Health Research Symposium 2021
23 November 2021

HKU Med | LKS Faculty of Medicine
Department of Family Medicine & Primary Care
香港大學家庭醫學及基層醫療學系
家庭醫學

Project No.: 13142471

In-depth Study of the Cost-effectiveness of the Risk Assessment and Management Programme for Hypertension (RAMP-HT) for Patients with Uncontrolled Hypertension in Primary Care in Hong Kong

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Introduction:
Burden of uncontrolled hypertension

- Up to 13% of global deaths and 50% of cardiovascular diseases (CVD) were attributable to uncontrolled blood pressure (BP)

- Achieving BP control (i.e. <140/90 mm Hg) in even half the patients with medium to high CVD risk could avert 77 million deaths

- Efficacious interventions to control BP and reduce complications:
  - Pharmacotherapy
  - Exercise
  - DASH diet
  - Smoking cessation
  - Alcohol moderation
  - Self-BP monitoring

Introduction:
45% patients has uncontrolled BP in HK (2010)

USUAL 1° CARE

Doctor-led care

3-5 min consultation
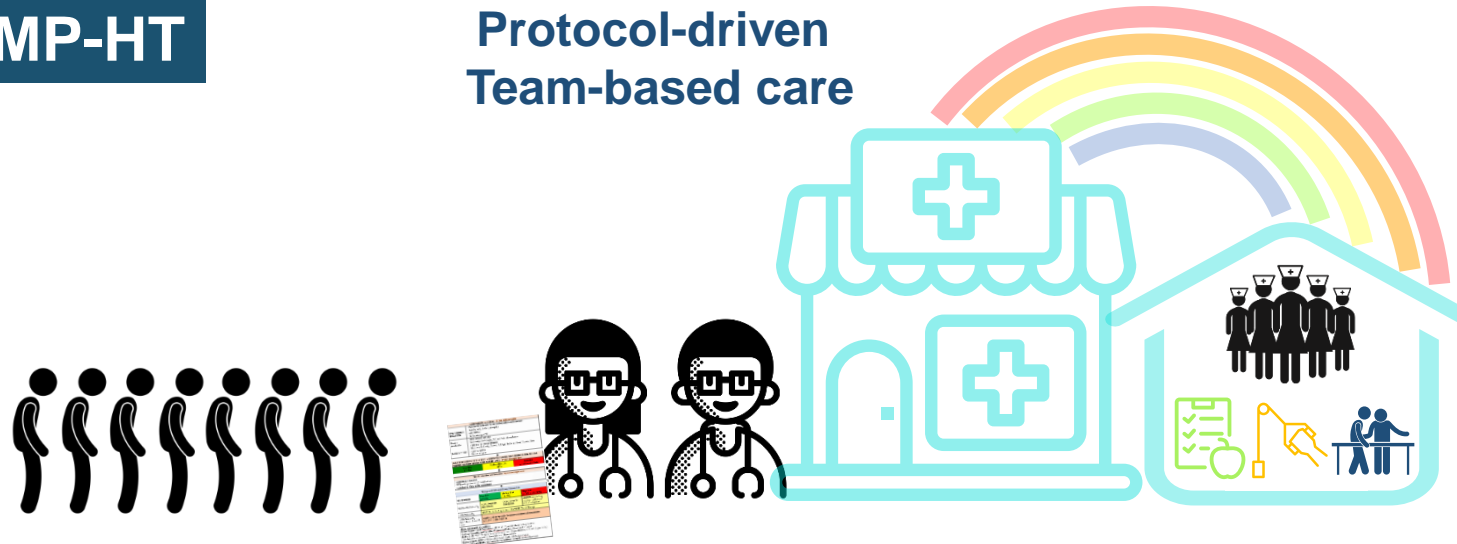
Allied health + Specialists
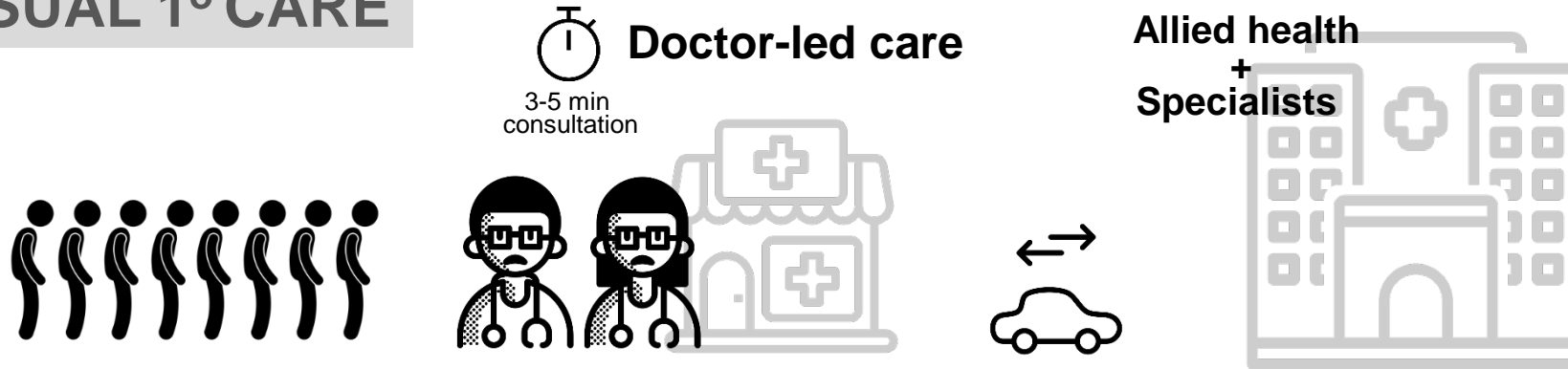
Barriers to care:
- Lack of comprehensive primary care services
- Poor adherence to clinical guidelines
- Non-compliance to medication and lifestyle interventions

RAMP-HT

Protocol-driven Team-based care

- ✓ Task delegation
- ✓ Improved access to allied health professionals
- ✓ Enhanced electronic platform
  → facilitate team communication
  → clinical decision making

Introduction:
RAMP-HT – the proposed solution

- Launched by the Hospital Authority in 2011 to improve hypertension management in public 1° care
- Evidence-based protocol driven programme integrated to GOPC services, incorporating:

Nurse: Comprehensive CVD risk assessment

Nurse: Total CVD risk stratification

Nurse: Health education + referral as necessary

Multi-disciplinary team: Risk-guided intervention

Objective: To examine the 5-year effectiveness of RAMP-HT on reducing cardiovascular complications and mortality, 5-year cost-effectiveness and estimated lifetime cost-effectiveness of RAMP-HT

Study design:
Population-based cohort study over 5 years
RAMP-HT participants vs usual care patients

i) Effectiveness analysis
- Electronic health records from the HA Clinical Management System:
  - Incident CVD, ESRD, & mortality
  - BP, LDL-C, TG, FG, BMI
  - Prescriptions
  - Use of allied health interventions

ii) Costing analysis
- Costing questionnaires at the HA – HAHO, Cluster and Clinics
- Public healthcare costs and utilization rates:
  - Hospitalizations
  - AED attendances
  - SOPC / GOPC visits
- Private healthcare costs survey from patient subset (n=486)

iii) Cost-effectiveness analysis
- SF-6D health preference survey from patient subset (n=873)
- Empirical data on medical costs and transitional probabilities for complication status

Participants

All patients aged > 18 years with a diagnosis of HT without DM documented in the CMS, and received primary care from GOPC between October 2011 and September 2013

RAMP-HT (n=120,045)

Usual care (n=212,097)

- Enrolled in at least 1 RAMP-HT intake assessment (n=83,758)

- CVD/ESRD/DM/death on or before baseline (n=11,927)
- Lost to follow- up (n=82)

RAMP-HT (n=108,045)

Usual care (n=104,671)

- CVD/ESRD/DM/death on or before baseline (n=23,182)
- Lost to follow-up (n=486)
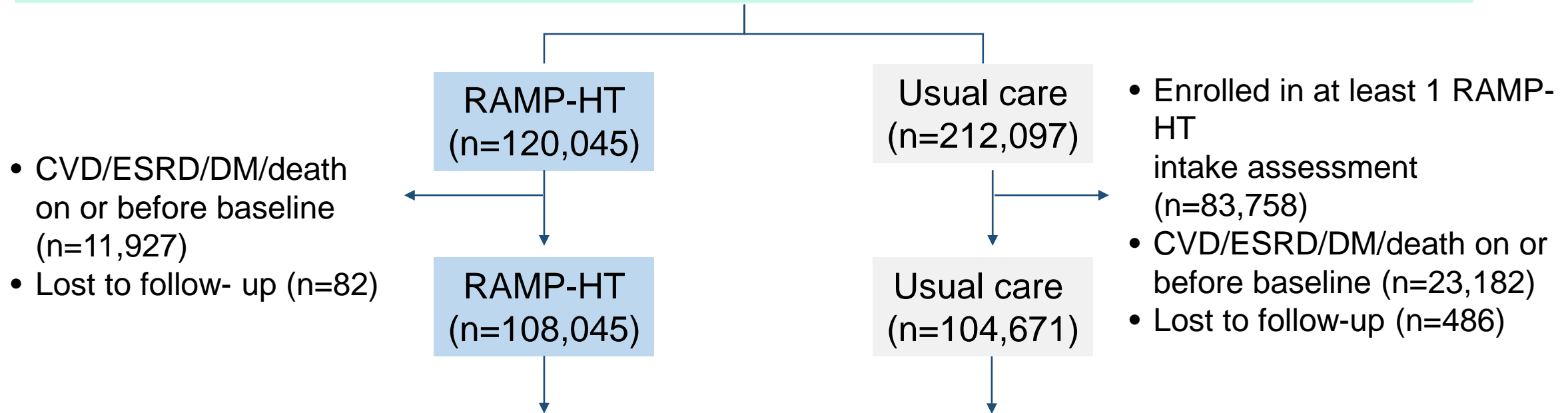
Propensity score matching
(RAMP-HT = 79,161; Usual care = 79,161 Total = 158,322)
Covariates: gender, age, smoking status, BP, TC/HDL-C ratio, LDL-C, triglyceride, fasting glucose, BMI, eGFR, Charlson Comorbidity Index, use of anti-hypertensive drugs, lipid-lowering agents, frequency of service utilization

Baseline characteristics

Mean ± SD / %	RAMP-HT (n = 79,161)	Usual Care (n = 79,161)	p-value
Socio-Demographics			
Gender, female	57.6 %	57.6 %	0.88
Age, year	66.0 ± 11.0	66.0 ± 12.9	0.25
Smoker, current	7.66 %	7.72 %	0.62
Clinical Parameters			
Systolic blood pressure, mmHg	136.2 ±15.40	136.2 ±17.0	0.74
Diastolic blood pressure, mmHg	76.3 ±10.6	76.4 ± 11.2	0.51
Low-density lipoprotein cholesterol, mmol/L	3.23 ± 0.81	3.23 ± 0.84	0.99
Triglycerides, mmol/L	1.47 ± 0.90	1.47 ± 0.91	0.89
Body mass index, kg/m^2	25.5 ± 3.8	25.5 ± 4.6	0.97
eGFR < 60ml/min/1.73m^2	3.68 %	3.88 %	**0.03***
Fasting Glucose, mmol/L	5.39 ± 0.65	5.40 ± 0.67	0.19
Charlson Comorbidity Index	3.09 ± 1.14	3.09 ± 1.30	0.58
Treatment modalities			
Use of ACE inhibitors/ARB	19.50 %	19.34 %	0.41
Use of β-blocker	37.16 %	36.88 %	0.25
Use of Calcium channel blockers	69.42 %	69.38 %	0.84
Use of Diuretic	12.69 %	12.64 %	0.75
Use of Statins	7.71 %	7.60 %	0.42
Public Health service utilization			
Overnight hospitalization	0.14 ± 0.51	0.15 ± 0.56	0.50
Accident & Emergency	0.41 ± 1.04	0.41 ± 1.05	0.59
Specialist out-patient clinic	1.69 ± 2.92	1.70 ± 3.04	0.49
General out-patient clinic	5.47 ± 2.34	5.84 ± 3.01	**<.0001***

Differences between groups were determined using independent t-test or Chi-squared test. *p<0.05
ACE, angiotensin-converting enzyme; ARB, angiotensin II receptor blockers; eGFR, estimated glomerular filtration rate

Effectiveness after 5 years

- **Outcome measures**:
  1) cardiovascular diseases (CVD, composite of coronary heart disease, heart failure, and stroke)
  2) end-stage renal disease (ESRD)
  3) all-cause mortality

- **> 5% absolute risk reduction** for CVD or all-cause mortality in RAMP-HT

Event	RAMP-HT (n = 79,161)		Usual care (n = 79,161)		ARR	NNT (95% CI)	HR (95% CI)
	Cases with event	Incidence rate (cases / 100 person years) (95% CI)	Cases with Event	Incidence rate (cases / 100 person years) (95% CI)			
CVD	7,237	2.06 (2.01,2.11)	11,835	3.30 (3.25, 3.36)	5.81%	17 (16,19)	0.62 (0.60, 0.64)*
ESRD	706	0.20 (0.18, 0.21)	1,244	0.35 (0.33, 0.37)	0.68%	155 (129, 194)	0.62 (0.57, 0.68)*
All-cause mortality	3,987	1.12 (1.09, 1.16)	8,701	2.47 (2.42, 2.51)	5.95%	20 (19,21)	0.54 (0.52, 0.56)*

Hazard ratios (HR) were determined using multivariable Cox proportional hazard regression, adjusted for age, gender, smoking status, clinical parameters, and usage of anti-hypertensive medications and lipid-lowering agents at baseline.

ARR, absolute risk reduction; CI, confidence interval; CVD, cardiovascular disease; ESRD, end-stage renal disease; HR, hazard ratio; NNT, number-needed-to-treat. *p<0.05
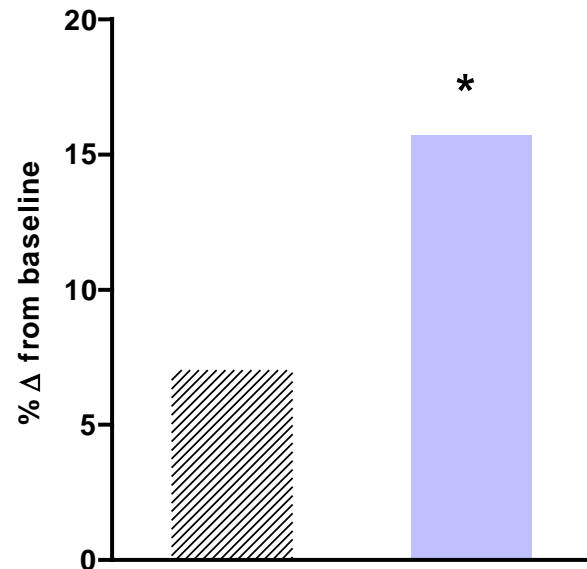
Effectiveness after 5 years

- **Increase in proportion (%) of patients meeting clinical targets**
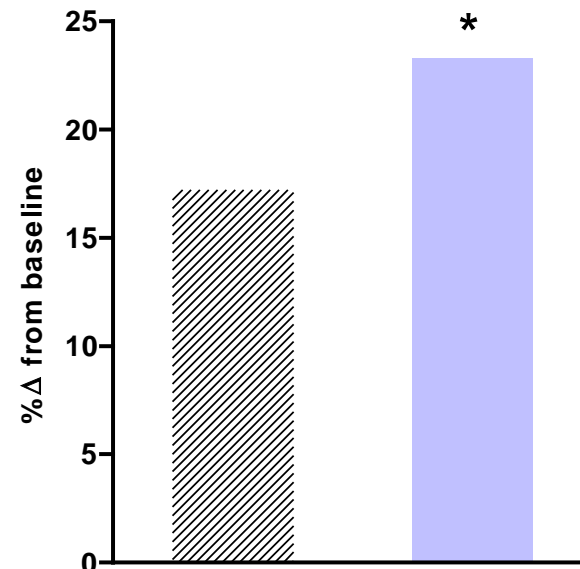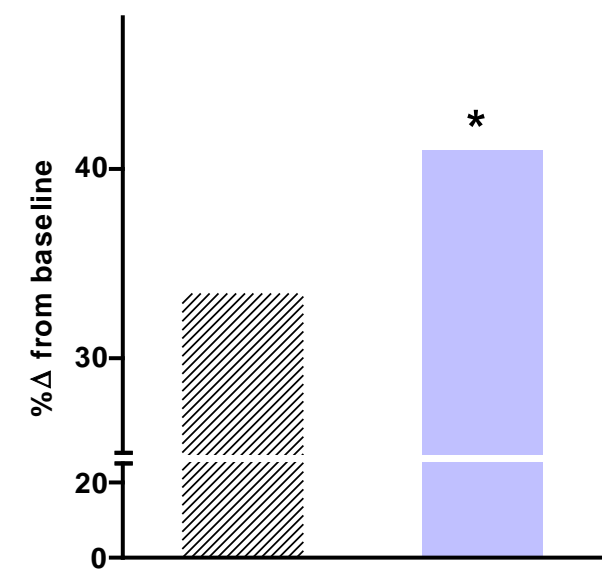
Differences between groups was determined by logistic regression with propensity score fine stratification weightings. ** p<0.05.

Costing analysis - RAMP-HT cost

- **Costing questionnaires** administered at the 1) HA Head Office; 2) Cluster; and 3) Clinic level
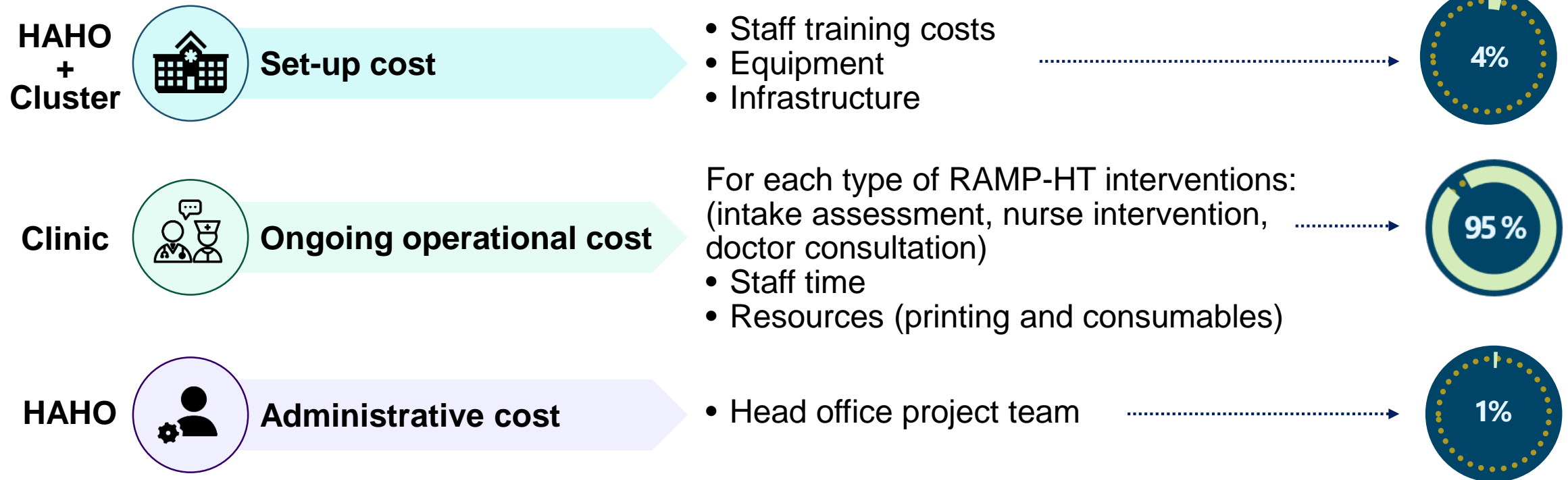
- **Perspective:** Health service provider

HAHO + Cluster — **Set-up cost**
- Staff training costs
- Equipment
- Infrastructure

4%

Clinic — **Ongoing operational cost**
For each type of RAMP-HT interventions: (intake assessment, nurse intervention, doctor consultation)
- Staff time
- Resources (printing and consumables)

95 %

HAHO — **Administrative cost**
- Head office project team

1%

Total programme cost per patient over 5 years: **HK$521**

Costing analysis - RAMP-HT cost

Ongoing operational cost by year in programme

Unit costs by intervention

Contribution to total staff cost:
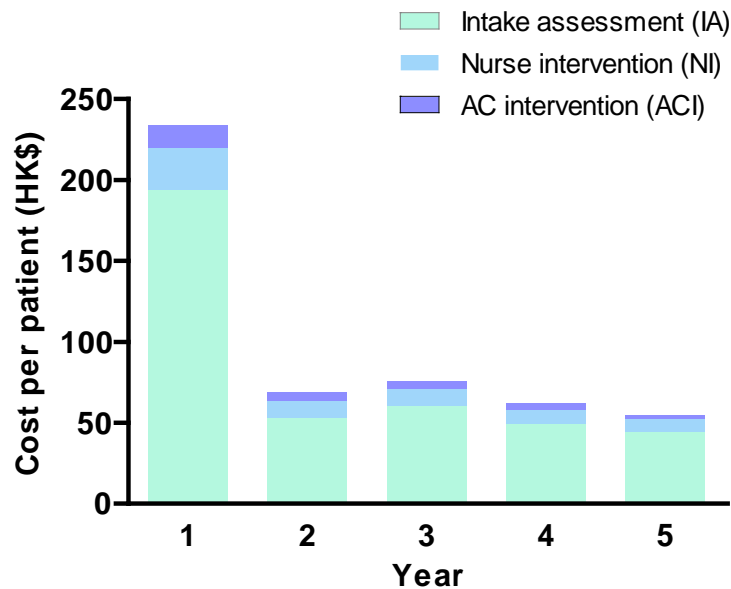
- > 90% cost attributed to **intake assessment** sessions
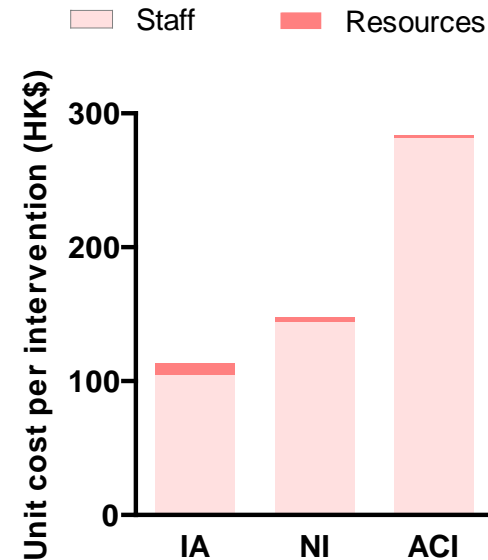
- **Staff cost** responsible for > 93% of total unit cost per intervention
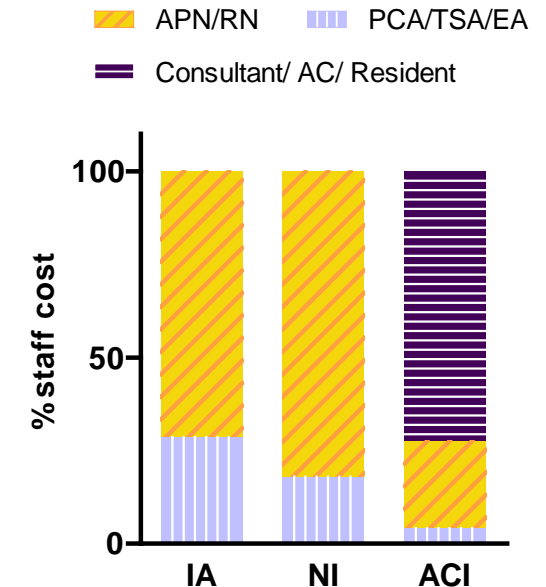
- **Nurses and doctors** accounted for majority of staff costs

Costing analysis
- Public and private healthcare expenditure

Public healthcare expenditure

Cost per attendance:
A&E: $990
SOPC: $1,110
GOPC: $385
Allied Health: $550
Hospitalization: $4,680/d

Legend: Usual Care, RAMP-HT

- **Significantly lower** costs for A&E and SOPC attendance, and overnight hospitalization

Private healthcare expenditure

Private healthcare costs survey from patient subset (n=486)

Legend: Usual Care, RAMP-HT

- **No differences** in private medical costs

Data are mean ± SD. Differences between groups was determined by independent t-test. *$p<0.05$

Costing analysis
- Public healthcare expenditure over 5 years

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Public healthcare expenditure

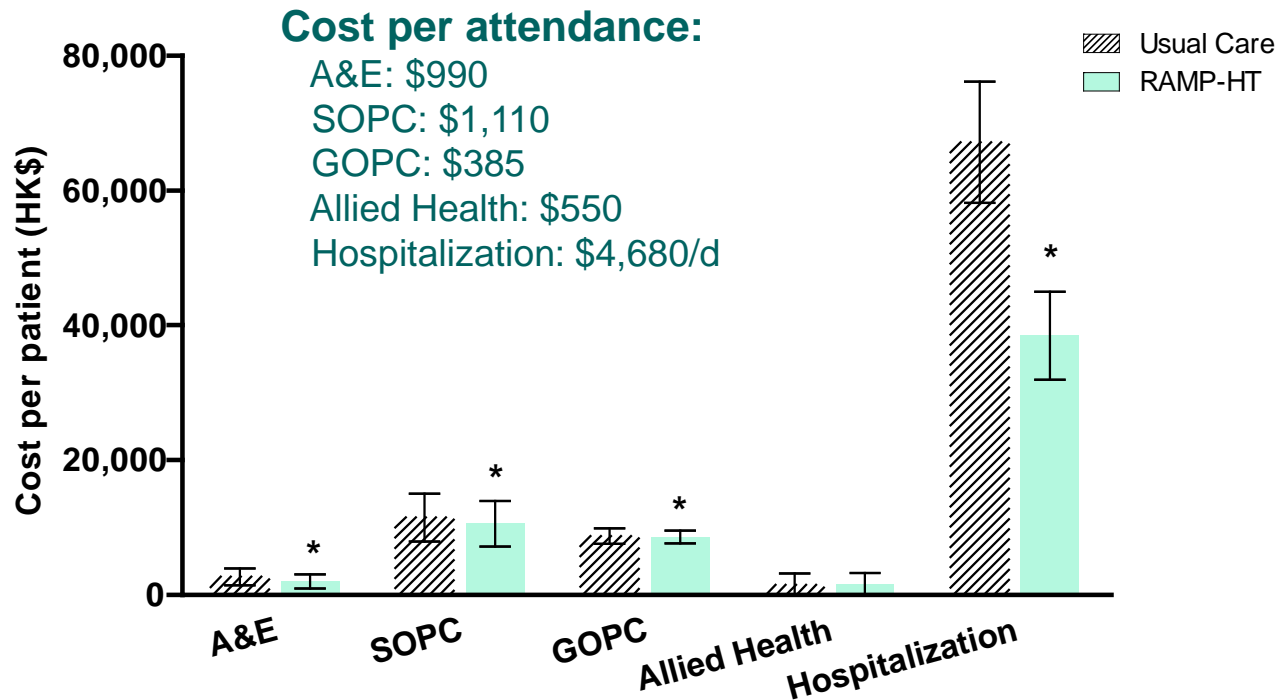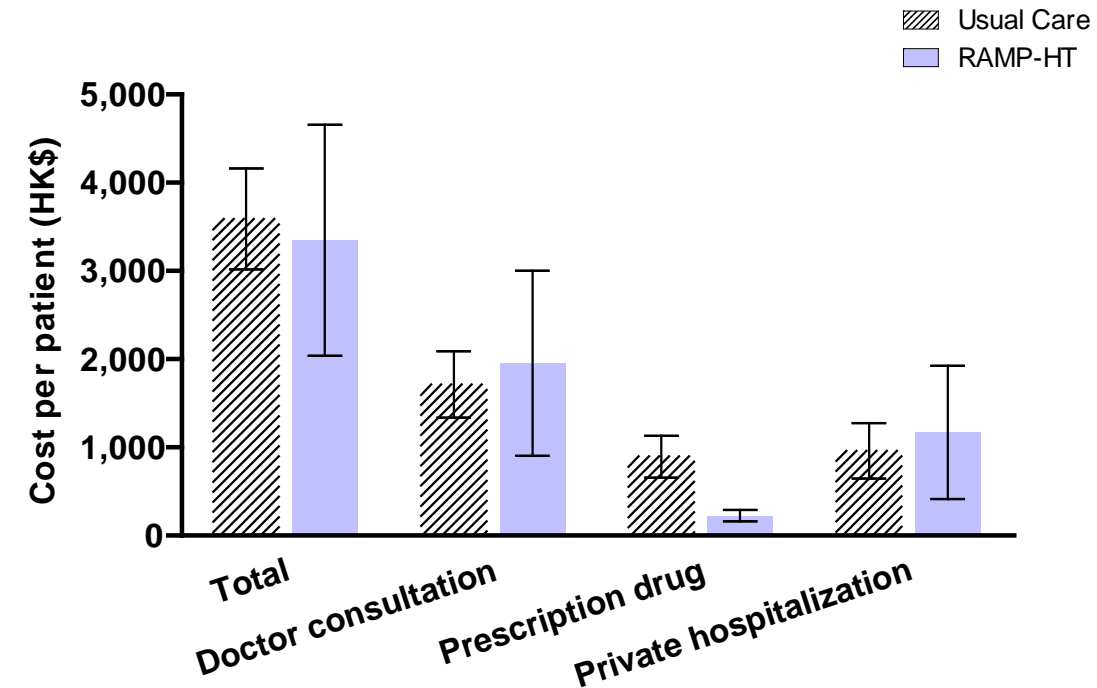Annual cost of public service utilization = ∑ N of health services used x unit cost of health services

Legend: RAMP-HT, Usual Care

+ RAMP-HT programme cost ($521)
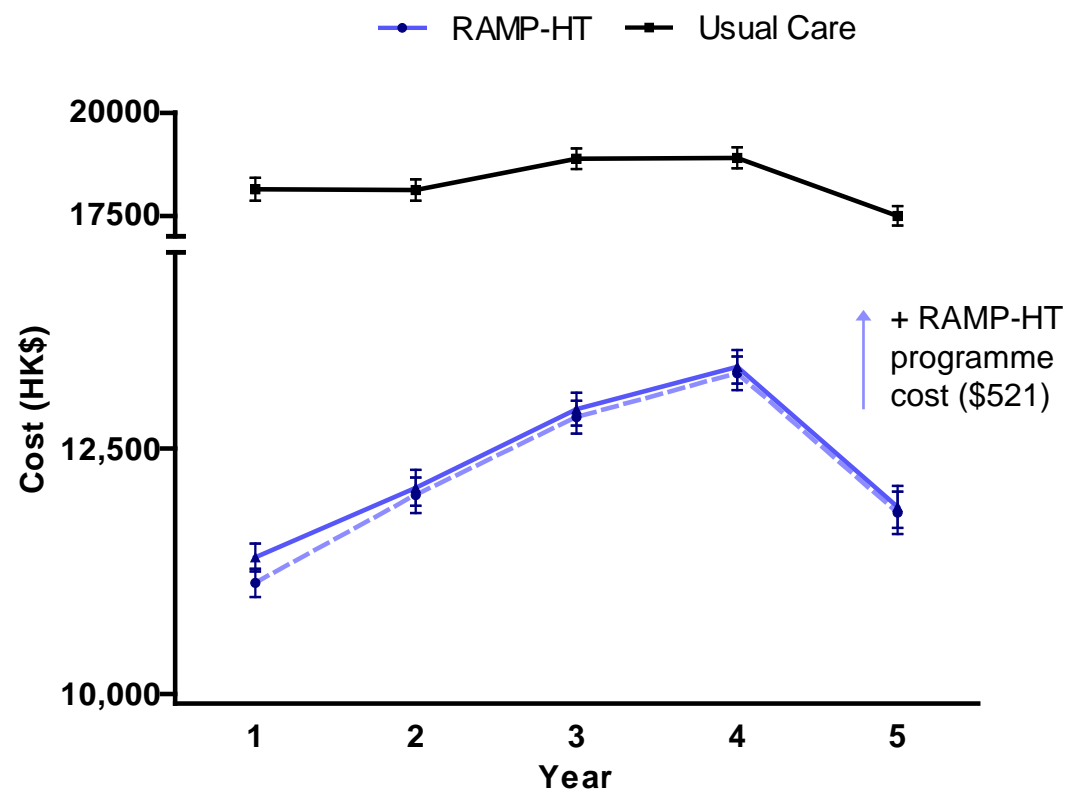
	RAMP-HT	Usual Care
Total expenditure	$61,093	$ 91,561
RAMP-HT cost	$521	---
Total costs over 5 years	**$61,614**	**$91,561**
∆ **Difference**	**- $29,947**	

- **108,127 HT patients** enrolled into RAMP-HT before Oct 2013

- **Saved HK$3.2 billion** over 5 years

Cost-effectiveness after 5 years

Actual 5-year cost-effectiveness

- Program costs per event reduced = Program costs x number-needed-to-treat (NNT)
- Program costs per event-free year gained = Program costs / event-free year gained
- Costs of service utilization were assumed to be identical for both groups

	CVD	ESRD	All-cause mortality
Effectiveness			
Number-needed-to-treat (NNT)	17	155	20
Event-free year gained	0.273	0.153	0.149
Cost-effectiveness (HK$)			
Per event reduced	**$9,058**	**$80,819**	**$10,345**
Per event-free year gained	**$1,905**	**$3,395**	**$3,490**

CVD, cardiovascular disease; ESRD, end-stage renal disease.
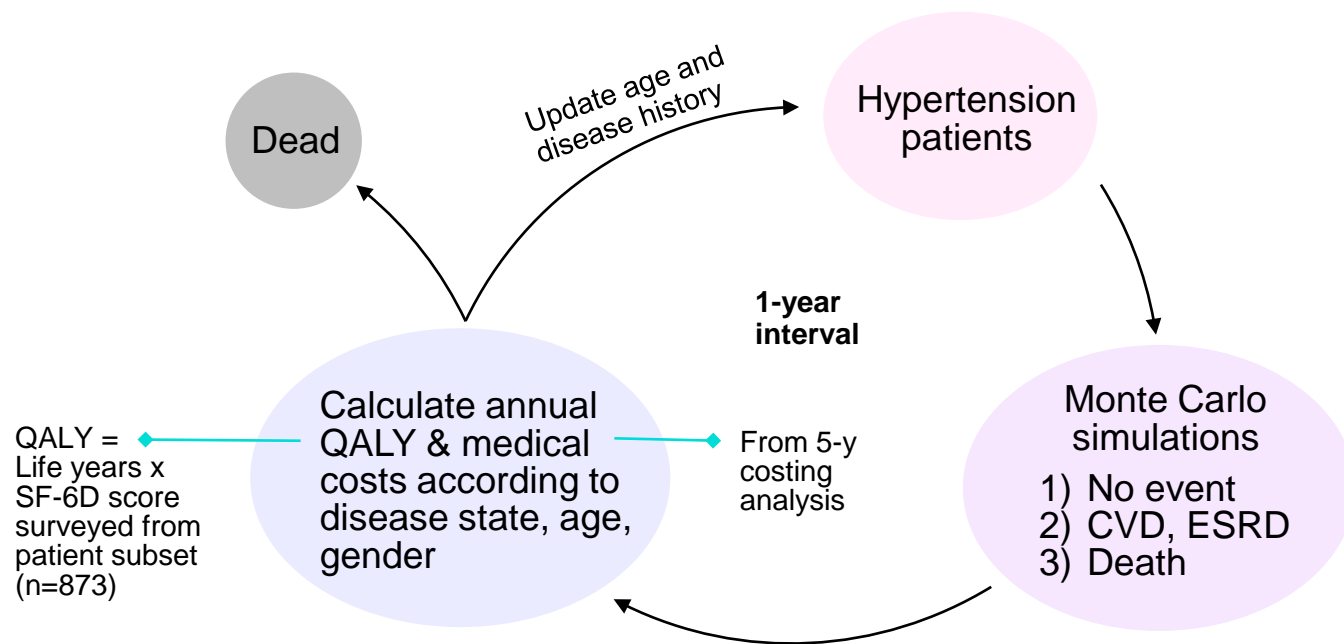
Cost-effectiveness over lifetime

Estimated lifetime cost-effectiveness

Markov modelling with Monte Carlo simulations

	RAMP-HT	Usual Care
Cost (HK$)	338,050 ± 182,150	343,619 ± 188,233
QALY	12.5 ± 5.0	12.3 ± 5.1
Life years	0.273	0.153
Incremental cost (HK$)	**- $5,569**	
Incremental QALY	0.2	
Incremental life years	0.187	
Incremental cost-effectiveness ratio (ICER)	NA	

Data are mean ± SD

Cost-effectiveness plane. RAMP-HT vs Usual care

Dead

Update age and disease history

Hypertension patients

1-year interval

QALY = Life years x SF-6D score surveyed from patient subset (n=873)

Calculate annual QALY & medical costs according to disease state, age, gender

From 5-y costing analysis

Monte Carlo simulations
1) No event
2) CVD, ESRD
3) Death

✓ RAMP-HT **dominated over usual care** and was estimated to save **HK$5,569 per patient** over the lifetime

CVD, cardiovascular disease; ESRD, end-stage renal disease; SF-6D, short-form six-dimension health index; QALY, quality-adjusted life years

Strengths and limitations

Strengths

- Population-based cohort can accurately reflect the actual impact of the RAMP-HT in the primary care setting

- Patients with long follow-up period (median 5.3 years)

- High reliability and quality of data as the data extracted from HA CMS

- Based on empirical evidence

Limitations

- Unobserved confounders may be present (e.g. Motivation, adherence, diet, physical activity, alcohol consumption, mental health)

- Events identified by diagnosis codes

- Package costs for health service utilization

Conclusion

RAMP-HT is an evidence-based, feasible, effective, and cost-saving intervention to improve HT care in the naturalistic busy primary care setting

- ↓ CVD, ESRD and mortality compared to usual care
- ↓ public healthcare expenditure
- Cost-saving

Future studies:

- Longer term (up to 10 years) evaluation of effectiveness / cost-effectiveness
- Subgroup analyses to identify the optimal delivery model
- 360° qualitative evaluation (stakeholder, HCP, patients, carers)

Acknowledgments

- Hospital Authority head office

- Chief of service of the Department of Family Medicine and Primary Healthcare of all HA clusters

- RAMP-HT coordinators

- Statistics & Workforce Planning Department of the HA Strategy and Planning Division

- Social Science Research Centre, HKU

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