HEALTH ECONOMICS
RADIOTHERAPY IN CERVICAL CANCER

Alfredo Polo MD, PhD

Applied Radiation Biology and Radiotherapy Section
Division of Human health

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International Atomic Energy Agency

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COSTS
OUTCOMES


COSTS
PERSPECTIVE
OUTCOMES

COSTS

- Direct medical costs
- Direct non-health care costs
- Changes in use of informal caregiver time
- Patient time costs

PERSPECTIVE

OUTCOMES

- Societal
- Patient
- Payer

COSTS

- Direct medical costs
- Direct non-health care costs
- Changes in use of informal caregiver time
- Patient time costs

PERSPECTIVE

- Cost-minimization analysis
- Cost-benefit analysis
- Cost-effectiveness analysis
- Cost-utility analysis

OUTCOMES

- Societal
- Patient
- Payer

COST-MINIMIZATION	COST-BENEFIT	COST-EFFECTIVENESS	COST-UTILITY
• The outcome of interest for the experimental treatment or intervention does not differ from the standard treatment, resulting in the intervention with the least cost being the favoured intervention. • It may not be "cost-effective" to perform an economic analysis of interventions that do not differ from a standard intervention or treatment.	• In a cost-benefit analysis, both cost and effects are valued in terms of currency. • It is very difficult to value a year of life saved or a cancer prevented. • The output of the cost-benefit analysis is an unit-less ratio with a higher number being preferred.	• The cost (numerator) remains the same while the denominator contains the outcome or effect of interest (overall survival, disease-free survival or number of cancers prevented or detected). • The Result is a ratio with the units $/life year or $/disease-free life year. • Threshold to separate cost-effective interventions is $50,000/life year. • There are some, however, that think this ratio should be higher	• The cost (numerator) remains the same while but the denominator is quality-adjusted survival, which is usually measured in quality-adjusted life years (QALYs). • A QALY is a discounted value of health care that adjusts survival by a patient preference for the health state a patient was in at the time of the measurement. • Cost-utility analyses are helpful in trying to compare nonsimilar health interventions.

Konski, A. (2008). Economic analysis of health care interventions. Semin Radiat Oncol, 18(3), 168-174.

INCREMENTAL COST-EFFECTIVENESS RATIO (ICER)

$$ICER = \frac{(C_1 - C_0)}{(E_1 - E_0)}$$

C_1 = Cost of new intervention
C_0 = Cost of the reference intervention
E_1 = Outcome of new intervention (Benefit, Effect or Utility)
E_0 = Outcome of the reference intervention (Benefit, Effect or Utility)

INCREMENTAL COST-EFFECTIVENESS RATIO (ICER)

	Reference treatment	New treatment
Cost	1000$	1200$
Outcome (Effect)	65 %	75 %

$$ICER = \frac{(C_1 - C_0)}{(E_1 - E_0)}$$

$$ICER = \frac{1200 - 1000}{75-65}$$

ICER = 20$ per each 1% increment in effect

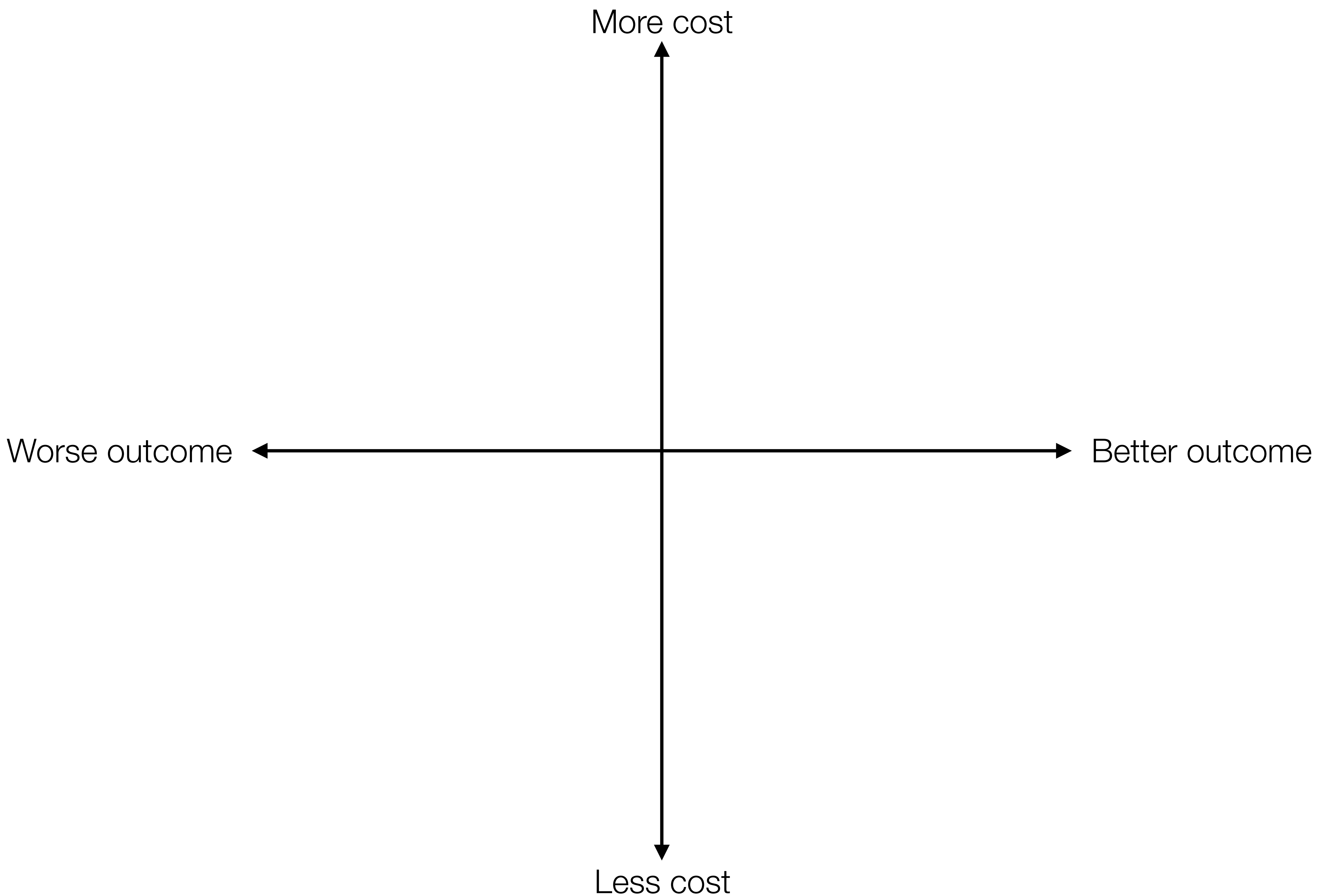
INCREMENTAL COST-EFFECTIVENESS RATIO (ICER)

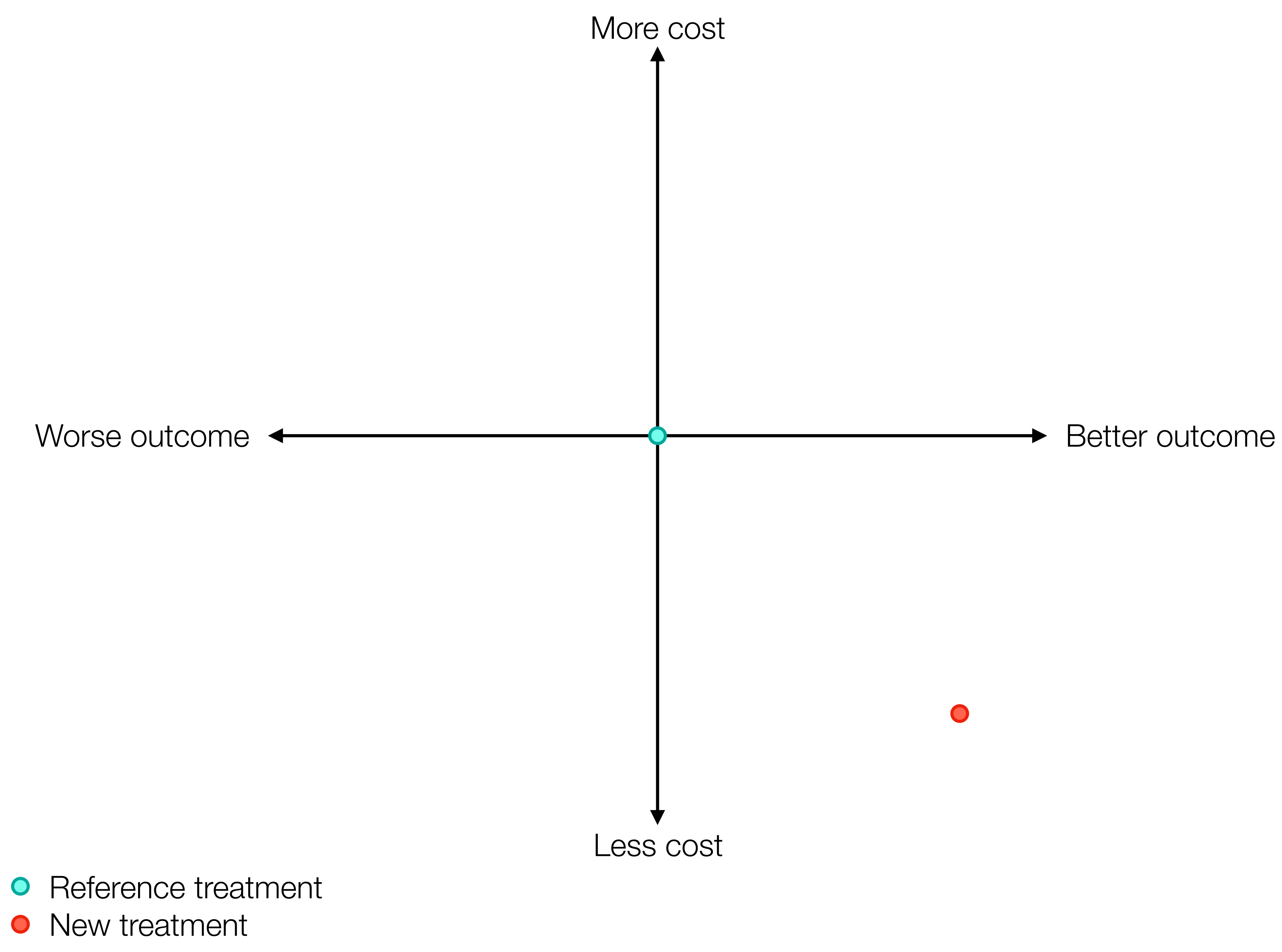
	Reference treatment	New treatment
Cost	1000$	2000$
Outcome (Effect)	60 %	65 %

$$ICER = \frac{(C_1 - C_0)}{(E_1 - E_0)}$$

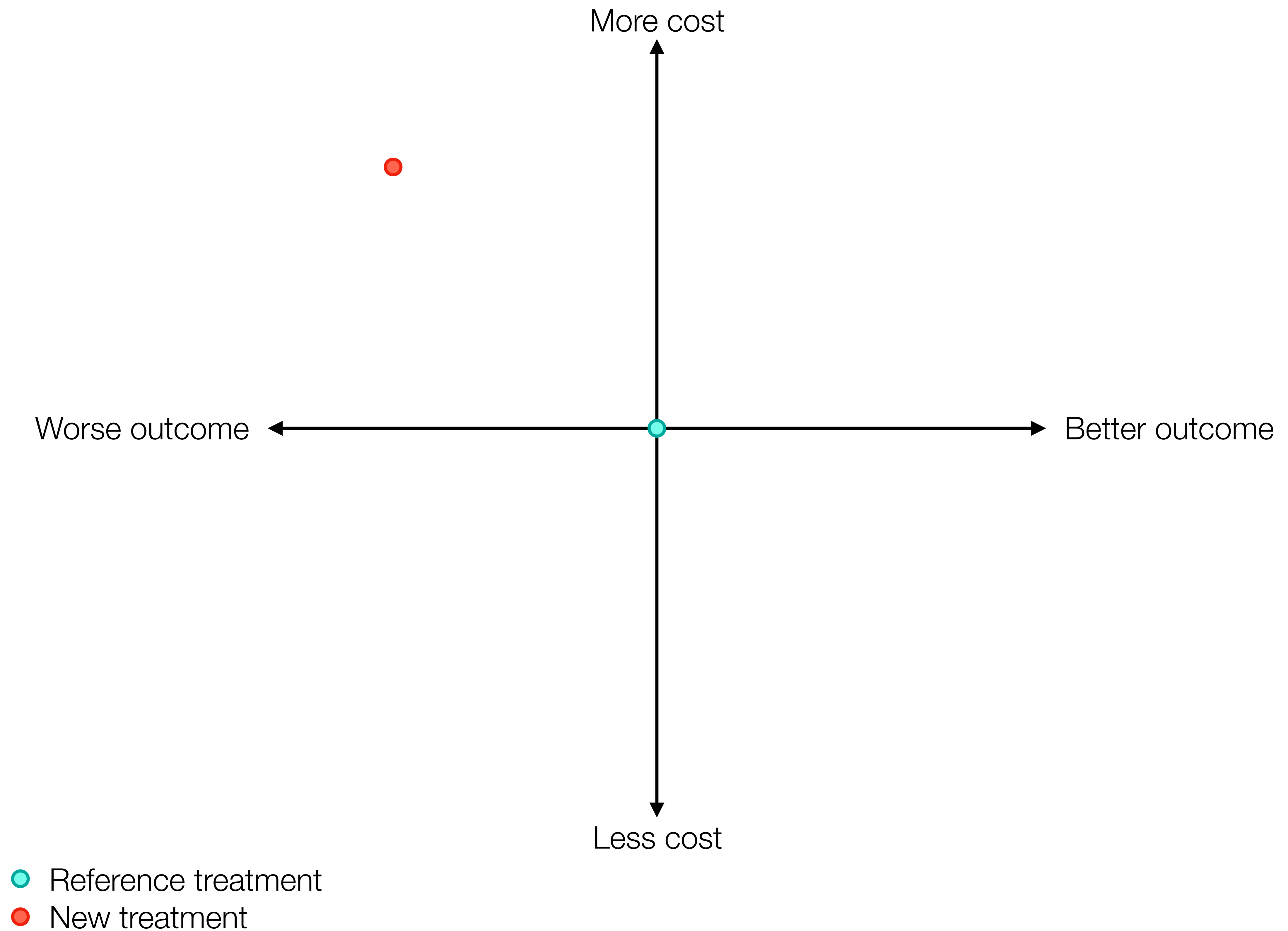
$$ICER = \frac{1200 - 1000}{75-65}$$

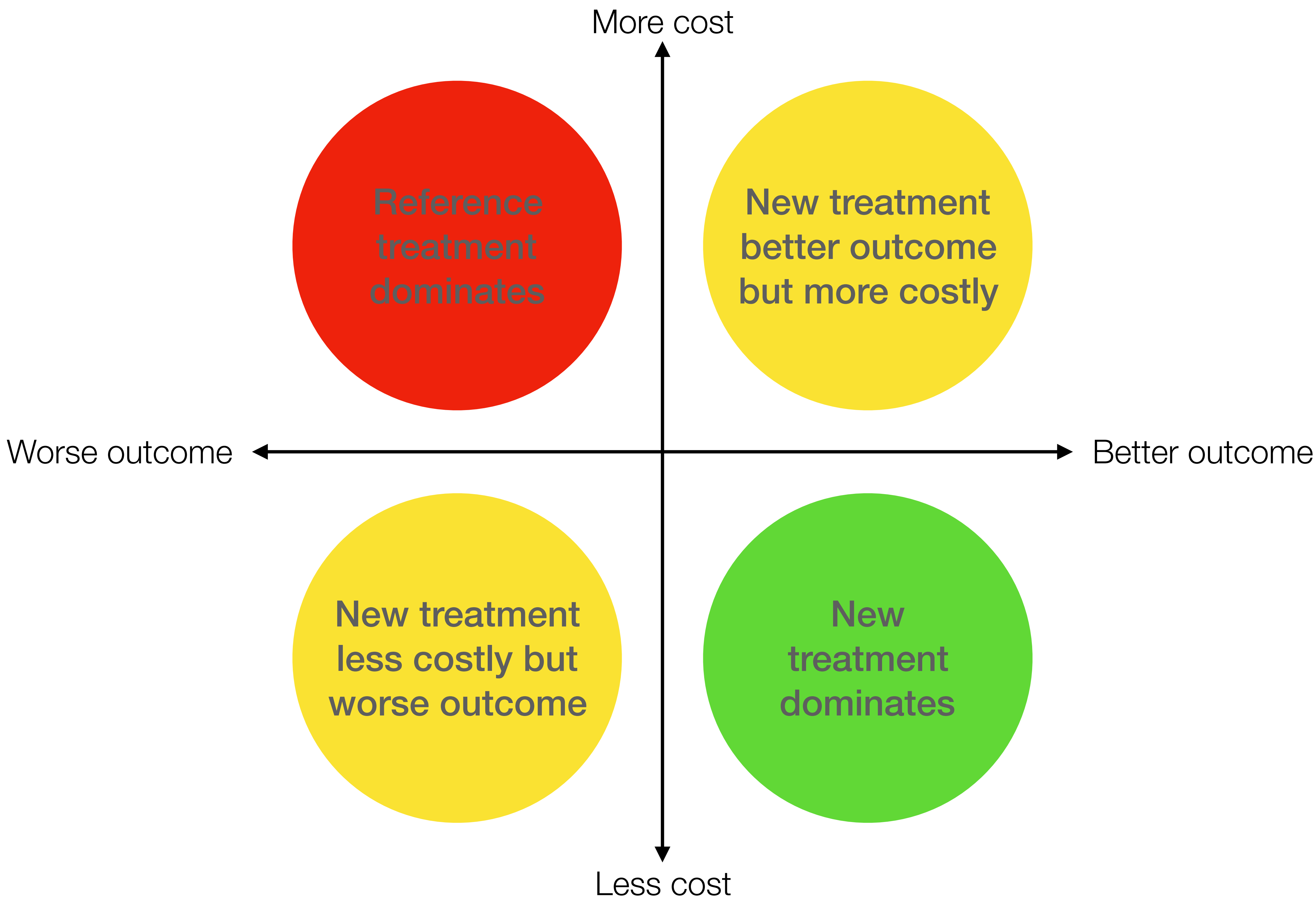
ICER = 200$ per each 1% increment in effect

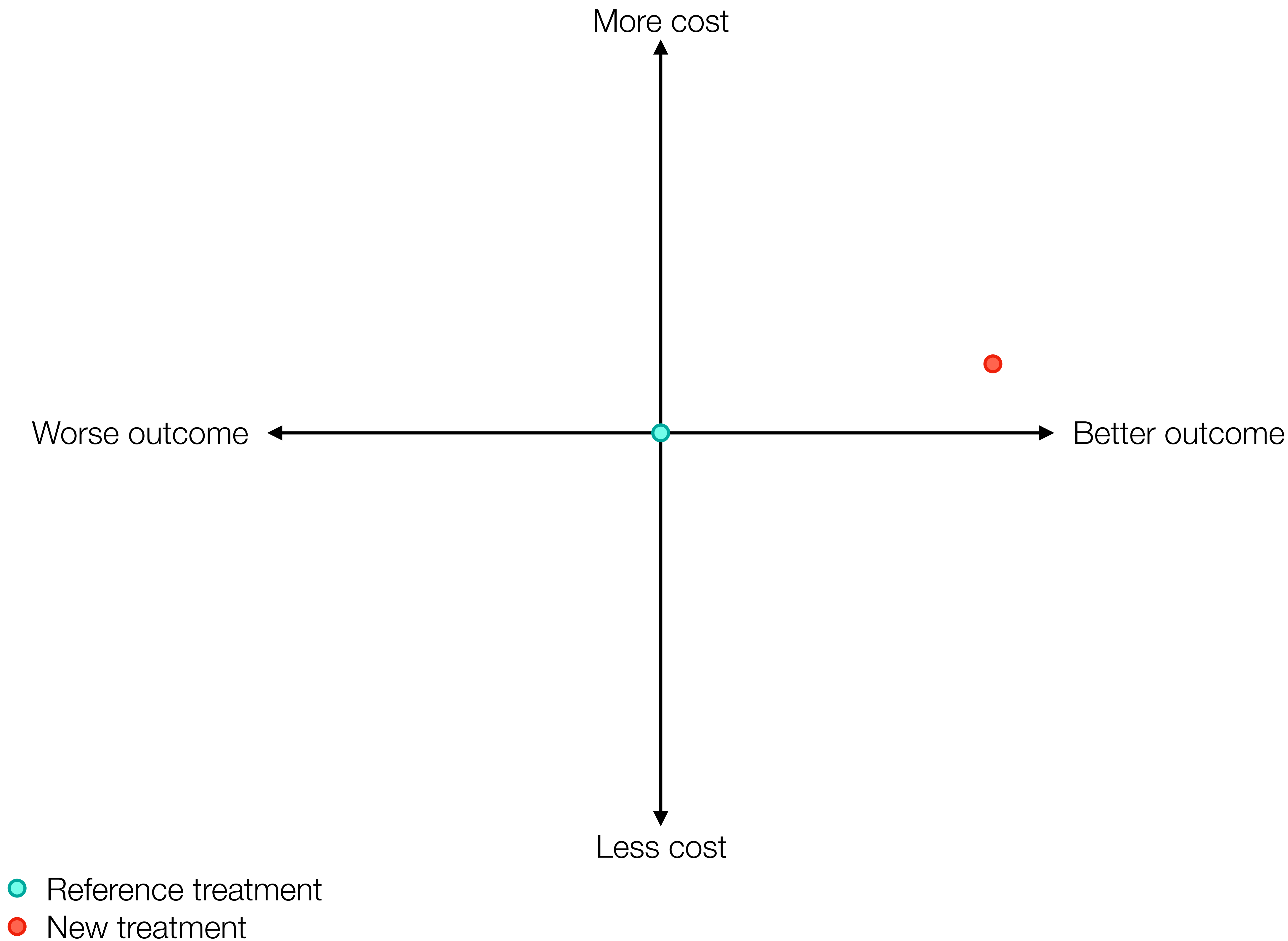

More cost
Worse outcome
Better outcome
Less cost

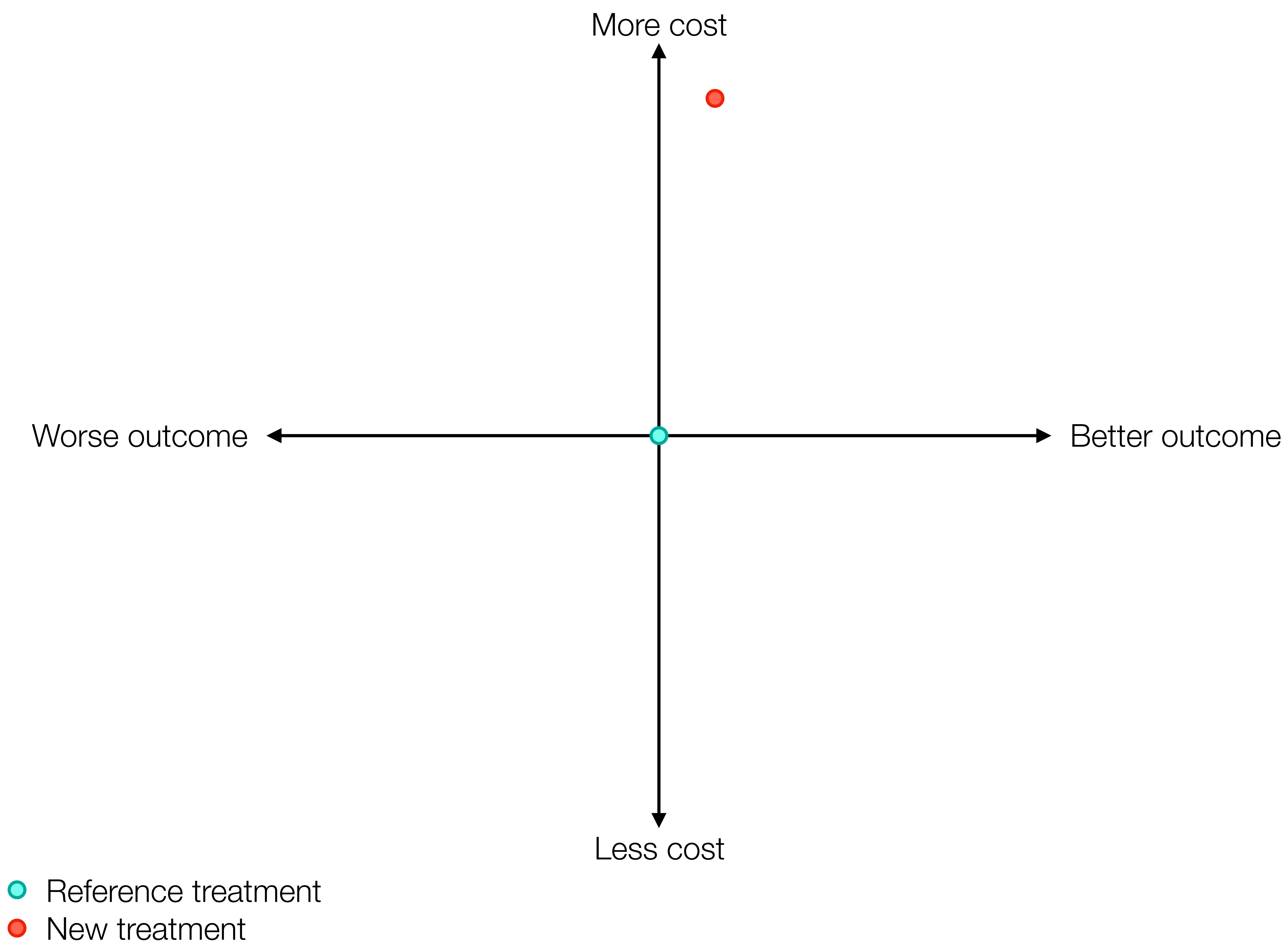


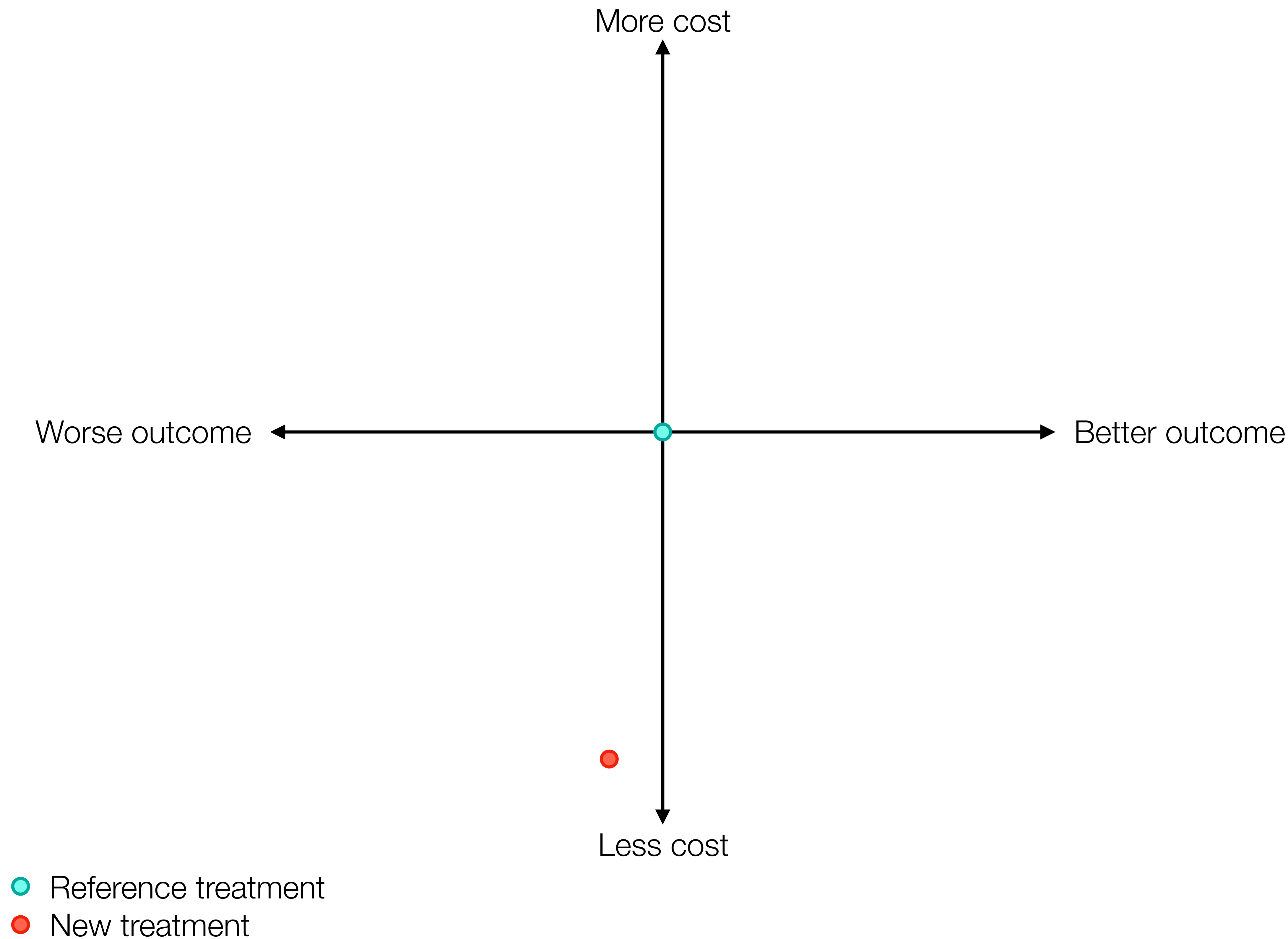
More cost
Worse outcome
Better outcome
Less cost
Reference treatment
New treatment


More cost
Worse outcome
Better outcome
Less cost
Reference treatment
New treatment

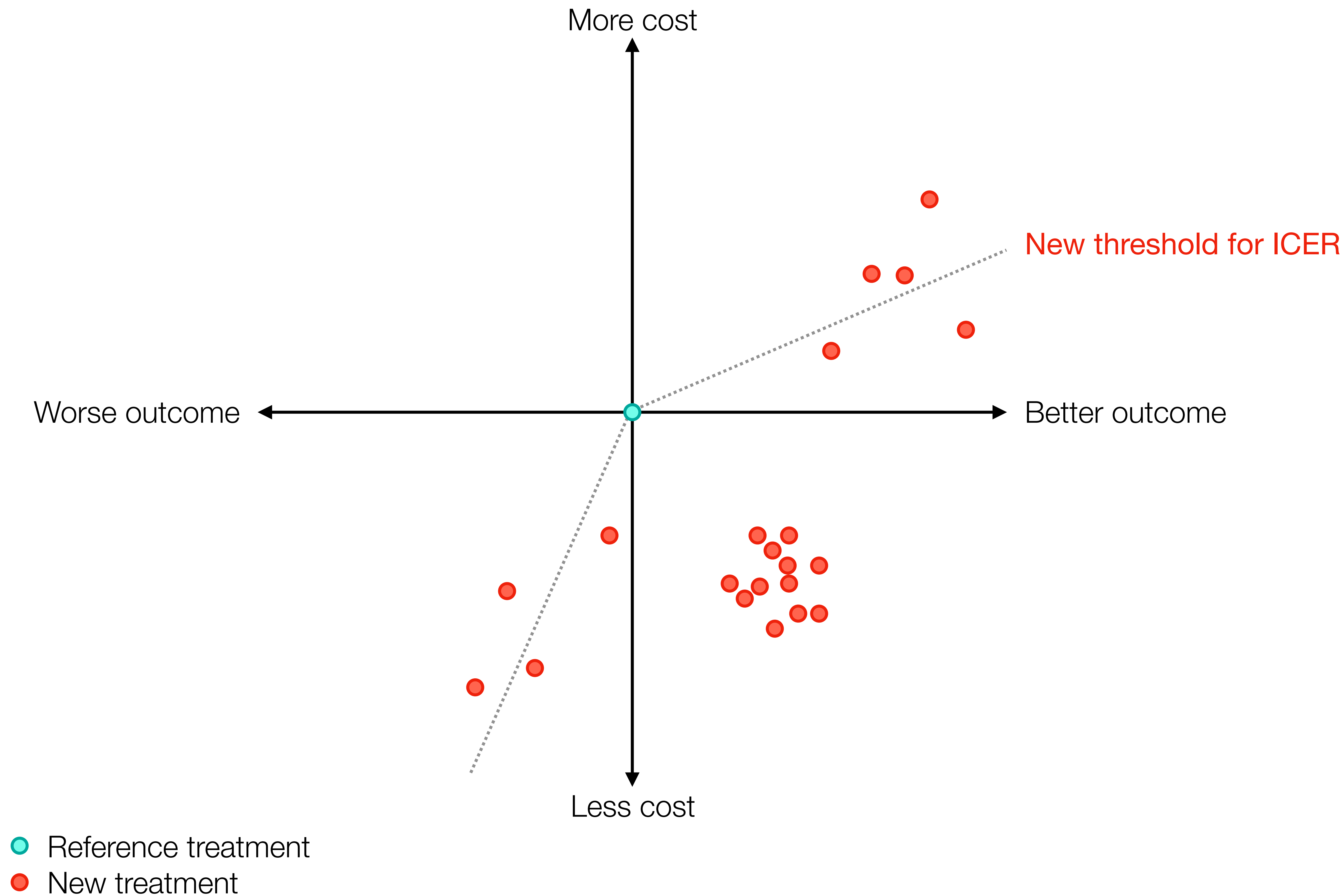

More cost
Reference treatment dominates
New treatment better outcome but more costly
Worse outcome
Better outcome
New treatment less costly but worse outcome
New treatment dominates
Less cost


More cost
Worse outcome
Better outcome
Less cost
Reference treatment
New treatment


More cost
Worse outcome
Better outcome
Less cost
Reference treatment
New treatment


More cost
Worse outcome
Better outcome
Less cost
Reference treatment
New treatment


More cost
Threshold for ICER
Worse outcome
Better outcome
Less cost
Reference treatment
New treatment


More cost
New threshold for ICER
Worse outcome
Better outcome
Less cost
Reference treatment
New treatment

THRESHOLDS FOR ICER

- Level of costs and effects that an intervention must achieve to be acceptable in a given health-care system.
- Hard vs. Soft thresholds
- Threshold approach vs. Budget approach
- Cost-effectiveness affordability

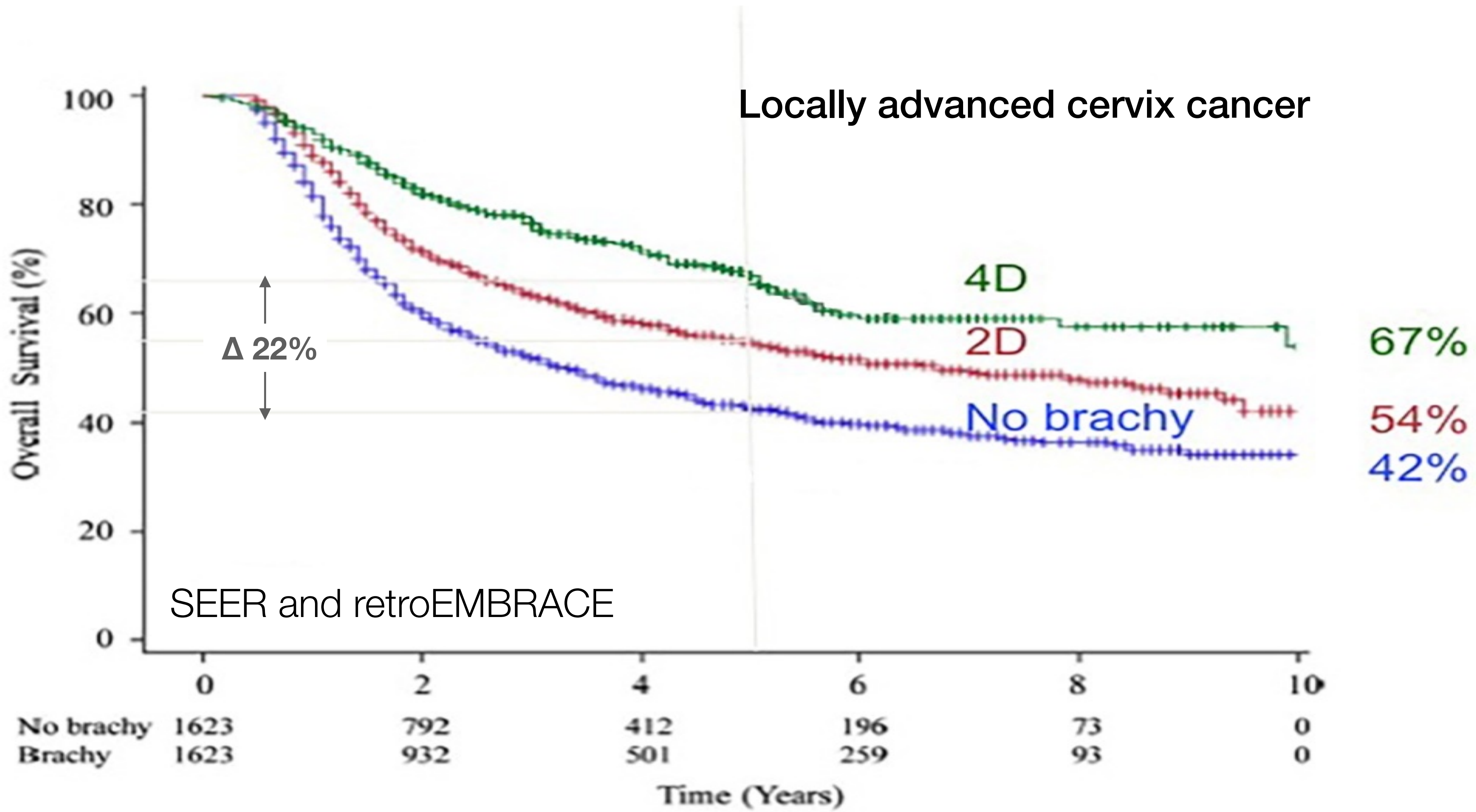
Weinstein M, Zeckhauser R. Critical ratios and efficient allocation. J Public Econ 1973;2:147–57.
Torrance GW, Siegel JE, Luce BR. Framing and designing the cost-effectiveness analysis. In: Gold MR, Siegel JE, Russell LB, Weinstein MC, eds., Cost-Effectiveness in Health and Medicine.
Eichler, H. G., Kong, S. X., Gerth, W. C., Mavros, P., & Jönsson, B. (2004). Use of cost-effectiveness analysis in health-care resource allocation decision-making: how are cost-effectiveness thresholds expected to emerge. Value Health, 7(5), 518-528.

THRESHOLDS FOR ICER IN CERVIX CANCER

- No consensus in US for C/E criterion threshold
- Interventions costing less than $100,000 per QALY gained are typically considered economically reasonable
- A $50,000 per QALY gained criterion is commonly cited as the minimum of willingness to pay

Kim, H., Rajagopalan, M. S., Beriwal, S., Huq, M. S., & Smith, K. J. (2015). Cost-effectiveness analysis of 3D image-guided brachytherapy compared with 2D brachytherapy in the treatment of locally advanced cervical cancer. Brachytherapy, 14(1), 29-36.

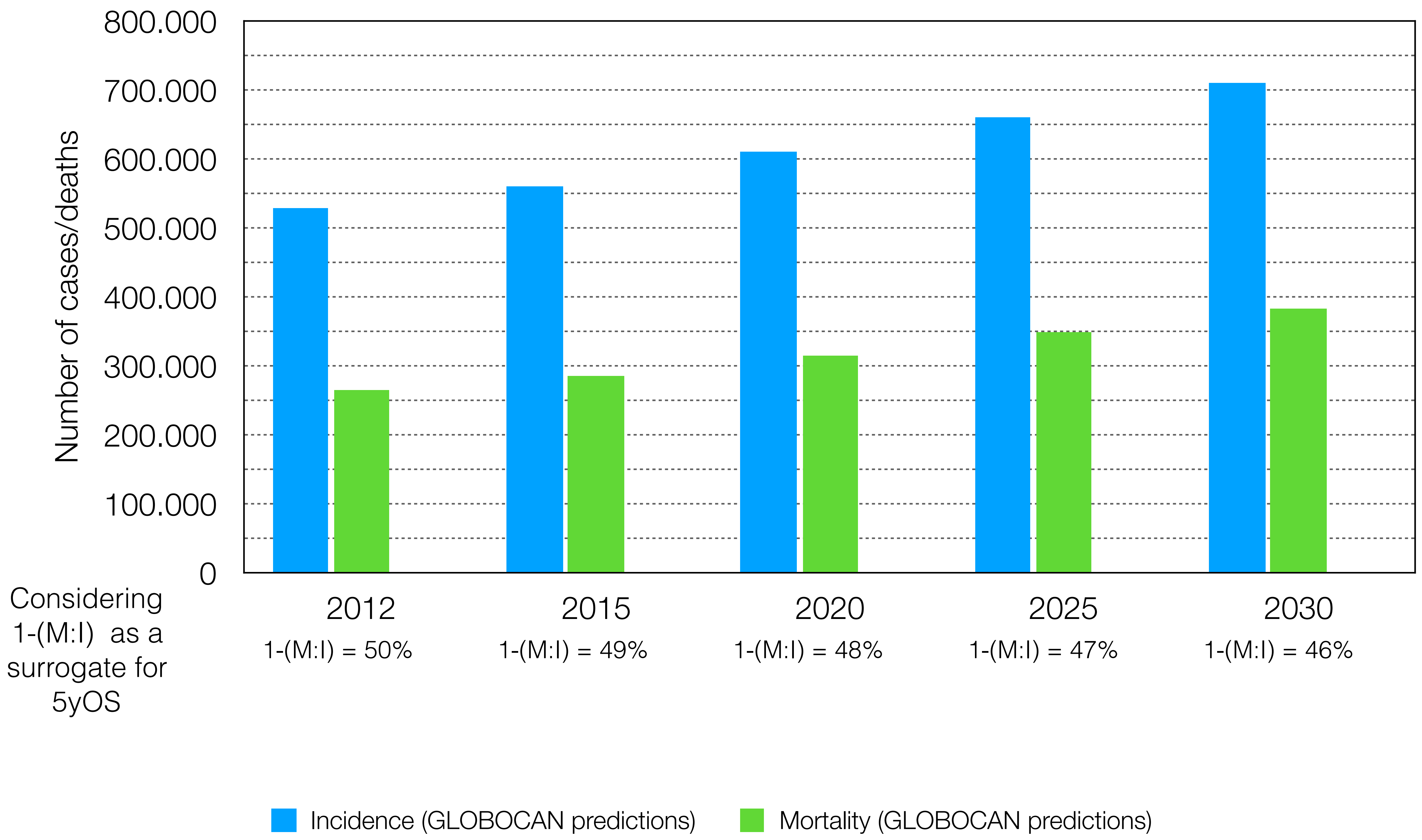
COST-EFFECTIVENESS OF INTERVENTIONS IN CERVIX CANCER



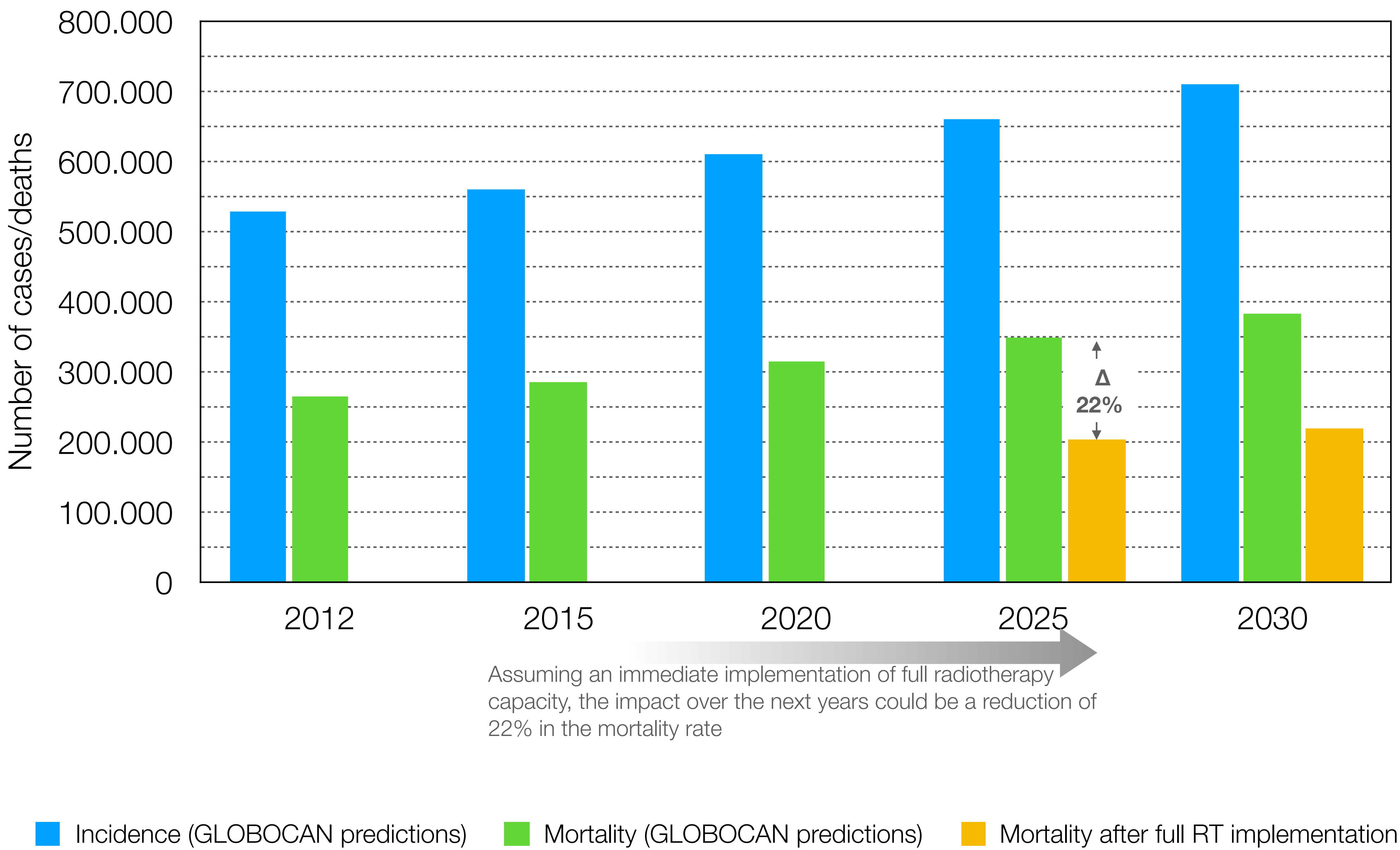
Han, K., Milosevic, M., Fyles, A., Pintilie, M., & Viswanathan, A. N. (2013). Trends in the utilization of brachytherapy in cervical cancer in the United States. Int J Radiat Oncol Biol Phys, 87(1), 111-119.
Sturdza, A., Pötter, R., Fokdal, L. U., Haie-Meder, C., Tan, L. T., Mazeron, R. et al. (2016). Image guided brachytherapy in locally advanced cervical cancer: Improved pelvic control and survival in RetroEMBRACE, a multicenter cohort study. Radiother Oncol, 120(3), 428-433.

COST-EFFECTIVENESS OF INTERVENTIONS IN CERVIX CANCER

Author	Reported years	By stage				All stages combined	Case-mix	Comment
		Stage I	Stage II	Stage III	Stage IV			
Komaki et al. 1995 Hanks et al., 1983 Coia et al., 1990	1973	79 %	62 %	25 %	-			Patterns of care study (Radiation Oncology Facilities)
	1978	75 %	58 %	39 %	-		I: 36% II: 41% (IIB:28%) III: 20%	
	1983	81 %	57 %	47 %	-		I: 38% II: 40% III: 18% Unknown: 4%	
Jones et al., 1995	1984	IA: 93% IB: 80%	IIA: 67% IIB: 64%	37 %	11 %	68 %	61% early 39% advan.	Patterns of care study (American College of Surgeons)
Potter et al., 2000	1993-1997	IA: 100% IB: 61%	IIA: 75% IIB: 69%	IIIA: 48% IIIB: 46%	IVA: 40% IVB: 0%	58 %	13% early 87% advan.	Single institution 3y OS
Chemoradiotherapy, 2008	1987 - 2006	-	-	-	-	60% (RT) 66% (RTCT)	IIB/III: 72%	Meta-Analysis 15 trials 3452 women
Han et al., 2013	1998 - 2009	-	-	-	-	46% EBRT 58% EBRT + BT	IB2: 8% II: 52% III: 35% IV: 3%	SEER review 7359 women 4yOS
Sturdza et al., 2016	1998-2012	IA: 100% IB: 83%	IIA: 80% IIB: 70%	IIIA: 42% IIIB: 42%	32 %	65% (RT no CT) 69% (RTCT)	IB: 16% IIA: 6% IIB-IV: 76%	RetroEMBRACE 5y OS 69% is the target for fully implemented RTCT



800.000
700.000
600.000
500.000
400.000
300.000
200.000
100.000
0
Number of cases/deaths
2012
2015
2020
2025
2030
Considering 1-(M:I) as a surrogate for 5yOS
1-(M:I) = 50%
1-(M:I) = 49%
1-(M:I) = 48%
1-(M:I) = 47%
1-(M:I) = 46%
Incidence (GLOBOCAN predictions)
Mortality (GLOBOCAN predictions)


800.000
700.000
600.000
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300.000
200.000
100.000
0
Number of cases/deaths
Δ
22%
2012
2015
2020
2025
2030
Assuming an immediate implementation of full radiotherapy capacity, the impact over the next years could be a reduction of 22% in the mortality rate
Incidence (GLOBOCAN predictions)
Mortality (GLOBOCAN predictions)
Mortality after full RT implementation

Brachytherapy 14 (2015) 29−36

BRACHYTHERAPY

Cost-effectiveness analysis of 3D image-guided brachytherapy compared with 2D brachytherapy in the treatment of locally advanced cervical cancer

Hayeon Kim[1,*], Malolan S. Rajagopalan[1], Sushil Beriwal[1], M. Saiful Huq[1], Kenneth J. Smith[2]

[1]*Department of Radiation Oncology, University of Pittsburgh Cancer Institute, Pittsburgh, PA*

[2]*Department of Medicine, University of Pittsburgh School of Medicine, Pittsburgh, PA*

Table 3
ICER for 3D IGBT compared with 2D conventional brachytherapy

Strategy	Cost ($)	Incremental cost	Effectiveness (QALY)	Incremental effectiveness (QALY)	ICER ($ per QALY gained)
2D	18,817	—	2.01	—	—
3D IGBT (CT)	21,820	3003	2.17	0.16	18,634
3D IGBT (MRI)	23,293	4476	2.17	0.16	27,774

ICER = incremental cost-effectiveness ratio; 3D = three-dimensional; IGBT = image-guided brachytherapy; 2D = two-dimensional; QALY = quality-adjusted life-year.

- Using the threshold for ICER of $50000, MRI-based brachytherapy can be adopted as treatment of locally advanced cervix cancer.
- Other factors have to be analysed (time consumption…)

INCREMENTAL COST-EFFECTIVENESS RATIO (ICER)

BRACHYTHERAPY IN LOWER-MIDDLE INCOME COUNTRIES

	EBRT only	EBRT + 3DBT
Cost	1606$	2316$
Outcome (Effect)	42 %	69 %

$$ICER = \frac{(C_1 - C_0)}{(E_1 - E_0)}$$

$$ICER = \frac{2316 - 1606}{69-42}$$

$$ICER = \text{26\$ per each 1\% increment in effect}$$

CONCLUSIONS