Caveats in Cost-Effectiveness Analysis of Remote Patient Monitoring:

Impact of survivor adjustment of QALYs on decision making metrics

Tobias Wirth[1], Steffen Pauws[1,2]

[1]Philips Research, Eindhoven, NL, [2]Tilburg University, Tilburg, NL

Background

Whole System Demonstrator

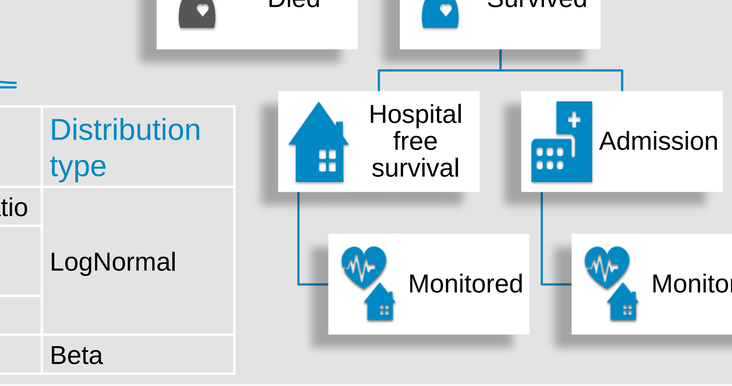
- Largest randomized controlled trial for Telehealth introduced in three regions in the UK (Cornwall, Newham, Kent) from 2008-2009.
- Focused on three chronic conditions, diabetes, COPD and congestive heart failure in elderly population.
- Provide evidence base to support investment decisions for virtualized care solutions for chronic disease management.

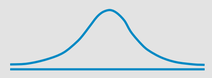
Outcomes	Usual Care (n=1,584)	Tele-Health (n=1,570)	Relative difference
Mortality [1]	8.3%	4.6%	-45%
QALY (EQ-5D) [2]	0.549	0.560	+2%
Total cost* [2] (incl. equipment costs)	£ 5,559	£ 6,384	+15%
Hospital tariff per head [2]	£ 2,448	£ 2,260	-8%
Admission proportion [2]	48.2%	42.9%	-11%
ED admissions per head [2]	0.68	0.54	-21%
Elective adm. per head [2]	0.49	0.42	-14%
Outpatient visits per head [2]	4.68	4.76	+2%
ED visits per head [2]	0.75	0.64	-15%
Average Length of Stay [2]	5.68	4.87	-14%

*Annual equivalent cost of self-reported service use

Probabilistic sensitivity analysis

Simulation
- Half-cycle correction
- 12 monthly cycles
- 1000 simulation runs
- 1000 patients





Input parameter	Distribution type
Death hazard ratio	LogNormal
Admission hazard ratio	
Total Cost	
QALY	Beta

Objective

When evaluating telehealth interventions addressing an chronically ill population we propose to adjust survivor-reported QALYs for bias due to loss to follow-up of non-survivors. Our survivor-adjustment model favors decision making on cost-effectiveness of telehealth for pending market introduction by health systems or payers.

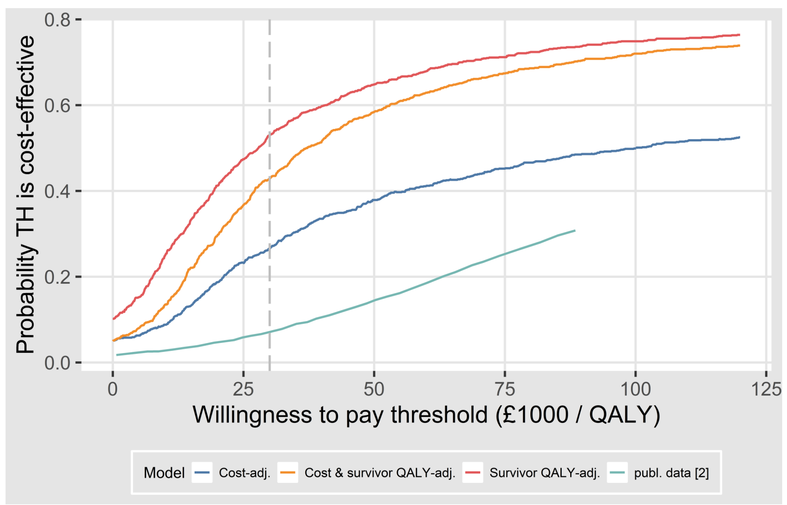
Methods: We built probabilistic decision-analytic models to compare patient-reported costs and QALYs of telehealth in addition to usual care based on published evidence and uncertainty [2].

Model: Our models apply adjustments to outcomes of cost and QALY. The cost-adjustment model is populated with raw QALYs and costs adjusted for baseline costs, demographics and number of chronic conditions as reported in [2]. Our survivor QALY-adjustment model aims to compensate the effect of different mortality rates among the control and intervention group which causes bias due to loss to follow-up of more patients in the control arm. This model uses raw cost data.

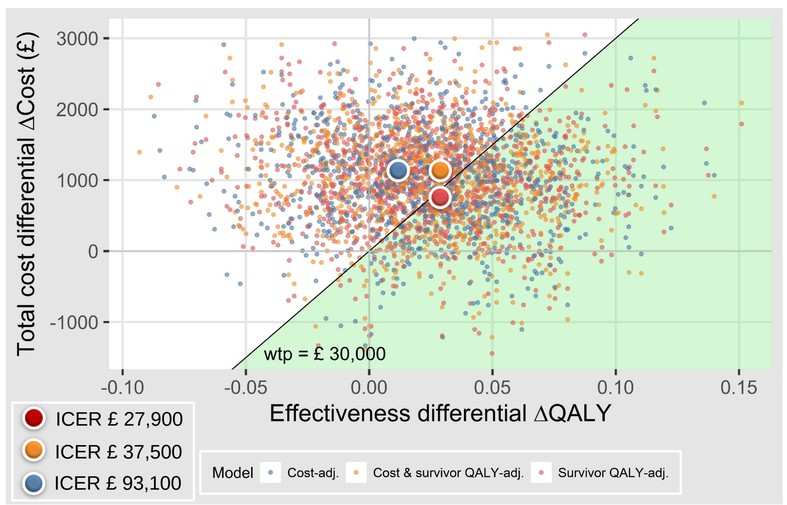
Our cost- and survivor QALY-adjustment model adjusts both outcomes. This model may be prone to over-adjustment. We computed decision metrics such as, net monetary benefit, incremental cost-effectiveness ratio and acceptability, expected value of perfect information.

Results: The WSD reported an ICER of £92,000 and an CEA of 11% at willingness to pay threshold of £30,000 [2]. We reproduced the reported ICER by our cost-adjustment model. Our combined cost and QALY adjustment model produced an ICER of £37,500 and an CEA of 43%. Our survivor QALY-adjustment model produced an ICER of £27,900 and the probability of cost effectiveness increased to 53%.

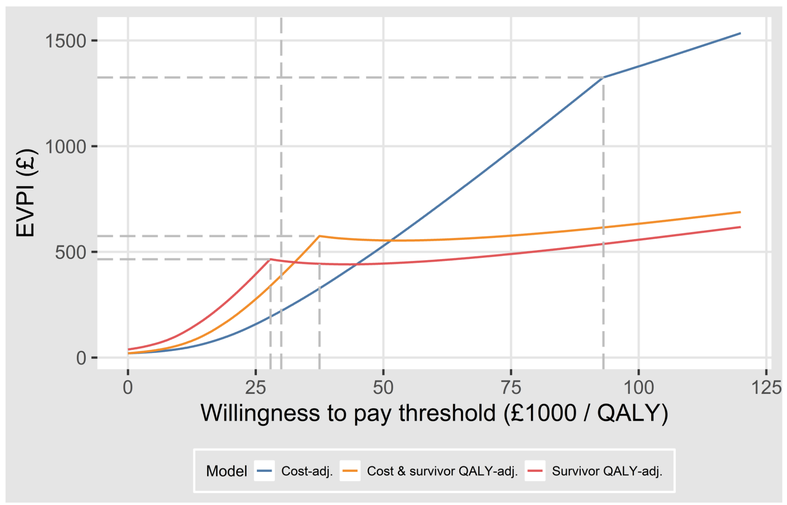
Cost-Effectiveness Acceptability



Cost-Effectiveness Plane



Expected Value of Perfect Information



Decision Making Metrics

Model	ICER [£ / QALY]	CEA wtp = £30k	NMB UC	NMB TH	EIB	EVPI
Cost-adjustment model from [2]	92000	11%				
Cost-adjustment model	93043	26%	£ 11069	£ 10317	- £ 752	£ 220
Cost & survivor QALY-adj. model	37482	43%	£ 9701	£ 9480	- £ 221	£ 387
Survivor QALY-adjustment model	27850	53%	£ 9545	£ 9609	+ £ 64	£ 458

	QALY UC	QALY TH	Δ% QALY	Total Cost UC	Total cost TH	Hospital use cost per event
Cost-adjustment model from [2]	0.549§	0.560§	+2%	£ 5401#	£ 6511#	
Cost-adjustment model						
Cost & survivor QALY-adj. model	0.503*	0.533*	+6%	£ 5401#	£ 6511#	£ 4725 (UC) £ 4680 (TH)
Survivor QALY-adjustment model				£ 5559§	£ 6384§	

* survivor adjustment: $\Pr(survival) \cdot QALY$

§ raw mean

adjusted mean

Summary

Caveats

Measuring difference in QALYs between baseline and at 1-year follow-up in an chronically ill population introduces survivor bias due to different mortality rates prevalent in the trial arms.

The control group's mean QALY is biased towards QALYs reported by healthier patients because the control group's higher mortality rate causes more of the sicker patients to die before follow-up.

Remedial Adjustments

- Adjust for bias due to loss to follow-up of non-survivors.
- Use patient-specific change in QALYs starting at baseline and aggregated over multiple follow-up measuring moments.

Improved Decision Making Metrics

Model	ICER $\left[\frac{£}{QALY}\right]$	CEA wtp = £30k	Δ% QALY	EIB
Cost-adj. model from [2]	92000	11%	+2%	
Survivor QALY-adj. model	27900	53%	+6%	+ £ 64

Conclusions

- Uncorrected bias can influence decision making on cost-effectiveness of the intervention.
- Value of Information analysis can help define a price point for further study to reduce uncertainty for decision maker

References:

[1] Steventon, A. et al. Effect of telehealth on use of secondary care and mortality: findings from the whole system demonstrator cluster randomized trial. 3874, 1–15 (2012).

[2] Henderson, C. et al. Cost effectiveness of telehealth for patients with long term conditions (Whole Systems Demonstrator telehealth questionnaire study): nested economic evaluation in a pragmatic, cluster randomized controlled trial. BMJ 346, f1035 (2013).

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