Screening for diabetic retinopathy among type 2 diabetic patients

Analytics for Population Health Management (PHM)

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Population health management (PHM): care model

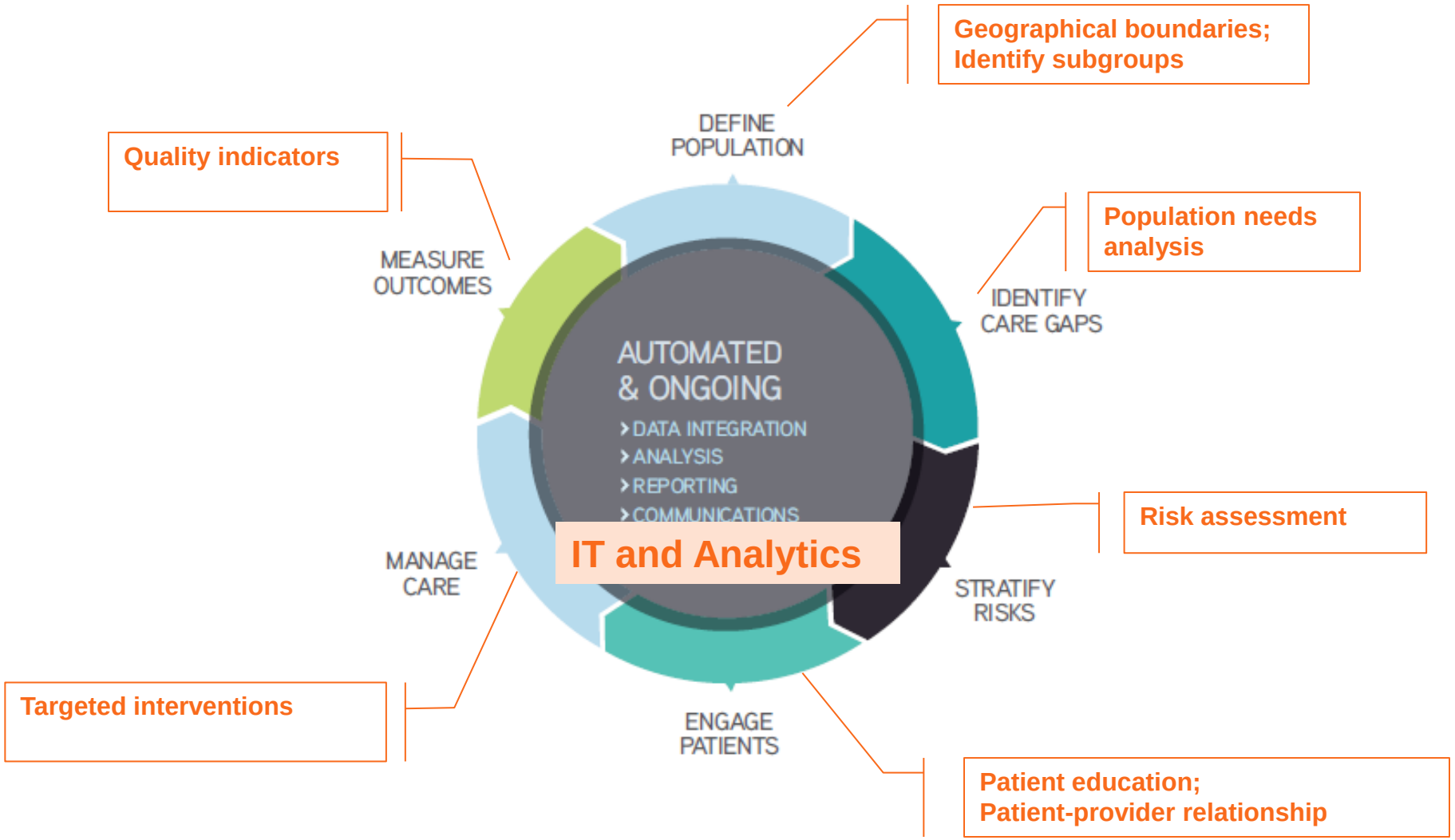
- It has recently gained serious attention from mainstream healthcare organizations, and been looked as the future of healthcare.
- The emphasis is clearly shifting from volume to value, while continuing to provide person-centered quality healthcare across the population.

PHM: definition & goal

- Population is heterogeneous.
- PHM: To target **right interventions** to the **right person** at the **right time**.
- Goal of PHM: To keep a population as healthy as possible, minimizing the need for expensive interventions (eg emergency department visits, admissions, procedures).

Population health management: a roadmap for Provider-Based Automation in a New Era of Healthcare

PHM: Key components



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Stratify Risks

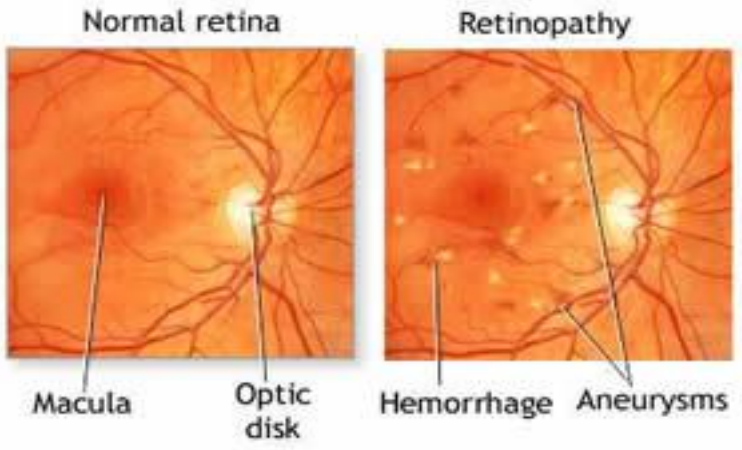
Screening for diabetic retinopathy among type 2 diabetic patients: Developing a risk stratification tool for cost effective screening

Team and Funding

- Supported by Ministry of Health (MOH)-Competitive Research Grant (CRG) for 2 years (May 2013-Mar 2015)
- HSOR team collaborates with:
  - Dr Nikolle Tan and Dr Rajagopalan Rajesh from TTSH
  - Dr Lew Yii Jen from NHG polyclinics

Background

- The prevalence of diabetes mellitus (DM) is >10% in Singapore. Approximately 60% of type 2 diabetic patients develop diabetic retinopathy in 20 years in UKPDS study.
- According to a cross-sectional study in 2008 by SNEC, 35% of Malay diabetic patients had any DR, 9.0% had vision-threatening DR.
- Blindness due to diabetic retinopathy (DR) is the major disability among diabetic patients.



Background

- DR is often asymptomatic even in its more advanced stages. Evidences have shown that early management could prevent vision loss.

- In Singapore, annual screening for diabetic retinopathy using retinal photograph is suggested for all diagnosed DM patients managed at polyclinics regardless of their risks.

- Recent cost effectiveness studies have shown that universal annual screening for DR is not cost-effective.

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Background

Universal screening

- Screening all who are not screened before
- Annual follow-up screening for all

Risk stratified screening

- Screening all who are not screened before
- Follow-up screening tailored to individual's risk:
  - Patients with very low risk screened every 3 years;
  - High-moderate risk groups: screening frequency tailored

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Objectives

- To develop and validate a prognostic model to stratify the risk of developing DR for type 2 diabetic patients
- To evaluate the cost-effectiveness of risk stratified screening vs. universal screening

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Method

Study design	• Predictive modeling for risk stratification using retrospectively collected screening data;
Inclusion	• Type 2 DM patients who did screening in NHG polyclinics in years 2010-2013;
Exclusion	• Patients had DR or any other eye complications diagnosed at the first screening; • Patients had no any follow-up screening;

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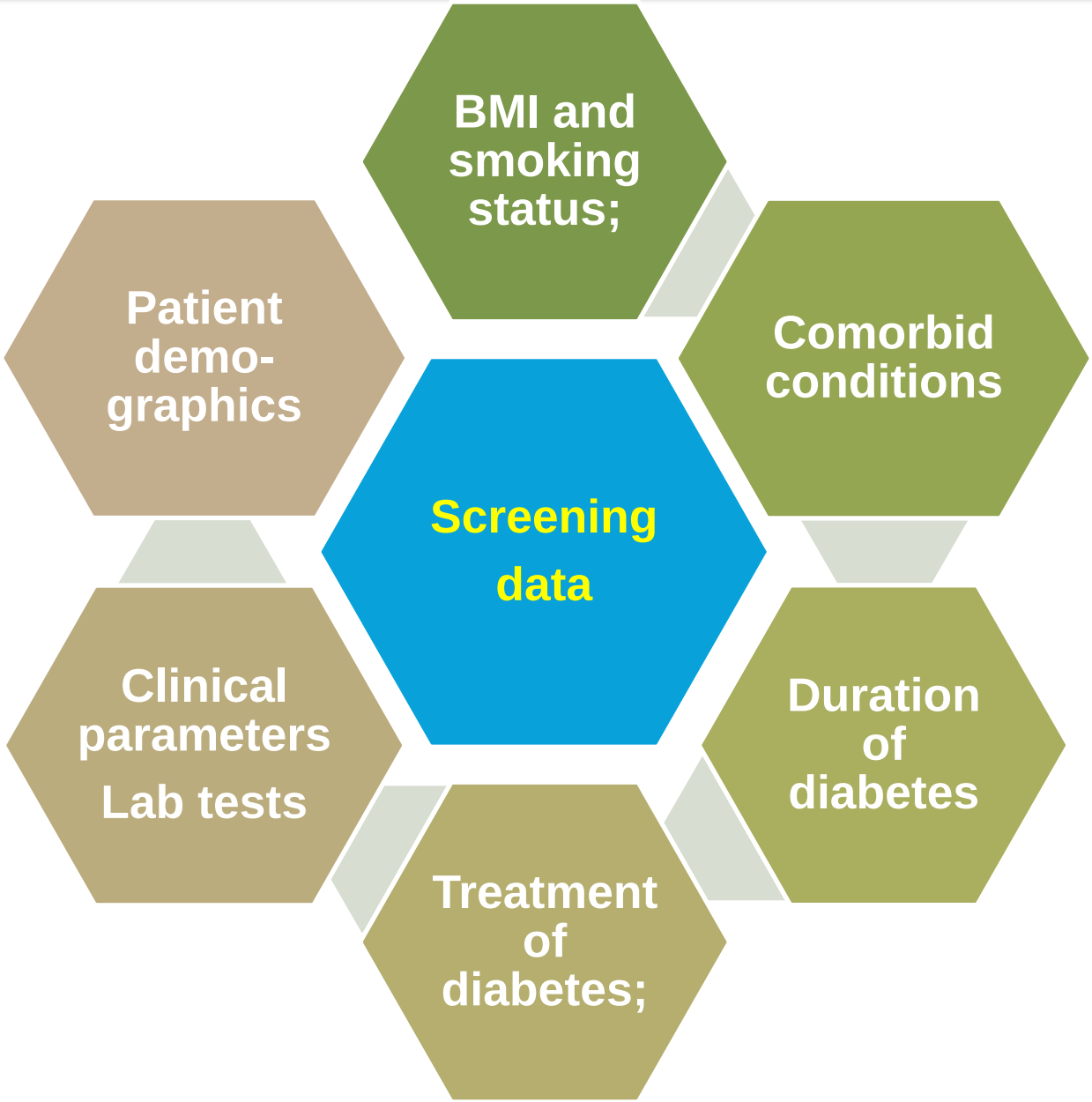
Method: data collected



Method: outcome to be modelled

Risk status

- Event: patients with any DR diagnosed;
- Censored: patients had no DR diagnosed at last screening;

Time to status: time from 1st screening to

- Event: time of any DR first diagnosed
- Censored: time of last screening;

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Modeling

Model development

Parameter estimation: cox regression;

Model fitting: Stepwise selection + BIC

Model validation

Bootstrap validation

Model assessment

Discrimination: Harrell's C concordance statistic;

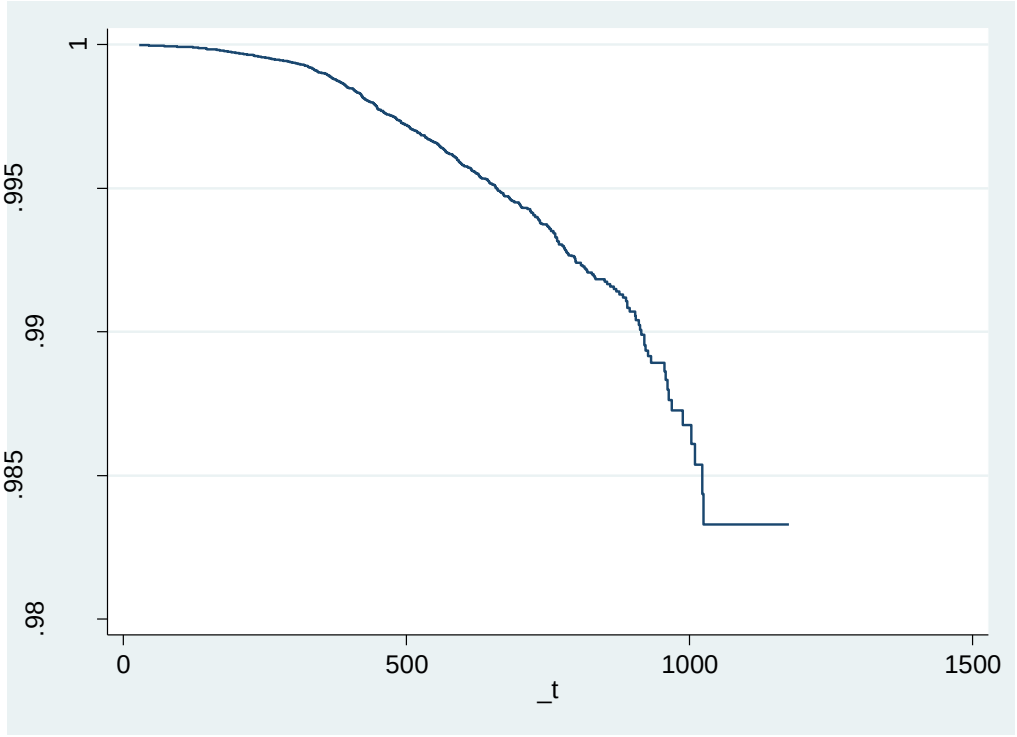
Calibration: Cox-Snell residual and the goodness of fit test.

Final model developed by Cox model

Predictor	Bootstrap correction	Coefficient	Hazard coeff. (95%CI)
Avg Hba1c level in last 1year	0.004	0.27	0.266(0.23- 0.31)
Age	-0.001	0.02	0.021(0.01- 0.02)
Stroke	0.007	0.45	0.443(0.21- 0.67)
Duration of Diabetes	0.002	0.02	0.018(0.01- 0.03)
Dyslipidemia	-0.009	-0.30	-0.201(-0.64--0.04)
Peripheral Neuropathy	0.03	0.50	0.470(0.00- 0.99)

Final model: deployment

- Algorithm: For a patient with *X*, at time *t*
  - $Risk = 1 - S(t, X) = 1 - S_0(t)^{\exp(X,\beta)}$
  - $S_0(t)$ is the baseline survivorship



6 months: 0.9999
1 year: 0.998
1.5 years: 0.996
2 years: 0.992
2.5 years: 0.989
3 years: 0.983

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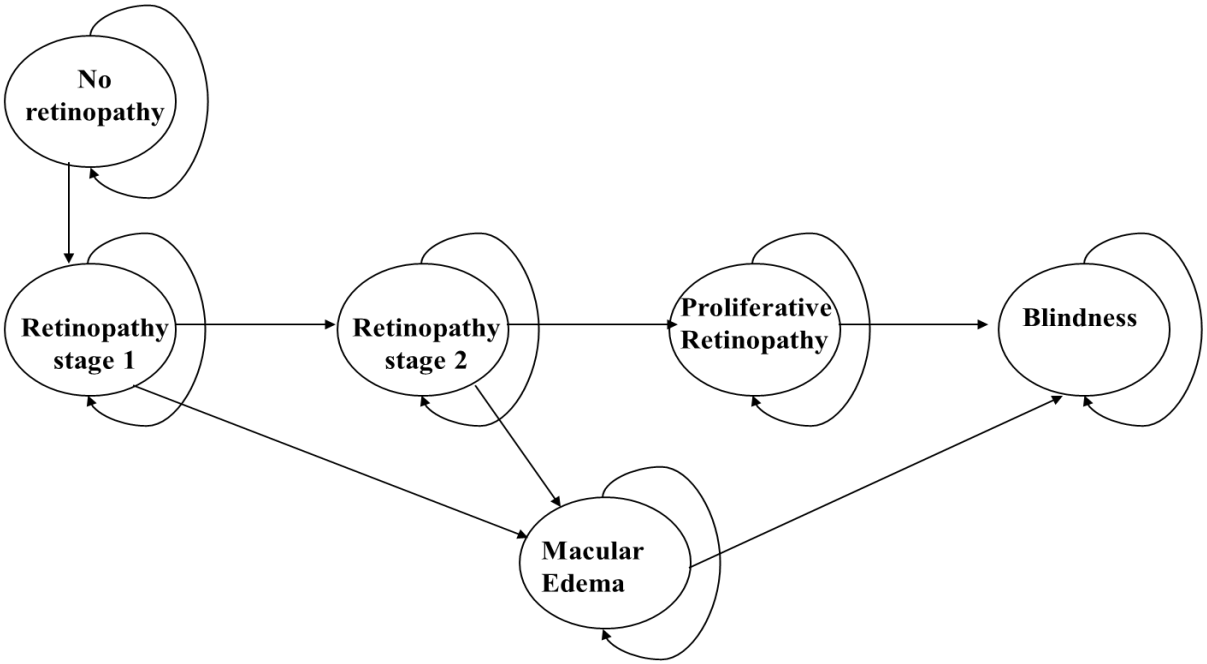
Next step: cost-effective analysis



- Markov disease progression model
- Microsimulation

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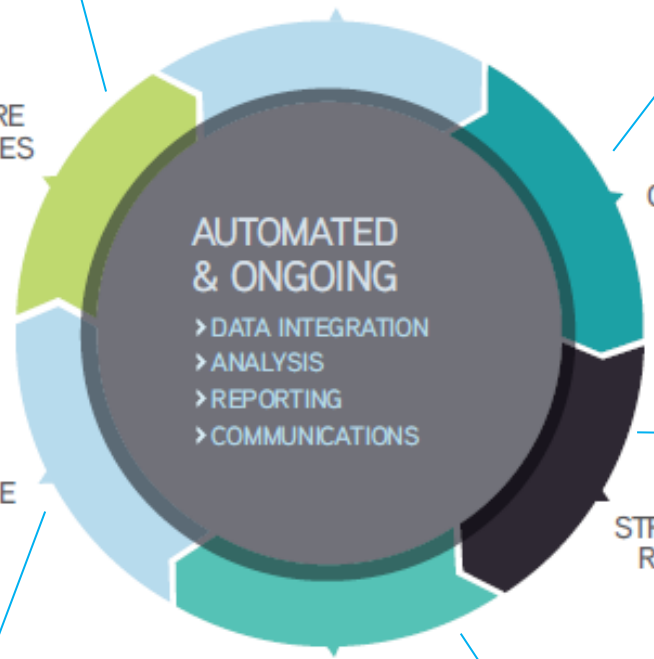
Collaboration Opportunities



Data mining;
Geoanalytics;

Social media;
Modeling & simulation

Predictive modeling;
Machine learning;
statistical modeling

Social media;
Shared decision modeling

Telemonitoring;
Cloud computing based population management

Disease modeling & Microsimulation;
Cost effectiveness analysis;
Visual-analytics;

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