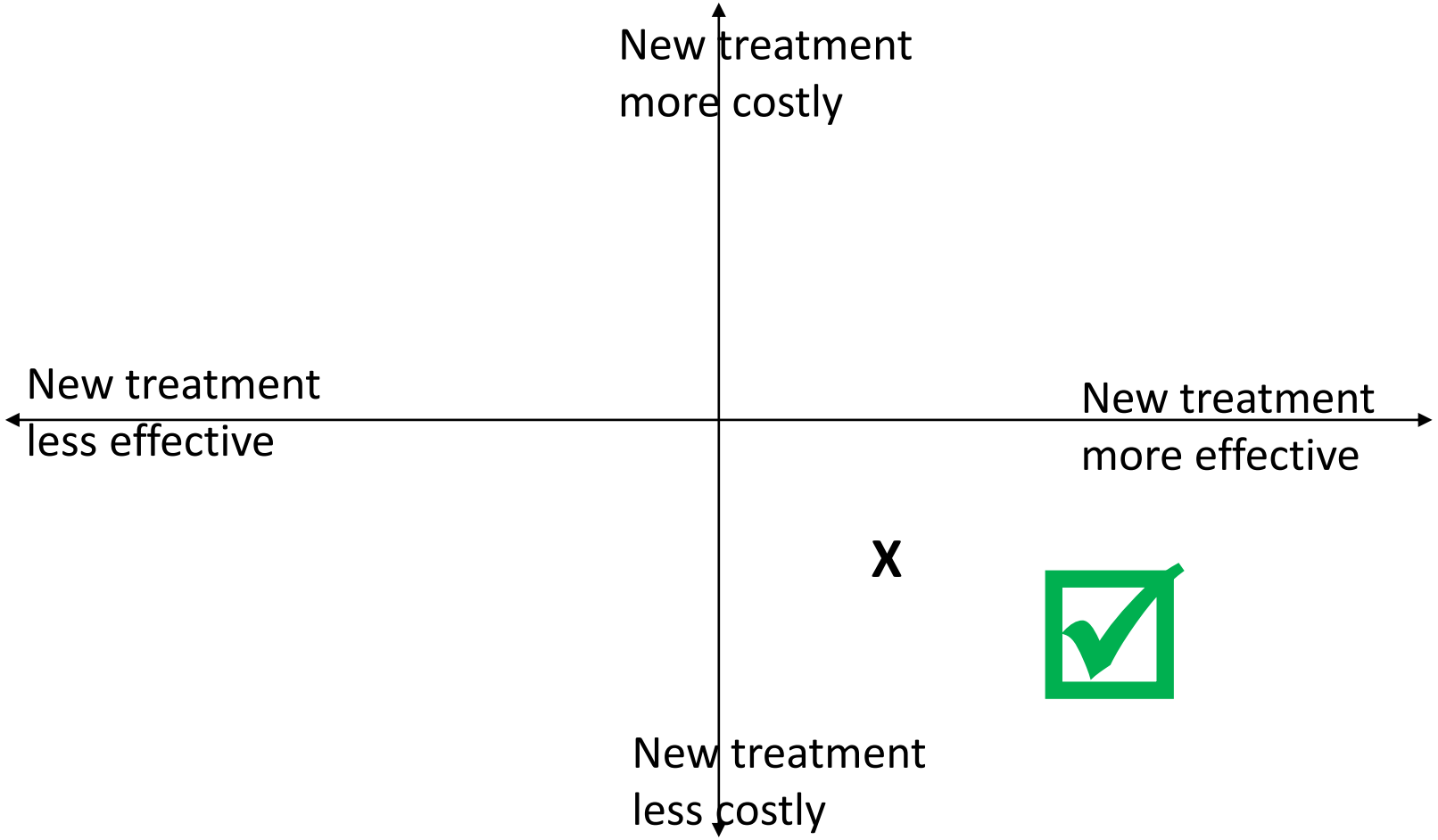
3. Timeframe

Summary

- This **does not** mean that we think that a cost-increasing intervention is not worthwhile:
  - In Greer paper, small increase in overall costs comes in return for improved QoL and increased survival
  - A cost-consequence analysis would likely validate the intervention as cost-effective
  - But this is **not** the same thing as reducing costs. Reduced costs in LMOL do not guarantee cost-savings.
  - Hence, survival-effects make forward-counting cost-consequence analysis all the more important

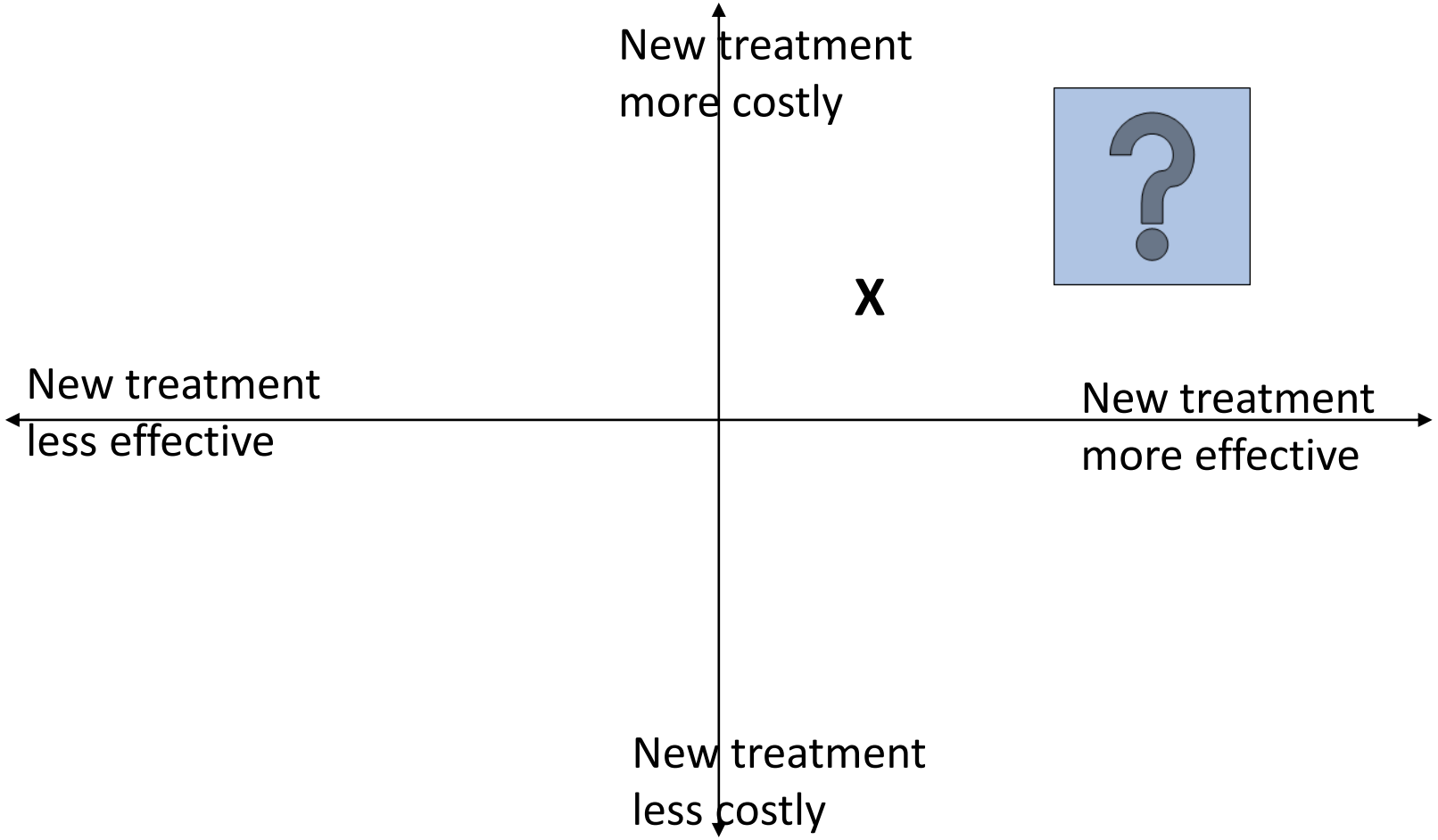
1. Introduction

Cost-consequence analysis



1. Introduction

Cost-consequence analysis



3. Timeframe

Summary

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  - In Greer paper, small increase in overall costs comes in return for improved QoL and increased survival
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  - But this is **not** the same thing as reducing costs. Reduced costs in LMOL do not guarantee cost-savings.
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4. **Concluding remarks**

Concluding remarks

Analyzing healthcare cost data

The core function of economic evaluation is estimating an intervention's impact on **resource use**

The best economic studies understand this and frame research questions accordingly

RE: Dependent variable

What is intervention impact on cost of care during study period?

NOT

What is intervention impact on mean daily cost of care? What is intervention impact on dy/dx of cost of care?

Concluding remarks

Analyzing healthcare cost data

The core function of economic evaluation is estimating an intervention's impact on **resource use**

In the context of survival effects, that means careful measurement and framing of results

RE: Timeframe

What is intervention impact on costs, counting forwards over an episode of care?

NOT

What is intervention impact on costs, counting backwards for last weeks or months of life?

Concluding remarks

Analyzing healthcare cost data

Caveats:

1. Weaker methods may reflect constraints in practice
2. The guidance discussed here is far from comprehensive
   - Statistical issues in modelling costs
   - Outliers and selection bias

Economic evidence is

- Essential to maximize provision of effective care
- Sparse in the field of palliative and hospice care
  - ➢ Opportunities for high-impact studies

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Thank You

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