Correcting A Cost-Effectiveness Analysis (CEA) with Suggestions on Ways of Avoiding Misinterpretations and Calculating Errors Associated with Them: The Singapore Diabetes Prevention CEA.

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Introduction and Objectives

A Singapore cost-effectiveness analysis (CEA) of diabetes prevention based on the US Diabetes Prevention Program (DPP) concluded that metformin and lifestyle modifications are both cost-effective. We corrected a number of errors in that analysis. A new decision tree, with new input data, will be modeled assessing corrected probabilities, including the baseline utilities, correctly discounting both costs and utilities, and recalculating ICERs with appropriate methods, eliminating strongly and weakly dominated alternatives. We will be expanding the deterministic analysis using the NMB (Net Monetary Benefit) framework to validate the results. Deterministic NLCs (Net Loss Curves) analysis will show the importance of indicating the correct optimal treatment vs. the alternative that was considered cost-effective in the Singapore analysis but was not. A PSA (Probabilistic Sensitivity Analysis) will be performed along with an EVPI (Expected Value of Perfect Information), and probabilistic NLCs (Net Loss Curves) analysis to assess uncertainty, the value of reducing it and the implications of making the wrong decision as to cost-effective therapy. Moreover, we assess the advantage of the NLC method over other measures in cost-effectiveness analysis when multiples alternatives are being evaluated. We concluded that only lifestyle was cost-effective and explored various graphics, indicating the appropriate conclusion, minimizing chance of misinterpretation. We then assessed the impact of adopting metformin as cost-effective in error.

Methods

A new improved model, correcting the main flaws (probabilities, yearly cost and utilities, discounting, ICER calculation), lead us to produce a more accurate cost-effectiveness analysis, expanding the analysis using the NMB approach to complement the conclusions and assessing the uncertainty (PSA and EVPI - NLCs). A summary of the analyses is shown in the Figure 1. The Singapore authors applied health care system and societal perspectives, using the same incorrect ICER methodology and questionable parameter data (probabilities, costs, and utilities) in both cases. Our assessment only uses the health system perspective to illustrate the errors and advantages to correcting them and in indicating the level of uncertainty in the analysis and value of getting the right answer.

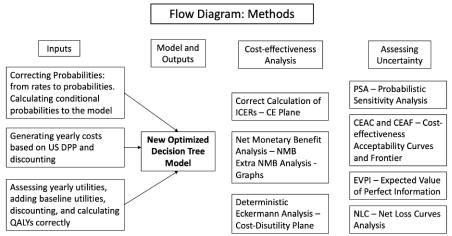

Figure 1 Summary of Analyses

Results

The difference between expected values for Costs and QALYs vs. our results ranged from -11.9% to 6.6% (costs), and from -3.3% to -2.6% (QALYs). Placebo and metformin were both strongly dominated by lifestyle. Lifestyle was the cost-effective at any conventional WTP.

Calculation of ICERs - Probabilistic

Intervention	Cost US$	QALY	ICER vs. NME1		ICER vs. NME2	NME2
Lifestyle	7,929	1.963				
Placebo	8,304	1.928	Dominated	(*)		
Metformin	8,871	1.938	Dominated	(*)		

NME1: is the next most effective intervention, not strongly dominated
NME2: is the most effective intervention, not weakly dominated
(*) Placebo and Metformin are, in this case, strongly dominated by Lifestyle

Table 1 Expected Costs and QALYs and calculation of ICERs

Probabilistic - NMB				Higher Net Benefit	
WTP US$	Placebo	Lifestyle	Metformin		
50,000	88,115	90,205	88,044	90,205	Lifestyle
53,000	93,900	96,093	93,859	96,093	Lifestyle
65,048	117,133	119,740	117,212	119,740	Lifestyle
100,000	184,534	188,340	184,959	188,340	Lifestyle

Table 2 Net Monetary Benefit at different WTP – From PSA

Various visual depictions clearly show dominance of lifestyle over metformin and placebo. The cost-effectiveness plane shows metformin and placebo as dominated. The cost-disutility plane shows how placebo and metformin are technically and economically inefficient (and can measure the degrees of inefficiency) and CEACs indicate minimal decision uncertainty.

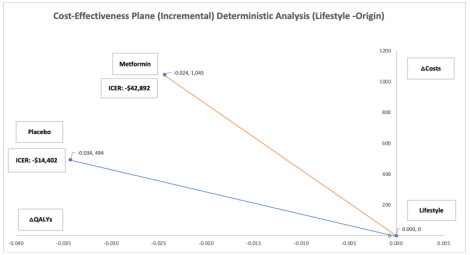

Figure 2 Deterministic Incremental CE-Plane (Lifestyle - Origin)

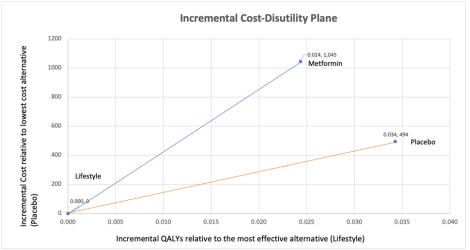

Figure 3 Cost-Disutility Plane (Lifestyle at the origin – the least costly and the highest effectiveness)

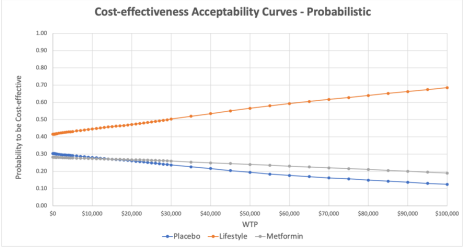

Figure 4 Cost-effectiveness Acceptability Curves.

Loss Curves show losses from implementing metformin over lifestyle Net Loss Curves show losses of choosing metformin over lifestyle (at US$70,000 WTP, approximately US$2,650 per patient).

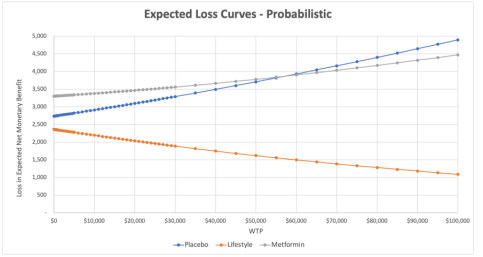

Figure 5 Expected Net Loss Curves

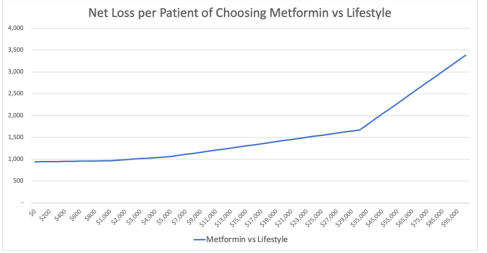

Figure 6 Net Loss of choosing the suboptimal alternative (Metformin) over Lifestyle

Conclusions

When more than two alternatives are included in CEAs, ICER calculations can easily be made in error. The use of various graphics and calculation of Expected Losses has advantages for communicating CEA results, providing extra information to 1) reduce chances of misinterpreting non-optimal choices as optimal and 2) measuring the impact of such errors. The Singapore DPP CEA miscalculated ICERs and made other errors; decision makers adopting those results could impose significant costs on patients.