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In-depth Cost-effectiveness Study of the Multidisciplinary Risk Factor Assessment and Management Programme (RAMP) of the Hospital Authority

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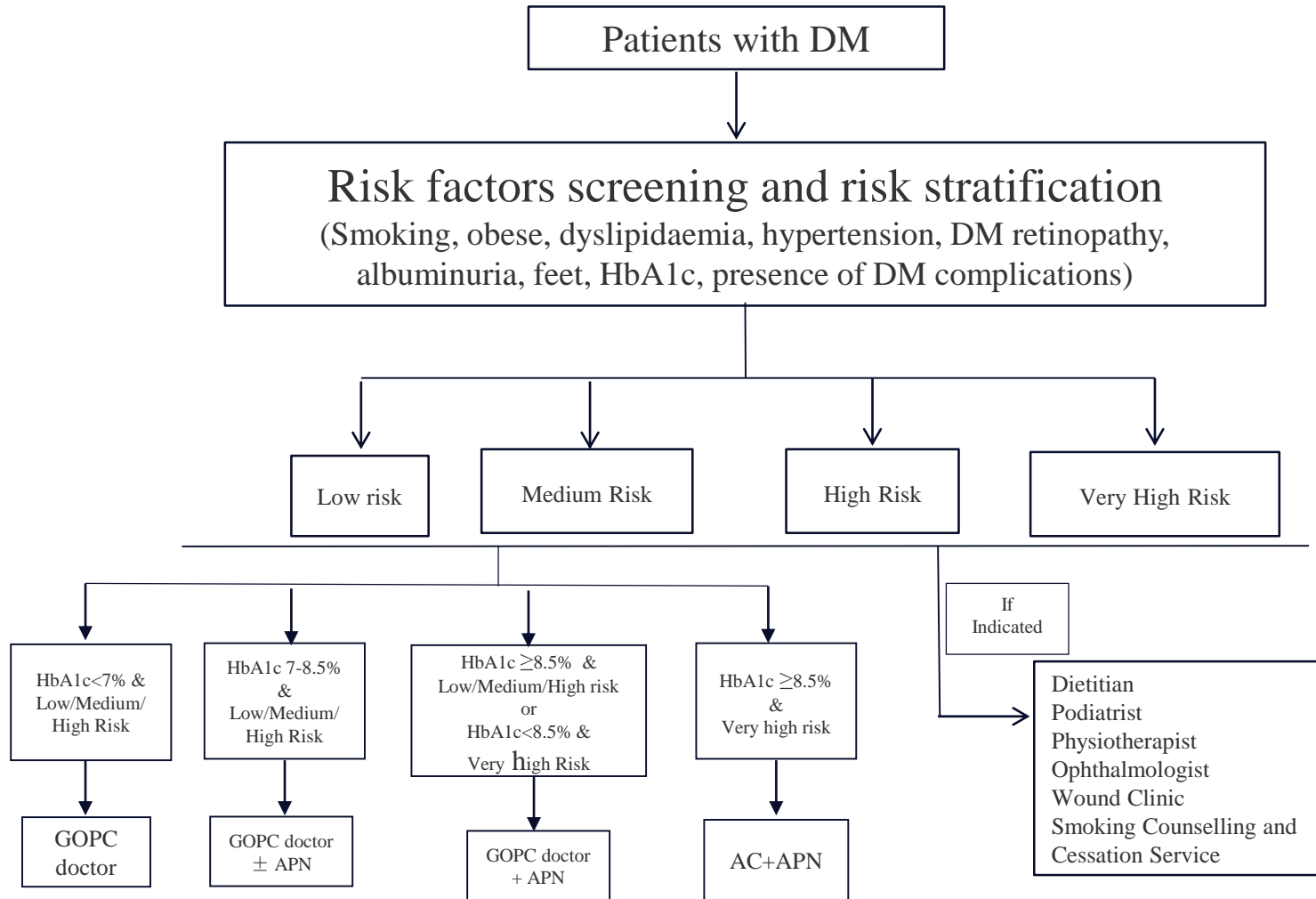
Introduction



- Diabetes mellitus-
 - Globally: 415 million in 2013, 642 million in 2035.
 - Hong Kong: prevalence around 10%. (6.4% of the expenditure of the health expenditure)
 - Hong Kong: More than 60% diagnosed DM patients receiving public primary care

- Risk Assessment and Management Programme Program for patients with diabetes (RAMP-DM)
 - To enhance the primary care service for DM patients
 - Since Aug 2009 in public primary care clinics
 - Aim to reduce complications and improve quality of care

RAMP-DM



Aim



- To evaluate the cost-effectiveness of RAMP-DM compared to usual primary care:
 - (A) over a 5-year study period
 - (B) over a life-time

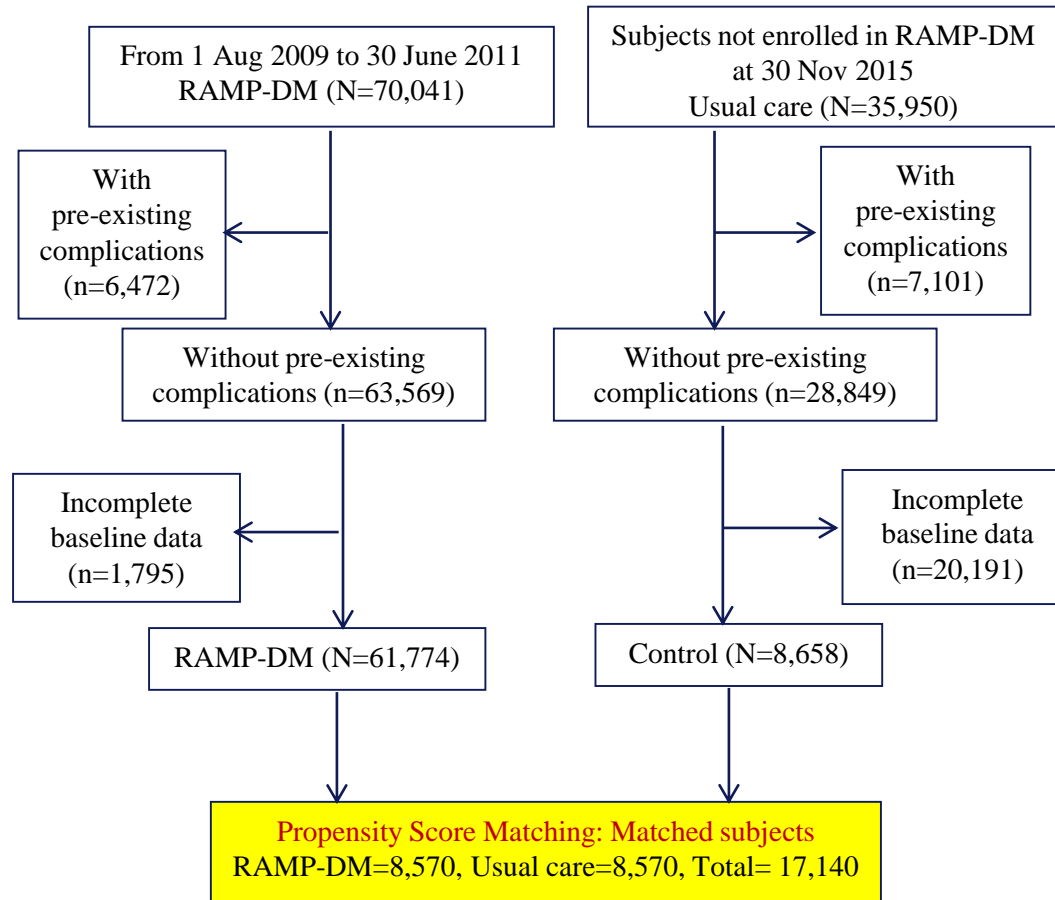


Methods

- A 5-year cohort study—Effectiveness and cost-effectiveness of RAMP-DM
 - **Effectiveness**

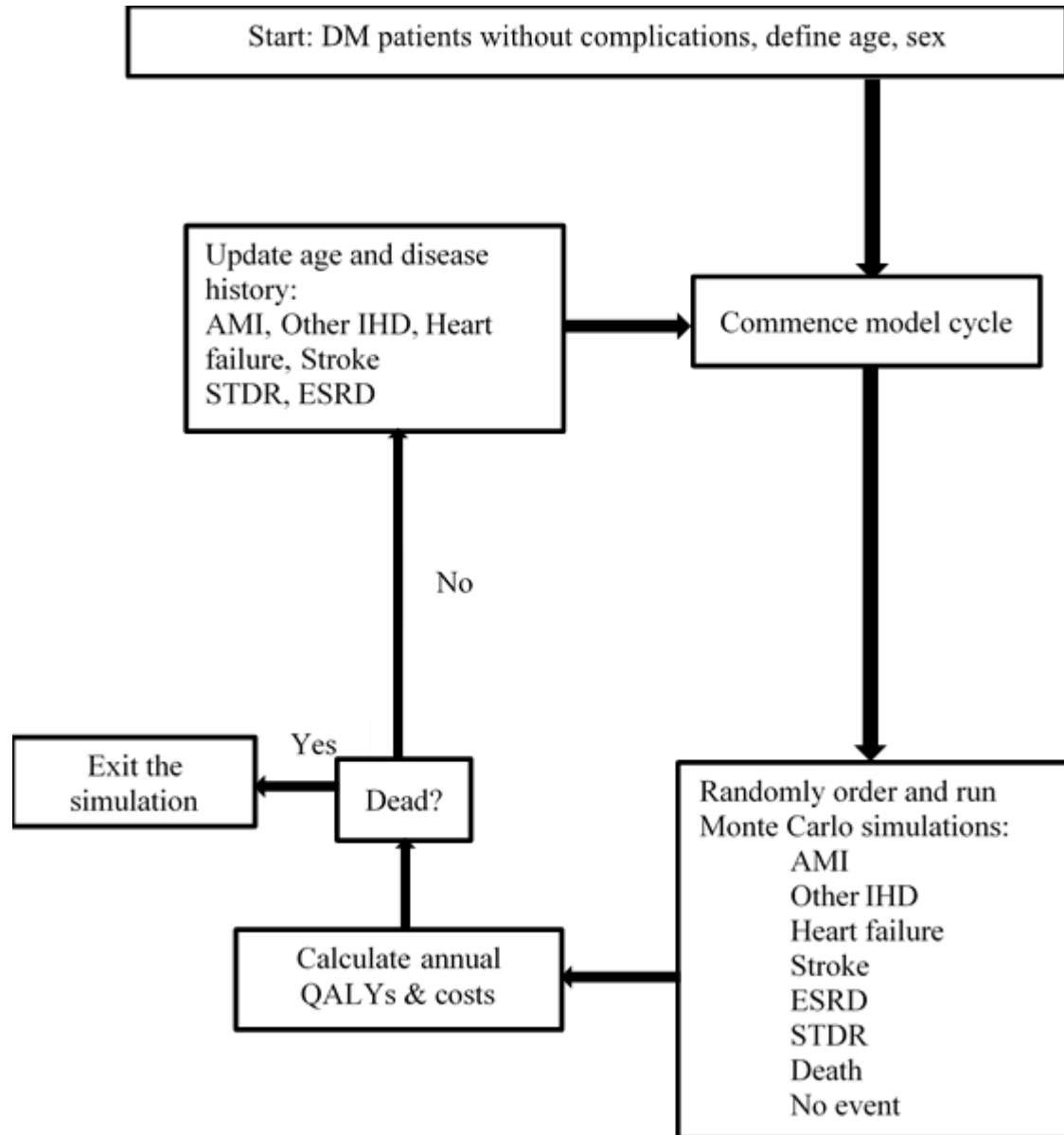
No. of complications and death reduced
 - **Costs, from the public provider's perspective and societal perspective**
 - (1) Resources to run RAMP-DM: questionnaire to all cluster offices and two clinics from each cluster (7 clusters)
 - (2) Central administrative costs of RAMP-DM: HA Finance Office
 - (3) Health service utilization costs of RAMP-DM and usual care: Computerized Medical System of Hospital Authority
 - (4) Patients' costs: time and motion study
- A Discrete Event Simulation model—cost-effectiveness of RAMP-DM over a lifetime

Subjects





Discrete Event Simulation model



Subjects at entry

- 67±12 years old
- 52% female
- 10,000 subjects for each group

Estimation of Health Utility

- 1,825 (GOPC) and 355 (SOPC) DM subjects recruited
- Completed Chinese (HK) SF-12v2 Health Survey by telephone
- HK SF-6D algorithm to determine utility scores from SF-12v2 data to calculate gain/loss in quality adjusted life years (QALYs)

Decrements of health preference-based utility due to DM complications

Variable	Mean(utility score)	(95% CI)
Utility of DM subjects with no complications	0.883	(0.778, 0.989)
Utility decrements		
Female	-0.024	(-0.041, -0.007)
MI	-0.017	(-0.042, 0.008)
Other IHD	-0.017	(-0.042, 0.008)
Heart failure	-0.017	(-0.042, 0.008)
Stroke	-0.042	(-0.072, -0.012)
ESRD	-0.055	(-0.093, -0.017)
STDR	-0.043	(-0.075, -0.010)



Annual Probability of Mortality of DM Patients

- Six diabetic complications (AMI, other IHD, CHF, stroke, ESRD and amputation) were found to increase the risk of mortality from previous studies.
- Mortality rates were estimated by 4 groups
 - Group 1: subjects die in the year without any pre-existing diagnosis of any complication (Gompertz model)
 - Group 2: subjects without pre-existing complications and die in the year of occurrence of a new complication (Logistic model)
 - Group 3: subjects with pre-existing complications and die in the year of occurrence of a new complication (Logistic model)
 - Group 4: subjects who have developed complications, survived the event year and die in subsequent years (Gompertz model)



Estimation of probability of mortality

- 128,309 DM patients with no complication at 1 January 2009 as identified from HA CMS, Cohort followed to 31 December 2013

Scenario	Model 1	Model 2	Model 3	Model 4
	Death in years without any complications	Death in the 1st year of events, without history	Death in the 1st year of events, with history	Death in years with history but not events
Eligible subjects for analysis	128,309	10,896	2,634	10,534
Eligible Patient-year	585,369	10,896	2,634	50,093
No. of death	4,985	1,783	1,047	559
Function form	Gompertz	Logistic	Logistic	Gompertz
Parameters	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)	Coefficient (SE)
Constant	-13.736(0.085)	-6.591(0.598)	-6.530(0.403)	-15.572(0.304)
γ	0.141(0.001)			0.172(0.004)
Age		0.066(0.003)	0.068(0.005)	
Female	-0.683(0.029)	-0.315(0.056)		-0.577(0.086)
AMI_Event		3.869(0.725)	0.916(0.101)	
Other_IHD_Event		1.495(0.721)		
HF_Event		1.894(0.722)	0.298(0.096)	
Stroke_Event		1.637(0.719)	0.555(0.106)	
ESRD_Event		3.303(0.721)	1.175(0.104)	
Amputation_Event				
AMI_History				-0.549(0.204)
Other_IHD_History				
HF_History			-0.481(0.189)	
Stroke_History				0.247(0.092)
ESRD_History				0.573(0.124)
Amputation_History				



Estimation of annual cost of health service utilisation

- Public health services: retrospective cohort estimated impact of diabetic complications on medical costs (128,309 DM patients from HA CMS)
- Private health services: survey on convenience sample of 1,825 GOPC and 355 SOPC DM subjects
- Cost multipliers derived and applied to baseline cost to calculate extra cost associated with age, sex, occurrence of a DM complication and history of complications



Public annual health service cost multipliers for DM patients

Variables	Multiplier
Age – 63	1.02
Female	1.01
New complication (event year)	
MI	4.50
Other IHD	2.88
Stroke	7.04
Heart failure	4.56
STDR	1.52
ESRD	9.24
Existing complication	
MI	2.01
Other IHD	1.33
Stroke	2.43
Heart failure	2.10
STDR	1.22
ESRD	2.56

Baseline cost = HK\$11,015 for a male diabetic patient, age 63 with no complication

Private annual health service cost multipliers for DM patients

Variables	Multiplier
Age – 65	0.97
Female	1.30
Complication	
Heart disease (MI, other IHD or heart failure)	2.34
Stroke	1.52
STDR	2.08
ESRD	1.93

Baseline cost = HK\$1,457 for a male diabetic patient, age 65 with no complication



Public direct medical costs

- Annual public direct medical costs=
 \sum No. of units of each health service pre year \times unit cost of the service
- Annual incremental costs associated with each type of diabetic complications in the event year and subsequent years: generalized linear model

Private direct medical costs

- Costs data were collected from questionnaires
- Annual incremental costs associated with each type of diabetic complications : generalized linear models



Results-application of cost models

For example, the annual direct medical costs of a 70-year old female diabetic subject with history of ESRD in the event year of a new stroke can be estimated by:

Step 1, the public direct medical cost=
 $11,015 \times 1.02^{(70-63)} \times 1.01 \times 7.04 \times 2.56 = 230,313$ (HKD)

Step 2, the private direct medical cost=
 $1,457 \times 0.97^{(70-65)} \times 1.29 \times 1.52 \times 1.93 = 4,734$ (HKD)

Step 3, the total direct medical cost=
 $230,311 + 4,734 = 235,045$ (HKD)





Main assumptions of CEA model

- All subjects free of DM complications at entry
- A subject can develop more than one complication, but recurrence of the same complication was not simulated in this model
- The risk of the first occurrence of any of the six diabetic complications was dependent on age, sex and intervention group
- Effectiveness of RAMP-DM was assumed to be maintained over a lifetime
- Health service costs and mortality were dependent on age, sex, and disease status
- Health preference utility determined by sex and complications



Results



Effectiveness of RAMP-DM

Endpoints	No. of observed events			ARR	NNT
	RAMP-DM (N=8570)*	Usual care (N=8570)*	No. of events avoided		
Any complication	1,315	2,455	1,140	13.30%	8
CVD	1,057	2,054	997	11.63%	9
AMI	240	529	289	3.37%	30
Other IHD	387	924	537	6.27%	16
Heart failure	291	693	402	4.69%	21
Stroke	445	727	282	3.29%	30
ESRD	391	696	305	3.56%	28
STDR	48	174	126	1.47%	68
All-cause death	682	1,830	1,148	13.40%	7

*Propensity score matched cohort

Subject costs of RAMP-DM



Items	Average cost per subject in first year (HK\$)	
	Subject	Accompanying person
(a)Costs per session:		
RAMP-DM travel cost	11	7
RAMP-DM travel time cost	45	41
RAMP-DM clinic attendance time cost	71	77
Total travel and time costs	127	125
Average patient cost per session		149
(b)Costs per subject in first 12 months:		
Average number of sessions per subject	1.93	246
Percentage of subjects with accompanying person (%)	17.2	42
Total RAMP-DM cost per subject from subjects' perspective		287

* Based on results from the time and motion study

5-year CE of RAMP-DM from Public Health Provider's perspective



	Cost per subject (HKD)		
	RAMP-DM	Usual care	Difference
RAMP-DM set-up cost (mean(range))	41	0	41
RAMP-DM administrative cost	5		5
RAMP-DM intervention cost(mean(range))			
First year	461	0	461
Second year	249	0	249
Third year	191	0	191
Forth year	183	0	183
Fifth year	141	0	141
Total costs of RAMP-DM program over 5 years	1,271	0	1,271
Healthcare utilization cost			
First year	14,829	27,110	-12,281
Second year	16,981	32,601	-15,620
Third year	17,768	31,868	-14,100
Forth year	20,200	27,821	-7,621
Fifth year	20,166	27,858	-7,692
Total costs of healthcare utilization over 5 years	89,944	147,258	-57,314
Total costs over 5 years	91,215	147,258	-56,043

(A) From 1 Aug 2009 – 30 June 2010, a total of 62,940 subjects without previous complications were enrolled into RAMP-DM.

To **30 Nov 2015**, the total net-saving was **3,527,346,420 HKD (3.5 billion)**

(B) From 1 Aug 2009 – 30 Nov 2015, a total of 316,869 subjects were enrolled into RAMP-DM. To **30 Nov 2020**, the total net-saving will be around **17,758,289,367 HKD (~17.8 billion)**



Transition probabilities of complications

- Transition probabilities of developing the six DM complications were based on the incidence rates in RAMP-DM and usual care groups in the cohort study on effectiveness
- The sex-specific annual transition probabilities were calculated

	Average transitional probabilities (in the first cycle, at the age of 67*)					
	AMI	Other IHD	Heart failure	Stroke	ESRD	STDR
Male						
RAMP-DM group	0.512%	0.860%	0.556%	1.031%	0.812%	0.157%
Usual care group	1.222%	2.451%	1.228%	1.509%	1.637%	0.563%
Female						
RAMP-DM group	0.474%	0.861%	0.577%	0.910%	0.813%	0.094%
Usual care group	1.000%	1.797%	1.549%	1.540%	1.303%	0.288%

* The hazard ratios for age were applied to estimate age-specific transition probability for each complication

Costs over a lifetime



	Cost per subject per year (HKD)	
	RAMP-DM	Usual care
RAMP-DM program costs		
First year		
set-up cost	41	Nil
Administrative cost	5	Nil
On-going cost	415	Nil
sub-total	461	Nil
From 2nd year onwards		
On-going cost	208	Nil
Public direct medical costs		
Baseline costs	11,015	11,015
Complication costs		
Event year	× relevant multiplier	× relevant multiplier
Subsequent years	× relevant multiplier	× relevant multiplier
Private direct medical costs		
Baseline costs	1,475	1,475
Complication costs	× relevant multiplier	× relevant multiplier
Total costs	program costs + (patient cost 287 per year) + public direct medical costs + private direct medical costs	public direct medical costs + private direct medical costs

Cost-effectiveness of RAMP-DM over a lifetime



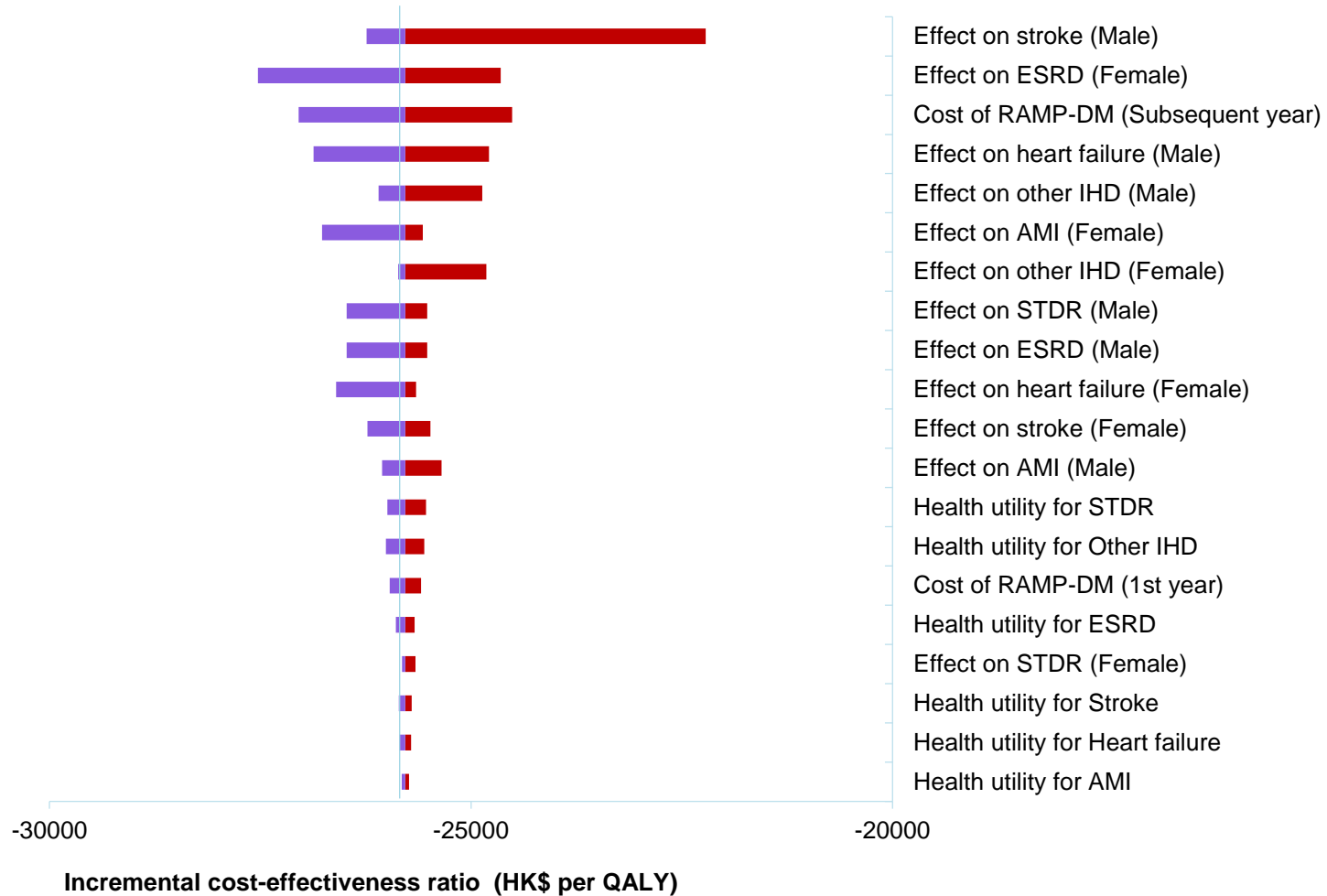
Per person from age 67	Cost (HK\$)	LY	QALY	Incremental cost (HK\$)	Incremental QALY	ICER (HK\$ per QALY)
	(a)		(b)	(c)	(d)	(c) / (d)
Health service provider's perspective						
RAMP-DM	161,954	8.6	7.4	-18,314	0.6	Cost saving
Usual care	180,268	7.9	6.8			
Societal perspective						
RAMP-DM	164,414	8.6	7.4	-15,854	0.6	Cost saving
Usual care	180,268	7.9	6.8			

Costs and effectiveness discounted at 3.5% per year

One-way Sensitivity analysis



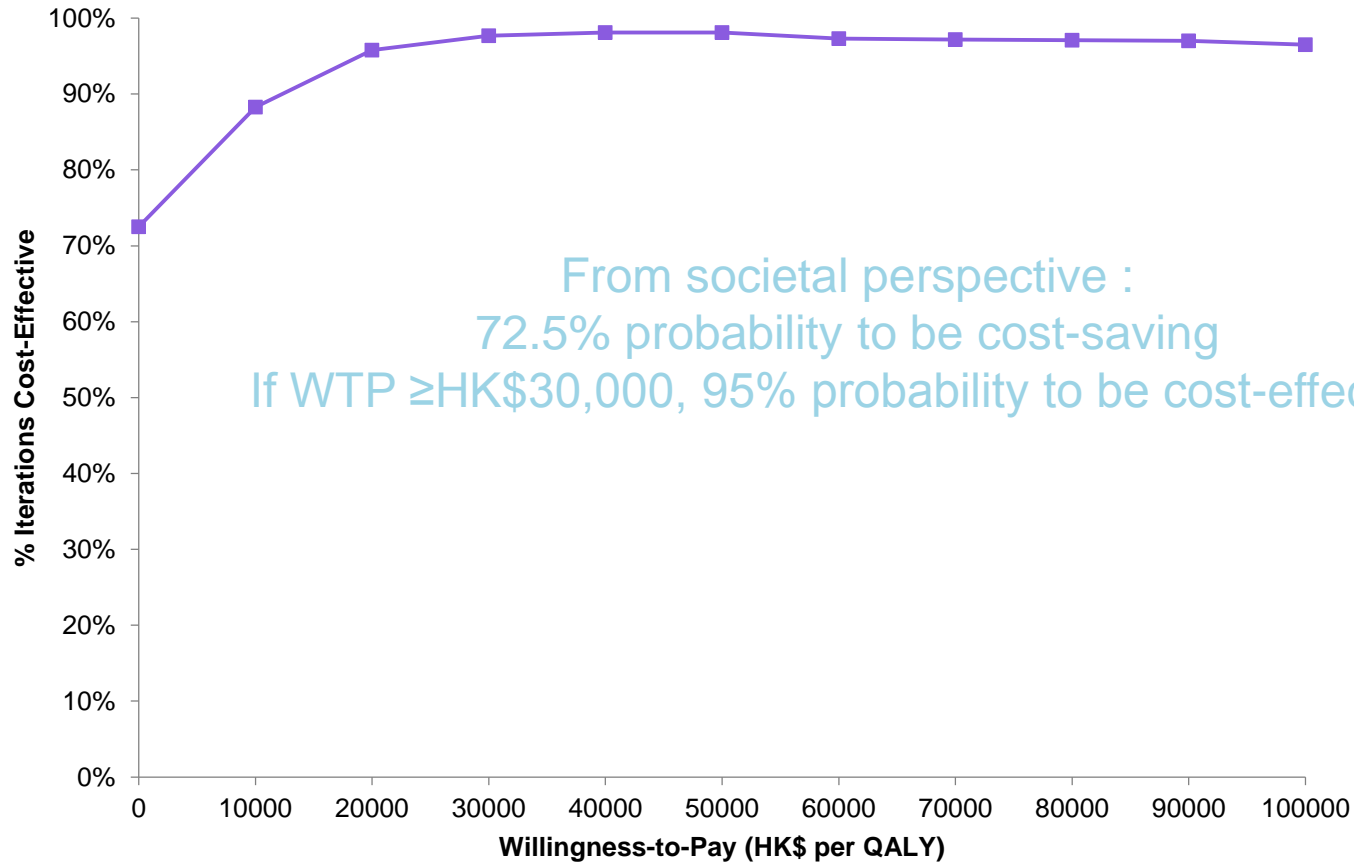
Tornado diagram (societal)



Probabilistic Sensitivity analysis



CE Acceptability curve (societal)





Conclusions

- Over a 5-year observation period, RAMP-DM
 - Reduced diabetic complications (any complication by 13.3%)
 - Reduced all-cause mortality (13.4%)
 - Costs **saved** HK\$56,043 per subject over 5-year
- Over a lifetime , RAMP-DM
 - **gained** 0.6 QALYs per subject over lifetime
 - **saved** HK\$18,314 per subject over lifetime



Limitations

- **The effectiveness of RAMP-DM** : a propensity score matched observational study, not a randomized control trial
- **The lifetime cost-effectiveness of RAMP-DM**: extrapolated from costs and effectiveness findings in a 5-year's observational study
- **HRQoL of DM patients**: a convenience sampling, cross-sectional
- **Diagnosis of clinical outcomes**: documented ICD and ICPC codes
- **DM subjects**: recruited from the public sector only

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Thank you for your
attention!

Q&A

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