

# HEALTH SERVICES & OUTCOMES RESEARCH

# 2013







# FOREWORD

In the era of rapidly ageing patients and their increasing medical complexities, advancing health technologies and impending rising healthcare cost, providing evidence for decision making and knowledge translation cannot be more crucial. Strengthening the continuum of care to ensure patient-centric integration requires a paradigm shift in the way we re-organise healthcare in NHG's Central Regional Health System. Pivotal to these innovations to improve our healthcare system is the need for rigorous evidence from multiple sources, using multiple methodologies and analytics that capitalise on the multidisciplinary HSOR team. The seamless institutional framework linking senior management with HSOR has facilitated our understanding of their needs in planning for the Regional Health System and population health management. It also helps to deliver evidence that is relevant, useable and solution-oriented.



The year saw the beginnings of big data analytics and interactive visualisation – a strategy to deliver the deluge of information in a simple summarised way that best informs our decision makers within NHG and beyond. The year also saw the beginnings of collaboration with Imperial College London/Lee Kong Chian School of Medicine on the evidence of effectiveness and innovations in eLearning for medical education. Both initiatives will pave the way for further development in the immediate years.

Activities aligned with the fundamental backbone three missions of the department; i.e. providing best available evidence for decision making and knowledge translation; building capacity and advancing knowledge in health services research, continued during the year. This report is a compilation of the work. I wish you a happy reading.

**PROF CHEE YAM CHENG**  
Group Chief Executive Officer  
*National Healthcare Group*



## OUR VISION

To add years of healthy life to the people of Singapore through excellence in Health Services Research.

## OUR MISSION

We will improve the quality of healthcare by providing best available evidence for decision making and knowledge translation; and building capacity and advancing knowledge in HSR.

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PROJECTS

POPULATION HEALTH  
& MANAGEMENT OF  
DISEASES

## CLUSTERING OF FREQUENT ADMITTERS IN THE CENTRAL REGION

Teow Kiok Liang, Dr Nakul Saxena

### BACKGROUND

The National Healthcare Group is responsible for the healthcare in Central Region (defined as Ang Mo Kio, Toa Payoh, Hougang, Kallang, Novena, Bishan, Serangoon and Geylang), one of the oldest regions in Singapore with a population of 1.4 million. Many of the patients in the Central Region have multiple chronic conditions.

Univariate analysis is a basic tool in descriptive analysis, and is useful to compute the prevalence of each condition. Multivariate analysis on the other hand, is useful in analysing data involving more than one variable. In this study, we wanted to know if there was “group membership” by chronic conditions among the patients.

### METHODS

We identified patients who were staying in the Central Region and with admissions to Tan Tock Seng Hospital (TTSH) in 2012. For each patient, the last admission date in 2012 was tagged as the index date. With this index date, we looked back 1 year to count the total number of admissions for this patient. Patients with three to four admissions were then included in the study. We further extracted their chronic conditions that were tagged in the Chronic Disease Management Registry.

We then applied a clustering algorithm (IBM SPSS Modeller 15, K-means) to cluster patients based on their chronic conditions into four and six clusters.

### RESULTS

There were 2,659 patients with three to four admissions, of which 2,349 had at least one chronic condition. The prevalence of the chronic conditions is shown in Table 1. Dyslipidaemia (L), hypertension (H), and diabetes (D) were the most prevalent chronic conditions.

**Table 1 – Prevalence of chronic conditions among selected 2,349 patients**

Chronic condition	Prevalence
Dyslipidaemia (L)	76.0%
Hypertension (H)	72.0%
Diabetes (D)	50.0%
Chronic Kidney Disease (K)	47.0%
Coronary Heart Disease (C)	32.0%
Stroke (S)	26.0%
Heart Failure (HF)	18.0%
Chronic Obstructive Pulmonary Disease (COPD)	10.0%
Asthma (A)	9.0%
Atrial Fibrillation (AF)	6.0%
Hip Fracture (Hip F)	5.0%
Osteoporosis (O)	3.0%
Spine Fracture (Sp F)	3.0%

Table 2 shows four clusters, with the first cluster showing a higher prevalence of chronic obstructive pulmonary disease (COPD) and asthma (A), and three other clusters with dyslipidaemia (L), hypertension (H) and diabetes (D) but different degrees of chronic kidney disease (K), coronary heart disease (C) and stroke (S). For the six-cluster results, we saw the appearance of a group with chronic kidney disease (K) but without diabetes, and another group of osteoporosis (O), though the number was small (Table 3).

Table 2 – Four clusters

Cluster	LH+A+COPD	DHL+C+K+F	DHL+K+S	HL+S
<b>Cluster size</b>	<b>37.0%</b>	<b>27.0%</b>	<b>20.0%</b>	<b>16.0%</b>
Dyslipidaemia (L)	68.0%	99.0%	98.0%	88.0%
Hypertension (H)	59.0%	99.0%	97.0%	83.0%
Diabetes (D)	26.0%	80.0%	100.0%	33.0%
Chronic Kidney Disease (K)	21.0%	80.0%	100.0%	21.0%
Coronary Heart Disease (C)	11.0%	89.0%	17.0%	27.0%
Stroke (S)	0.0%	16.0%	45.0%	100.0%
Heart Failure (HF)	2.0%	64.0%	4.0%	8.0%
Atrial Fibrillation (AF)	2.0%	11.0%	7.0%	6.0%
Chronic Obstructive Pulmonary Disease (COPD)	16.0%	11.0%	7.0%	9.0%
Asthma (A)	14.0%	8.0%	9.0%	4.0%
Hip Fracture (Hip F)	5.0%	6.0%	5.0%	5.0%
Osteoporosis (O)	4.0%	3.0%	3.0%	4.0%
Spine Fracture (Sp F)	3.0%	3.0%	3.0%	3.0%

Table 3 – Six clusters

Cluster	LH+A+COPD	DHL+K+S	DHL+C+K+F	LH+C+S	LH+K	Hip+DHL+K
<b>Cluster size</b>	<b>28.0%</b>	<b>22.0%</b>	<b>20.0%</b>	<b>14.0%</b>	<b>12.0%</b>	<b>4.0%</b>
Dyslipidaemia (L)	66.0%	98.0%	100.0%	98.0%	73.0%	81.0%
Hypertension (H)	53.0%	98.0%	99.0%	92.0%	74.0%	91.0%
Diabetes (D)	34.0%	100.0%	91.0%	33.0%	0.0%	62.0%
Chronic Kidney Disease (K)	1.0%	85.0%	94.0%	8.0%	100.0%	59.0%
Coronary Heart Disease (C)	2.0%	15.0%	92.0%	77.0%	18.0%	30.0%
Stroke (S)	8.0%	52.0%	20.0%	54.0%	18.0%	32.0%
Heart Failure (HF)	3.0%	5.0%	77.0%	12.0%	14.0%	6.0%
Atrial Fibrillation (AF)	2.0%	6.0%	12.0%	6.0%	5.0%	9.0%
Chronic Obstructive Pulmonary Disease (COPD)	16.0%	7.0%	10.0%	11.0%	15.0%	8.0%
Asthma (A)	16.0%	9.0%	7.0%	6.0%	9.0%	1.0%
Hip Fracture (Hip F)	2.0%	0.0%	4.0%	1.0%	0.0%	100.0%
Osteoporosis (O)	3.0%	2.0%	3.0%	4.0%	4.0%	18.0%
Spine Fracture (Sp F)	2.0%	4.0%	2.0%	3.0%	3.0%	9.0%

## CONCLUSION

The use of a clustering algorithm allowed us to study the multi-chronic situation among the frequent admitters (3-4 admissions). A better understanding of the patients would allow us to treat them in a more customisable and yet holistic manner.

## COMMUNITY HEALTH ASSIST SCHEME PATIENT MOVEMENT STUDY OF NATIONAL HEALTHCARE GROUP POLYCLINICS AND GENERAL PRACTITIONER SERVICES

Dr Zhu Zhecheng, Teow Kiok Liang, David Kok<sup>1</sup>, Low Wan Ting<sup>1</sup>

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### BACKGROUND

This study seeks to understand how patients under the Community Health Assist Scheme (CHAS) are using both the National Healthcare Group Polyclinics (NHGP) and general practitioner (GP) services for their acute and chronic conditions. Three questions were answered in this study:

- 1) What is the distribution of chronic and acute workload across NHGP and GP?
- 2) How many CHAS patients switched from NHGP to GP?
- 3) How many CHAS patients returned to NHGP, and why?

### METHODS

Four sets of data were available for this study: 1) NHGP CHAS patient visits from January 2011 to August 2013; 2) GP CHAS claims from January 2012 to August 2013; 3) CHAS tier information (orange/blue card holder); and 4) table of chronic conditions covered by CHAS/Chronic Disease Management Programme (CDMP). A patient cohort was first defined, and then individual patients were tracked to study the switch pattern and subsidy usage pattern.

### RESULTS

Figure 1 is a snapshot of an interactive chart illustrating how patients are utilising the chronic subsidies. It was observed that many patients did not use up their chronic subsidy during the study period.

Figure 1 – Chronic subsidy balance

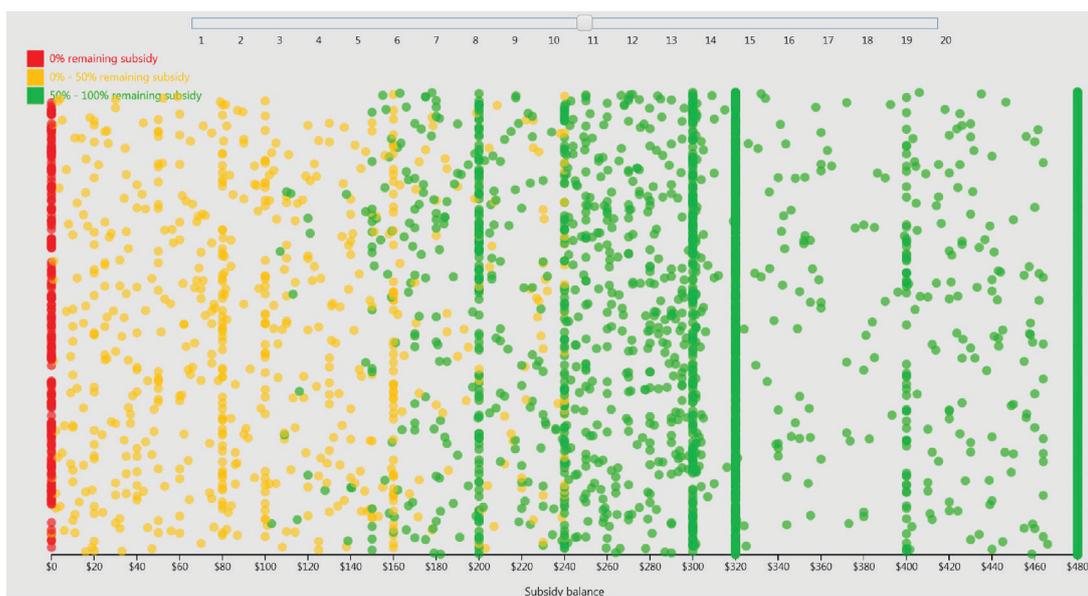
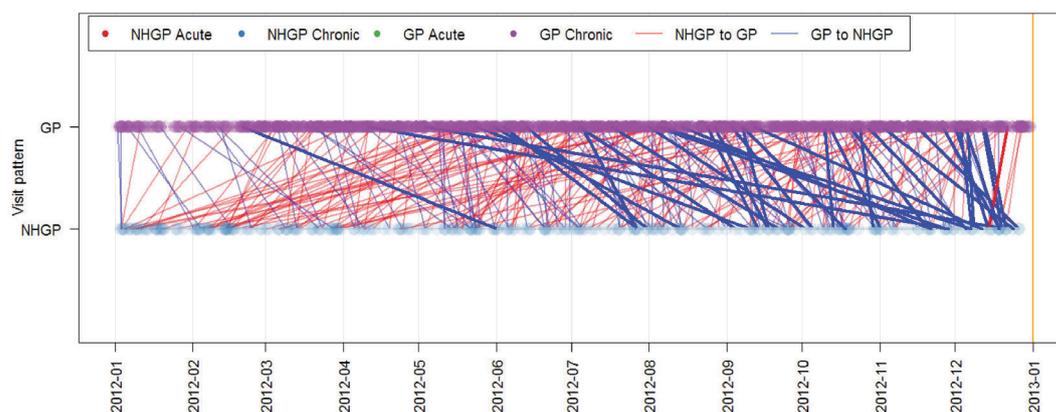


Figure 2 illustrates the switch patterns of CHAS patients who used up their chronic subsidy. It was observed that not many patients returned to NHGP for chronic visits after they used up their chronic subsidy.

Figure 2 – Switch patterns of CHAS patients who used up their chronic subsidy



CONCLUSION

Such a study helped healthcare service providers to analyse how CHAS patients were using services under the current policy.

## FUNCTIONAL STATUS OF ELDERLY SINGAPOREANS

Dr May Me Thet, Dr Sun Yan, Wong Lai Yin, Charis Ng Wei Ling, Dr Pradeep Paul George Gunapal

### BACKGROUND

Functional disability has several public health implications such as increased demand for health care, poor quality of life, higher morbidity and mortality. Profiling the functional disability and associated factors is of great importance in population health management and health services planning. The aim of this study was to identify risk factors associated with disability in basic activities of daily living (BADL) and instrumental activities of daily living (IADL) in community-dwelling elderly Singaporeans.

### METHODS

The data was derived from a cross-sectional population-based survey conducted in Marine Parade. The presence of disability was determined by asking the participants' ability to carry out BADLs and IADLs independently. BADL items included feeding, dressing and undressing, transferring, showering and toileting, whereas IADLs included using the telephone, ability to travel more than a walking distance, shopping, preparing own meals, doing house work, managing own medicines and handling own money. Logistic regression analyses were used to identify the factors associated with disability in performing BADLs and IADLs.

### RESULTS

Of 3,752 eligible elderly, 2,454 were included in the analyses. Overall functional disability prevalence was 14.7% for IADLs and 3.3% for BADLs. Risk factors associated with disability in at least one BADL were older age, completed junior college, of Indian ethnicity, self-reported diabetes, weak or failing kidneys, stroke, pain, vision impairment, urinary incontinence, cognitive impairment and presence of depressive symptoms. Risk factors associated with disability in at least one IADL were older age, of Indian and Malay ethnicity, had either primary education or no formal education, bigger housing, self-reported diabetes, stroke, osteoporosis, pain, hearing loss, urinary incontinence, dementia, cognitive impairment and presence of depressive symptoms.

Table 1 – Factors associated with disability in at least 1 BADL and 1 IADL

	BADL			IADL		
	Odds Ratio	95% CI	p value	Odds Ratio	95% CI	p value
<b>Age group (years)</b>						
60-64	1.00			1.00		
65-74	3.45	1.29 – 9.25	0.014	1.86	1.38 – 2.52	<0.001
75-84	8.93	3.07 – 25.99	<0.001	3.98	2.71 – 5.86	<0.001
Above 85	36.47	11.99 – 110.95	<0.001	20.32	12.64 – 32.69	<0.001
<b>Gender</b>						
Male	1.00			1.00		
Female	0.98	0.53 – 1.81	0.939	1.16	0.86 – 1.56	0.332
<b>Educational level</b>						
Degree and diploma	1.00			1.00		
Junior college	0.12	0.03 – 0.59	0.009	0.53	0.19 – 1.42	0.206
Secondary	0.68	0.25 – 1.87	0.459	1.13	0.63 – 2.04	0.680
Primary	1.49	0.51 – 4.34	0.461	2.05	1.13 – 3.70	0.018
No formal education	0.95	0.31 – 2.88	0.923	2.68	1.44 – 4.97	0.002
<b>Ethnicity</b>						
Chinese	1.00			1.00		
Indian	8.44	3.85 – 18.48	<0.001	3.14	1.83 – 5.37	<0.001
Malay	1.03	0.51 – 2.08	0.942	2.15	1.51 – 3.05	<0.001
Others	2.25	0.95 – 5.34	0.066	1.15	0.58 – 2.29	0.682
<b>Housing type</b>						
2-room	1.00			1.00		
3-room	1.26	0.58 – 2.77	0.559	1.80	1.21 – 2.67	0.004
4-room	1.97	0.82 – 4.72	0.129	3.31	2.15 – 5.08	<0.001
5-room	0.90	0.29 – 2.81	0.852	1.73	1.06 – 2.82	0.028
<b>Covariates</b>						
Diabetes	2.10	1.24 – 3.57	0.006	1.80	1.37 – 2.37	<0.001
Stroke	14.37	6.78 – 30.48	<0.001	3.33	2.03 – 5.46	<0.001
Weak/failing kidneys	4.21	1.75 – 10.13	0.001	2.21	1.51 – 3.21	<0.001
Pain	1.96	1.06 – 3.60	0.031	1.95	1.47 – 2.57	<0.001
Urinary incontinence	2.23	1.24 – 4.01	0.008	1.64	1.16 – 2.33	0.005
Vision impairment	2.22	1.09 – 4.54	0.029	1.91	1.37 – 2.67	<0.001
Cognition	3.71	1.86 – 7.42	<0.001	2.74	1.85 – 4.04	<0.001
Depression	6.02	3.11 – 11.67	<0.001	3.51	2.44 – 5.05	<0.001
Dementia				43.97	10.58 – 182.81	<0.001

## CONCLUSION

The study has identified the risk factors associated with functional impairment in Singaporean elderly. Future research with a longitudinal study design is recommended for a better understanding of functional disability and associated risk factors in the local elderly population.

## HEALTH STATUS PROFILES OF COMMUNITY-DWELLING ELDERLY: A LATENT CLASS ANALYSIS

Charis Ng Wei Ling, Dr Luo Nan<sup>1</sup>, Dr Heng Bee Hoon

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### BACKGROUND

Elderly populations are highly heterogeneous in their health status due to the variability and interdependency of multiple health dimensions over time. In recent years, studies have used latent class analysis (LCA) to study the heterogeneity of health among the elderly. Latent class analysis is a statistical method for identifying unobservable or latent classes within a population using multiple indicators. Also known as a “person-centred” approach, the focus of LCA is on the relationships among individuals, as compared to other statistical methods such as regression analysis and factor analysis, where the focus is on relationships among variables.

This study aimed to identify the health status profiles of older adults based on measures of health in the physical, mental, and social dimensions, and to examine the socio-demographic characteristics associated with each health status profile.

### METHODS

Data for this study was derived from a community-based survey of residents 60 years and above living in 2- to 5-room housing in Marine Parade. Seven indicators were selected to represent the 1) physical (chronic conditions, ADL dependency, and pain); 2) mental (depression and cognition); and 3) social (perception of social isolation and frequency of socialising) dimensions of health.

LCA was performed with Mplus Version 6.1. The goal of LCA is to group individuals into classes, with each class containing individuals with similar indicator patterns, but different from individuals in other classes. LCA estimates two types of parameters: 1) indicator probabilities describe the patterns of indicators for each class, and consist of the probability that an indicator is associated with the class; and 2) class membership probabilities reflecting the individuals' probabilities of belonging to each class.

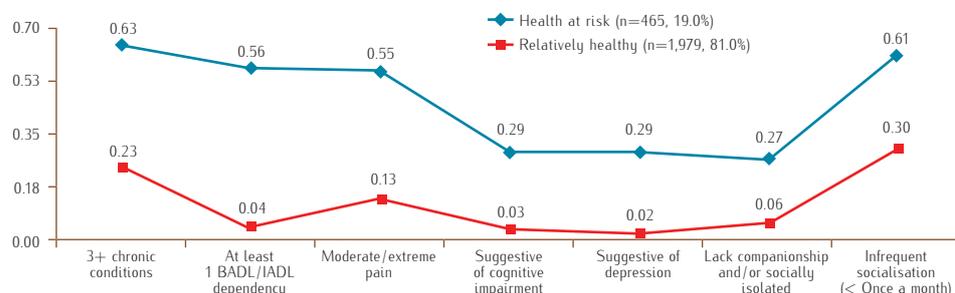
Data for the seven health status indicators was fitted in a step-wise manner with models of differing number of classes until no improvement in fit was observed. The best model was then selected based on fit indices such as entropy, the Lo-Mendell-Rubin likelihood ratio test, and the Akaike Information Criteria (AIC) and Bayesian Information Criteria (BIC) values. Finally, a multivariable logistic regression was conducted in Stata 12.0 to examine the socio-demographic characteristics associated with each class.

### RESULTS

A total of 2,444 respondents were included in the analysis. The results suggested a 2-class solution provided the best overall fit and explanation of the observed health status indicators frequencies.

Figure 1 presents the health status indicator probabilities ( $\lambda$ ) for the two classes. The “Health at risk” profile represented 465 (19.0%) elderly individuals of the sample, and was characterised by high probabilities of 3+ chronic conditions ( $\lambda=0.63$ ), at least one BADL or IADL dependency ( $\lambda=0.56$ ), moderate or extreme pain ( $\lambda=0.55$ ), cognitive impairment ( $\lambda=0.29$ ), depressive symptoms ( $\lambda=0.29$ ), social isolation ( $\lambda=0.27$ ), and infrequent socialisation ( $\lambda=0.61$ ).

Figure 1 – Health status indicator probabilities ( $\lambda$ ) of the “Health at risk” and “Relatively healthy” profiles



The “Relatively healthy” comprised 1,979 (81.0%) elderly of the sample, and individuals in this group had lower probabilities of 3+ chronic conditions ( $\lambda=0.23$ ), at least one BADL or IADL dependency ( $\lambda=0.04$ ), moderate or extreme pain ( $\lambda=0.13$ ), cognitive impairment ( $\lambda=0.03$ ), depressive symptoms ( $\lambda=0.02$ ), social isolation ( $\lambda=0.06$ ), and infrequent socialisation ( $\lambda=0.30$ ).

The logistic regression revealed socio-demographic differences between the health status profiles. Using the “Relatively healthy” profile as the reference group, individuals who were older (65–74, 75–84, 85+ years), female, of non-Chinese ethnicity (Indian, Malay, Others), had primary and lower education, and were either unemployed or not employed were more likely to belong to the “Health at risk” profile (Table 1).

Table 1 – Odds ratios of socio-demographic characteristics for the “Health at risk” profile#

	Odds Ratio	95% CI	p value		Odds Ratio	95% CI	p value
<b>Age (years)</b>				<b>Housing type</b>			
[60–64]	1.00			[4-/5-room]	1.00		
65–74	1.49	1.21 - 1.85	<0.001	3-room	0.87	0.69 - 1.10	0.233
75–84	2.43	1.81 - 3.26	<0.001	2-room	1.24	0.93 - 1.65	0.142
85+	8.20	5.58 - 12.04	<0.001	<b>Personal monthly income</b>			
<b>Gender</b>				[≥\$1,000]	1.00		
[Male]	1.00			\$500–\$999	0.79	0.57 - 1.09	0.144
Female	1.50	1.22 - 1.85	<0.001	≤\$499	1.01	0.73 - 1.40	0.931
<b>Ethnicity</b>				Refused/don't know	0.79	0.56 - 1.11	0.175
[Chinese]	1.00			<b>Work status</b>			
Indian	2.95	2.04 - 4.28	<0.001	[Employed]	1.00		
Malay	1.51	1.14 - 1.98	0.004	Unemployed	6.60	3.74 - 11.66	<0.001
Others	1.97	1.28 - 3.04	0.002	Not employed*	2.08	1.54 - 2.81	<0.001
<b>Educational level</b>				# Reference group: Relatively healthy profile			
[Secondary & higher]	1.00			[ ] Reference groups			
Primary & lower	2.19	1.75 - 2.73	<0.001	* refers to housewives & retirees			

CONCLUSION

By using LCA, we identified two distinct health status profiles of the elderly, which took into account the heterogeneity of the elderly population in terms of multiple dimensions of health. Selected socio-demographic characteristics were also found to be associated with the different health status profiles, which furthered our understanding of the social stratifications related to the health status of the elderly, and provided implications for the structuring of future public health interventions targeted at the older population.

## NATIONAL HEALTHCARE GROUP POLYCLINICS PATIENT ANALYSIS BY REGION

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### BACKGROUND

Earlier studies have found that the patient catchment for National Healthcare Group Polyclinics (NHGP) are quite localised. In 2012, there were 2.87 million visits to the nine NHG polyclinics – Ang Mo Kio, Bukit Batok, Choa Chu Kang, Clementi, Hougang, Jurong, Toa Payoh, Woodlands, and Yishun. These regions have different proportions of patients residing in 1- to 3-room dwelling units and elderly residents aged 65 years and above. The population demographics of Singapore are available from the Department of Statistics (DOS), stratified by the Development Guide Plan (DGP). This study aimed to examine the resident utilisation of NHGP by age and dwelling units.

### METHODS

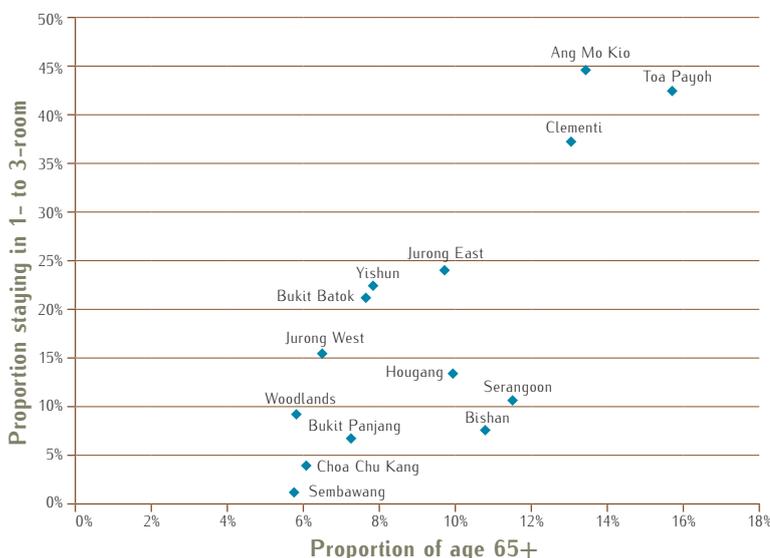
We used DOS resident population data in 2012, which included the number of residents staying in the various types of dwelling units by DGP, stratified by age and DGP. In this study, we focused on residents aged 65 years and above, and those staying in 1- to 3-room units. NHGP visits data in 2012 were also extracted, with age data classified into <65 and 65+, and addresses mapped into DGPs.

We studied those DGPs that were well covered by NHGP. For each of these DGP, we counted the number of patients that had at least one NHGP visit in the year (by total and 65+), and derived the percentage of population that had at least one visit with NHGP for each DGP (by total and 65+).

### RESULTS

Figure 1 shows that DGPs with a higher proportion of elderly also had a higher proportion of those living in 1- to 3-room units. These represented potential areas that may need more support.

**Figure 1 – Proportion of residents staying in 1- to 3-room units with age 65+ for selected DGPs**

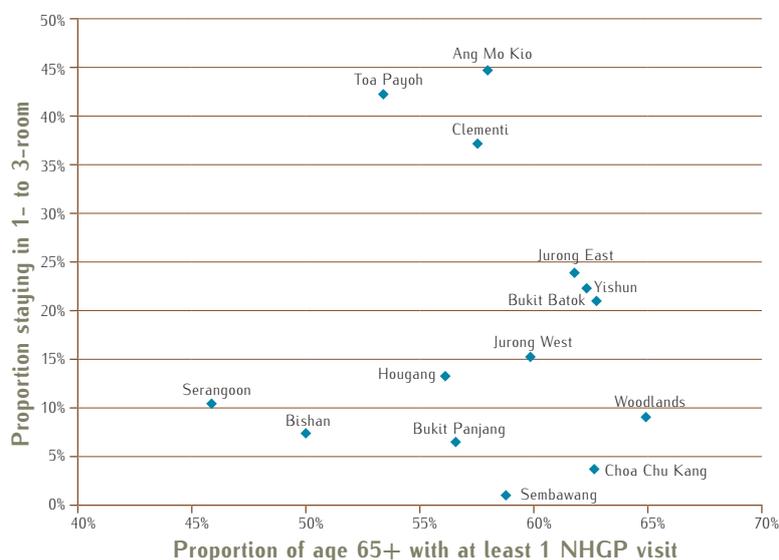


As seen in Table 1, in DGPs covered by NHGP, about 29.0% of the total resident population and 59.0% of elderly had visited NHGP at least once in 2012. In Figure 2, we see that Ang Mo Kio, Toa Payoh and Clementi, DGPs with a higher proportion of residents living in 1- to 3-room units, have an elderly utilisation of 56.0%, which is lower than the utilisation rate of over 60.0% in Woodlands, Choa Chu Kang and Bukit Batok, DGPs with a lower proportion of residents living in 1- to 3-room units.

Table 1 – Resident demographics and NHGP utilisation in selected DGPs

DGP	Pop '000	Elderly%	1-3room%	All ages utilisation	65+ utilisation
Ang Mo Kio	178.9	13.0%	45.0%	29.0%	58.0%
Toa Payoh	126.1	16.0%	42.0%	28.0%	53.0%
Clementi	91.2	13.0%	37.0%	31.0%	58.0%
Jurong East	86.5	10.0%	24.0%	33.0%	62.0%
Yishun	186.4	8.0%	22.0%	33.0%	62.0%
Bukit Batok	142.6	8.0%	21.0%	31.0%	63.0%
Jurong West	271.9	7.0%	15.0%	32.0%	60.0%
Hougang	217.4	10.0%	13.0%	27.0%	56.0%
Serangoon	123.3	12.0%	11.0%	20.0%	46.0%
Woodlands	247.7	6.0%	9.0%	33.0%	65.0%
Bishan	92.7	11.0%	7.0%	21.0%	50.0%
Bukit Panjang	131.1	7.0%	7.0%	28.0%	57.0%
Choa Chu Kang	174.3	6.0%	4.0%	31.0%	63.0%
Sembawang	73.0	6.0%	1.0%	27.0%	59.0%

Figure 2 – Utilisation of age 65+ for those staying in 1-3 room for selected DGPs



CONCLUSION

More than 60% of the resident population, especially the elderly, in certain DGPs had visited NHGP. Further, DGPs with more elderly and residents living in 1- to 3-room units did not necessary have the highest utilisers. It might be that these residents sought treatment with private general practices, were healthier, or were already enrolled in other programmes. Further investigations might be needed to understand the health status and health seeking behaviour of these residents.



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PROJECTS

ORGANISATION  
& DELIVERY OF  
SERVICES

## ANALYSIS OF PATIENT WAITING TIME GOVERNED BY A GENERIC MAXIMUM WAITING TIME POLICY WITH GENERAL PHASE-TYPE APPROXIMATIONS

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### BACKGROUND

Waiting time can affect patient satisfaction and the quality of care in the emergency department (ED). In particular, studies have shown that waiting time accounted for more than 50.0% of total patient turnaround time at ED. A variety of methods have been used to predict waiting times, such as quantile regression and discrete event simulation. However, most methods do not take into consideration how the waiting time will be affected when interventions are introduced. Without knowing the impact of different interventions on the waiting time, we cannot tell which interventions are effective. The objective of this study was to examine a new mean waiting time and its variance governed by a policy such that patients who would experience a long wait are assumed to be processed within a short period.

### METHODS

Under the maximum waiting time policy under consideration, original patient waiting distribution was transformed to a piecewise distribution where one piecewise discontinuous and one piecewise continuous distributions were further investigated. Under the phase-type (PH) distribution assumption on the original waiting time, we established closed-form formulae for the mean and its variance. By fitting PH distributions to patient waiting data of an emergency department in Singapore, the values of the new mean and its variance was estimated using the obtained formulae with different threshold choices. The distribution of original waiting time distribution is shown in Figure 1 with an illustration of the maximum waiting policy. Figure 2 demonstrates the transformed waiting distribution of two different cases discussed in the study.

Figure 1 – Illustration of original waiting distribution and maximum waiting time policy

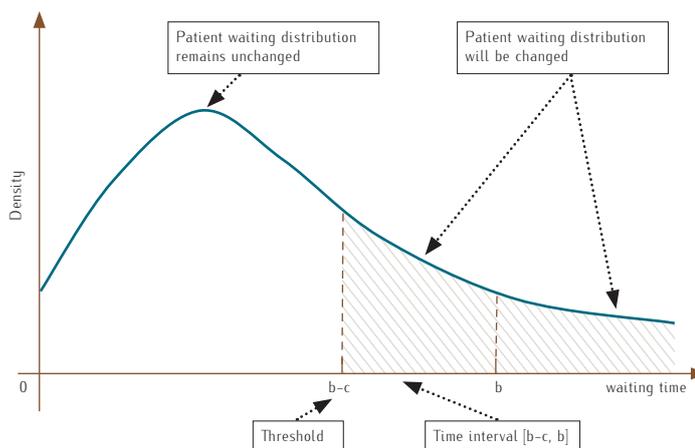
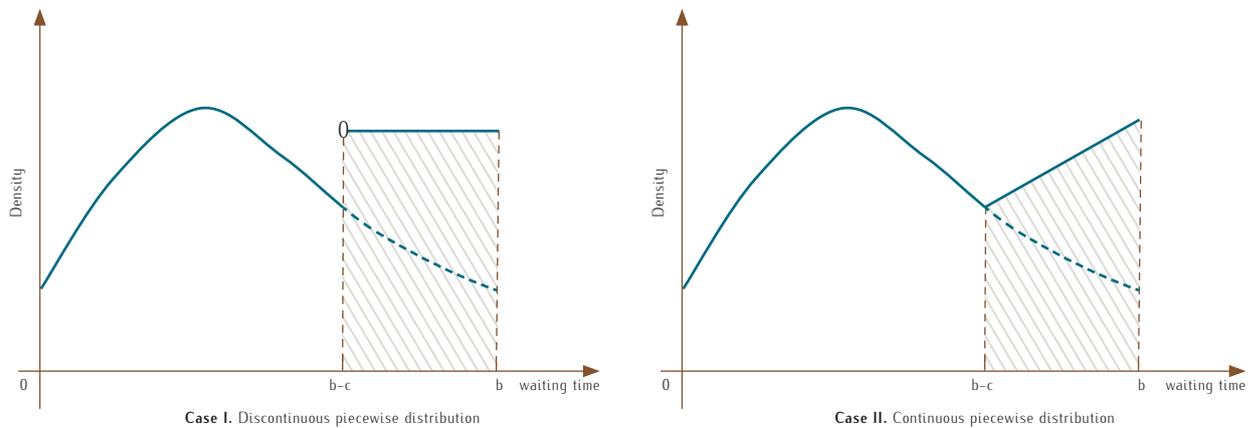


Figure 2 – Illustration of transformed waiting distribution



RESULTS

In the study, we used PAC3 (patient acuity category) patient data of an emergency department in Singapore from November 2011 to February 2012. There are four levels of patient acuity, with PAC1 being the most serious and PAC4 the least severe. PAC3 patient data was selected as this group of patients accounted for a large proportion of attendances, compared to the other levels. Waiting time under consideration referred to the time from the end of nurse triage to the start of doctor consultation. By analysing the goodness of fit with different choices of phases in fitting, the preferred phase of the PH distribution that had an optimal fit was phase 12. With different choices of the threshold such as the 95th and 75th percentile, mean, and median of the data, we estimated the new mean and variance with the obtained PH approximation as shown in Table 1.

Table 1 – Estimates of mean and variance of transformed waiting time

Threshold (b)	Length of time interval (c)	Mean (variance)		Reduction on mean (variance)	
		Discontinuous	Continuous	Discontinuous	Continuous
128	50	47.7 (1062.4)	47.3 (1021.2)	5.7 (30.5)	6.5 (33.2)
	40	47.6 (1052.9)	47.6 (1054.5)	5.9 (31.1)	5.9 (31.0)
	35	47.6 (1055.8)	47.7 (1069.0)	5.9 (30.9)	5.7 (30.1)
70	30	38.2 (355.0)	38.9 (376.5)	24.5 (76.8)	23.1 (75.4)
	20	39.0 (379.7)	39.7 (406.3)	22.9 (75.2)	21.5 (73.4)
	10	40.1 (423.1)	40.5 (441.6)	20.8 (72.3)	20.0 (71.1)
51	20	32.0 (166.3)	33.1 (184.0)	36.8 (89.1)	34.6 (88.0)
	10	33.7 (194.1)	34.3 (208.4)	33.4 (87.3)	32.2 (86.4)
	5	34.7 (215.6)	35.0 (224.0)	31.4 (85.9)	30.8 (85.3)
40	20	26.2 (82.9)	27.7 (92.0)	48.2 (94.6)	45.3 (94.0)
	15	27.3 (86.5)	28.5 (97.0)	46.0 (94.3)	43.7 (93.7)
	10	28.5 (104.9)	29.3 (104.9)	43.7 (93.8)	42.1 (93.1)

CONCLUSION

Hospital managers may use the estimates concerning new waiting time under the maximum waiting policy for managing care intensity and resource planning.

### MONITORING MEDICATION ERRORS FOLLOWING THE IMPLEMENTATION OF A CLOSED LOOP MEDICATION MANAGEMENT SYSTEM IN TAN TOCK SENG HOSPITAL

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#### BACKGROUND

Since February 2011 when Tan Tock Seng Hospital (TTSH) introduced the Closed Loop Medication Management system, there have been a slew of interventions aimed at reducing medication errors. However, the system for monitoring medication errors relies on voluntary reports from involved staff. Inherently, medication errors were expected to be underreported. In 2012, TTSH was awarded a grant under the Healthcare Quality Improvement Fund. This study aimed to estimate the rate of medication errors through direct observation of the various processes in medication management including pre-prescription, prescription, dispensing and administration. Additionally, it aimed to determine if there was a difference in the incidence of errors detected through direct observation versus voluntary reports, and to report the magnitude of this difference. This report focuses specifically on errors related to medication administration.

#### METHODS

The study was conducted from April 2012 to May 2013.

Clusters of medication doses served to patients in a particular ward were observed by the research nurse for administration errors. Sampling of doses to be observed was stratified by ward (Intensive Care Unit (ICU) vs General ward) and shift (day vs night). Assuming a medication error rate of 5.0%,  $\alpha=5.0\%$  and up to 1.0% deviation from the actual error rate, the target sample size for each floor was 2,000 (or overall sample size of 20,000 doses from all wards).

The total number of doses observed per ward was based on convenience rather than proportionate sampling. The timing of observation for specific wards was pre-determined. Convenience sampling was likewise used to identify which patients as well as nurses administering the medication were to be observed during each particular observation session. All observed errors were classified as follows:

- 1) Category A (Potential errors) — Circumstances or events that have the capacity to cause error
- 2) Category B (Near misses) — An error occurred but did not reach the patient
- 3) Category C (Medication errors) — An error occurred that reached the patient but did not cause harm

#### RESULTS

The observed medication administration errors were predominantly potential errors. Error rate for the day and night shift was 24.0% and 35.0% respectively, with the significantly higher error rate for the night shift attributed mainly to higher potential error rates (Table 1). There was no difference in the rates of near misses and medication errors between day and night shifts.

Table 1 – Comparison of error rates by shift and error type

	Day doses (n=18,950)		Night doses (n=1,567)		OR (95% CI), Day shift as reference
	n	%	n	%	
Potential error (A)	4,165	21.98	463	29.55	1.34 (1.24, 1.46)*
Near miss (B)	70	0.37	3	0.19	0.52 (0.16, 1.64)
Medication error (C)	344	1.82	21	1.51	0.74 (0.48, 1.14)
Total errors (A+B+C)	4,579	24.16	487	34.99	1.29 (1.19, 1.39)*

\*Risk of error is significantly higher during the night shift

Overall error rates were significantly higher in the general ward than in the ICU, again mainly due to higher potential error rates in the general wards (Table 2).

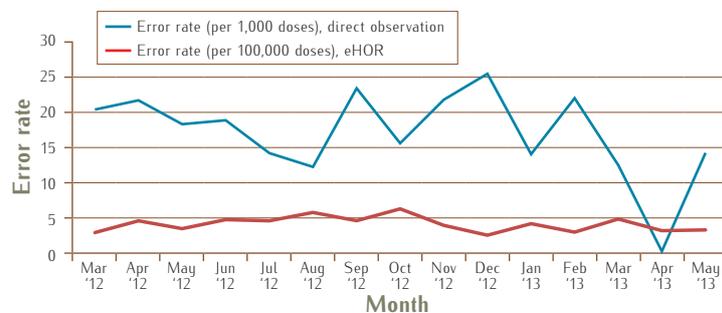
Table 2 – Comparison of error rates by ward and error type

	ICU (n=1,022)		General Ward (n=19,495)		OR (95% CI), ICU as reference
	n	%	n	%	
Potential error (A)	142	13.89	4,486	23.01	1.66 (1.42, 1.93)*
Near miss (B)	3	0.29	70	0.36	1.22 (0.39, 3.88)
Medication error (C)	15	1.47	350	1.80	1.22 (0.73, 2.04)
Total errors (A+B+C)	160	15.66	4,906	25.17	1.61 (1.39, 1.86)*

\*Risk of error is significantly higher for General Ward than ICU

Category C error rates detected through voluntary reports from the electronic Hospital Occurrence Reporting System (eHOR) and direct observation were compared. Except for April 2013, much higher error rates were detected through direct observation for the rest of the study period (Figure 1). The ratio of voluntary reported errors to directly observed errors was as high as 1:1,106 in December 2012.

Figure 1 – Monthly comparison of Category C error rates (Direct observation per 1,000 doses vs eHOR per 100,000 doses)



CONCLUSION

The great majority of medication administration errors were potential errors. Voluntary reporting of medication errors are indispensable tools for quality improvement. However, there is much to be done to improve rates of voluntary reporting. Organisations must identify innovative approaches to improve rates of voluntary reporting of errors.

## DISCRETE EVENT SIMULATION STUDY FOR NATIONAL UNIVERSITY HOSPITAL EYE CLINIC RAPID IMPROVEMENT EVENT

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<sup>2</sup> National University Hospital, Eye Clinic

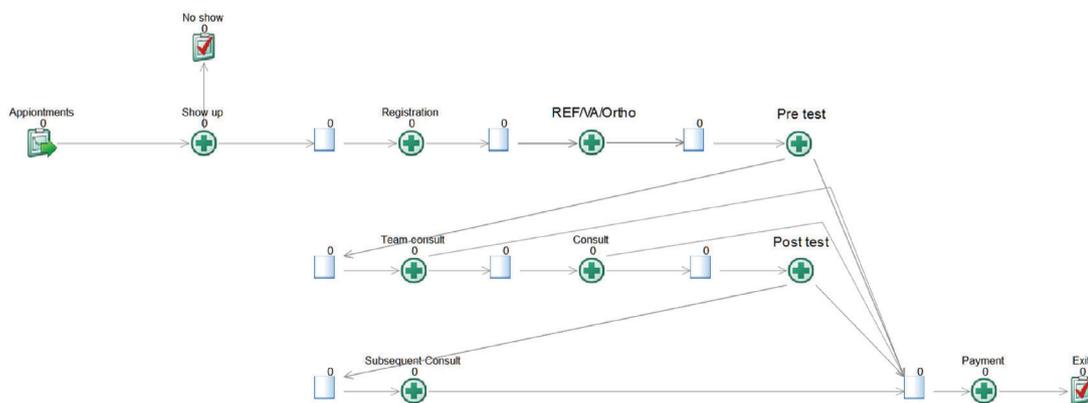
### BACKGROUND

The objective of this study was to construct a discrete event simulation (DES) model for the National University Hospital's (NUH) Eye Clinic Rapid Improvement Event (RIE) to help understand patient flow and to test various scenarios. In a DES model, situations in the current clinic practice can be replicated to help visualise and identify the gaps and bottlenecks. It is also used to test different scenarios including appointment scheduling and manpower configuration to meet the target key performance indicators.

### METHODS

Two sources of data were used to construct the DES model: the first being raw Eye clinic transaction data which included clinic, patient type, visit date, appointment time, and the other was summarised station timings. Model parameters were either based on the raw data or were user-specified. Registration start time was considered as the patient's arrival time. Turnaround time (TAT) was calculated from registration start to patient end. Waiting time at each station was calculated from the end time of the previous station. Figure 1 illustrates the patient flow in the Eye Clinic.

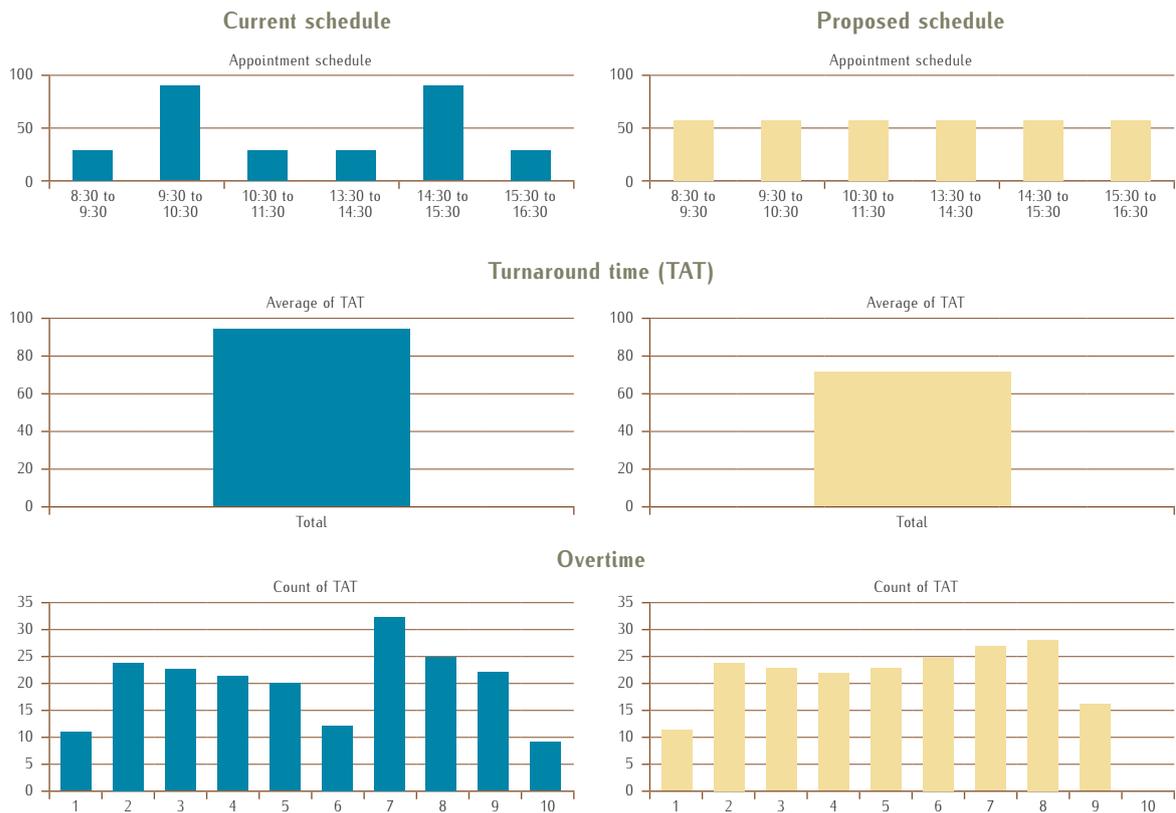
Figure 1 – Patient flow in Eye Clinic



RESULTS

Figure 2 illustrates the impact of a smooth appointment schedule on the TAT and overtime. It was observed that the proposed schedule significantly reduced both TAT and overtime without the introduction of extra resources.

Figure 2 – Comparison of current and proposed schedule



CONCLUSION

Such a study would help operation managers in specialist outpatient clinics to better plan their clinic resources to achieve better key performance indicators.

### NURSE SHIFT PLANNING AT TAN TOCK SENG HOSPITAL'S EMERGENCY DEPARTMENT USING A MIXED INTEGER PROGRAMMING MODEL

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#### BACKGROUND

Emergency departments (ED) are one of the most challenged components of the healthcare system with respect to patient delays and heavy workloads. Clinical management of patients in ED is complex due to the urgency, dynamic status of patients and uncertainty of patient's diagnoses. Patients are triaged, seen, tested, imaged, treated, observed and re-seen by nurses, junior and senior physicians. Workloads in ED can change greatly by day of the week, time of the day, and by shift. Thus, balancing workload with nurse staffing is a complex issue at ED. In this study, the objective was to derive an optimal nurse shift planning by developing a mathematical model, so as to minimise mean deviation of workloads of overall time slots in a day.

#### METHODS

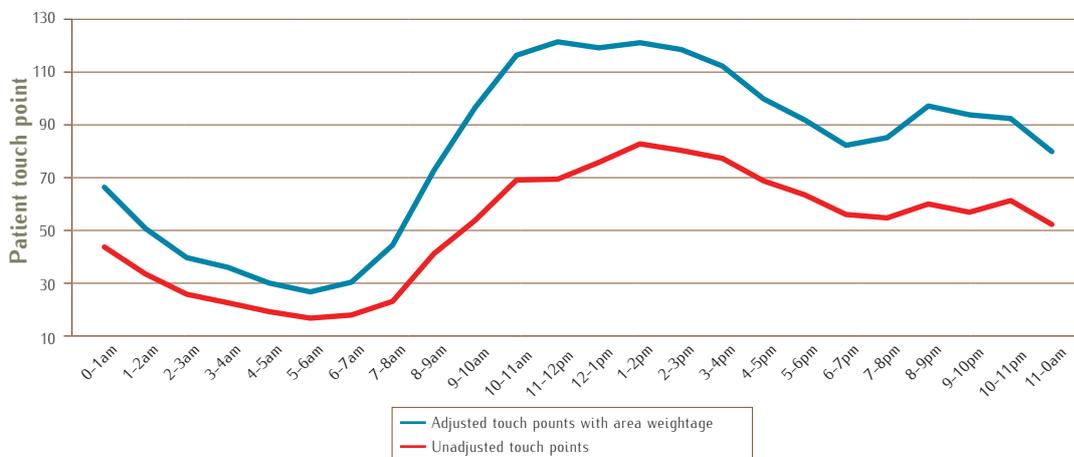
We analysed patient administrative data of Tan Tock Seng Hospital's ED from November 2012 to January 2013. Main functional areas at ED under consideration included triage, ambulatory urgent care (AUC), EDC consult, EDC observation rooms, EDX consult, EDX observations rooms and EDX isolated area, decontamination area, and resuscitation. AUC, EDC consult and EDX consult are three consult areas. Generally, EDC consult and EDX consult are both for ED urgent care but the latter is specifically for febrile cases.

By studying patient touch points by location and time of day, we derived the adjusted touch points using estimated weightage by area, which referred to patient loads or demands at ED. There were six shifts for the nursing staff, which included three major shifts (morning, afternoon and night shifts), and three minor shifts consisting of one morning and two afternoon shifts. In the study, shift timings were adjustable. A mixed integer programming (MIP) model was developed where decision variables were shift timings and number of nurses of each shift, subjected to some practical considerations and requirements, including total capacity, minimum number of nurses on each major shift, workload per nurse not worse off than the current worst case, and so on. The objective of the MIP model was to minimise the mean deviation of workloads over 48 half-hours of a day. The MIP model was solved using CPLEX ILOG optimisation solver.

#### RESULTS

Average touch points, including both unadjusted and adjusted with area weightages, are shown in Figure 1. We can see that adjusted hourly patient touch points ranged from 30 to 120 in which the lowest demand fell between 3am to 7am, while the highest demand occurred during 10am to 3pm. Presently, 55 nurses are allocated to the six shifts, with 14 nurses assigned to morning major shift, 16 nurses to afternoon and night major shifts, 5 to morning minor shift, 3 to the first afternoon minor shift (starting from 3pm) and 1 to another afternoon minor shift (starting from 4pm).

Figure 1 – Average patient touch points by hour



In the MIP model, the total capacity was increased to 60. Both morning and night major shifts had at least 14 nurses and the shift times remained unchanged. Solving the model with the optimisation solver, we derived the numbers of nursing staff on shifts to be 14, 11, 14, 9, 8, and 4, respectively. The starting time for the minor afternoon shift was also proposed to change from 4pm to 5pm. The results are summarised in Table 1, showing a reduction of 25.0% in mean deviation of overall workloads, compared with the current assignment.

Table 1 – Comparing present nurse staffing on shift with obtained results

Shift	Current scenario	Suggested scenario
Morning 7:00am – 3:30pm	14	14
Afternoon 1:00pm – 9.30pm	16	11
Night 9:00pm – 7.30am	16	14
Minor morning (AM)	5	9
Minor afternoon 1 (PM1)	3	8
Minor afternoon 2 (PM2)	1	4
Minor AM time	9:00am – 5:30pm	9:00am – 5:30pm
Minor PM1 time	3:00pm – 11:30pm	3:00pm – 11:30pm
Minor PM2 time	4:00pm – 12:00am	5:00pm – 3:30am
Mean deviation	0.194	0.145
Reduction	-	25.0%
<b>Total staff</b>	<b>55</b>	<b>60</b>

CONCLUSION

In this study, we proposed an approach and solution for nursing staff planning by using a mathematical model. Hospital managers may implement the proposed scenario at ED to improve manpower management and balance workloads.

### IMPACT ANALYSIS OF FAMILY MEDICINE CENTRE ON POLYCLINIC ATTENDANCE

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#### BACKGROUND

With the setup of the new Family Medicine Centre (FMC), a certain volume of attendances at the National Healthcare Group Polyclinics (NHGP) could be diverted. The objective of this study was to estimate the magnitude of FMC's impact on the volume of NHGP attendances, specifically of Ang Mo Kio and Serangoon FMCs on Ang Mo Kio and Hougang Polyclinics.

#### METHODS

Three sets of data were available: NHGP attendance data in 2012, location of polyclinics and FMCs, the updated list of NHGP patients with Community Health Assist Scheme (CHAS) sign up. It was assumed that patients in the CHAS list were more likely to convert from NHGP to FMC. Hence, non-CHAS patients were excluded from this analysis. A three-step procedure was applied to estimate the impact of FMCs on polyclinics:

- 1) Identify polyclinic chronic attendances from patients that have signed up with CHAS
- 2) Study the geographic distribution of existing attendances
- 3) Project the volume of attendances that may be diverted to FMC

#### RESULTS

Figures 1 and 2 illustrate the geographic catchment by distance and proportion of NHGP patients to Ang Mo Kio and Serangoon FMCs respectively.

Figure 1 – Geographic catchment by distance of Ang Mo Kio FMC

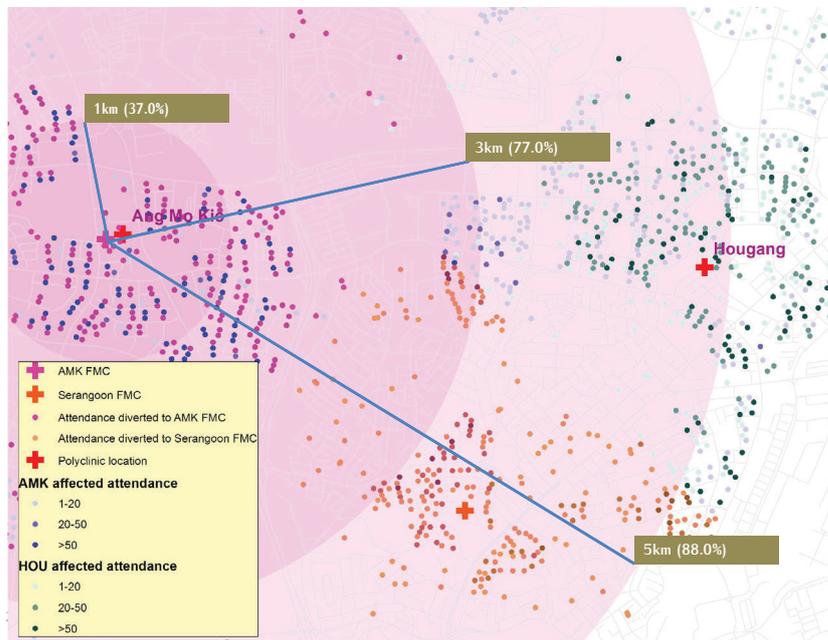
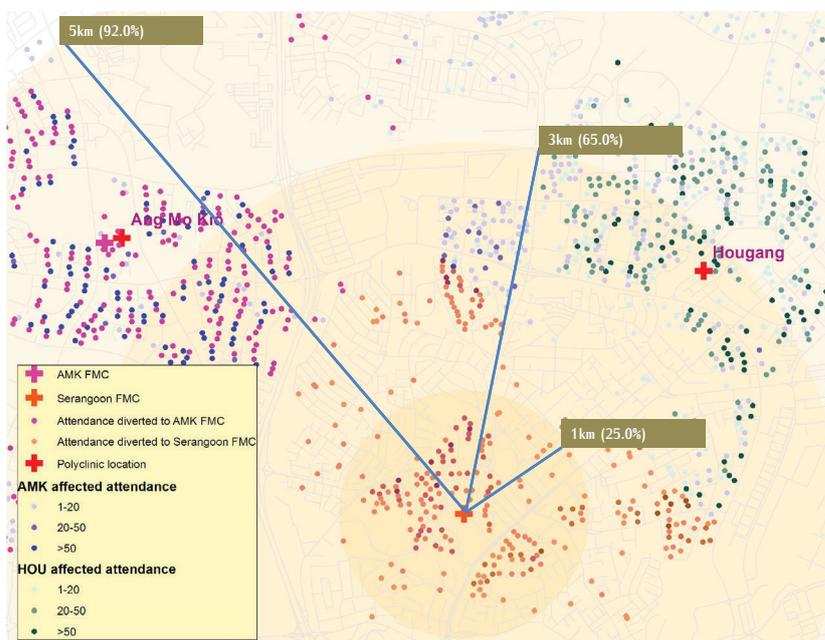


Figure 2 – Geographic catchment by distance of Serangoon FMC



## CONCLUSION

Such a study enabled the NHGP management to examine and understand the potential impact of the FMCs on patient volume in existing polyclinics so that resource and capacity planning can be carried out to serve the patients in the catchment region better.

### IMPLEMENTATION AND VALIDATION OF DIGIT TRIPLETS TEST VIA TELEPHONE IN SINGAPORE

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#### BACKGROUND

Hearing loss is the most common disabling condition in the world. According to estimates by the World Health Organisation (WHO) in 2005, almost 10.0% of the global population has hearing loss. This number continues to rise due to a growing global population and longer life expectancies. However, hearing loss is largely under-diagnosed and under-treated due to the cost of screening, diagnosis, and treatment. Therefore, telephonic screening can be an alternative cost saving technology.

Currently, the gold standard hearing test remains the pure tone audiogram performed in a sound-proof room by a professional audiologist, with the results interpreted together with an Ear, Nose and Throat (ENT) specialist after clinical consultation. This can be costly to both patients and the health care system. Therefore, to improve access to screening technologies for hearing impairment, we implemented and validated a digit triplets test via telephone in Singapore. In addition, we examined the improvement in the performance of the telephonic test by incorporating the results of the Single Global Question (SGQ): "Do you or your family think that you may have hearing loss?" in a screening algorithm.

#### METHODS

Sound files with pre-mixed digit triplets and noise were obtained from HörTech gGmbH. The test introduction, instruction, result, and recommendation were developed and recorded in the four official languages in Singapore. A similar adaptive testing procedure as described by Smits and Houtgast (2005) was used. The SGQ, digit triplets test via telephone and pure tone audiometry test were performed on all participants. Since there was no gold standard speech-in-noise test available in Singapore, a proper validation of the telephone test was not possible. A decision was made to validate the telephone test against the gold standard hearing test – pure tone audiometry instead.

We tested the performance of the digit triplets test via telephone vis-a-vis pure tone audiometry by subject; and a screening algorithm that included demographic characteristics, results of the digit triplets test via telephone, and the results of the SGQ by subject. Logistic regression was conducted to derive the probability that a participant has hearing impairment, and the area under the receiver operating characteristic curve (AUC) of screening algorithms with different variables was calculated. The best signal-to-noise ratio (SNR) obtained in each participant's worse performing ear was entered into the logistic regression.

## RESULTS

A total of 577 participants were recruited from the otolaryngology outpatient clinic of the National University Hospital. 572 participants who completed both the telephone test and pure tone audiometry in at least one ear were included in the analysis. The demographic and hearing profile of the subjects is shown in Table 1.

**Table 1 – Demographic and hearing profile of participants**

	Participants with hearing loss (n=245, 42.8%)	Participants without hearing loss (n=327, 57.2%)	p value
Age, Mean (SD)	54.3 (17.7)	41.0 (14.9)	<0.05
Gender, Counts (%)			
Male	140 (24.5)	141 (24.6)	<0.05
Female	105 (18.4)	186 (32.5)	
Ethnicity, Counts (%)			
Chinese	186 (32.5)	234 (40.9)	0.131
Malay	12 (2.1)	18 (3.2)	
Indian	26 (4.5)	27 (4.7)	
Others	21 (3.7)	48 (8.4)	
Hearing level*, Counts (%)			
≤25 dB	NA	327 (57.2)	NA
26–40 dB	119 (20.8)	NA	
41–55 dB	58 (10.2)	NA	
56–70 dB	34 (5.9)	NA	
71–90 dB	27 (4.7)	NA	
>90 dB	7 (1.2)	NA	

\*Based on worse performing ear

The AUC was 0.755 for the digit triplets test via telephone when used alone. By including age, gender, and results to the SGQ, the screening algorithm yielded an AUC of 0.834. All the independent variables were highly significant ( $p < 0.05$ ) (Table 2).

**Table 2 – Logistic regression results of the screening algorithm (by subject)**

	Estimate	Standard error	z value	Pr (> z )
(Intercept)	-3.2033	0.4367	-7.34	0.0000
Telephone test	0.1452	0.0220	6.61	0.0000
Age	0.0468	0.0073	6.38	0.0000
Gender: Male	0.4399	0.2251	1.95	0.0507
Modified single question: Yes	1.4041	0.2388	5.88	0.0000

## CONCLUSION

The telephone test was implemented and validated against the pure tone audiometry. The screening algorithm derived was sensitive in identifying people with hearing loss and can be used for mass screening of hearing loss in Singapore.

## SETTING 'OPTIMAL' UTILISATION TARGETS FOR ELECTIVE OPERATING THEATRES

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<sup>1</sup> National University Health System Way

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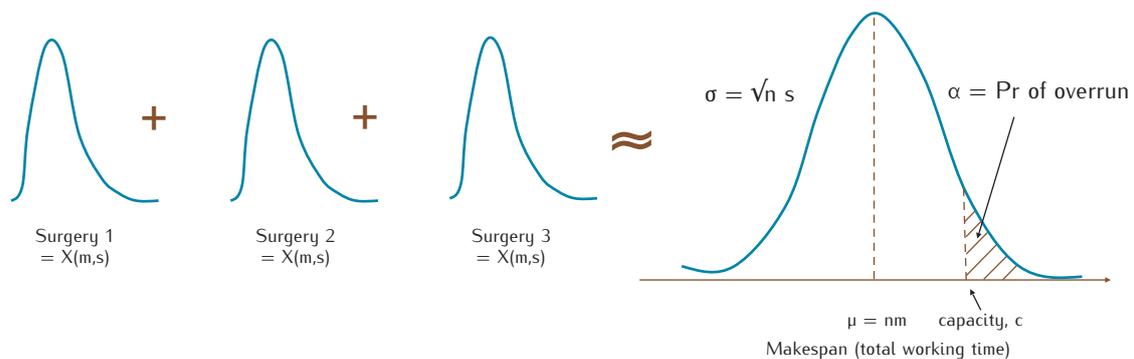
### BACKGROUND

Operating theatres (OT) are expensive resources and an “optimal” utilisation target will depend on many factors: demand, variation in the surgical durations, staff overtime, proportion of electives and emergency surgeries, and specific equipping of theatres. Intuitively, departments with low variation in surgical duration can operate at a higher theatre utilisation. Here we formalise this intuition and propose a quantitative approach to set utilisation targets, taking into account two factors: 1) a suitable measure of variation of the department’s surgery duration (beyond the standard deviation); and 2) the same probability of overtime for all departments.

### METHODS

OTs record the mean and standard deviation of all surgery durations. We introduce the measure “makespan” as the time elapsed from start of the first surgery, to the end time of the last surgery, whether in a half-day or full-day session. The average ( $\mu$ ) and standard deviation ( $\sigma$ ) of the makespan can be computed by using the mean ( $m$ ) and standard deviation ( $s$ ) of the surgical durations. This is based on a normal approximation from the central limit theorem shown graphically in Figure 1.

Figure 1 – Relating capacity, makespan, variation and overtime



The probability of overtime ( $\alpha$ ) is the chance that the makespan exceeds the capacity ( $c$ ) which can be 4.0 or 8.5 hours. We relate these parameters to find the number of surgeries ( $n$ ) and utilisation in Equations (1) and (2). Equation (3) shows that the utilisation is approximately proportional to the term  $s/\sqrt{m}$ . We will compare this variation measure with standard measures and show that it is suitable for utilisation planning.

RESULTS

Table 1 shows the summary statistics of the surgery durations by departments, variation measures and the utilisation targets, given a probability of overrun of 35.0%. Paediatric Orthopaedics (PO) has a lower variation ( $s/\sqrt{m}=0.71$ ) than Hand & Reconstructive Microsurgery (HRM) ( $s/\sqrt{m}=1.63$ ), which explains why PO operates at a higher utilisation than HRM (91.0% versus 81.0%), with both having the same probability of overtime. Note that the other variation measures may not correlate just as well with the target utilisation.

Table 1 – Optimal utilisation targets for departments

Departments	Variation measures				Proposed target utilisation (%)
	Mean	SD	$s/m^{\circ}$	$s/\sqrt{m}^{\#}$	
Paediatric Orthopaedics (PO)	2.4	1.1	0.46	0.71	91.0%
Adult Reconstructive	3.3	1.5	0.45	0.83	90.0%
Cardiothoracic & Vascular Surgery (CTVS)	4.2	2.1	0.50	1.02	87.0%
Urology	2.7	1.7	0.63	1.03	87.0%
Colorectal	4.3	2.3	0.53	1.11	86.0%
Paediatric Surgery	3.0	2.0	0.67	1.15	86.0%
Ear, Nose & Throat (ENT)	2.9	2.0	0.69	1.17	86.0%
Breast surgery	5.5	2.8	0.51	1.19	85.0%
Hepatobiliary	5.0	2.7	0.54	1.21	85.0%
General Surgery	3.3	2.3	0.70	1.27	85.0%
Hand & Reconstructive Microsurgery (HRM)	4.6	3.5	0.76	1.63	81.0%

<sup>∘</sup>Coefficient of variation (standard deviation divided by mean)

<sup>#</sup>Proposed measure of variation (standard deviation divided by square root of mean)

While the overall hospital OT utilisation was 86.0%, we were able to discern individual departments’ targets ranging from 81.0% to 91.0% using no more information than the routine statistics of surgery durations. This range would be smaller if the differences in variations ( $s/\sqrt{m}$ ) were smaller across the departments.

The probability of overtime of 35.0% was empirically chosen. Figure 2 shows the trade-off relationship between overtime probability and utilisation target for the PO and HRM departments grouped by the variation measure. Both curves reflected that higher utilisation comes with a larger chance of overtime. However, HRM will have a ‘lower’ operating curve compared with PO. We therefore think that the variation measure  $s/\sqrt{m}$  is a key metric that explains the target utilisation.

Figure 2 – Utilisation target versus probability of overtime

$$nm + z_{1-\alpha} \sqrt{ns} = c \quad (1)$$

$$\text{Utilisation} = \frac{nm}{c} \quad (2)$$

$$\approx 1 - \frac{z_{1-\alpha}}{\sqrt{c}} \left[ \frac{s}{\sqrt{m}} \right] \quad (3)$$

CONCLUSION

This is an example of setting utilisation targets in an operational setting, balancing the natural variation (surgery duration of departments) and fairness (same probability of overtime). The method can also be used to plan the number of half- or full-day sessions when opening a block of new theatres.

## EFFECTIVENESS OF A CARE COORDINATOR-LED PATIENT MANAGEMENT FOR STABLE HYPERTENSION AND HYPERLIPIDAEMIA

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<sup>2</sup> National Healthcare Group Polyclinics, Lean Office

### BACKGROUND

A new model of care for patients with stable hypertension and/or hyperlipidaemia was piloted in Toa Payoh Polyclinic (TPY). This programme can potentially free up doctors' time for more complex cases and reduce unnecessary visits while keeping the patient's chronic condition stable. The evaluation aimed to assess the performance of the programme in terms of health service utilisation, control of blood pressure (BP) and low density lipoprotein (LDL) as well as one-year cost of polyclinic services for both conditions.

### METHODS

The new model involved care coordinator-led patient management, standardised follow-ups and evidence-based protocols for those whose hypertension and/or hyperlipidaemia were stable for at least 6 months. Patients received education on medication, self-management and lifestyle changes; mid-year care coordinator's assessment and annual doctor's assessment. BP and LDL control were compared within and between patients from TPY polyclinic (programme) and patients from Ang Mo Kio (AMK) and Hougang (HOU) Polyclinics (standard care). Comparisons of one-year polyclinic bill sizes were likewise done for TPY versus AMK and HOU patients. Costs comprised hypertension/lipid-related cost (including consultations), pharmacy cost and cost related to conditions other than the chronic disease.

### RESULTS

Of the 215 patients who completed 1 year of follow-up, 51 patients had a diagnosis of hypertension alone, 42 had hyperlipidaemia, and 122 had both hypertension and hyperlipidaemia. With regard to health service utilisation, only 1 (0.5%) had an unplanned emergency department (ED) visit, and 2 (0.9%) were hospitalised for complications of chronic disease (Table 1).

**Table 1 – Proportion with ED visits and hospitalisations among patients who completed 1 year in the programme**

Outcome	Chronic disease			All patients N=215
	Patients with hypertension only n=51	Patients with hyperlipidaemia only n=42	Patients with both diseases n=122	
ED visit	0 (0.0)	0 (0.0)	1 (0.8)	1 (0.5)
Hospitalisation	0 (0.0)	0 (0.0)	1 (1.6)	1 (1.9)

Controlling for the effect of baseline BP, there was no significant difference in BP control at 1 year between programme and non-programme patients (Table 2).

Table 2 – Multivariate analysis for predictors of elevated final BP

Covariate	Odds Ratio (95% CI)
Initial BP	
Elevated	1.26 (0.66, 2.42)
Normal (Ref)	-
Programme enrolment	
Not enrolled	1.52 (0.94, 2.48)
Enrolled (Ref)	-

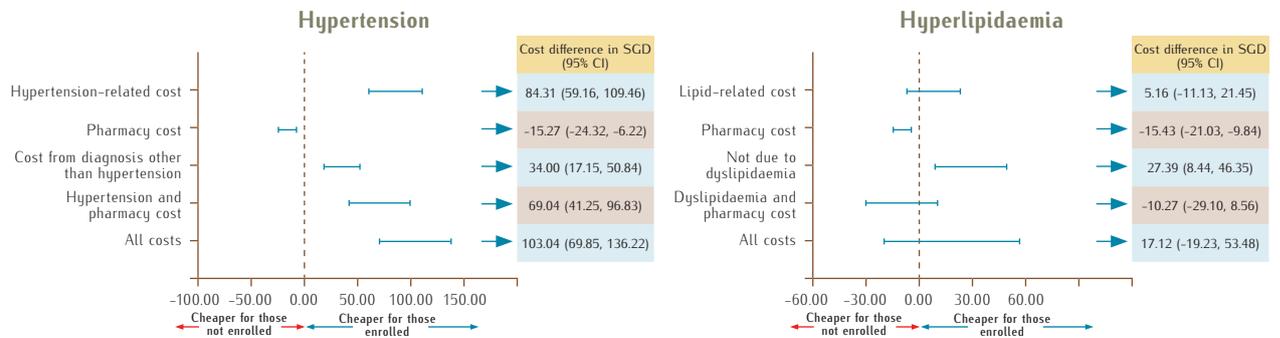
Using 3.4 mg/dl as a cut-off for LDL, non-programme patients had a greater risk of elevated LDL by the end of 1 year (OR=1.79; 95% CI: 1.00-3.18) (Table 3).

Table 3 – Multivariate analysis for predictors of elevated final LDL

Covariate	Odds Ratio (95% CI)
Initial LDL	
Elevated	5.59 (0.74, 42.41)
Normal (Ref)	-
Programme enrolment	
<b>Not enrolled</b>	<b>1.79 (1.00, 3.18)</b>
Enrolled (Ref)	-

Hypertension-related cost was cheaper for programme patients (difference=\$84.31; 95% CI: \$59.16-\$109.46) (Figure 1). For both diseases, non-chronic disease cost was cheaper for programme patients (patients with hypertension: difference=\$34.00, 95% CI: \$17.15-\$50.84; patients with hyperlipidaemia: difference=\$27.39, 95% CI: \$8.44-\$46.35). However, pharmacy cost was more expensive.

Figure 1 – Difference in full year cost (SGD) for patients enrolled and not enrolled in programme



CONCLUSION

Compared to patients receiving standard care, BP and LDL control were not inferior for patients enrolled in the new care model. LDL control was even better for programme patients. Total one-year cost of polyclinic services for hypertensive patients was cheaper for programme patients.





PROJECTS

HEALTH & WELFARE  
ECONOMICS

## COST EFFECTIVENESS OF ANTI-OXIDANT VITAMINS PLUS ZINC TREATMENT TO PREVENT PROGRESSION OF INTERMEDIATE AGE-RELATED MACULAR DEGENERATION – A SINGAPORE PERSPECTIVE

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Dr Yong Shao Onn<sup>1</sup>

<sup>1</sup> Tan Tock Seng Hospital, Eye Clinic

### BACKGROUND

Age-related macular degeneration (AMD) is one of the leading causes of blindness in elderly populations around the world. The stages of AMD are categorised as: 1) early, when visual symptoms are inconspicuous; 2) intermediate, where vision deterioration is beginning; and 3) late, in which severe loss of vision is usual. Late stage AMD, also known as wet AMD, is a cause for poor visual function, anxiety, depression, falls, and impaired activities of daily living.

A large randomised controlled trial has found that provision of high dose anti-oxidant vitamins and zinc (AREDS formulation) to certain AMD patients was clinically effective in preventing progression to wet AMD. The objective of this study was to determine if providing high dose anti-oxidant vitamins and zinc treatment to patients with intermediate AMD aged 40 to 79 years is cost effective in preventing progression to wet AMD.

### METHODS

A hypothetical cohort of Categories 3 and 4 AMD patients from Tan Tock Seng Hospital was followed for 5 calendar years to determine the number of patients who would progress to wet AMD given the following treatment scenarios:

- 1) AREDS formulation or placebo followed by ranibizumab (as needed) for wet AMD
- 2) AREDS formulation or placebo followed by bevacizumab (monthly) for wet AMD
- 3) AREDS formulation or placebo followed by aflibercept (VIEW I and II trial treatment regimen)

Costs (discounted at a rate of 3.0%) were estimated for the above scenarios from the providers' perspective, and cost effectiveness was measured by cost per disability adjusted life year (DALY) averted with a disability weight of 0.22 for wet AMD.

### RESULTS

Over 5,400 patients could be prevented from progressing to wet AMD cumulatively if AREDS formulation were prescribed. AREDS formulation followed by ranibizumab was cost effective compared to placebo-ranibizumab or placebo-aflibercept combinations (cost per DALY averted: S\$23,662.30 and S\$21,138.80 respectively) (Table 1). However, bevacizumab (monthly injections) alone was more cost effective compared to AREDS formulation followed by bevacizumab.

Table 1 – Cost per DALY averted based on possible treatment options for patients with wet AMD

Follow up of the 2012 hypothetical cohort		RANIBIZUMAB : Given as needed at a cost of \$1,634 per injection		
5 years (till end of 2016)	Cost of treatment module A	Cost of treatment module B	[Cost of treatment module A] – [Cost of treatment module B]	Cost per DALY averted
	\$446.0M	\$510.7M	-\$64.7M	\$23,662.30
	<b>BEVACIZUMAB : Given 12 injections a year at a cost of \$351 per injection</b>			
	Cost of treatment module C	Cost of treatment module D	[Cost of treatment module C] – [Cost of treatment module D]	Cost per DALY averted*
	\$282.9M	\$282.8M	\$0.1M	-\$36.50
	<b>AFLIBRCEPT: Given monthly for first 3 months followed by once every 2 months for the first year followed by a capped pro re nata (PRN—as and when required) protocol from year 2 at a cost of \$1,643.45 per injection.</b>			
Cost of treatment module E	Cost of treatment module F	[Cost of treatment module E] – [Cost of treatment module F]	Cost per DALY averted*	
\$427.3M	\$485.1M	-\$57.8M	\$21,138.80	

Treatment module A: AREDS formulation followed by Ranibizumab (as needed) for those who have progressed to wet AMD.

Treatment module B: No AREDS formulation followed by Ranibizumab (as needed) for those who have progressed to wet AMD.

Treatment module C: AREDS formulation followed by Bevacizumab (monthly) for those who have progressed to wet AMD.

Treatment module D: No AREDS formulation followed by Bevacizumab (monthly) for those who have progressed to wet AMD.

Treatment module E: AREDS formulation followed by Aflibercept (treatment as per VIEW I and II trials) for wet AMD

Treatment module F: No AREDS formulation followed by Aflibercept (treatment as per VIEW I and II trials) for wet AMD

\* Bevacizumab (monthly 1 injection) alone was cost effective compared to preventive anti-oxidant vitamins + Zn followed by bevacizumab.

## CONCLUSION

Prophylactic treatment with AREDS formulation for intermediate AMD patients, followed by ranibizumab or aflibercept for patients who progressed to wet AMD was found to be cost-effective. These findings have implications for intermediate AMD screening, treatment and healthcare planning in Singapore.

## ECONOMIC BURDEN OF BACK PAIN

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<sup>1</sup> Tan Tock Seng Hospital, Pain Management Clinic

### BACKGROUND

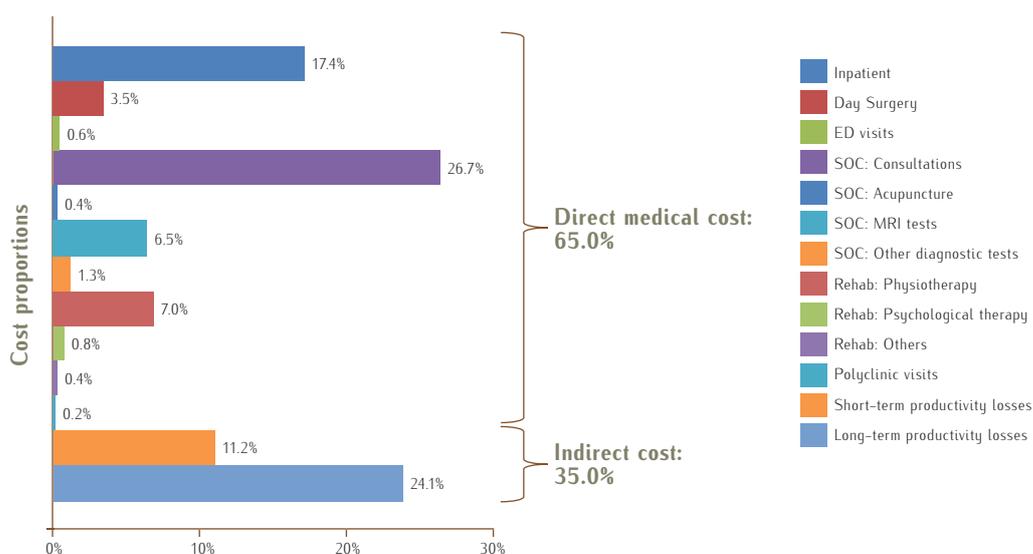
Back pain is a common health problem and a major cause of disability worldwide. The Global Burden of Disease 2010 Study estimated that years lived with disability among back pain patients accounted for 10.7%. In addition to its burden on global health, the musculoskeletal condition also represents a significant economic burden to the society. Studies across Europe estimated the burden to be between US\$1,021 and US\$8,321. Indirect cost such as productivity losses (time off work and early retirement) represents a major burden (55.0% to 94.0%). In Asia, literature on economic burden studies existed for occupational back pain but no studies on all-cause back pain was ever published. Understanding the societal cost will offer economic insights for back pain conditions to both healthcare providers and employers within a highly urbanised city-state.

The objective of this study was to quantify the economic burden of back pain among subjects attending a hospital-based Pain Management Clinic (PMC) in Singapore.

### METHODS

This was a cohort study measuring the societal cost of back pain. Patients attending the PMC at Tan Tock Seng Hospital were screened for back pain using the Brief Pain Inventory and clinical judgement. Direct medical cost included hospital admissions, day surgeries (DS), emergency department (ED) visits, specialist outpatient (SOC) utilisation, outpatient rehabilitation (rehab) and polyclinic visits (Figure 1). Indirect cost measures included short-term (time off from work) and long-term (early retirement) productivity losses.

Figure 1 – Proportions of societal cost components



With the exception of SOC visits and rehab sessions, healthcare utilisation was identified based on ICD-9 and 10 codes for back pain. Hospital case-notes were analysed to identify SOC visits and rehab sessions for back pain. Information about employment status (currently employed or early retirement, occupation) was used to measure productivity losses. The human capital approach was applied to calculate productivity losses measuring sick leave dispensed for short-term losses and early retirement due to back pain for long-term losses. All costs were measured in 2012 Singapore dollars. A multivariate generalised linear model (GLM) was fitted for the association between cost and significant factors from the bivariate analyses.

## RESULTS

Average societal cost of back pain per patient was estimated to be \$2,785 (95% CI: \$2,107–\$3,463) per year. SOC utilisation (34.6%) and productivity losses (35.0%) contributed high proportions to the overall cost. Total direct medical cost constituted 65.0% of the total cost whilst 35.0% was for indirect cost (Figure 1). Bivariate analyses showed statistical significance ( $p < 0.05$ ) among age, education, employment status, occupation before back pain, Oswestry Disability Index (ODI) and Short-Form 36 Mental score (SF-36). Multivariate analysis suggested that employment status, occupation categories prior to back pain, ODI and SF-36 Mental score were significantly associated with societal cost (Table 1).

**Table 1 – Multivariate generalised linear model for societal cost of back pain**

Independent variables	Rate Ratio (95% CI)
<b>Age</b>	0.99 (0.98 – 1.01)
<b>Education</b>	
Degree	–
Diploma	1.16 (0.67 – 2.00)
GCE "A" Levels	1.25 (0.59 – 2.61)
GCE "O" Levels	0.81 (0.51 – 1.29)
Less than Secondary 4	0.94 (0.46 – 1.89)
Less than Primary 6	0.73 (0.33 – 1.59)
Others	1.13 (0.68 – 1.88)
Unknown	2.88 (0.86 – 9.56)
<b>Currently employed</b>	0.35 (0.21 – 0.58)*
<b>Occupation before back pain</b>	
Non-physical work	–
Physical work	0.98 (0.47 – 2.04)
National Service Personnel	1.81 (0.74 – 4.45)
Housewife	0.33 (0.18 – 0.61)*
Unemployed	0.26 (0.11 – 0.59)*
Student	0.15 (0.06 – 0.35)*
Retiree	0.57 (0.25 – 1.31)
Unknown	0.13 (0.03 – 0.55)*
<b>Brief Pain Inventory, Pain Severity (0–10)</b>	1.03 (0.94 – 1.17)
<b>Oswestry Disability Index (0–100)</b>	1.02 (1.01 – 1.03)*
<b>SF-36 Mental Score (0–100)</b>	0.99 (0.98 – 1.00)*

\* $p < 0.05$

## CONCLUSION

This was the first study to estimate the cost of back pain in the Singapore population. Back pain costs the society \$2,785, which is much higher than asthma (\$633) and myopia (\$900) reported in Singapore. Back pain patients were high utilisers of SOC resources, but this may be due to the setting where the population was selected. Indirect cost constituted 35.0% of the overall cost, which was lower compared with overseas' studies. One possible reason for the lower indirect cost could be due to patients reporting for work despite suffering from back pain. Findings from the multivariate GLM suggested positive associations between independent factors (not employed, involved in non-physical work prior to back pain, higher disability and lower quality of life) and societal cost. The cost distributions and its associated factors are valuable information for policymakers in understanding factors associated with back pain condition for future development of intervention strategies.

## COST EFFECTIVE SCREENING FOR METICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS COLONISATION AT HOSPITAL ADMISSION

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<sup>1</sup> Tan Tock Seng Hospital, Department of Infectious Disease

### BACKGROUND

Meticillin-Resistant Staphylococcus Aureus (MRSA) is one of the most common sources of nosocomial infections and it significantly contributes to poorer clinical outcomes and higher utilisation. Screening for MRSA colonisation upon admission and isolation of identified MRSA carriers has been proposed as a strategy to prevent nosocomial spread of MRSA. Some studies have showed that universal screening was not cost effective as compared to selective screening. There were two objectives for this study – firstly, to develop and validate a prognostic model for targeting high risk patients for screening at admission; and secondly, to identify the most cost effective screening strategy for MRSA upon hospital admission using decision analysis.

### METHODS

Patients who did MRSA screening upon admission to Tan Tock Seng Hospital in 2012 were included. Patients who were discharged and readmitted within 72 hours were excluded. A risk prediction model was developed and validated to select high risk patients for MRSA screening. The model was developed using stepwise logistic regression and Bayesian Information Criteria; split validation was applied to test the internal validity of the model. Markov decision analysis was then applied to identify the cost-effective screening strategy. Five strategies were compared in terms of the cost per infection prevented:

- 1) Polymerase Chain Reaction (PCR) screening for all;
- 2) PCR screening for selected high risk patients;
- 3) Culture screening for all;
- 4) Culture screening for selected high risk patients; and
- 5) No screening.

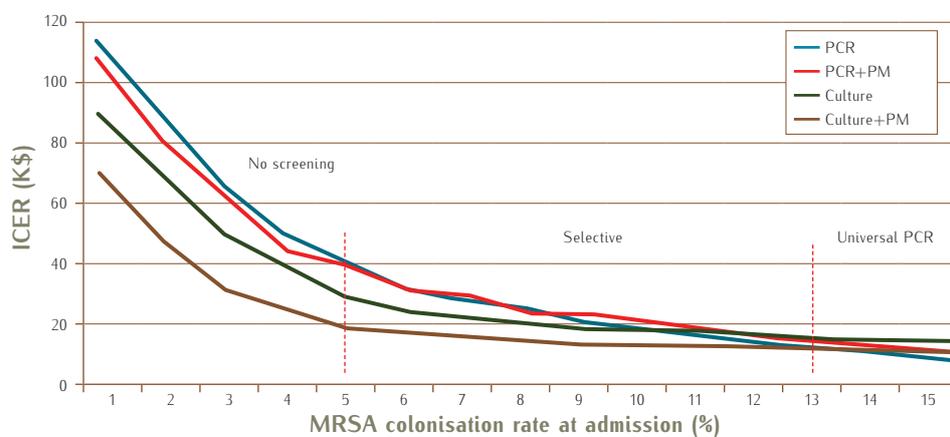
### RESULTS

In the risk prediction model, the predictors identified in descending importance were: previous MRSA colonisation; age; infection in last 90 days; preceding hospital admission in last 90 days; nursing home admission in last 90 days; chronic kidney diseases, and stroke. The c-statistics of the receiver operating characteristic (ROC) of the prediction model was 0.81 (95% CI: 0.81-0.82). Considering the cost of infection treatment, MRSA prevalence rate, the incidence rate of hospital infection, the sensitivity and specificity of the prediction model, the most cost effective screening strategy was selective PCR screening. As shown in Table 1, the Incremental Cost Effective Ratio (ICER) for selective PCR screening is S\$10.6K, which is less than the current treatment cost for infection, averaging S\$18K. Figure 1 shows that the most cost effective screening strategy varied with the MRSA prevalence rate at hospital admission.

Table 1 – ICERs of the five screening strategies

	Cost (S\$)	Infection (no.)	Incremental cost (S\$)	Incremental Infection prevented (no.)	ICER
No screening	293.3M	372	-	-	-
Selective culture	294.8M	296	1.6M	77	19.7K
Selective PCR	295.5M	230	0.7M	66	10.6K
Universal culture	295.7M	274	2.4M	-44	-
Universal PCR	296.8M	192	1.3M	38	34.2K

Figure 1 – Incremental cost per infection prevented as varied with the MRSA colonisation rate at admission



## CONCLUSION

This study suffered a few limitations: some model parameters were from literature, which may not be suitable for the local context; more local data needed to be collected for model calibration; cohort simulation was used, therefore the results may not make sense statistically. Nonetheless, the study provided an evidence-based decision tool for policy makers to standardise care and set guidelines on cost effective infectious disease control in hospitals.



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PROJECTS

RESEARCH DESIGN  
& METHODOLOGIES

### METHODOLOGICAL QUALITY OF SYSTEMATIC REVIEWS COMPARING INTRAVITREAL BEVACIZUMAB AND ALTERNATES FOR NEOVASCULAR AGE-RELATED MACULAR DEGENERATION – A SYSTEMATIC REVIEW OF REVIEWS

Dr Pradeep Paul George Gunapal, Dr Joseph Antonio D. Molina, Dr Heng Bee Hoon

#### BACKGROUND

Medical and public health decisions are informed by systematic reviews (SRs), which makes the quality of reviews an important scientific concern. Evidence from observational studies and few randomised clinical trials suggest that off-label bevacizumab is effective for the treatment of neovascular age-related macular degeneration (AMD). However, evidence from SRs on the effectiveness of bevacizumab for AMD is equivocal, with some SRs favouring intravitreal bevacizumab while some do not. This sets the stage for a critical appraisal of the quality of SRs on intravitreal bevacizumab for neovascular AMD.

Our study aimed to systematically collate and evaluate the evidence from recent SRs of bevacizumab for neovascular AMD.

#### METHODS

Literature searches were carried out in Medline, Embase, Cochrane databases for all SRs on the effectiveness of bevacizumab for neo-vascular AMD, published between 2000 and 2013. Titles and abstracts were assessed against the inclusion or exclusion criteria using the Joanna Briggs Institute (JBI) study eligibility form. Data was extracted using the JBI data extraction form. The quality of the SRs was assessed using JBI's critical appraisal checklist for SRs. Decisions on study eligibility and quality were made by two reviewers, and any disagreements were resolved by discussion.

#### RESULTS

Ten relevant reviews were identified from 30 citations. The average quality score of the reviews was 7 out of a maximum possible quality score of 10 (95% CI: 6.2-7.8). Of the ten reviews, 60.0% had a quality score of 7 or lower due to reasons such as methodological limitations, search strategies were only identified in two reviews, independent study selection and quality assessment of included studies were infrequently performed (Table 1). Selection and publication bias were not addressed in all included reviews.

Five of the ten reviews fulfilled the review's inclusion criteria. All five reviews showed bevacizumab to be effective for neovascular AMD in the short-term when used alone or in combination with photodynamic therapy (PDT) or Pegaptanib.

Table 1 – JBI critical appraisal quality score and summary of conclusions of the retrieved reviews

First author, year published	JBI quality score	Authors' conclusion
<b>"Systematic" in title, abstract or methods</b>		
Regis Bruni Andriolo, 2006	7	Evidence demonstrates that bevacizumab alone or combined with PDT, focal photocoagulation and triamcinolone is more effective for neovascular diseases.
Jamie M Pitlick, 2012	5	Bevacizumab appears to be effective for AMD when compared to verteporfin PDT or pegaptanib.
Jan SAG Schouten, 2008	9	Visual acuity improves and central retinal thickness decreases in patients with exudative AMD after bevacizumab.
Focke Ziemssen, 2009	8	Bevacizumab appears to be safe and effective for AMD in the short term.
S Jyothi, 2010	7	There is sufficient evidence to advocate the effective use of Optical Coherence Tomography (OCT) guided administration of intravitreal bevacizumab for neovascular AMD.
<b>Other reviews with language that implied a critical and comprehensive intent</b>		
Christine Schmucker, 2012 <sup>†</sup>	9	Evidence from head-to-head raised concern about increased risk of ocular and systemic adverse events with bevacizumab.
Christine Schmucker, 2010 <sup>‡</sup>	10	The studies of bevacizumab show too many methodological limitations to rule out major safety concerns.
Shalini S Lynch, 2007 <sup>†</sup>	3	Uncontrolled studies support the benefit of intravitreal bevacizumab in neovascular AMD, in the short term.
Paul Mitchell, 2011 <sup>†</sup>	4	In contrast to ranibizumab, current safety data for bevacizumab are incomplete and not yet robust.
Derrick P Smit, 2007 <sup>†</sup>	3	Evidence suggests that intravitreal bevacizumab alone or in combination has beneficial effect in various neovascular and edematous retinal conditions.

<sup>†</sup> These reviews were not included as they did not fulfill the review's inclusion criteria.

<sup>‡</sup> These studies primarily looked at the safety of bevacizumab, without focusing on its effectiveness.

<sup>†</sup> Major criteria for quality appraisal were not satisfactorily fulfilled, hence not included.

## CONCLUSION

Overall, the reviews on the effectiveness of intravitreal or systemic bevacizumab for neovascular AMD received good JBI quality scores (mean score = 7.0 points), with a few exceptions. The good quality reviews interestingly found bevacizumab to be effective for neovascular AMD whilst the reverse was true for the bad quality reviews. The study also highlighted the suboptimal reporting of SRs on this topic. Reviews with poor methodology may limit the validity of the reported results; hence efforts should be made to improve the design, reporting and publication of SRs across all journals.

### DIFFERENTIAL FACTORING OF THE SAFER-HOME INSTRUMENT

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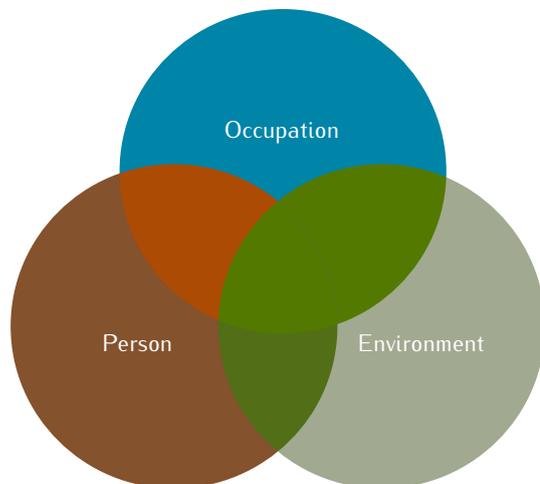
<sup>2</sup>Department of Continuing and Community Care, Tan Tock Seng Hospital

#### BACKGROUND

The Safety Assessment of Function & the Environment for Rehabilitation – Health Outcome Measurement and Evaluation (SAFER-HOME) tool is an instrument developed for the assessment and monitoring of home safety interventions in clinical practice. SAFER-HOME has been used by occupational therapists (OT) in the “Stepping Out” component of the Community Health Engagement Programme (CHEP) as part of the assessments administered to determine home safety.

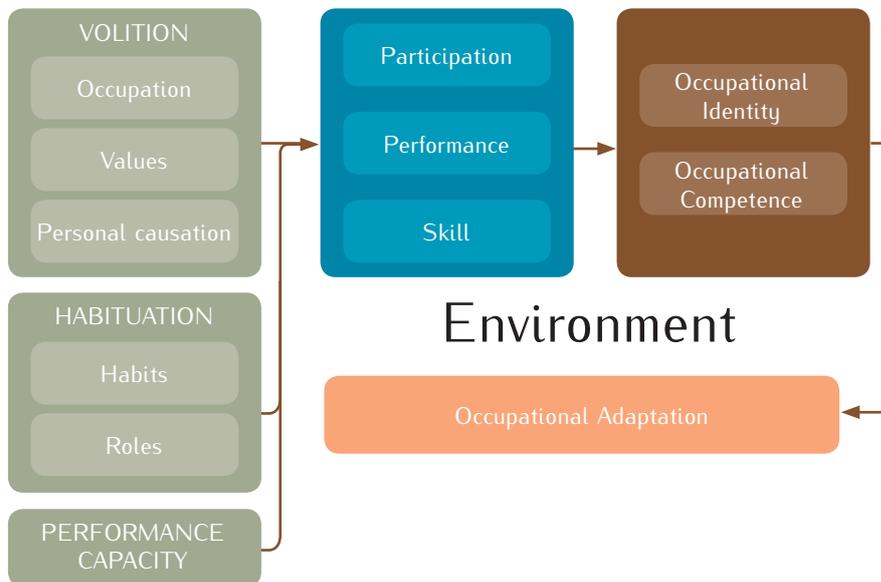
The instrument was originally built upon the conceptual foundations of the person-occupation-environment (PEO) model. The PEO conceptualises the various activities conducted by a person (occupation) as an interaction between the activities, the person and the environment (Figure 1).

Figure 1 – Person-environment-occupation model



There are however more ways to conceptualise the concepts of home safety which may offer additional insights on how home safety can be improved. One such way is through an alternative model, the Model of Human Occupation (MOHO) (Figure 2). The MOHO, like PEO, also conceptualises how occupations arise. Their difference lies in what each conceive as the process in which occupations come about. The MOHO conceptualises occupation to arise from three basic building blocks: volition, habituation and performance capacity. These primary constructs give rise to other processes which eventually leads to a state of occupational adaptation. This is in contrast to the approach by PEO which focuses on the different forms of dynamic interactions that can arise from person-environment-occupation. This difference in conceptualisation can change how we perceive home safety and provide alternative insights. This study therefore aimed to create an alternative factor structure of the SAFER-HOME instrument using the MOHO and input from the OTs within the “Stepping Out” programme.

Figure 2 – Model of Human Occupation



METHODS

While MOHO has many components within it, for the purpose of refactoring the SAFER-HOME, we would consider only the primary constructs and environment. Through further discussions, only “performance capacity” and “environment” would be used to refactor the items. A group of five OTs within the programme were asked to classify each of the items within the SAFER-HOME into “performance capacity”, “environment” or both. The item would fall into each subscale if the item was amenable to interventions in the respective subscale. If the OT deems the item to be unnecessary, the item could be proposed to be deleted. The outcomes of the reclassification were tallied and the highest votes won.

After reclassification, confirmatory factor analysis (CFA) was used to determine if the new refactored structure had a similar fit as the original factor structure. Fit indices were used to compare the fit between the original and the refactored models.

RESULTS

A total of 928 SAFER-HOME assessments were conducted and completed. The SAFER-HOME was conducted on homes of participants of the “Stepping Out” programme. Table 1 summarises the results of the refactoring after consultation with the OTs.

Table 1 – Co-occurrence matrix between original and refactored subscales

Subscales	Environment	Performance capacity	Both	Deleted	Original subscales subtotal
Bathroom & toilet	5	3	3	0	11
Communication & scheduling	1	0	2	0	3
Eating	0	2	0	0	2
Environmental hazards	10	0	1	2	13
Household	0	7	2	0	9
Kitchen	0	2	6	0	8
Leisure	0	1	0	0	1
Living situation	2	1	0	0	3
Medication, addiction & abuse	0	3	0	0	3
Mobility	3	5	2	0	10
Personal care	0	8	0	0	8
Wandering	1	0	0	2	3
Refactored subscales subtotal	22	32	16	4	-

The deleted items in the new subscales were due mainly to the recruitment criteria for the programme. The environment subscale comprised items mainly from “environmental hazards” suggesting these items were less amenable through personal factors. Besides “environmental hazards”, the remaining items from the original scales contributed just 55.0% of the items in the “environment” subscale. When this was compared to the “performance capacity” subscale, it illustrated the heavy involvement in personal factors remediation during intervention.

Both the original and refactored structured were analysed using CFA to find out if they had comparable data fit to each other. The RMSEA were .049 and .050 while the SRMR were .056 and .057 for the original and refactored models respectively. The results suggested that both the original and refactored instrument were comparable in data fit. The data suggested both models were similar in their abilities in conceptualising the data generating process.

After ascertaining that both models were similar, we can see that both offered different forms of insight to the patient’s abilities and disabilities. Using the original factor structure, interventions were focused on specific types of activities or environment. Using the SAFER-HOME in this manner would allow the therapist to communicate and target areas of concern in terms of activities or environment. The new factor structure adopted a generic approach which would help the therapist by suggesting if the environment or the physical capacity should be the focus of intervention. While the results from this refactoring does not inform us if the environment and physical capacity scores are generalizable to novel contexts not directly assessed by the instrument, it does provide a gauge of these two elements in the current context of the home. Furthermore, the refactored instrument also leads the therapist to consider how the performance capacity and environment can lead eventually to occupational adaptation.

### CONCLUSION

The SAFER-HOME has been refactored using the MOHO. The results of the refactoring suggested that the refactored instrument was comparable to the original instrument in terms of data fit. The ability to compute an alternative interpretation of the scores holds the potential to provide additional insights into how abilities and disabilities of the patient and its relation to occupational adaptation.



# PUBLICATIONS

## ORIGINAL ARTICLES

1. *Chong MS, Tan WS, Chan M, Lim WS, Ali N, Ang YY, Chua KC.* Cost of informal care for community-dwelling mild-moderate dementia patients in a developed Southeast Asian country. [International Psychogeriatrics 2013; 25 \(9\): 1475-1483](#)
2. *Sun Y, Lee SH, Heng BH, Chin VS.* 5-year survival and rehospitalisation due to stroke recurrence among patients with haemorrhagic or ischaemic strokes in Singapore. [BMC Neurology 2013; 13: 133](#)
3. *George PP, Oh CM, Loh PT, Heng BH, Lim FS.* Right-siting chronic kidney disease care – A survey of general practitioners in Singapore. [Annals Academy of Medicine \(Singapore\) 2013; 42 \(12\): 646-656](#)
4. *Ang YG, Heng BH, Liew AST, Chong PN.* Quality of care of patients with chronic kidney disease in National Healthcare Polyclinics from 2007 to 2011. [Annals Academy of Medicine \(Singapore\) 2013; 42 \(12\): 632-639](#)

## REVIEW ARTICLE

5. *Ng CWL, Ng KP.* Does practice size matter? Review on effects of quality of care in primary care. [British Journal of General Practice 2013; 63 \(614\): e604-e610](#)

## LETTER

6. *Sanjay S, Chin YC, Sun Y, Ong EL, Au Eong KG.* Awareness of HbA1c and its relationship with diabetic retinopathy among adult diabetic patients attending a tertiary ophthalmic centre. [Diabetes Care 2013; 36 \(1\): e1](#)

# AWARDS & GRANTS

## CONFERENCE PRESENTATION AWARDS

8<sup>th</sup> Singapore Public Health & Occupational Medicine Conference, Singapore  
August 2013

Best Oral Presentation

**Dr Sun Yan**

Risk stratification model for population health management in Central Region

## RESEARCH GRANTS

MOH Health Services Research Competitive Research Grant

Screening for diabetic retinopathy among patients with Type 2 diabetes mellitus:  
Developing a risk stratification tool for identifying a cost-effective strategy

**Dr Sun Yan** (PI)

**Dr Pradeep Paul George Gunapal** (Co-investigator)

**Chong Wai Fung** (Co-investigator)

**Tan Woan Shin** (Co-investigator)

**Dr Heng Bee Hoon** (Co-investigator)

**Amount: \$222,288**

Finding a way to know our patients: Identifying patients at risk of  
hospital admission and readmission

**Tan Woan Shin** (PI)

**Dr Sun Yan** (Co-investigator)

**Chong Wai Fung** (Co-investigator)

**A/Prof Ding Yew Yoong** (Co-investigator)

**Teow Kiok Liang** (Co-investigator)

**Charis Ng Wei Ling** (Co-investigator)

**Dr Heng Bee Hoon** (Co-investigator)

**Dr John Abisheganaden, TTSH** (Collaborator)

**Dr Lew Yui Jen, NHGP** (Collaborator)

**Amount: \$209,410**

# TRAINING & EDUCATION

## Health Programme Planning and Evaluation (HaPPE)

### March 2013

Speakers: *Kelvin Teo Wee Sheng*  
*Li Ruijie*  
*Charis Ng Wei Ling*  
*Dr Pradeep Paul George Gunapal*  
*Dr Joseph Antonio D. Molina*

The programme cycle includes both programme implementation as well as evaluation. The outcome of the evaluation is influenced to a large extent by the soundness of the programme plan. The inability to demonstrate the value and effectiveness of a programme through a formal evaluation jeopardises financial support for the programme. Additionally, the lack of a formal evaluation makes it difficult to propose input and process changes because areas for improvement cannot be identified. The one-day course aimed to equip participants with an understanding of the fundamentals of planning a health programme, and the need for a formal evaluation as well as the requirements and general methods for conducting an evaluation.

## 12<sup>th</sup> Healthcare Operations Research Appreciation Course (ORAC)

### July 2013

Speakers: *Dr Meng Fanwen*  
*Dr Zhu Zhecheng*  
*Palvannan R.K.*  
*Teow Kiok Liang*

Many healthcare issues benefit from a holistic and quantitative framework to identify the leverage points and to engage different stakeholders. The 2-day course introduced operations research (OR) concepts with healthcare applications, and focused on building intuition around theory through the use of illustrative examples and insights from results that supported and informed decision making. Case studies demonstrated the applications of OR techniques as well as the process of problem solving during the engagement with the decision maker.

## Introduction to Health Services Research

### October 2013

Speakers: *Li Ruijie*  
*Dr Joseph Antonio D. Molina*  
*Dr Pradeep Paul George Gunapal*  
*Tan Woan Shin*  
*Teow Kiok Liang*

The one-day introductory course provided an overview of the basic concepts, rationale, general and discipline-specific methods used in carrying out health services research. Using practical exercises, case studies and examples of real-world HSR projects, the objective of the course was to familiarise participants with a repertoire of methods often encountered in the conduct of health services research.

## Synthesising and Contextualising the Evidence in Health Services Research

### November 2013

Speakers: *Dr Joseph Antonio D. Molina*  
*Dr Pradeep Paul George Gunapal*  
*Tan Woan Shin*

The past three decades have witnessed an exponential growth in the number of published scientific literature, many of which are primary studies with overlapping aims and objectives. With the birth of the evidence-based healthcare movement, significant progress has been achieved in refining methods for synthesising scientific evidence. Health technology assessments (HTA) in particular, involve integrative techniques which may incorporate economic evaluations (EE) in order to make findings and conclusions relevant to a particular context. This half-day course aimed to equip participants with an understanding of the rationale and uses of systematic reviews, its relevance to health services research as well as the process involved in conducting a systematic review. The course also covered important considerations for appraising economic evidence and the relevance of conducting EE within HTAs.

# CONFERENCE PRESENTATIONS

JANUARY

## **Up and Up: A Forum on Community Care, Singapore**

1. **Govinda Raj A, Ng CWL, Teo KWS, Leong IYO**  
Bridging the palliative care gap: Evaluation of Project CARE
  2. **Molina JAD, Ismail NH**  
Stepping out for the elderly: Preventing falls in the community
- 

JUNE

## **20<sup>th</sup> IAGG World Congress of Gerontology and Geriatrics, Seoul**

3. **Ismail NH, Leong IYO, Teoh ML, Molina JAD**  
Stepping out into active life – A community-based fall prevention programme for the elderly
- 

JULY

## **Operational Research Applied to Health Services (ORAHS), Istanbul**

4. **Brailsford S, Roberts C, Rafman H, Teow KL**  
The effect of outlying patients to clinically inappropriate wards
  5. **Meng FW, Teow KL, Ooi CK, Heng BH, Palvannan R.K., Tay SY**  
Modelling patient waiting time via a transformed piecewise distribution using General Phase-Type distributions
- 

AUGUST

## **8<sup>th</sup> Singapore Public Health & Occupational Medicine Conference, Singapore**

6. **Saxena N, George PP, Heng BH, Lim TH, Yong SO**  
Is prescribing anti-oxidant vitamins + Zn to prevent progression of intermediate age-related macular degeneration (AMD) cost effective? A Singapore perspective
7. **Ng CWL, Govinda Raj A, Teo KWS, Leong IYO**  
Satisfaction with end-of-life care for nursing home residents
8. **George PP, Heng BH, Ng CWL**  
Determinants of health-related quality of life among community-dwelling elderly in Singapore
9. **George PP, Heng BH, Molina JAD, Hui TW**  
Intravitreal bevacizumab for neovascular age-related macular degeneration – A systematic review of systematic reviews
10. **Ang YG, Saxena N, Lew YJ**  
Antihypertensive drug utilisation in National Healthcare Group Polyclinic
11. **Lobo CA, George PP, Molina JAD, Heng BH**  
The perceptions of telemedicine among patients in primary care – A literature review
12. **Chong WF, Sun Y, Heng BH, Thet MM, Tay SY, Loh SS, Seow E**  
Performance of RAPS and REMS in predicting in-hospital mortality

13. **Sun Y, Abisheganaden J, Heng BH, Choo P**  
Risk stratification model for population health management  
in Central Region
- 

SEPTEMBER **OR55, Exeter**

14. **Brailsford S, Roberts C, Rafman H, Teow KL**  
Right patient, wrong ward: The effect of outlying patients to  
clinically inappropriate wards

**Singapore Health & Biomedical Congress 2013, Singapore**

15. **Ng CWL, Govinda Raj A, Teo KWS, Leong IYO**  
Satisfaction of bereaved families on an end-of-life programme  
for nursing home residents
16. **Meng FW, Teow KL, Ooi CK, Tay SY**  
Evaluation of patient waiting time in emergency department  
governed by a generic maximum waiting time policy
17. **Molina JAD, Singh KB, Ng YH, Lim HT, Tung YC**  
Health resource use and outpatient cost of a care coordinator-led  
programme for stable hypertension and hyperlipidaemia
18. **Singh KB, Molina JAD, Chong WS, Haron NS, Er LH, Koa MY,  
Wong KM, Ng Y, Lim HT, Tung YC**  
Effectiveness of using a care coordinator and protocolised  
management (i-control 2 Programme) in patients with stable  
hypertension and hyperlipidaemia
- 

OCTOBER **ISOQOL 20<sup>th</sup> Annual Conference, Miami**

19. **Ng CWL, Luo N, Heng BH**  
Health status profiles of community-dwelling elderly using self-reported  
health indicators: A latent class analysis
20. **George PP, Heng BH, Ng CWL**  
Determinants of health-related quality of life among  
community-dwelling elderly in Singapore
- 

NOVEMBER **ISPOR 16<sup>th</sup> Annual European Congress, Dublin**

21. **Saxena N, George PP, Heng BH, Lim TH, Yong SO**  
Cost effectiveness of anti-oxidant vitamin + zinc treatment to prevent  
the progression of intermediate age-related macular degeneration to  
its wet form: A Singapore perspective

**World Congress on Integrated Care 2013, Singapore**

22. **Molina JAD, Ismail NH, Heng BH, Leong IYO**  
Engaging the community – A community-based falls prevention  
programme for the elderly
23. **Teo KWS, Chong WF, Sun Y, Leong IYO**  
Effectiveness and cost impact analysis of a Post Acute Care at Home  
(PACH) programme
24. **Teo KWS, Govinda Raj A, Ng CWL, Leong IYO**  
Economic impact analysis of an end-of-life programme for nursing  
home residents in Singapore

# THE TEAM

1. **Dr Heng Bee Hoon**  
MBBS, MSc (Public Health), FAMS  
Director



2. **A/Prof Ding Yew Yoong**  
MBBS, FRCP, FAMS, MPH  
Visiting Consultant  
(Senior Consultant & Clinical Associate  
Professor, Geriatric Medicine, TTSH)



3. **Charis Ng Wei Ling**  
BA (Psychology & Communications),  
MPH  
Senior Research Analyst



4. **Cheryl Lobo**  
BA (History)  
Information Specialist



5. **Chong Wai Fung**  
BN, MBA, MPH  
Principal Research Analyst



6. **Dr Gary Ang Yee**  
MBBS, MPH  
Registrar



7. **Dr Joseph Antonio D. Molina**  
MD, MSc (Public Health)  
Principal Research Analyst



8. **Kelvin Teo Wee Sheng**  
BA (Economics) (Magna Cum Laude),  
MA (Economics)  
Research Analyst



9. **Li Ruijie**  
MSc (Occupational Therapy)  
Senior Research Analyst



10. **Dr May Me Thet**  
MBBS, MSc (Public Health)  
Research Analyst



11. **Dr Meng Fanwen**  
MSc (Operations Research),  
PhD (Operations Research)  
Operations Research Specialist



12. **Dr Nakul Saxena**  
BPharm, PhD (Epidemiology)  
Research Analyst



13. **Palvannan R.K.**  
BEng (Mechanical Engineering), MEng  
(Industrial & Systems Engineering)  
Operations Research Specialist



14. **Dr Pradeep Paul George Gunapal**  
BSMS, MSc (Epidemiology)  
Principal Research Analyst



15. **Dr Sun Yan**  
MSc (Data Mining),  
PhD (Medical Informatics)  
Medical Informatics and Biostatistics  
Specialist



16. **Tan Woan Shin**  
BSocSc (Hons) (Economics),  
MSocSc (Economics)  
Principal Research Analyst



17. **Teow Kiok Liang**  
BEng (Electrical Engineering),  
MSc (Industrial & Systems Engineering)  
Operations Research Specialist



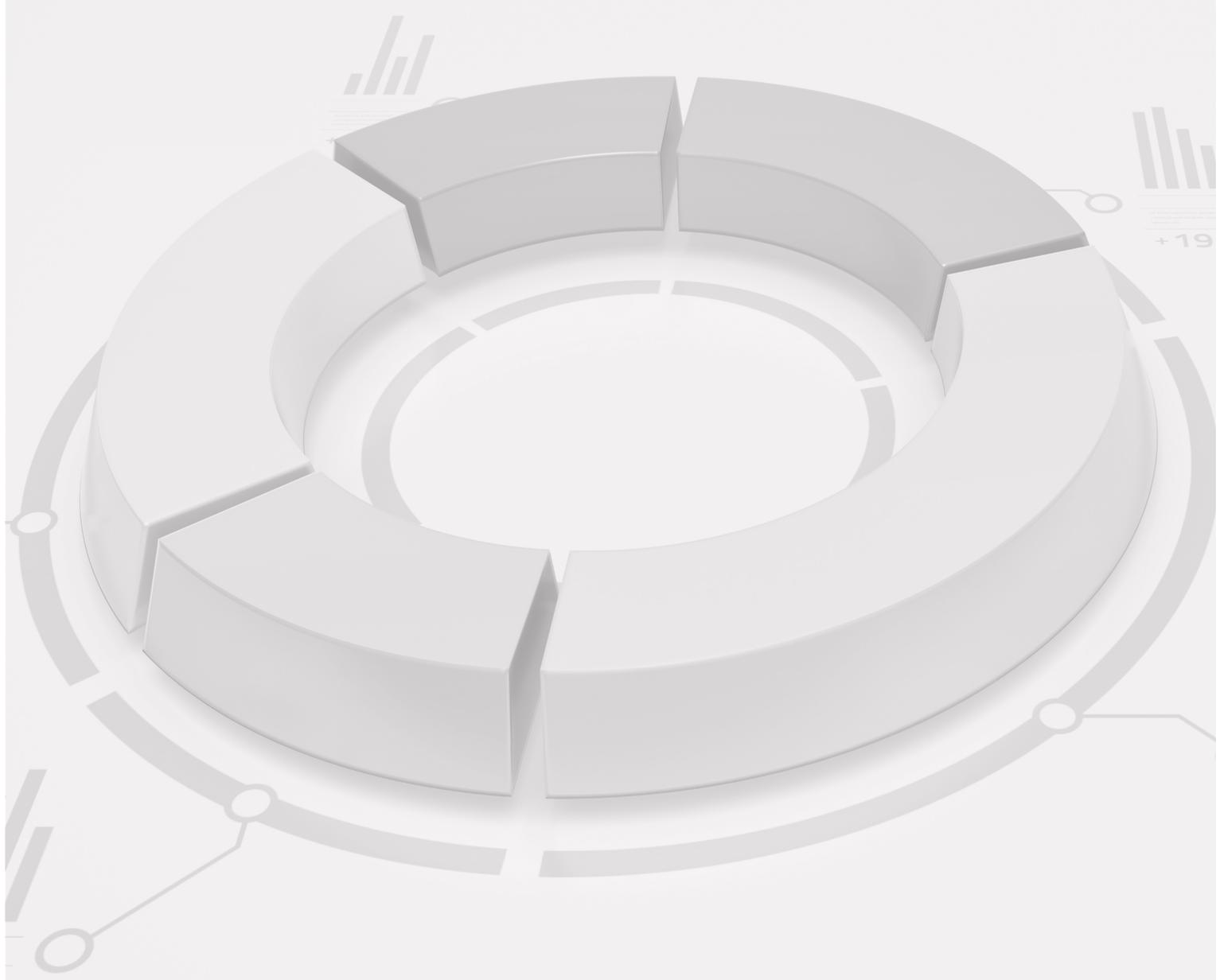
18. **Dr Zhu Zhecheng**  
MSc (Information Engineering), PhD  
(Industrial & Systems Engineering)  
Operations Research Specialist



19. **Alex You Xiaobin**  
BEcon (Statistics), MSc (Statistics)  
Research Analyst







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