The impact on health burden of adopting hemoglobin a1c as an additional screening/diagnosing criterion for diabetes

Ming-Chin Yang

Institute of Health Policy and Management
National Taiwan University
National Health Insurance Medical Expenditure Negotiation Committee
Department of Health
July 2011

Outline

- Introduction
- Method and material
- Results
  - General population
  - Diabetic population
  - Sensitivity analyses
- Conclusions

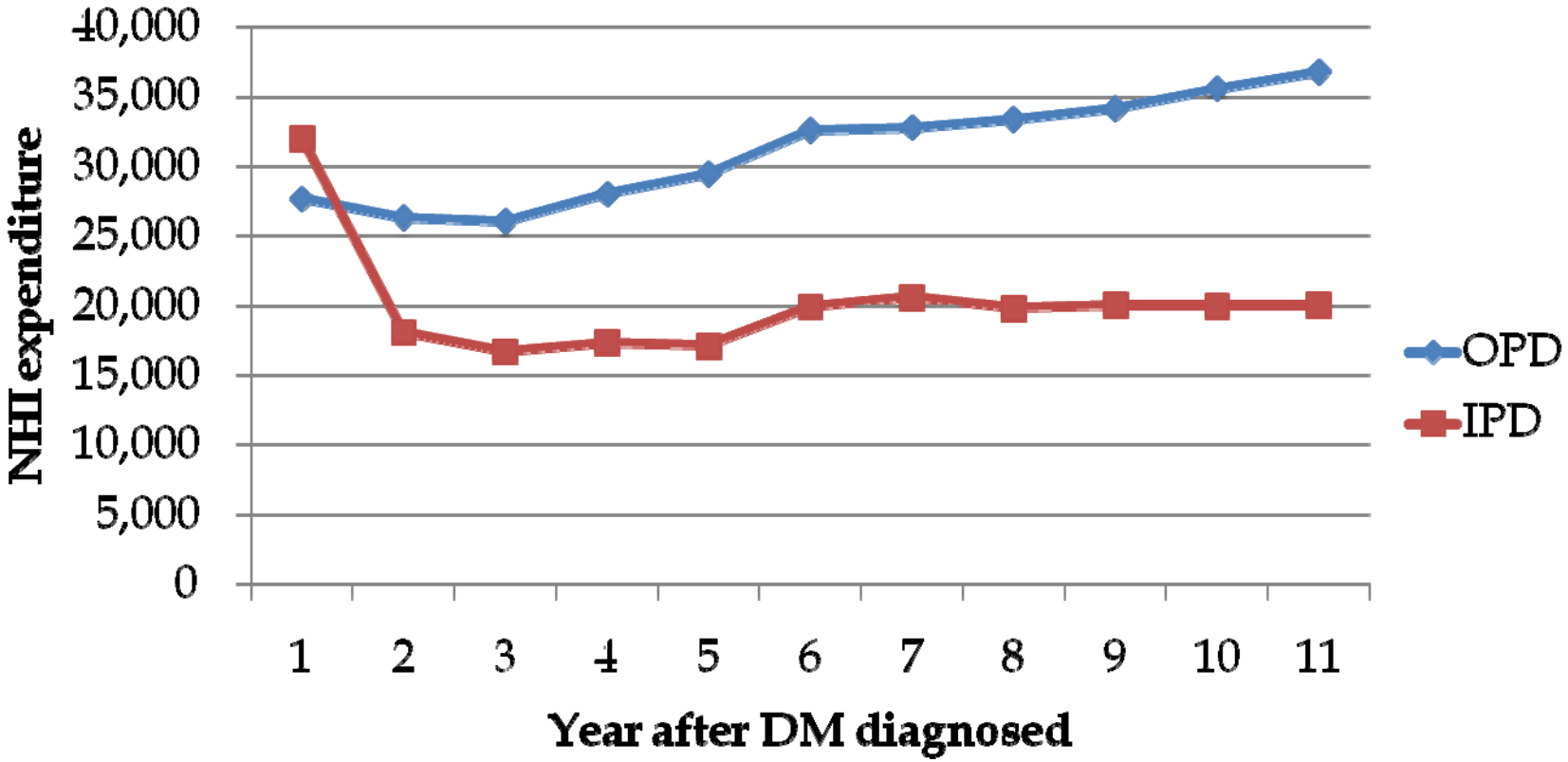
Introduction

Background

- Diabetes mellitus is a common and serious disease that requires continuous intervention to reduce the risk of complications.
- Almost 20% of DM patients were unaware of having it.

Age group	Prevalence(%)		Incidence(%)		Untreated rate(%)
	Survey	NHI	Survey	NHI	
<20	0.4	0.1	—	0.04	65
20-29	1	0.3	—	0.1	69
30-39	1.9	1.1	—	0.4	42
40-49	6.1	3.8	—	1.0	37
50-59	12.8	10.3	—	1.9	20
60-69	20.2	19.7	—	2.7	2
70-79	20.2	24.5	—	2.9	0
80+	20.8	22.5	—	3.1	0

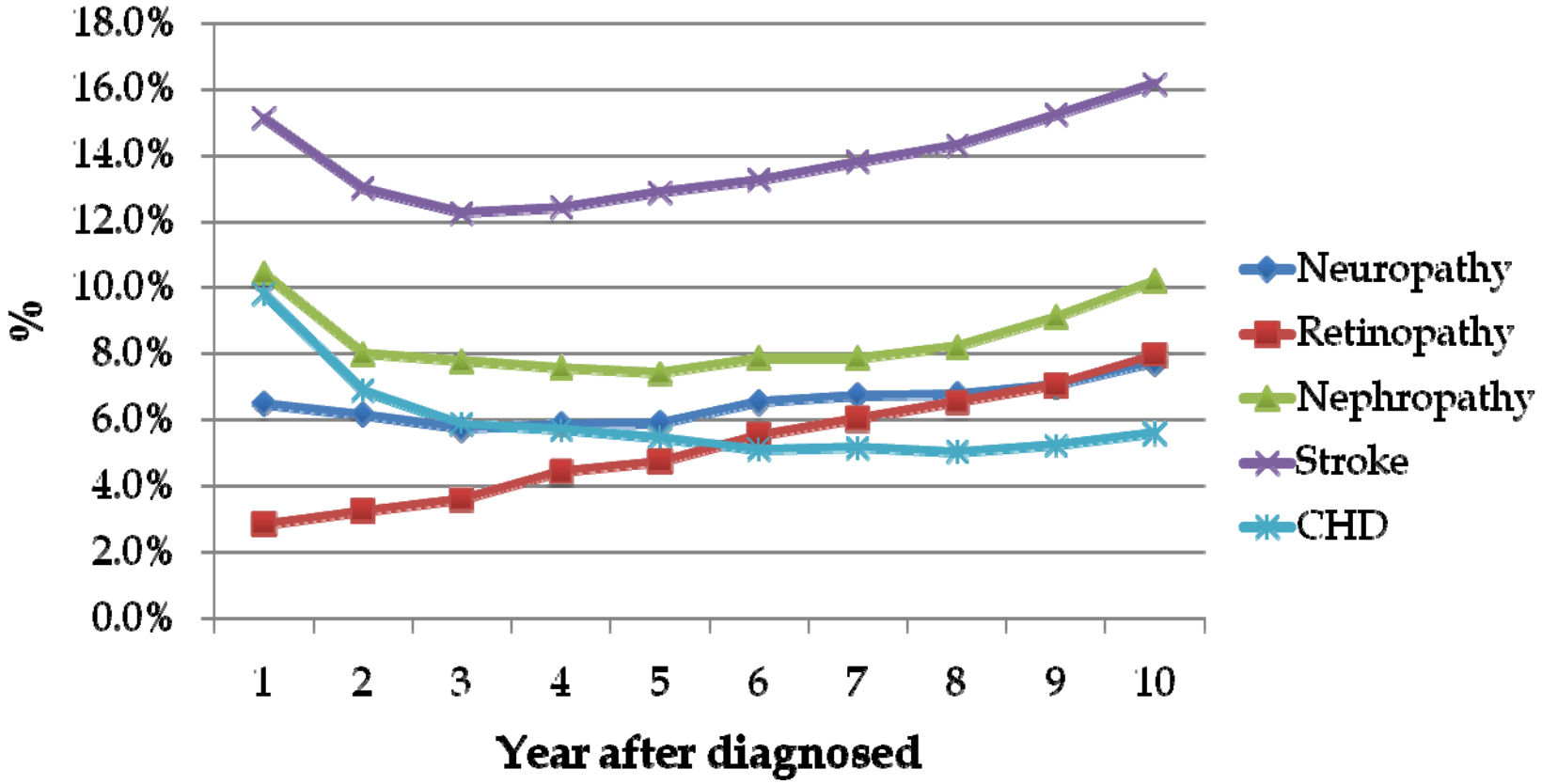
Annual Medical Expenditure of DM,
by type of service and years after diagnosed



- Data source: NHI database.
- Sample: 166,151 newly diagnosed DM patients in 1999.
- Definition: ICD 9 CM code occurred 2 times in OPD or 1 time in IPD.

Prevalence of DM related Complications

by years after DM diagnosed



- Data source: NHI database.
- Sample: 131,616 newly diagnosed DM patients without any DM-related complications in 1999.

Criteria for the diagnosis of diabetes

- The American Diabetes Association (ADA) recently recommended the use of A1C test to diagnose diabetes with a threshold of $\geqq$6.5%

A1C testing

- **For undiagnosed diabetes**
  - A1C **identifies 1/3 fewer case** of undiagnosed diabetes than FPG
  - More convenient test (A1C) may actually increase the number of diagnosis

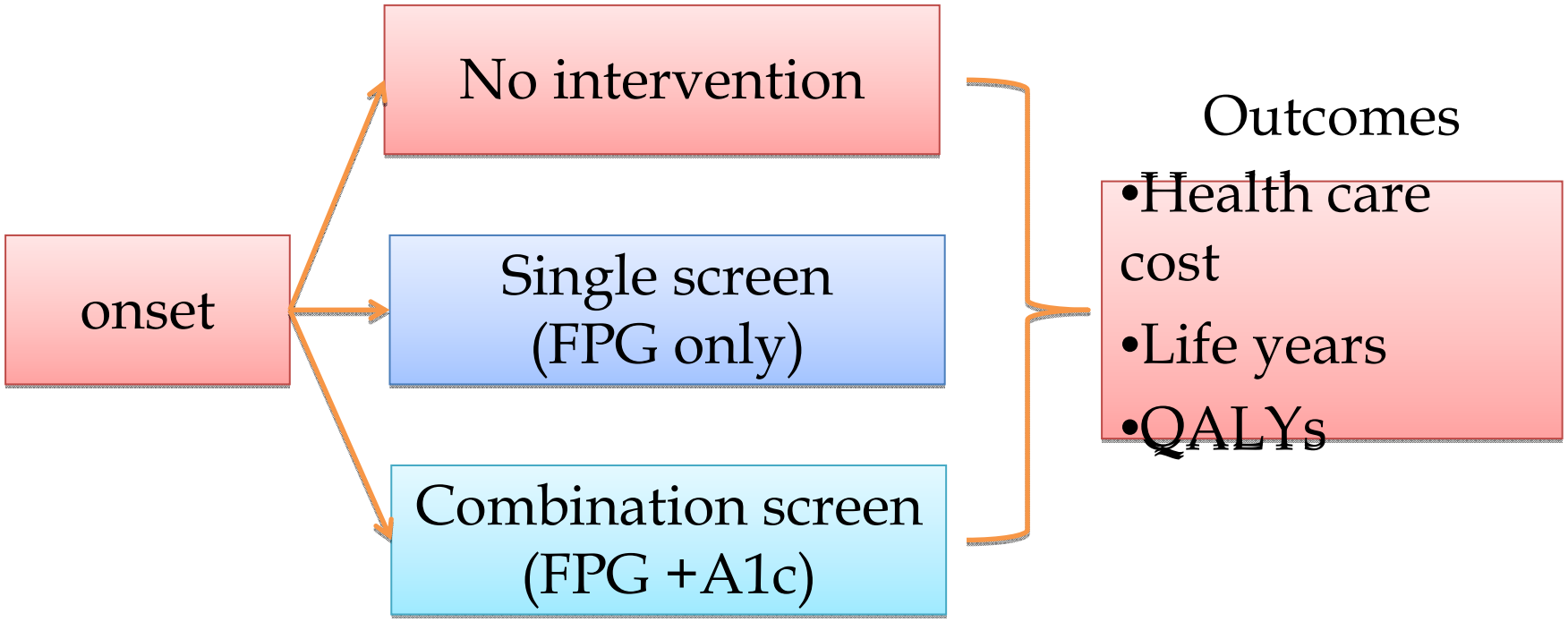
Advantage	Disadvantage
• Greater convenience • Greater pre-analytical stability • Less day-to-day perturbations during periods of stress and illness	• Greater cost and limited availability of A1C testing • Incomplete correlation between A1C and average glucose in certain individuals • Misleading in patients with anemia and hemoglobinopathies

Objective

- To estimate the cost and consequences of adopting A1C test as an additional screening/diagnosing criterion for diabetes mellitus.

Method and material

Conceptual Framework



Data Sources and Analysis

- A **single-payer perspective** (NHI perspective) was assumed.
- Transitional probabilities came from exiting papers.
- Healthcare utilizations were obtained by analyzing patients newly diagnosed with DM in 1999 from the NHI claims file (followed for 10 years)
- Cost-effectiveness results were computed by using the Treeage pro 2009 software.
- Costs and benefits are discounted at **3%** and cost are expressed in **2009 US dollars**.

Modeling

- A **Markov model** of screen strategies was used to simulate lifetime diabetes-related health care costs and QALYs for general population and diabetics.
- A hypothetical **person** aged **30 year** was used to estimate the results of different strategies.

Assumptions

- **Undiagnosed diabetic patients** will be diagnosed **5 years later**.
- All people who screened positive (false or true) will receive a diagnostic test, **OGTT, as golden standard**.
- Each patient only assign **one complication**.
  - Complication was calculated according to its severity and time of occurrence.
- The **payment in the NHI fee schedule (RVUs) for** related procedures or treatments remained the same over the years, and each point equals to one dollar.

Parameters: Screening

Parameter	Base-Case Analysis	Probabilistic Sensitivity Analysis Distribution	Data Source
Prevalence of diabetes			
Age 30 y	0.011	Unif(0.011, 0.019)	NHI, NHIS
Diabetes Screening			
Sensitivity of single screen	0.436	Unif(0.414, 0.458)	Dr. HY Lee
Specificity of single screen	1.000	Unif(0.95, 1.00)	
Sensitivity of combination screen	0.723	Unif(0.687, 0.759)	
Specificity of combination screen	0.973	Unif(0.924, 1.00)	
Costs, $			
OGTT test	10.793	Not varied	NHI
Single screen test (FPG only)	1.724	Unif(1.548, 1.892)	
Combination screen test (FPG or A1C)	6.897	Unif(6.21, 7.59)	

Parameters: Transition Probabilities

Parameter	Base-Case Analysis	Data Source
Microalbuminuria	0.033	Hoerger et al., 2004
Blind from macular	0.033	CDC, 1998
Blind from proliferative	0.015	CDC, 1998
ESRD	0.004	Hoerger et al., 2004
Amputation	0.028	Hoerger et al., 2004;CDC, 1998
Additional amputation	0.110	Hoerger et al., 2004
Macular edema	0.047	CDC, 1998
Noproliferative diabetic retinopathy	0.021	CDC, 1998
Clinical nephropathy	0.075	Hoerger et al., 2004
Proliferative diabetic retinopathy	0.002	CDC, 1998
Peripheral neuropathy	0.003	CDC, 1998
CHD	0.020	CJ Chang et al., 2000
Angina	0.058	UKPDS 38
Myocardial infraction	0.158	UKPDS 38
Congestive heart failure	0.039	UKPDS 38
Stroke	0.065	UKPDS 38

Parameters: Mortality and Others

Parameter	Base-Case Analysis	Probabilistic Sensitivity Analysis Distribution	Data Source
Mortality			
Myocardial infraction			
1st time	0.226	Not varied	Almbrand et al., 2000
2nd time	0.373		
3rd time	0.606		
4th time	0.826		
5th time	0.956		
Stroke (event)	0.142	Logn(0.142, 0.107)	Taylor et al., 1996
Stroke (after event)	0.092	Logn(0.092, 0.069)	Taylor et al., 1996
CHD	0.080		CH Tseng, 2004
ESRD	0.160		CH Tseng, 2004
LEA	0.105	Logn(0.105, 0.08)	Reiber, Boyko and Smith, 1995
Others			
Time from diabetes onset to diagnosis, y	5		Hoerger et al., 2004
Discount rate applied to life-years, QALYs	0.03	0.00~0.05	Assumed
Discount rate applied to cost	0.03	0.00~0.05	Assumed

Parameters: utility

Event/state	utility	References
Healthy	1.000	Assumed
DM without complication	0.814	Clarke, Gray and Holman, 2002
Peripheral vascular disease	0.570	Tengs and Wallace, 2000
Active ulcer	0.600	Carrington et al., 1996
Healed ulcer	0.814	Palmer et al., 2004
Amputation after event	0.680	Clarke, Gray and Holman, 2002
Amputation (event year)	-0.109	Clarke, Gray and Holman, 2002
Angina	0.682	Clarke, Gray and Holman, 2002
Background diabetic retinopathy	0.814	Palmer et al., 2004
Myocardial infraction after event	0.736	Clarke, Gray and Holman, 2002
Myocardial infraction (event year)	-0.129	Clarke, Gray and Holman, 2002
Congestive heart failure	0.633	Clarke, Gray and Holman, 2002
Proliferative diabetic retinopathy	0.794	Australian Institute of Health and Welfare, 2003
Macular edema	0.794	Australian Institute of Health and Welfare, 2003
Blindness	0.734	Clarke, Gray and Holman, 2002
Microalbuminuria	0.814	Palmer et al., 2004
Neuropathy	0.624	Australian Institute of Health and Welfare, 2003
Clinical neuropathy	0.814	Palmer et al., 2004
Dialysis	0.490	Tengs and Wallace, 2000
Stroke after event	0.545	Clarke, Gray and Holman, 2002
Stroke (event year)	-0.181	Clarke, Gray and Holman, 2002

Results

Life Years after the age 30, undiscounted

	General population	Incremental Lys	Diabetic population	Incremental Lys
no intervention	44.70		39.44	
single screen (FPG only)	44.80	0.10	42.76	3.31
combination (FPG+A1c)	44.82	0.12	44.83	5.39

General population: compared with no intervention

Strategy	Cost		Effectiveness		ICER (cost per Ly)
	Total cost	Incremental Cost	Total Lys	Incremental Lys	
No intervention	5405.85		23.71		
Single screen (FPG only)	5413.50	7.65	23.76	0.05	164.60
Combination screen (FPG+A1c)	5455.05	49.19	23.77	0.06	872.47

Strategy	Cost		Effectiveness		ICER (cost per QALY)
	Total cost	Incremental cost	Total QALYs	Incremental QALYs	
No intervention	5405.85		22.81		
Single screen (FPG only)	5413.50	7.65	22.86	0.06	132.43
Combination screen (FPG+A1c)	5455.05	49.19	22.87	0.07	733.82

General population: FPG+A1c vs. FPG only

Strategy	Cost		Effectiveness		ICER (cost per Ly)
	Total cost	Incremental cost	Total Lys	Incremental Lys	
Single screen (FPG only)	5413.50		23.76		
Combination screen (FPG+A1c)	5455.05	41.55	23.77	0.01	4188.30

Strategy	Cost		Effectiveness		ICER (cost per QALY)
	Total cost	Incremental cost	Total QALYs	Incremental QALYs	
Single screen (FPG only)	5413.50		22.86		
Combination screen (FPG+A1c)	5455.05	41.55	22.87	0.01	4472.67

Diabetic population: compared with no intervention

Strategy	Cost		Effectiveness		ICER (cost per Ly)
	Total cost	Incremental cost	Total Lys	Incremental Lys	
No intervention	24199.94		21.15		
Single screen (FPG only)	30055.88	5855.94	22.64	1.49	113,986.43
Combination screen (FPG+A1c)	33858.94	3803.07	23.54	2.39	117,122.32

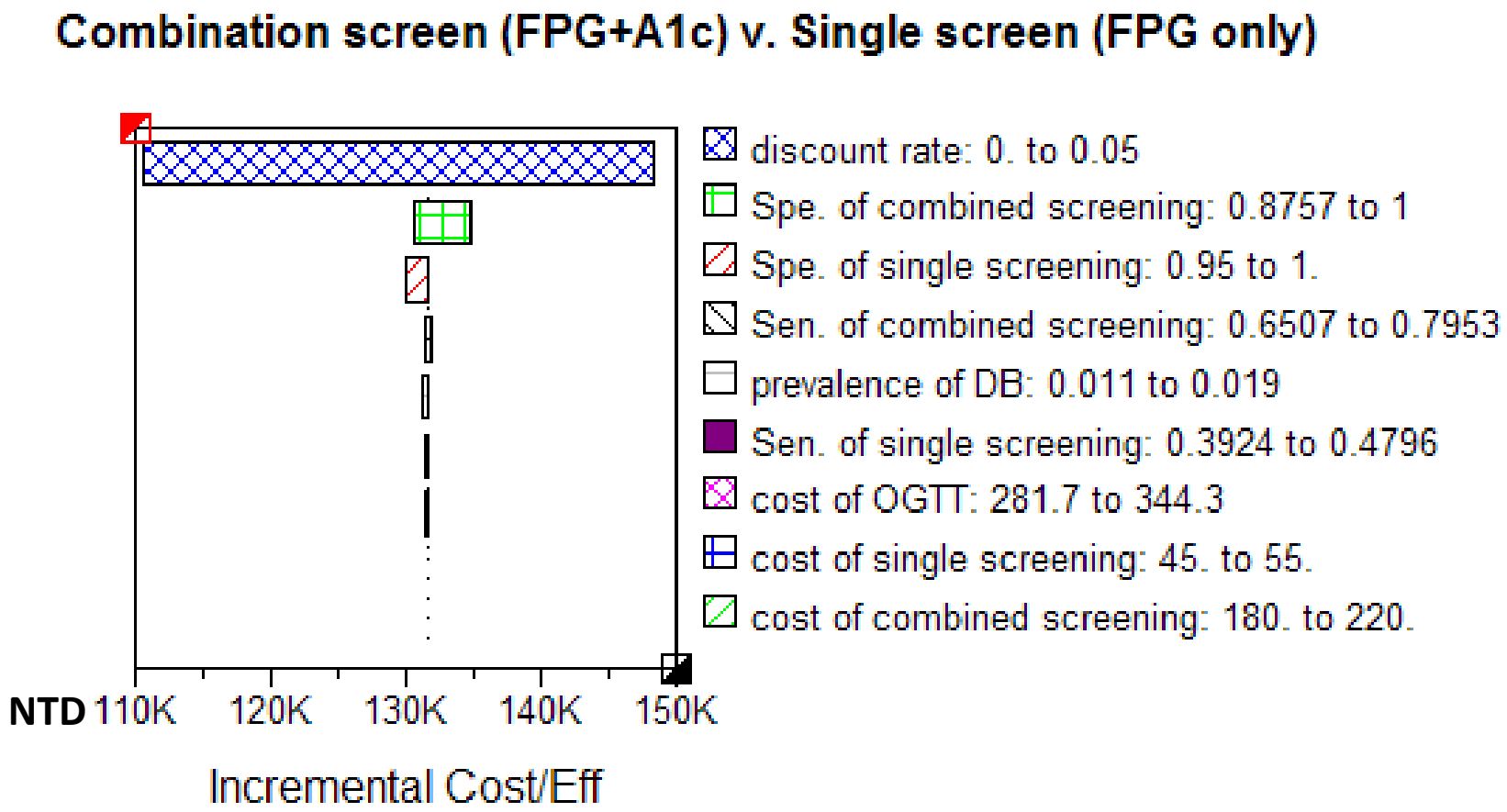
Strategy	Cost		Effectiveness		ICER (cost per QALY)
	Total cost	Incremental cost	Total QALYs	Incremental QALYs	
No intervention	24199.94		16.82		
Single screen (FPG only)	30055.88	5855.94	18.21	1.39	121,797.26
Combination screen (FPG+A1c)	33858.94	3803.07	19.06	2.24	125,120.33

Diabetic population: FPG+A1c vs. FPG only

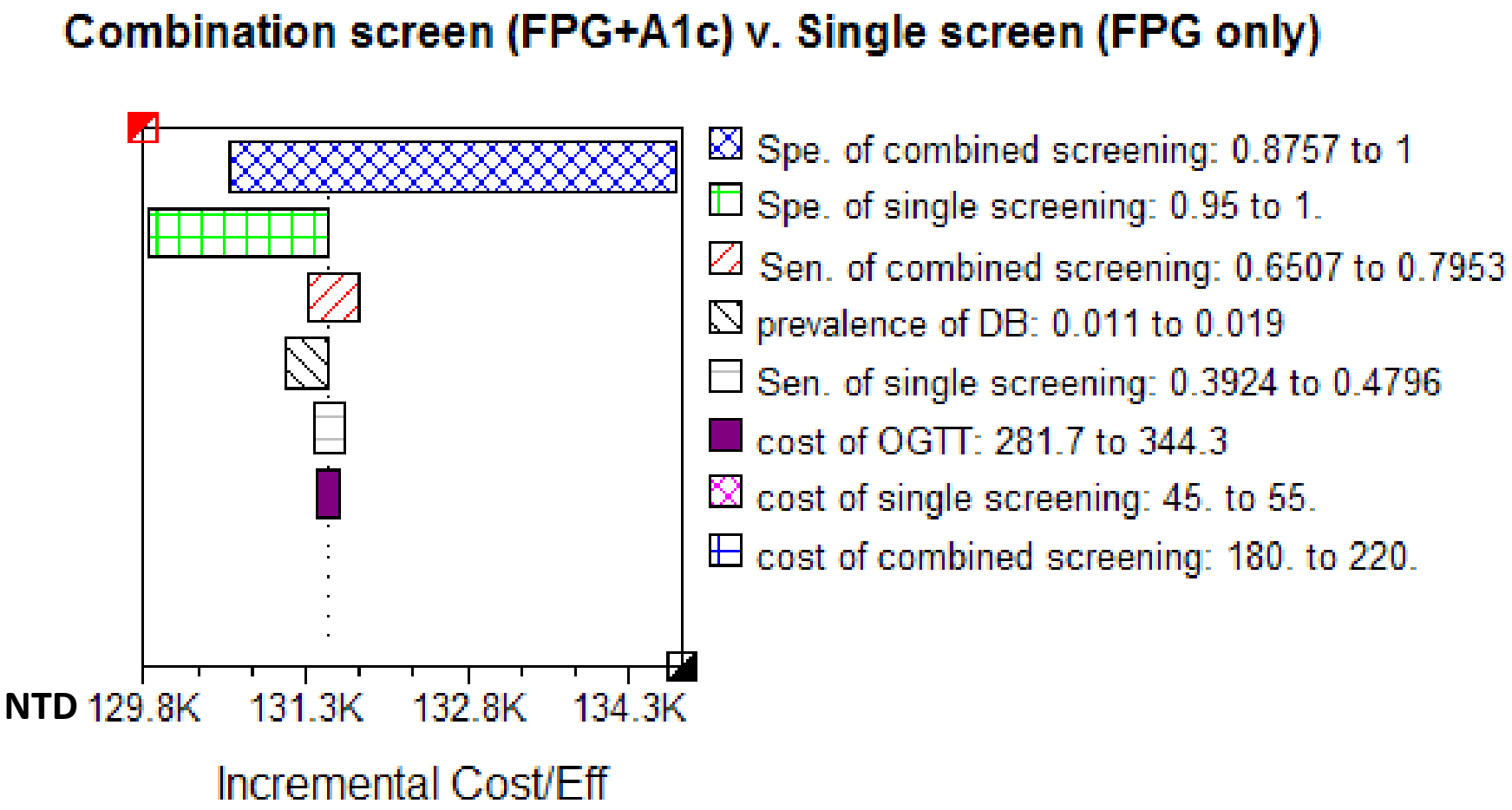
Strategy	Cost		Effectiveness		ICER (cost per Ly)
	Total cost	Incremental cost	Total Lys	Incremental Lys	
Single screen (FPG only)	30055.88		22.64		
Combination screen (FPG+A1c)	33858.94	3803.07	23.54	0.90	4,217.35

Strategy	Cost		Effectiveness		ICER (cost per QALY)
	Total cost	Incremental cost	Total QALYs	Incremental QALYs	
Single screen (FPG only)	30055.88		18.21		
Combination screen (FPG+A1c)	33858.94	3803.07	19.06	0.84	4,503.70

Tornado diagram: compared 2 strategies



Tornado diagram: compared 2 strategies



Limitations

- Interaction of different complications were not estimated.
- Information of transition probabilities on disease were lack in Taiwan.
- Cost of combination screen (FPG+A1c) was overestimated.

Conclusions

Conclusions

- When adopting A1c as an additional screening criterion, it will increase both the life year and the lifetime health cost.
- In terms of life years, it will increase 0.90 years of life at an additional cost of $3803.07, thus yielding the ICER of NT$4,217.35.
- In terms of QALYs, it will increase 0.84 QALY at an additional cost of $ 3803.07, thus yielding the ICER of NT$4,503.70.
- WHO suggests that when the ICER of an intervention is lower then 1 GDP per capita (which is $ 20,783 in 2010), it is considered as very cost-effective.

Acknowledgement

- Diabetes Association of the Republic of China
- Dr. Lee, HY
- Ms. Lai, CL
- Ms. Liao, CH

Thank You
For Your Attention