Health Services & Outcomes Research

2015

FOREWORD

2015 remembers tenth year since founding of HSOR. It has come a long way in providing evidence to its stakeholders, made possible by its multi-disciplinary team strongly supported by engaging stakeholders and senior management. It had adapted to changes as what used to be advanced health services and operations research techniques and innovative outputs are now standard and fundamental building blocks of the work, a sign of growth and progress.

The year also saw the formation of the NHG Strategic Research and Analytics (N-STRAT) collaborative network that brought together domain knowledge resources from six departments. This hopes to further strengthen NHG's capability in providing evidence and enhancing situation awareness to achieve an effective and sustainable healthcare system beyond 2020.

HSOR continued with population-based programme evaluation and surveys aligned with NHG's priorities and workplan. It supported the evaluation of the Frequent Admitter programme through a pragmatic design that segregated patients into true and apparent frequent admitters, which are disparate groups with differing characteristics, and requiring different approaches in interventions. The department also started a longitudinal survey of the population in the Central Region that collects biopsychosocial data using validated instruments, with the ultimate goal of building a single measure of population health. This will form a baseline population health measure for future comparison within NHG's Central Region, and can potentially be deployed for comparison across other Regional Health Systems.

Against a backdrop of a national push for productivity, HSOR adapted a methodology to measure institution productivity for monitoring and benchmarking with international centres. At SHBC 2015, it held the HSR symposium organised as 'Data Science' and 'Decision Science' programmes aligned with the need to grapple with large heterogeneous healthcare data and decision modelling.

During the year, collaboration on evidence reviews of e-Learning with the Lee Kong Chian School of Medicine continued. Two staff members started their PhD programmes at NTU and the University of Adelaide in end-of-life research and health technology assessment, respectively, aligned with our mission of building capacity and advancing knowledge in HSR.

This report is a compilation of work carried out during the year. Happy reading.

Prof Philip Choo
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.

CONTENTS

PROJECTS

POPULATION HEALTH & MANAGEMENT OF DISEASES

MORTALITY TRENDS OF LOWER EXTREMITY AMPUTATIONS IN DIABETES PATIENTS IN TAN TOCK SENG HOSPITAL

Dr Gary Ang Yee, Dr Lin Lee Kai, Dr Yap Chun Wei

BACKGROUND

Lower extremity amputation (LEA) is defined as the complete loss in the transverse anatomical plane of any part of the lower limb. The prognosis of LEAs is poor especially in patients with diabetes mellitus, with 1-year mortality rate ranging from 11.3% to as high as 50.2%. However, there is limited data in the literature on Asian populations even though the prevalence of diabetes mellitus in Asian populations is high. This study was conducted to address the gap locally.

METHODS

We performed a retrospective study of all LEA performed at Tan Tock Seng Hospital (TTSH) from 1 January 2008 to 31 December 2013 in patients with diabetes mellitus (n=1,363) using the National Healthcare Group Diabetes Registry. The outcomes of interest were death from all causes.

RESULTS

Baseline characteristics are shown in Table 1. The number of diabetes patients with first LEA done in the year decreased from 274 in 2008 to 206 in 2013. The mean age of patients was 63.9 years old, which is younger than those found in many overseas studies. Indians were over represented in the study. The mean HBA1c also increased from 8.8 in 2008 to 9.3 in 2013. The mean follow-up period was 2.9 years. During the study period, 602 (44.2%) patients died, of whom majority (173, 28.7%) died from cardiovascular causes.

30-day mortality
In 2008, 6.9% of diabetes patients who underwent first LEA died within 30 days whereas in 2013, the percentage was 5.3%. Overall, the 30-day mortality rate for the period 2008 to 2013 was 5.5%.

1-year mortality
In 2008, 19.3% of diabetes patients who underwent first LEA died within 1 year whereas in 2013, the percentage was 24.3%. Overall, the 1-year mortality rate for the period 2008 to 2013 was 20.7%.

CONCLUSION

The study showed that our patients are younger and many of them had poorly controlled diabetes mellitus. Indian patients were over represented. 1-year mortality remained high for these patients.

Table 1 – Baseline characteristics of diabetes patients with first LEA done in the year

	2008 (n=274)	2009 (n=238)	2010 (n=212)	2011 (n=229)	2012 (n=204)	2013 (n=206)	Total (n=1,363)
Age, mean (SD)	63.4 (12.0)	63.5 (11.6)	62.1 (11.9)	65.1 (14.0)	64.3 (12.2)	65.2 (12.9)	63.9 (12.4)
Gender							
Male, n (%)	155 (56.6)	151 (63.5)	144 (67.9)	149 (65.1)	126 (61.8)	124 (60.2)	849 (62.3)
Ethnicity							
Chinese, n (%)	177 (64.6)	164 (68.9)	136 (64.2)	145 (63.3)	135 (66.2)	140 (68.0)	897 (65.8)
Malay, n (%)	54 (19.7)	30 (12.6)	30 (14.2)	22 (9.6)	30 (14.7)	27 (13.1)	176 (12.9)
Indian, n (%)	37 (13.5)	42 (17.7)	44 (20.8)	50 (21.8)	32 (15.7)	33 (16.0)	255 (18.7)
Others, n (%)	6 (2.2)	2 (0.8)	2 (0.9)	12 (5.2)	7 (3.4)	6 (2.9)	35 (2.6)
Housing type							
1 room, n (%)	12 (4.4)	15 (6.3)	13 (6.1)	15 (6.6)	13 (6.4)	9 (4.4)	77 (5.7)
2 room, n (%)	12 (4.4)	17 (7.1)	11 (5.2)	15 (6.6)	10 (4.9)	14 (6.8)	79 (5.8)
3 room, n (%)	72 (26.3)	49 (20.6)	49 (23.1)	54 (23.6)	51 (25.0)	67 (32.5)	342 (25.1)
4 room, n (%)	92 (33.6)	89 (37.4)	74 (34.9)	72 (31.4)	65 (31.9)	57 (27.7)	449 (32.9)
5-room, n (%)	51 (18.6)	31 (13.0)	32 (15.1)	41 (17.9)	31(15.2)	28 (13.6)	214 (15.7)
Executive condominium, n (%)	9 (3.3)	12 (5.0)	13 (6.1)	10 (4.4)	15 (7.4)	11 (5.3)	70 (5.1)
Private, n (%)	12 (4.4)	13 (5.5)	11 (5.2)	17 (7.4)	9 (4.4)	8 (3.9)	70 (5.1)
Others, n (%)	14 (5.1)	12 (5.0)	9 (4.3)	5 (2.2)	10 (4.9)	12 (5.8)	62 (4.6)
Marital Status							
Single, n (%)	16 (5.8)	24 (10.1)	23 (10.9)	23 (10.0)	19 (9.3)	26 (12.6)	131 (9.6)
Married, n (%)	217 (79.2)	173 (72.7)	149 (70.3)	170 (74.2)	159 (77.9)	135 (65.5)	1,003 (73.6)
Widowed, n (%)	2 (0.7)	1 (0.4)	1 (0.5)	2 (0.9)	2 (1.0)	2 (1.0)	10 (0.7)
Divorced, n (%)	3 (1.1)	3 (1.3)	2 (0.9)	3 (1.3)	5 (2.5)	6 (2.9)	22 (1.6)
Not reported, n (%)	36 (13.1)	37 (15.6)	37 (17.5)	31 (13.5)	19 (9.3)	37 (18.0)	197 (14.5)
Diabetes							
Type 2, n (%)	268 (97.8)	233 (97.9)	206 (97.2)	225 (98.3)	201 (98.5)	203 (98.5)	1,336 (98.0)
Comorbidities							
Dyslipidemia, n (%)	232 (84.7)	197 (82.8)	182 (85.9)	194 (84.7)	184 (90.2)	189 (91.8)	1,178 (86.4)
Hypertension, n (%)	221 (80.7)	190 (79.8)	173 (81)	194 (84.7)	181 (88.7	179 (86.9)	1,138 (83.5)
Chronic kidney Disease Stage 3A-5, n (%)	31 (11.3)	23 (9.7)	32 (15.1)	37 (16.2)	29 (14.2)	42 (20.4)	194 (14.2)
HBA1c, mean (SD)	8.8 (2.4)	8.9 (2.5)	8.9 (2.6)	8.8 (2.7)	9.0 (2.7)	9.3 (2.8)	9.0 (2.6)
Follow up period in years, mean (SD)	4.3 (2.6)	3.8 (2.1)	3.3 (1.7)	2.6 (1.4)	2.0 (1.0)	1.3 (1.2)	2.9 (2.1)

ESTIMATING THE RISK OF FUTURE EMERGENCY DEPARTMENT VISIT DUE TO ASTHMA EXACERBATION DURING A DOCTOR CONSULT IN A PRIMARY CARE SETTING

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BACKGROUND

Emergency Department (ED) visits due to asthma exacerbation are potentially avoidable if the asthma condition is well-controlled. Hence, it is important to identify patients with poor asthma control who are at risk of an ED visit in the near future so that appropriate interventions could be given. This project aimed to develop a model to risk stratify patients during an asthma consultation in a primary care setting.

METHODS

This was a retrospective cohort study using information extracted from administrative databases. Patients who regularly visited any National Healthcare Group Polyclinics (NHGP) (except Woodlands and Yishun polyclinics) for asthma consultations between 2008 and 2014 were followed up until an ED visit due to asthma exacerbation. Patients were censored at death, or their next asthma consultation in the polyclinics, or their last known date of contact with National Healthcare Group (NHG) institutions.

A multivariate Cox regression model was constructed using patients seen between 2008 and 2011. A total of 64 variables related to patient demographics, comorbidities, previous visits and drugs dispensed were considered for the model. Significant variables were identified using univariate Cox regression, following by backward elimination of non-significant variables in the multivariate Cox regression model. Patients were risk-stratified into high-risk, moderate-risk and low-risk using the multivariate Cox regression model. Thresholds for risk-stratification were determined using chi-square scores. The final multivariate Cox regression model was validated using patients seen between 2012 and 2014, but who were not seen between 2008 and 2011.

RESULTS

There were a total of 109,086 asthma consultations between 2008 and 2011. Among these, 2,443 had an ED visit due to asthma exacerbation before the next asthma consultation or death. Patients seen between 2012 and 2014 but who were not seen between 2008 and 2011 had a total of 22,859 asthma consultations. Among these, 445 had an ED visit due to asthma exacerbation before the next asthma consultation or death.

The model identified age, ethnicity, chronic obstructive pulmonary disease (COPD), hypertension, previous history of Specialist Outpatient Clinic (SOC) asthma consultations in the past 12 months, previous history of ED visits due to asthma exacerbations in the past 12 months, number of inpatient admissions due to asthma exacerbations in the last 12 months, history of intubation and number of relievers used in the past 3 months as significant predictors (Table 1).

Table 1 – Significant predictors in final multivariate Cox regression model

Predictors	Hazard Ratio (95% CI)	p value
Demographics		
Age	0.996 (0.993 – 0.999)	0.006
Race		
Chinese	Reference	
Malay	1.601 (1.403 – 1.825)	<0.001
Indian	1.825 (1.599 – 2.083)	<0.001
Others	1.750 (1.447 – 2.117)	<0.001
Comorbidities		
COPD	0.718 (0.569 – 0.905)	0.005
Hypertension	0.783 (0.693 – 0.885)	<0.001
History		
Any SOC asthma visits in past 12 months?	1.871 (1.628 – 2.151)	<0.001
Any ED asthma visits in past 12 months?	3.661 (3.074 – 4.360)	<0.001
No. of asthma admissions in past 12 months	1.139 (1.026 – 1.265)	0.015
Any history of intubation?	1.841 (1.533 – 2.211)	<0.001
Drugs		
Number of relievers used in past 3 months	1.142 (1.101 – 1.184)	<0.001

CI – Confidence Interval

After risk-stratification, patients in the high-risk group were likely to have an ED visit due to asthma exacerbation within 1 month from the current asthma consult; patients in the moderate-risk group were likely to have an ED visit due to asthma exacerbation within 14 months from the current asthma consult, and patients in the low-risk group were not likely to have an ED visit due to asthma exacerbation before the next asthma consultation. The probabilities of an ED visit due to asthma exacerbation after the asthma consultation for both the training and validation sets are given in Table 2.

Table 2 – Probability of an ED visit due to asthma exacerbation after the asthma consultation (%)

Set	Risk	1 mth	3 mths	6 mths	12 mths	18 mths	24 mths
Training	High	44.6	54.5	54.5	≥84.8	≥84.8	≥84.8
	Medium	20.8	31.8	44.6	50.0	57.0	60.1
	Low	1.1	2.0	3.0	5.3	6.9	8.2
Validation	High	63.6	63.6	≥63.6	≥63.6	≥63.6	≥63.6
	Medium	19.3	24.5	31.0	37.9	37.9	≥37.9
	Low	1.2	2.1	3.2	5.0	7.7	9.4

CONCLUSION

The final Cox regression model developed in this study could be used to estimate the risk of future ED visit due to asthma exacerbation. This could help clinicians to identify high-risk patients and provide appropriate interventions to prevent future ED visits.

AN UPDATE OF REGIONAL HEALTH SYSTEM DATABASE

Teow Kiok Liang, Palvannan, R.K

BACKGROUND

In 2014, Health Services & Outcomes Research (HSOR) from National Healthcare Group (NHG) worked with Tan Tock Seng Hospital (TTSH), National University Hospital (NUH), Alexandra Hospital (AH) and National Healthcare Group Polyclinics (NHGP) to establish a database to support population health management. We termed this the Regional Health System (RHS) database. The study was approved by the NHG Domain Specific Review Board.

The database was drawn from the hospitals' and NHGP's operational data source. It consisted of patient demographics, health services utilisation, cost, diagnoses and chronic disease information from 2008 to 2013. The raw data had some inconsistencies with what had been reported in Ministry of Health's (MOH) Bulletins. In 2015, we built upon lessons learnt and did a database update to include an additional year of data, and improved the accuracy of the database.

METHODS

Using MOH Bulletins as the reference source, we consulted the information department of the various hospitals and NHGP to find out the discrepancies. We used a series of filtering criteria to generate another set of tables, and compared with the Bulletins figures again.

RESULTS

The investigations discovered several items that were in the raw data but were excluded in MOH Bulletins. For instance, raw inpatient data contained short-stay admissions like Emergency Department Therapeutic Unit (EDTU) and Day ward that were excluded from inpatient admissions reported in the Bulletins. Raw Specialist Operating Clinics (SOC) attendances included several non-SOC consults like dental visits.

The revised data sets were much closer to the Bulletins figures. The inpatient discharges comparisons are shown in Tables 1 and 2.

Table 1 – Inpatient discharges from RHS database

Hospital	2009	2010	2011	2012	2013	2014
AH	19,875	14,932	13,744	15,423	16,787	17,980
NUH	53,944	55,221	54,043	56,451	58,757	61,616
TTSH	59,639	58,492	55,744	54,065	54,119	55,356

Table 2 – Inpatient discharges from MOH Bulletins

Hospital	2009	2010	2011	2012	2013	2014
AH	19,876	14,930	13,742	15,328	16,578	17,686
NUH	58,186	59,842	56,613	56,696	58,827	61,509
TTSH	57,014	58,543	56,150	52,957	52,864	53,541

CONCLUSION

Although the RHS database was meant for general population profiling and not for administrative usage requiring precision, high data quality remained an important aspect. Through this exercise, we have derived a more consistent set of data for our use. Codes and filters generated could be reused for subsequent data updates.

USING CHARLSON COMORBIDITY INDEX AS AN AGE-RISK ADJUSTMENT METHOD FOR ADMINISTRATIVE DATABASE ANALYSIS

Alex You Xiaobin

BACKGROUND

In comparing healthcare outcomes of interventions (such as mortality, utilisation and cost) of two different patient groups, age and comorbidity burden often need to be adjusted. The Charlson Comorbidity Index (CCI) is an index that combines 19 comorbidities of patients to predict mortality. It is widely used in analysis of administrative databases as an index to measure the overall comorbidity burden, as well as outcomes such as resource use and cost. The CCI can also be applied to adjust outcomes so that the age and comorbidity factors are excluded from the explanatory model.

METHODS

Patients were eligible for inclusion into the programme if they were 60 years or older, and The overall CCI score (0 to 29 points) is a summation of the age score and 19 comorbidity scores (each comorbidity is awarded 1, 2, 3 or 6 points). The CCI divides patients into four risk categories: low (1-3), medium (4-5), high (6-7) and very high (8+).

For our data analysis, we included patients who were admitted to Tan Tock Seng Hospital (TTSH) in 2014. The 1-year resource use and cost were compared among the risk categories. A linear model was applied to test whether age and CCI risk categories were significant predictors of outcomes such as National Healthcare Group Polyclinic (NHGP), Specialist Outpatient Clinic (SOC), Emergency Department (ED) visits, inpatient admissions (IP), length of stay (LOS), and inpatient cost. The age and CCI risk categories were used to adjust healthcare utilisation and cost for comparison between two patient groups that have different age-CCI distribution.

RESULTS

Table 1 shows the demographics, chronic conditions, healthcare utilisation, and cost of patients in five CCI risk categories. The higher risk groups consisted of patients who were older, had more chronic conditions, and higher cost. While healthcare utilisation generally increased as the risk category increased, the number of polyclinic visits was the highest in the Medium (4-5) group.

Table 1 – Demographics, chronic conditions, healthcare utilisation and cost by CCI risk category

	CCI risk category				
	Unknown (0)	Low (1-3)	Medium (4-5)	High (6-7)	Very high (8+)
No. of patients	10,711	5,763	6,245	5,753	6,159
% of patients	30.9%	16.6%	18.0%	16.6%	17.8%
Mean CCI score	0	2.1	4.5	6.5	9.8
Mean age score	0	0.7	2.3	2.9	3.2
Age (years)	52.0	53.1	71.3	76.3	79.8
No. of chronic conditions	0.8	2.4	3.6	4.3	5.1
No. of IP admissions	1.1	1.3	1.4	1.6	2.0
No. of SOC visits	2.3	3.4	4.1	4.5	5.3
No. of ED visits	1.5	1.8	1.8	2.0	2.3
No. of day surgeries	0.1	0.2	0.2	0.2	0.2
No. of NHGP visits	1.6	2.7	3.0	2.8	2.7
Cost	$6,451.30	$10,865.30	$13,007.10	$16,154.60	$20,812.30

Table 2 shows the regression results. Age and CCI risk category were predictors of all outcomes except NHGP visits. Table 3 displays the age and CCI distribution of two patient groups (Group 1 & 2). Table 4 shows the healthcare utilisation and cost of Group 1 and 2, before and after adjustment. Although Group 1 has older and higher risk patients than Group 2, the differences in healthcare utilisation and cost between the two groups narrowed after adjustment.

Table 2 – Regression coefficients of six linear models

	NHGP	SOC	ED	IP	LOS	Cost
Age	NS	-0.68	-0.07	-0.05	0.95	-$1,404.18
CCI	0.04	0.62	0.12	0.16	1.84	$2,504.66

NS – Not significant

Table 3 – Age-CCI category distribution of Group 1 and Group 2 (%)

Group 1	CCI risk category				
Age	U	L	M	H	VH
0 (<50)	14.2	6.1	0.6	0.6	0.2
1 (50-59)	4.6	5.5	2.3	1.5	.8
2 (60-69)	4.4	4.0	5.2	3.1	2.9
3 (70-79)	3.2	1.0	5.8	4.5	5.4
4 (80-89)	2.2		3.5	5.2	7.4
5+ (>=90)	0.6		0.4	1.6	3.2

Group 2	CCI risk category				
Age	U	L	M	H	VH
0 (<50)	33.6	8.4	0.9	0.8	0.2
1 (50-59)	3.9	4.7	2.3	1.5	0.9
2 (60-69)	3.2	3.1	4.1	2.5	2.8
3 (70-79)	1.8	0.6	3.7	3.1	3.9
4 (80-89)	1.3		2.1	3.0	4.5
5+ (>=90)	0.4		0.3	0.8	1.4

U – Unknown; L – Low; M – Medium; H – High; VH – Very high

Table 4 – Healthcare utilisation and cost comparisons, before and after adjustment

Patient group	NHGP	SOC	ED	IP	LOS	Cost
Group 1	2.3	5.3	1.6	1.6	8.6	$14,356.69
Group 2	2.6	3.7	1.8	1.5	11.3	$13,459.19
Group 2 (with adjustment)	2.4	3.5	1.8	1.4	9.9	$12,460.52

CONCLUSION

Age and comorbidities are important factors that can impact health outcomes. In analysis, the effect of age and comorbidity should be isolated from the effect to be examined. The CCI measures the patients' ageing effect and comorbidity burden well. Thus, with age-comorbidity-adjustment, the outcome would better reflect the impact of the effect to be examined.

MORTALITY OUTCOMES OF ANTI-HYPERTENSIVE DRUGS

Dr Gary Ang Yee, Dr Nakul Saxena

BACKGROUND

The type of drugs to be used to treat hypertension has been the subject of several large studies and national guidelines. The fundamental goal of treatment should be the prevention of the important endpoints of hypertension, such as heart attack, stroke and heart failure. Patient's age, associated clinical conditions and end-organ damage also play a part in determining dosage and type of medication administered.

The several classes of anti-hypertensive drugs differ in side effect profiles, ability to prevent endpoints and cost. The choice of more expensive agents, when cheaper ones would be equally effective, may have negative impacts on national healthcare budgets. As of 2009, the best available evidence favours the thiazide diuretics as the first-line treatment of choice for high blood pressure when drugs were necessary. Although clinical evidence shows calcium channel blockers and thiazide-type diuretics are preferred first-line treatments for most people (from both efficacy and cost points of view), an Angiotensin-converting enzyme inhibitor (ACE-i) is recommended by the National Institute for Health and Care Excellence (NICE) in the United Kingdom for those under 55 years old.

There is currently no established guideline on which anti-hypertensive drug should be used as first-line in Singapore. The objective of the study was to assess the association between the following five classes of drugs and mortality in hypertensive patients:

i. Angiotensin-converting enzyme inhibitors (ACE-i)
ii. Angiotensin receptor blocker (ARB)
iii. Beta-blockers (BB)
iv. Calcium channel blockers (CCB)
v. Diuretics (D)

METHODS

This was a retrospective cohort study of hypertensive patients (≥18 years) from the National Healthcare Group Chronic Disease Registry from 1 January to 31 December 2007. The patients were followed up till December 2013, and the event of interest was death from all causes. As we were interested in the outcomes of the five classes of anti-hypertensive drugs only, we excluded patients on combination therapy in the study. Survival analysis was done to calculate the Hazard Ratio (HR) of patients on the five classes of anti-hypertensive drugs.

RESULTS

Table 1 shows the baseline characteristics of the patients. Over a mean follow up period of 4.8 (SD 1.4) years, 1,363 out of 10,547 (12.9%) patients died. Compared to ARB, the use of ACE-i (HR=0.63; 95% CI: 0.54-0.74), BB (HR=0.30; 95% CI: 0.25-0.36), CCB (HR=0.64; 95% CI: 0.54-0.75) and D (HR=0.72; 95% CI: 0.61-0.85) were protective and statistically significant. After adjusting for age, gender, ethnicity, housing type, duration of hypertension, systolic and diastolic blood pressure, compared to ARB, the use of BB (HR=0.43; 95% CI: 0.33-0.56), CCB (HR=0.55; 95% CI: 0.44-0.70), D (HR=0.56; 95% CI: 0.46-0.70) and ACE-i (HR=0.67; 95% CI: 0.54-0.83) were protective and statistically significant.

Table 1 – Baseline characteristics of hypertensive patients

	ACE-i (n=2,202)	ARB (n=1,655)	BB (n=2,635)	CCB (n=2,265)	D (n=1,790)
Age in years, mean (SD)	60.4 (11.9)	61.0 (12.8)	59.0 (10.5)	64.4 (12.5)	65.9 (11.4)
Gender					
Male, n (%)	1,179 (53.5)	730 (44.1)	1,144 (43.4)	919 (40.6)	622 (34.8)
Ethnicity					
Chinese, n (%)	1,763 (80.1)	1,381 (83.4)	2,378 (90.1)	1,941 (85.7)	1,542 (86.2)
Malay, n (%)	193 (8.8)	118 (7.1)	108 (4.1)	106 (4.7)	130 (7.3)
Indian, n (%)	175 (8.0)	110 (6.7)	103 (3.9)	149 (6.6)	73 (4.1)
Others, n (%)	71 (3.2)	46 (2.8)	50 (1.9)	69 (3.1)	45 (2.5)
Housing type					
1-room, n (%)	24 (1.1)	15 (0.9)	24 (0.9)	33 (1.5)	23 (1.3)
2-room, n (%)	51 (2.3)	24 (1.5)	53 (2.0)	59 (2.6)	44 (2.5)
3-room, n (%)	477 (21.7)	264 (16.0)	618 (23.5)	444 (19.6)	423 (23.6)
4-room, n (%)	861 (39.1)	606 (36.6)	898 (34.1)	719 (31.7)	618 (34.5)
5-room, n (%)	386 (17.5)	332 (20.1)	426 (16.2)	389 (17.2)	273 (15.3)
Executive, n (%)	129 (5.9)	123 (7.4)	137 (5.2)	144 (6.4)	107 (6.0)
Others, n (%)	274 (12.4)	291 (17.6)	479 (18.2)	477 (21.1)	302 (16.9)
Duration of hypertension in years, mean (SD)	3.9 (3.1)	4.1 (4.3)	4.1 (3.3)	3.7 (3.2)	3.9 (3.2)
Blood pressure in mmHg					
Systolic, mean (SD)	130.5 (10.0)	131.7 (12.5)	130.0 (11.4)	132.7 (11.6)	131.9 (11.1)
Diastolic, mean (SD)	78.3 (6.7)	78.2 (7.4)	78.2 (7.4)	78.5 (7.4)	77.9 (7.2)

CONCLUSION

This study showed that using ARB as monotherapy may have poorer outcomes in terms of mortality compared with using the other four classes of drugs as monotherapy. However, as our focus is only on patients on monotherapy, further research is needed to evaluate the outcomes of the different classes of anti-hypertensive therapies in combination.

CHARLSON COMORBIDITY INDEX RISK PROGRESSION OF TTSH INPATIENTS

Alex You Xiaobin, Palvannan R.K., Teow Kiok Liang

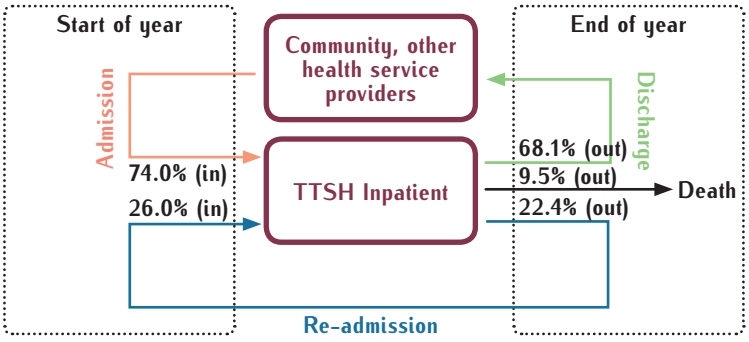
BACKGROUND

The comorbidity burden can be a variable to explain and predict new admitters or re-admitters to the hospital. The Charlson Comorbidity Index (CCI) is a measure of a patient's overall comorbidity burden. A patient flow Markov model with CCI risk segmentation can show the progression of re-admitters, the CCI distribution in new admitters, patients who have died, or were discharged in the following year after admission. Longitudinally, the CCI progression reflects how fast the progression of comorbidity is.

METHODS

As shown in Figure 1, in each calendar year, admitters to a hospital can be divided into new admitters or re-admitters, depending on whether they had a prior admission in the preceding year. These admitters are then further divided into three groups: discharged, re-admission and death, based on their outcome in the following year. A patient flow Markov model was applied to patients who were admitted to Tan Tock Seng Hospital (TTSH) from 2008 to 2014. The cross-sectional CCI risk category was determined by the CCI score at the end of the year. The distribution of CCI risk categories of the admitters and the outcomes, as well as the CCI risk progression of re-admitters were estimated by the patient flow Markov model.

Figure 1 – Patient flow Markov model



RESULTS

Table 1 shows the distribution of CCI risk categories among new admitters, of whom 65.7% do not have a CCI score. Table 2 shows the CCI risk category progression rate of TTSH's re-admitters. Each year 33.4% of these patients progress to one or more risk categories, same statistics in baseline progression calculated by using all CCI patients is 5.7%. The progression rate in TTSH inpatients is 5.9 times higher than the baseline CCI progression.

Table 1 – CCI risk category distribution for new admitters (%)

Unknown (0)	Low (1-3)	Medium (4-5)	High (6-7)	Very high (8+)
65.7	12.5	11.7	6.1	4.0

Table 2 – CCI progression transition probabilities for re-admitters

	Second year					
First year	Unknown (0)	Low (1-3)	Medium (4-5)	High (6-7)	Very high (8+)	Death
Unknown (0)	39.6	14.0	17.0	10.4	3.8	15.2
Low (1-3)	0.0	52.7	26.6	6.5	3.5	10.7
Medium (4-5)	0.0	0.0	47.6	25.0	10.5	16.9
High (6-7)	0.0	0.0	0.0	52.4	25.9	21.7
Very high (8+)	0.0	0.0	0.0	0.0	69.8	30.2

Table 3 shows the CCI risk category distribution by outcome. The unknown group has slightly higher mortality than the low risk group, because acute cause of death is not included in CCI.

Table 3 – CCI risk distribution by outcomes (%)

Risk Category	Discharged	Re-admission	Death
Unknown (0)	80.4	13.7	5.9
Low (1-3)	71.4	23.4	5.3
Medium (4-5)	52.4	35.2	12.4
High (6-7)	41.4	39.0	19.6
Very high (8+)	30.8	38.6	30.6

CONCLUSION

The patient flow Markov model reflects the CCI risk category distribution and progression in 1 year. The distribution and transition probabilities can be used in more accurate volume projection.

PROJECTS

ORGANISATION & DELIVERY OF SERVICES

STEPPING OUT – THE COMMUNITY HEALTH ENGAGEMENT PROGRAM

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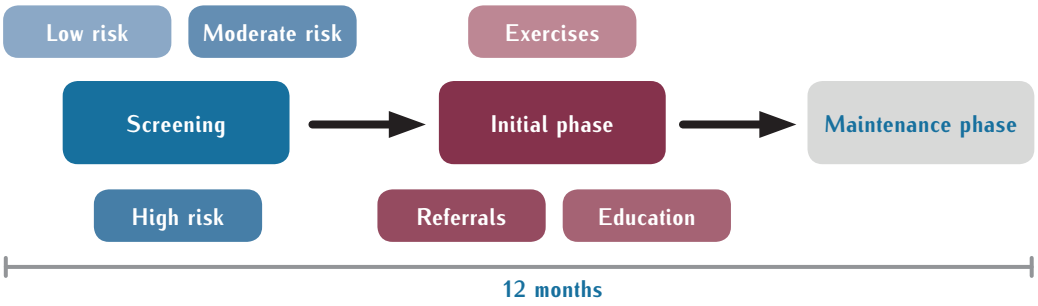
BACKGROUND

In the hospital setting, programs and safety standards have been put in place to prevent falls among patients. The elderly in the community are equally at risk of falls and thus require preventive interventions as well. The aim of this evaluation was to assess the effectiveness of the Stepping Out program in preventing falls, improving overall physical performance, general health, well-being and falls efficacy, as well as reducing falls-related health service utilisation.

METHODS

Stepping Out was a 52-week program for elderly residents of 1-2 room Housing and Development Board (HDB) flats. Participants were assigned to the appropriate intervention based on an assessment of falls risk. Interventions included physical exercises, education, referrals to healthcare providers as necessary, as well as to community partners. The initial 3-month phase was supervised by nurses and physical therapists. This was followed by a 9 month maintenance phase, during which supervision of exercises were handed over to community volunteers. The program was implemented one block at a time.

Figure 1 – Components of the Stepping Out Program

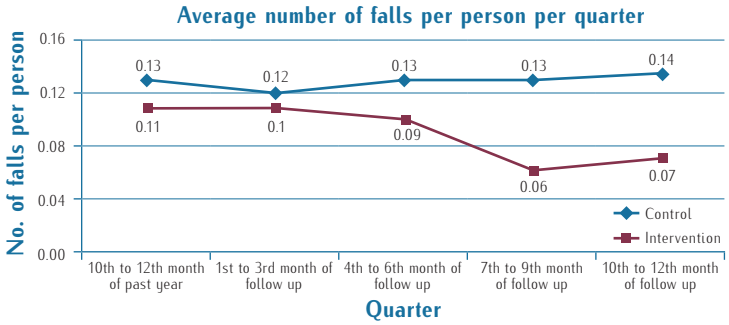


The evaluation utilised a prospective cohort design. From the third year of implementation, eligible participants were invited to join the program at least one year before receiving the intervention, during which data collected for that "baseline" year served as control data. Intervention data came from participants who were already receiving the intervention during a given year. Hence, the "exposed" group consisted of program participants already receiving the intervention, whilst controls comprised those who were invited to participate but who had yet to receive the intervention the following year. Outcomes were monitored annually until project completion on the fifth year.

RESULTS

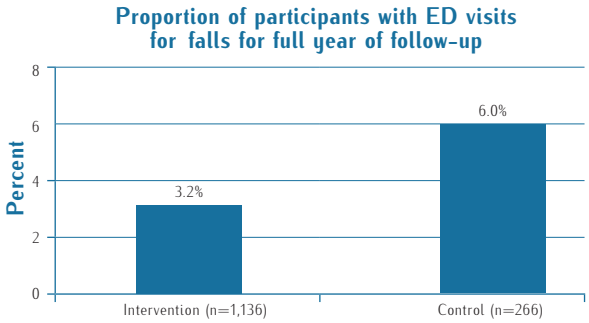
A total of 1,927 records were included in the analysis, 1,641 of which were from participants who received the intervention and 286 from participants who went through the 1-year pre-intervention (control) phase. Intervention participants had significantly better results for all physical performance and questionnaire-based assessments except the timed-up-and-go test. For the EQ-5D, results were significantly better for the intervention group in the domains of general health and usual activities. There was no significant difference in the 4 other domains. There was a significant improvement in Safety Assessment of Function and the Environment for Rehabilitation (Safer) score on follow-up for the intervention group. From baseline through the end of follow-up, point estimates for average number of falls per person were higher for controls. The difference increased from the 2nd to the 4th quarter of follow-up (Figure 2).

Figure 2 – Number of falls per person



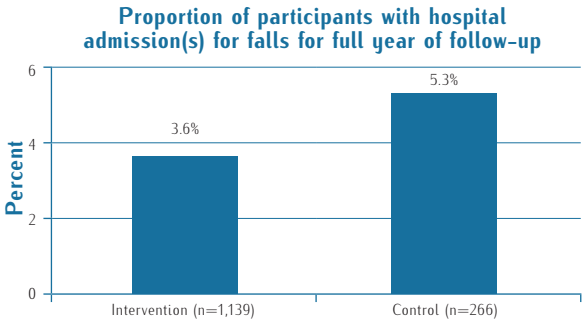
After adjusting for demographics, baseline fall history and fall risk, baseline physical, and other questionnaire-based assessments, participants in the intervention group had significantly fewer falls during the follow-up year compared to controls (OR=0.832; 95%CI = 0.724, 0.957). While the proportion of participants with ED visits was significantly lower for the intervention group, there was no significant difference in the proportion with hospital admissions for falls (Figure 3).

Figure 3 – Proportion of participants with ED visits and hospital admissions for falls



Odds Ratio for ED visits for falls	95% CI of OR
0.511	0.279, 0.936*

*Significant OR



Odds Ratio for admission for falls	95% CI of OR
0.672	0.361, 1.252

CONCLUSION

Results suggested that the Stepping Out program improved physical performance and reduced the incidence of falls in the elderly. Furthermore, it demonstrated that with adequate training, volunteers from the community may be equipped to take on a greater role in preventing falls among the elderly.

EFFECTIVENESS OF A HOME-BASED PAEDIATRIC PALLIATIVE CARE PROGRAM

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BACKGROUND

In Singapore, HCA Hospice Care has been providing a home-based paediatric palliative care service since 2012 through its Star PALS program. Services include pain and other symptom management, caregiver training, psychosocial and emotional support, respite for caregivers, equipment loans, allied health services, care coordination, advance care planning, end of life care at home, as well as bereavement care. The objectives of this program evaluation were to determine if there had been a difference between Star PALS patients and those who received standard care up to 1 year before death. Outcomes measured were time spent at home, unplanned utilisation, initiation of Advance Care Plan (ACP), quality of life and care giver burden.

METHODS

Objectives 1 and 2 (proportion of time spent at home, number of unplanned admissions, and proportion with Advance Care Plan): Using a retrospective cohort design, outcomes were compared between Star PALS patients who died and patients who were not enrolled in Star PALS who likewise died. Data on outcomes were collected up to 1-year prior to death. **Objective 3 (HRQOL and caregiver burden):** The evaluation was a single group study with assessments conducted prospectively at 0, 3, 6 and 12 months from enrolment. HRQOL and caregiver burden were assessed using the Health Utilities Index (HUI) and Zarit Burden Interview (ZBI) respectively.

RESULTS

Objective 1 (number of unplanned admissions and emergency department visits, and proportion of time spent at home):
There were 71 Star PALS patients and 67 controls included in this component of the evaluation. Star PALS patients were older (12.2 vs. 6.3 years) and had fewer non-Singapore residents (50.7% vs. 86.6%). Males comprised 63.4% of the Star PALS group vs. 61.2% for the controls. Among patients who had at least 1 year of observation before death, Star PALS patients had significantly fewer admissions (4.5 vs. 6.9). Star PALS patients likewise had significantly fewer hospital days in the year before death (40.8 vs. 93.1). Star PALS patients had significantly fewer admissions during the second and third quarters before death (Table 1).

Table 1. Quarter-specific number of admissions for Star PALS patients and controls

Quarter before death	Star PALS N	Star PALS Mean (sd)	Control N	Control Mean (sd)	Mean difference (95% CI)
First	69	1.49 (1.74)	57	1.28 (1.21)	-0.21 (-0.75, 0.34)
Second	68	1.12 (1.44)	51	1.92 (2.24)	0.80 (0.09, 1.52)*
Third	68	1.00 (1.46)	46	2.13 (2.46)	1.13 (0.33, 1.93)*
Fourth	68	0.87 (1.68)	42	0.98 (1.68)	0.11 (-0.55, 0.76)

*Significantly lower for Star PALS patients

There was no significant difference in the number of ED visits for the full year before death. However, during the quarter immediately before death, Star PALS patients had significantly fewer ED visits than controls. The proportion of time spent at home during the last year of life was significantly greater for Star PALS patients (Table 2).

Table 2. Proportion of time spent at home during the last year of life

Star PALS N	Star PALS Mean (sd)	Control N	Control Mean (sd)	Mean difference (95% CI)
68	0.89(0.14)	42	0.74 (0.21)	-0.15 (-0.21, -0.08)*

*Star PALS patients spent a significantly greater proportion of the last year at home

Objective 2 (Advance Care Plan):
A significantly greater proportion of Star PALS patients had a documented ACP or had a discussion about ACP with their healthcare provider. Among those with a full year of follow-up, 92.6% and 69.6% of Star PALS patients and controls, respectively discussed or had a documented ACP (OR=5.51; 95%CI = 1.55, 19.67).

Objective 3 (Caregiver burden and HRQOL):

Caregiver burden:
At baseline, 14% of respondents had little to mild burden. Three and six months later, the proportion with little to mild burden increased to over 23%. None of the respondents had little to mild burden at 12 months (however only 7 respondents were assessed at the end of 12 months).

Quality of life:
Though no tests of significance was conducted, results suggested a greater proportion of patients with more severe levels of sensation, mobility, cognition and self-care (based on HUI2) and vision, speech, ambulation, dexterity and cognition (based on HUI3) on follow-up compared to baseline. Though not statistically significant, results suggested a greater proportion with improved emotion and reduced pain on follow-up. The proportion who were free of pain and discomfort was significantly greater at 3 months compared with baseline (OR=2.58, 95%CI=1.12, 5.95).

CONCLUSIONS

Star PALS patients had significantly fewer admissions and cumulative hospital days during their last year than controls, spending a greater proportion of their final year at home. More Star PALS patients discussed or had an advance care plan. Caregivers of Star PALS patients had a reduction in caregiver burden for up to six months. Some HUI attributes may reflect the progressive course of the patients' illnesses, as well as of specific outcomes (pain and emotion) for which Star PALS interventions may have favourable effects.

PREDICTING 72-HOUR RE-ATTENDANCE AMONG CHRONIC OBSTRUCTIVE PULMONARY DISEASE PATIENTS AT THE EMERGENCY DEPARTMENT

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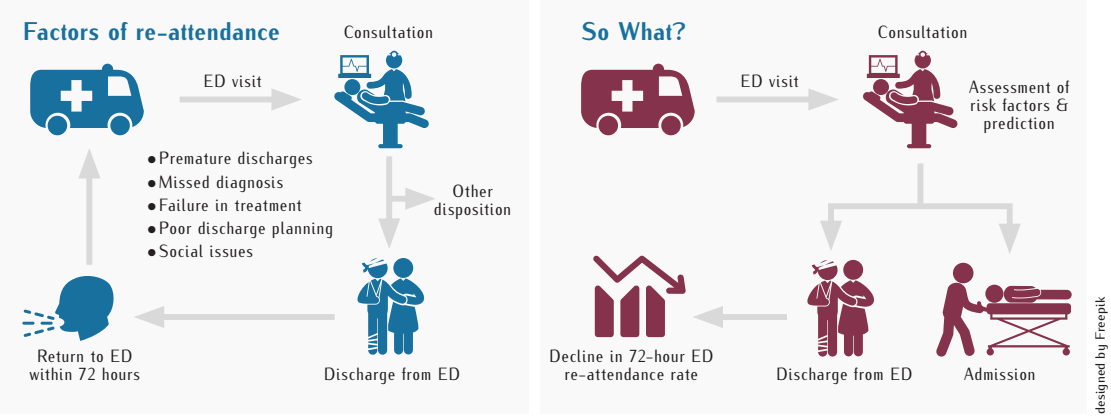
BACKGROUND

Emergency department (ED) re-attendance is an important quality of care indicator reported to the Ministry of Health. ED re-attendance rate above 5% may suggest poor quality of care. Chronic Obstructive Pulmonary Disease (COPD) is a major cause of morbidity and mortality that often leads to high utilisation at the ED. The objective of this study was to develop a model to predict 72-hour re-attendance at the ED among COPD patients (Figure 1).

Figure 1 – Predicting 72-hour re-attendance at ED

METHODS



All Tan Tock Seng Hospital (TTSH) ED encounters by COPD patients discharged without hospitalisation in 2011 to 2012 were used for model derivation. The model was prospectively validated using 2013's dataset. Variables considered were demographics, patient acuity categories (PAC), primary diagnosis, social issues, vital signs and lab tests. Logistic regression adjusted for significant factors ($p<0.01$) and clustering effect was conducted to develop the model. Receiver operating characteristic (ROC) curves was applied to assess the discrimination power of the model.

RESULTS

Of 3,869 ED encounters among COPD patients, 28% resulted in re-attendance at the ED within 72 hours. Age, race, COPD-related diagnoses, neurotic disorder, social issues and PAC 1 status were the most predictive factors for ED re-attendance (Table 1). C-statistics of the ROC curve was 0.85, while sensitivity and specificity of the model were 61.7% and 91.9% respectively (risk score=0.5) (Table 2). Applying the developed model to the validation set demonstrated good discriminative power (ROC=0.81) (Figure 2).

Table 1 – Risk factors in the final predictive model

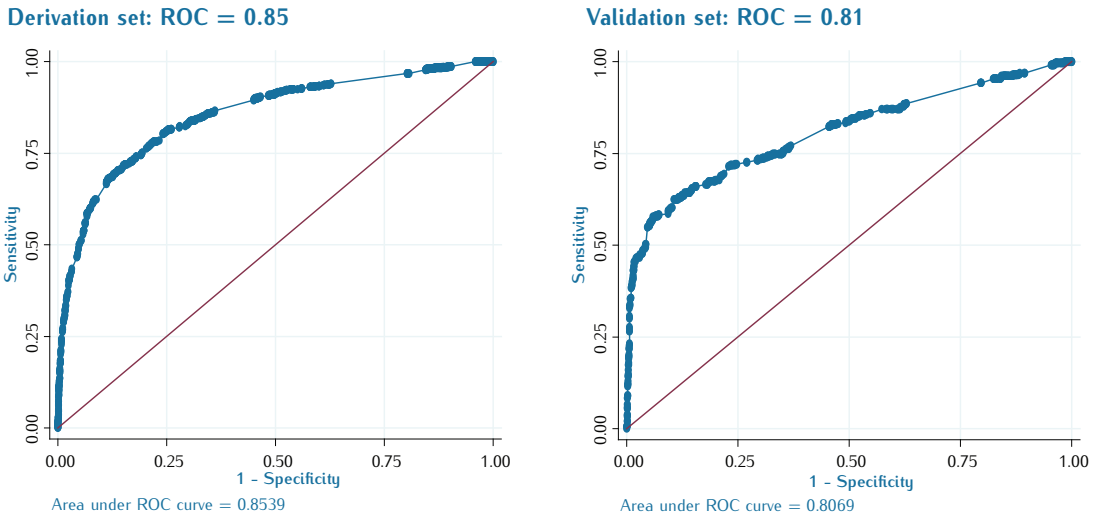
Variables	Odds ratio	95% CI
Age		
40 – 54	5.43	4.22 - 6.98
65 – 74	3.17	2.55 - 3.94
Race		
Chinese	3.41	2.68 - 4.33
Primary diagnosis		
COPD	2.61	2.05 - 3.33
Mental health disorder	5.00	2.18 - 11.45
Falls/ Functional Decline	3.80	1.86 - 7.77
PAC status		
PAC 1	2.12	1.69 - 2.66
PAC 3	0.08	0.03 - 0.22
Social issue	6.31	4.11 - 9.70
At least one handover	2.03	1.50 - 2.75
Normal potassium level	0.32	0.17 - 0.61
Temperature range	2.72	2.18 - 3.39

CI – Confidence interval

Table 2 – Model derivation and validation results

	Derivation set (N=3,869)	Validation set (N=1,933)
70% cutoff		
Sensitivity	33.2%	43.1%
Specificity	98.2%	98.6%
50% cutoff		
Sensitivity	61.7%	58.3%
Specificity	91.9%	92.9%
30% cutoff		
Sensitivity	76.8%	66.6%
Specificity	79.2%	81.9%

Figure 2 – C-statistics of ROC curve



CONCLUSION

Patients with COPD commonly attend ED. We have developed a model that identified high-risk characteristics of ED re-attendance within 72 hours. COPD patients with history of social issues, mental health and COPD exacerbation were high risk factors of re-attendance. The model demonstrated good calibration performance on the validation set. This model could potentially assist emergency physicians with appropriate disposition, reducing the risk of emergency re-attendance among COPD patients.

DEMENTIA CARE IN PRIMARY CARE – EFFECTIVENESS IN COMPARISON TO SPECIALIST AND ROUTINE CARE (INTERIM RESULTS)

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BACKGROUND

Dementia care in Singapore is predominantly provided in tertiary care. In 2012, a Primary Care Dementia Clinic (PCDC) was set up in Ang Mo Kio polyclinic to treat and manage stable dementia patients in primary care.

This study assessed if dementia patients followed-up at PCDC will (i) receive similar quality of care as those followed-up at Memory Clinic (MC) in TTSH; and (ii) receive better quality of care as those followed-up at Other Polyclinics (Others) with routine primary care.

METHODS

A quasi-experimental study, where dementia patient-caregiver dyads followed-up at PCDC, MC, and Other Polyclinics were recruited from September 2012 to May 2015. Quality of life (Quality of Life-Alzheimer's Disease, QOL-AD), adverse events (falls, hospital admissions, and emergency department (ED) attendances), and caregiver satisfaction (five domains – results communicated appropriately; appropriateness of diagnostic information; attitude of clinicians; information and advice to relatives; and usefulness of assessment), were measured at 1-year.

RESULTS

A total of 131 patient-caregiver dyads (PCDC – 45; MC – 63; Others – 23) completed the 1-year follow-up. The PCDC and MC groups were comparable in QOL-AD scores, number of falls, hospital admissions, ED attendances, and caregiver satisfaction at 1-year (Table 1 & 2). In comparing PCDC and Other Polyclinics, there were no differences in QOL-AD scores and adverse events (Table 1). However, PCDC received significantly better caregiver satisfaction than Other Polyclinics (Table 2).

Table 1 – Quality of Life & Adverse Events

Outcomes	Coef./IRR	Std. Err.	p value	95% Confidence interval	
PCDC vs. MC [MC]					
QOL-AD°	-1.68	1.03	0.11	-3.73	0.37
Adverse events#					
No. of falls	1.15	0.45	0.72	0.54	2.49
No. of hospital admissions	0.91	0.53	0.88	0.29	2.88
No. of ED attendances	1.21	1.34	0.87	0.14	10.69
PCDC vs. Others [Others]					
QOL-AD°	0.82	1.51	0.59	-2.20	3.84
Adverse events#					
No. of falls	0.67	0.62	0.67	0.11	4.09
No. of hospital admissions	0.65	0.42	0.50	0.18	2.30
No. of ED attendances	0.38	0.41	0.37	0.05	3.12

[ ] Reference group
IRR – Incidence Rate Ratio
°Ordinary Least Square regression
#Zero-inflated Poisson regression
Adjusted for: Age, gender, agitation/aggression, CDR Global, total comorbidities, Barthel

Table 2 – Sample questions from the 28-item Caregiver satisfaction questionnaire (% agreed)

Item	PCDC	MC	Others	p value PCDC vs. MC	p value PCDC vs. Others
Domain 1 – Results communicated appropriately					
Purpose of investigations clearly explained	95.6%	85.5%	60.9%	0.07	<0.001
Doctor explained purposes of prescribed medications	95.6%	98.3%	69.6%	0.54	<0.001
Domain 2 – Appropriateness of diagnostic information					
Doctor told me all I wanted to know about the illness	93.2%	93.5%	47.8%	0.83	<0.001
Course of disease explained in such a way that I know what to expect	90.9%	87.1%	52.2%	0.52	<0.001
Domain 3 – Attitude of clinicians					
I felt enough time was spent with me	95.6%	93.5%	69.6%	0.64	<0.001
Doctor looked into all concerns I expressed	97.8%	90.2%	69.6%	0.10	<0.001
Domain 4 – Information and advice to relatives					
Doctor asked about how I was coping with the stress of caregiving	75.0%	72.6%	17.4%	0.82	<0.001
After talking to the doctor, I know how to deal with the patient's illness	84.4%	88.7%	34.8%	0.45	<0.001
Domain 5 – Usefulness of the assessment					
Visiting the MC/PCDC/Polyclinic was accessible	93.3%	88.7%	73.9%	0.48	0.03
Satisfied with waiting time at MC/PCDC/Polyclinic	71.1%	77.4%	43.5%	0.48	0.02

CONCLUSION

PCDC provided similar quality of care as specialist care in the MC, in terms of quality of life, adverse events, and caregiver satisfaction. While there were no differences in quality of life and adverse events between PCDC and Other Polyclinics, PCDC attained greater caregiver satisfaction. This supports the importance of management of dementia in primary care, as quick access would allow for prompt treatment.

NEEDS OF PATIENTS IN THE VIRTUAL HOSPITAL PROGRAMME (PHASE 1 – QUALITATIVE)

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BACKGROUND

There is a group of patients frequenting the hospital's emergency department. These patients often have chronic diseases and problems coping in their communities, and a more comprehensive service that targets these problems would better serve these patients. As a step to building up this service, we embarked on a survey of their needs – needs that enable these patients to thrive and manage their conditions in their natural surroundings.

METHODS

There were 2 phases to this study. Phase 1 focused on the type of needs and their relationships of the patients as expressed by the service providers and patients. Phase 2 built upon the needs expressed in Phase 1 and aims to quantify the extent of each need in the patient population. In Phase 1, we face-to-face interviewed the service providers and patients to find out their perceptions relating to the needs of the patients to gain an all-rounded understanding of how needs were being perceived.

The interviews were conducted till saturation, operationally defined as no new themes for three consecutive interviews. The interviews were then coded. Interviews with the service providers focused on their roles in the care of the patient and how services fulfilled specific needs of the patient. We also explored the perceptions of gaps in services within the organisation of the service provider and in general. Interviews with the patients focused on their routines (e.g. eating, self-care, going to the market etc.). Through these routines, we explored the challenges faced by the patients in carrying these routines out and the strategies that used to overcome these challenges. We also explored the relationship between their abilities to overcome these challenges with their health related behaviours.

RESULTS

Altogether, 22 service providers and 9 patients were interviewed. Service providers comprised staff from Tan Tock Seng Hospital and their community partners. The service providers included doctors, pharmacists, social workers, physiotherapists, occupational therapists and administrators. Patients were selected from a pool of patients who had 3 or more hospital admissions. All the patients have some chronic diseases.

Four main themes were uncovered: "patient education, health literacy and behaviours", "access to services", "social support" and "functional status". We will focus on the theme "patient education, health literacy and behaviours". This theme explored the relationship between three closely linked concepts. Patient education is a process in which the service providers use to convey certain precautions and instructions to the patients. A wide variety of services rely on good patient education. This includes medication management, falls prevention, energy conservation, symptoms and anxiety management. This suggested that patients assume significant responsibilities in managing their conditions through information gained via education.

Through the interviews, we found that patient education was not a "one-size fits all" process, and different levels of contextualisation need to be done to cater to the unique needs of the patient. Not all patients are receptive towards the education. This can happen for a number of reasons, and often shows up in the form of patients not reading the educational materials or not remembering things that were being taught.

Even when patients remember what was taught, it does not always translate to health literacy. This retention of knowledge can be improved with subsequent reinforcements through the patient's social circles or repeated education. However, even with good retention of this knowledge, it does not automatically translate into better health behaviours. Adhering to good health behaviours requires patients to either form new habits or overcome ingrained habits, both of which are difficult to achieve in practice.

These three concepts, patient education, health literacy and behaviours, suggest a chain of events are necessary to effect a change in a patient's behaviour. There are challenges associated with each step that must be resolved, taking into account the unique contexts that the patient experiences in his/her natural environment. This theme highlights the challenges involved.

For patients, we uncovered seven themes in our interviews: "outlook", "preferences", "financial support", "social support", "continuity of care", "medical" and "health behaviours". We will focus on the theme "continuity of care". Continuity of care can be viewed as a construct with three unique dimensions: "person", "service" and "time". The "person" dimension refers to having the same person attending to the patient across episodes of care. This was highlighted as an important aspect of continuity of care as many patient preferences are only known to a clinician who has been closely involved in the care of the patient. In the absence of this clinician, the patient either has to rehash all of his/her preferences to the attending clinician, or choose to forgo having his/her preferences respected. Both of these options pose significant anxiety and discomfort.

Continuity of care in the "service" dimension refers to having the same institution managing the care of the patient. Having the same institution implies familiar practices and faces, both of which alleviates anxiety levels. There are instances where being admitted to a different institution was not by choice but by circumstances due to prevailing ambulance practices. Aside from this, continuity can also be broken when patients are handed off to community partners for management and the transition is not always smooth.

Continuity of care in the "time" dimension refers to continued access to services at all times. Exacerbation of patient's conditions can be unpredictable and for some cases, it can be managed either by the patient with instructions from a healthcare provider or a visit by the healthcare provider. This leads to the need of a reachable healthcare provider at various times of the day. Difficulty in finding a healthcare provider during certain hours suggests a genuine break in the continuity of care.

Continuity of care across the various dimensions is a concern to the patients and achieving good continuity can provide for a less stressful experience during a time of crisis for the patients.

CONCLUSION

There were several insights gained from the interviews with the service providers and the patients. Firstly, we gained a better understanding of the challenges to equipping our patients with the necessary skills and knowledge to manage their conditions better. There are numerous barriers that we have to consider removing to better prepare our patients to cope in the community. Secondly, the continuity of care issues suggested that patients do need support especially in times of crisis in the community. Ensuring that they get the help they need at the place and time of need will be a continuing challenge that needs to be overcome.

NEEDS OF PATIENTS IN THE VIRTUAL HOSPITAL PROGRAMME (PHASE 2 – QUANTITATIVE)

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[2] Tan Tock Seng Hospital, Respiratory and Critical Care Department

BACKGROUND

In 2013, Tan Tock Seng Hospital (TTSH) launched the Virtual Hospital (VH) Programme to provide post-discharge medical and social support for patients who have had 3 or more hospital admissions in a year. For each patient enrolled in the programme, a comprehensive and customised care plan to provide a basket of services is provided to help patients better manage their health.

The aim of this study is to identify the needs of VH patients, and to determine if existing basket of services offered in the VH programme is adequate, or if there are other services that patients may require.

METHODS

The study comprised two phases – a qualitative component of interviews, and a quantitative component of surveys. This report focuses on the quantitative phase.

This was a cross-sectional study, which utilised a survey, adapted from the Camberwell Assessment of Need for the Elderly (CANE) developed in the UK. The CANE is a comprehensive needs assessment tool suitable for use in a variety of healthcare settings (eg. primary care, nursing homes, mental health services), and consists of 24 problem areas. An additional area – Resilience, was included to determine areas of help that patients will require should they fall very ill, and if patients knew where to find help for those areas.

RESULTS

Of 236 patients contacted, 151 patients (64.0%) completed the survey. Majority of the patients reported either no need or met need across the 24 problem areas (Table 1). Among those whose needs were met, a large proportion received help from family and friends (Table 2). There was also a proportion of patients who were receiving help but reported that the help received was inadequate.

Table 1 – Distribution of needs

Need	No need		Met need		Unmet need		Not known	
	No.	%	No.	%	No.	%	No.	%
Environmental								
Accommodation	149	98.6%	2	1.3%	–	–	–	–
Looking after home	75	49.7%	71	47.0%	5	3.3%	–	–
Food	90	59.6%	61	40.4%	–	–	–	–
Money	94	62.2%	56	37.1%	1	0.7%	–	–
Benefits	102	67.5%	24	15.9%	11	7.3%	14	9.3%
Caring for someone else	151	100.0%	–	–	–	–	–	–
Physical								
Physical health	3	2.0%	148	98.0%	–	–	–	–
Drugs	99	65.6%	50	33.1%	2	1.3%	–	–
Eyesight/hearing/communication	114	75.5%	32	21.2%	4	2.6%	1	0.7%
Mobility/falls	71	47.0%	79	52.3%	1	0.7%	–	–
Self-care	126	83.4%	25	16.6%	–	–	–	–
Continence	123	81.5%	26	17.2%	2	1.3%	–	–
Psychological								
Psychological distress	139	92.1%	11	7.2%	1	0.7%	–	–
Memory	135	89.4%	13	8.6%	2	1.3%	1	0.7%
Behaviour	151	100.0%	–	–	–	–	–	–
Alcohol	151	100.0%	–	–	–	–	–	–
Deliberate self-harm	143	94.6%	5	3.4%	3	2.0%	–	–
Inadvertent self-harm	148	98.0%	3	2.0%	–	–	–	–
Psychotic symptoms	145	96.0%	6	4.0%	–	–	–	–
Social								
Company	123	81.4%	15	9.9%	9	6.0%	4	2.7%
Intimate relationships	129	85.5%	18	11.9%	4	2.6%	–	–
Daytime activities	120	79.5%	27	17.9%	4	2.6%	–	–
Information	92	60.9%	48	31.8%	11	7.3%	–	–
Abuse/neglect	149	98.6%	2	1.4%	–	–	–	–

Money was the top area that patients reported requiring help in should they fall very ill. This was followed by medication, medical appointments, self-care, food and shopping, and mobility (Table 2). Again there is a high reliance on family and friends to provide the help. However, about 10% to 40% of patients do not know where to seek help for the various areas if needed.

Table 2 – Resilience: Areas requiring help if very ill, and if they knew where to find help

Areas that need help			Where to find help: Family & friends only		Services only		Family, friends & services		Don't know	
	No.	%	No.	%	No.	%	No.	%	No.	%
Money	81	53.6%	26	32.1%	18	22.2%	2	2.5%	35	43.2%
Medication	58	38.4%	43	74.2%	2	3.4%	2	3.4%	11	19.0%
Medical appointments	57	37.7%	40	70.2%	3	5.2%	1	1.8%	13	22.8%
Self-care	53	35.1%	30	56.6%	1	1.9%	2	3.8%	20	37.7%
Food & shopping	52	34.4%	38	73.1%	6	11.5%	3	5.8%	5	9.6%
Mobility	50	33.1%	32	64.0%	2	4.0%	2	4.0%	14	28.0%
Looking after home	43	28.5%	31	72.1%	5	11.6%	–	–	7	16.3%
Emotional support	40	26.5%	23	57.5%	3	7.5%	–	–	14	35.0%
Information	21	13.9%	8	38.2%	4	19.0%	2	9.5%	7	33.3%

CONCLUSION

Patients reported more environmental and physical needs, than psychological and social needs. Most needs are met through family and friends. However, some patients still feel that the help received is inadequate for their needs.

While most patients tend to turn to family and friends for help if they should fall very ill, there is a group of patients who do not know where to seek help.

The findings provide consideration for the evaluation of patients' needs on a regular basis, and to expand the support network for patients to improve resilience.

BUKIT PANJANG POLYCLINIC PROJECTION

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BACKGROUND

A new polyclinic is slated to be built in Bukit Panjang to serve the growing primary care need in the region by 2020. This study was to understand the current patient profile in Bukit Panjang, estimate potential workload of the new Bukit Panjang polyclinic, and estimate the impact on workload of nearby polyclinics.

METHODS

This study applied a three-step analysis to project the potential workload of the new Bukit Panjang polyclinic and the existing polyclinics nearby as below:

1. Baseline analysis – Provides patient profiling of relevant region and analyses historical National Healthcare Group Polyclinics (NHGP) workload trend. It also covers geographic distribution and utilisation rate analysis.
2. Workload projection of relevant region – Includes both known patient projection and unmet demand projection.
3. Market share analysis – Calculates market share redistribution and estimates impact of the new polyclinic on existing polyclinics.
4. Workload projection – Final step to project workload of Bukit Panjang polyclinic.

RESULTS

Table 1 shows the baseline analysis of patient workload in the relevant region. It was observed that the distribution of patient load was quite localised (eg. most patients living in Bukit Batok would visit Bukit Batok polyclinic (BBK) and most patients living in Choa Chu Kang would visit Choa Chu Kang polyclinic (CCK)).

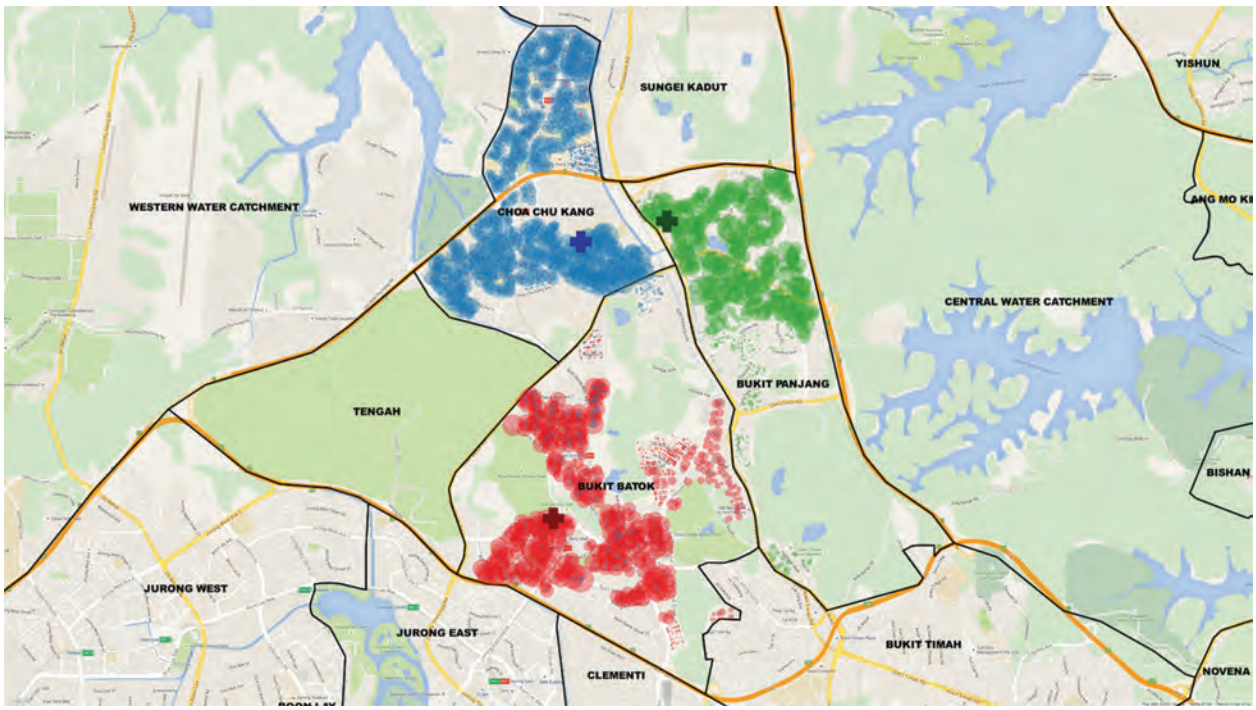
Table 1 – Baseline analysis of patient workload

Polyclinic / DGP	BBK	CCK	Other NHG Polyclinics	Total	Row % (BBK+CCK)/Total
Bukit Batok	173,653	6,187	14,893	194,733	92%
Bukit Panjang	18,285	111,474	18,802	148,561	87%
Choa Chu Kang	13,172	193,979	16,860	224,011	92%
Other DGPs	71,133	29,739	2,261,873	2,362,745	4%
Total	276,243	341,379	2,312,428	2,930,050	21%
Col % 3 DGPs/Total	74%	91%	2%	19%	

DGP – Development Guide Plan

Figure 1 illustrates the workload redistribution of the considered planning area. It was observed that the new Bukit Panjang polyclinic will have more impact on CCK due to the close location of the two polyclinics.

Figure 1 – Workload redistribution



CONCLUSION

This study helped to estimate the possible workload of a new polyclinic in the planning phase, and can be used as an analytical reference for decision makers.

LAKESIDE FAMILY MEDICINE CLINIC LOCATION ANALYSIS

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BACKGROUND

A new Family Medicine Clinic (FMC) will be set up near Lakeside MRT, to serve the growing primary care needs of patients on the Community Health Assist Scheme (CHAS) and Pioneer Generation (PG) package in the surrounding neighbourhood. This study provides some references in assessing the accessibility of Lakeside FMC and in estimating the potential clinic workload.

METHODS

Geographical catchment analysis was conducted to show the accessibility of Lakeside FMC through travel time on public transportation (bus and MRT). After this, a location analysis was performed to profile, stratify and count the potential patient load. Information provided include patient demographics, disease prevalence, number of patients with chronic or acute conditions, number of visits, number of polyclinic base patients (defined as having 2 visits for chronic conditions to the same polyclinic within 6 months), number of CHAS (blue/orange) and PG patients.

RESULTS

Figure 1 displays the map of Lakeside FMC and the surrounding planning area. A contour layer shows the duration of travelling time to Lakeside FMC for different addresses. Combined with the location of MRT stations, patients who live near MRT stations have shorter travelling time. This indicates that the traditional way of evaluating accessibility using direct distance may not reflect the actual situation. There may be an underestimation of patient load, especially when the service point can be easily accessed by MRT.

Figure 1 – Duration of travelling time to Lakeside FMC

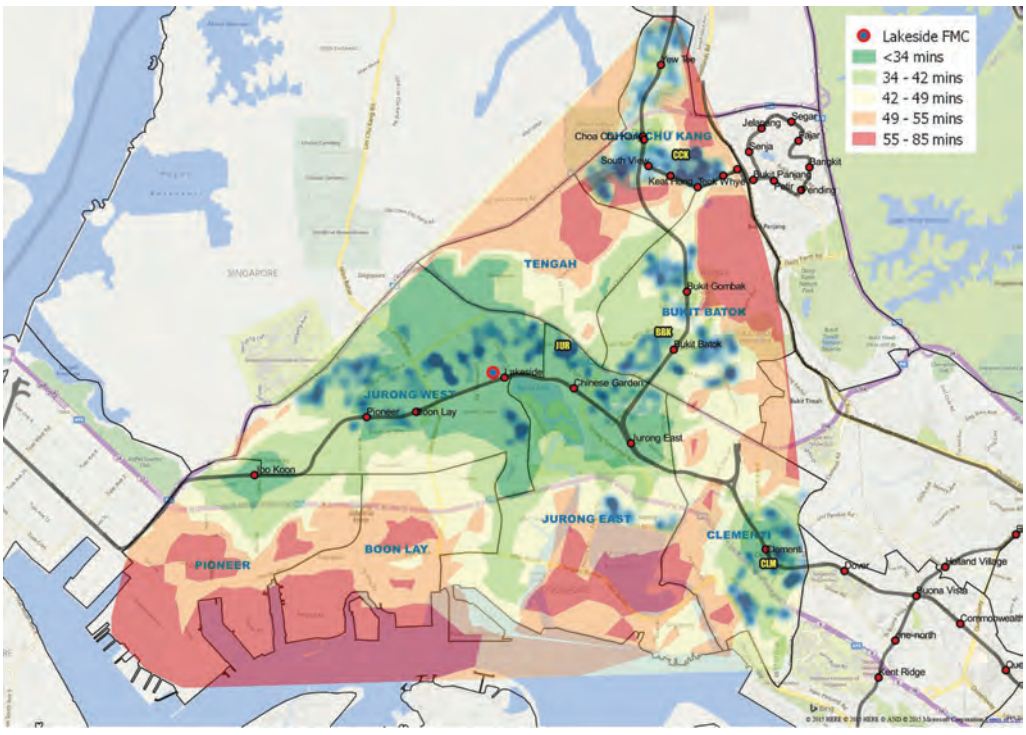

Table 1 lists the number of patients within three durations of travelling times: 15, 30 and 60 minutes. This is further stratified by certain polyclinics and base patients.

Table 1 – Number of patients stratified by duration of travelling times

Number of patients	4,171	24,863	83,832
Patients with at least 1 visit in polyclinic			
BBK	151	1,356	16,275
CCK	47	301	16,667
CLM	160	3,182	17,795
JUR	3,939	20,899	35,968
Base patients of polyclinic			
BBK	48	430	6,998
CCK	11	89	6,462
CLM	67	1,634	9,522
JUR	2,043	10,204	17,527

CONCLUSION

Such a study facilitates the estimation of potential workload for a new facility, and in evaluating the accessibility of patients living in surrounding planning areas.

TAN TOCK SENG HOSPITAL OUTPATIENT PHARMACY WORKFLOW AND DATA ANALYSIS

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BACKGROUND

Tan Tock Seng Hospital's main outpatient pharmacy sees a high workload and prescriptions profile are also highly varied, which then often leads to high waiting time. About 30%-40% of the prescriptions come from Specialist Outpatient Clinic (SOC) patients with prescriptions electronically ordered at the SOC. These are known as Medication Supply Verification (MSV) cases. The remaining 60%-70%, including refills and walk-ins, are prescriptions that are physically submitted at the B2 Pharmacy registration counters pharmacy counter. These are known as Non-MSV cases. Prescriptions and queue numbers are also divided into short and long ones.

This study examined various options to improve waiting time. One option considered was to move the Non-MSV cases to another location.

Objectives

1. To study if waiting time would improve if the Non-MSV cases were to relocate to another location,
2. To study the optimal staffing manpower ratio between backend picking of drugs and frontline dispensing for maximum efficiency

METHODS

We first studied the transaction data from the receiving of prescription order, entering the order, picking the medication, checking and finally dispensing. Data from other sources, such as manual collection by the team, was added to enrich the information. These data processing steps would serve as tools to track future improvements from various interventions.

Subsequently, a computer simulation model was developed to test out the various manpower deployment options. Using a discrete event simulation, we modelled the process from Registration, Pick-and-pack, till Dispensing. The study explored the option of relocating Non-MSV prescriptions to another site without increase in manpower.

RESULTS

Data analysis indicated that the Dispensing station had a higher waiting time than the Pick-&-Pack station and hence more attention should be placed. The data showed that the time needed for Registration, Pick-and-pack, and Dispensing had a ratio of about 1:2:4. This provided a basic manpower staffing guide, which will be adjusted dynamically with real-time queueing dashboard showing input of orders versus output of orders. The final ratio used is 1: 2: 5 to compensate the more variable dispensing time.

Second, the study tried different proportions of staffing across the long and short prescriptions. The recommendation was to be flexible in the staffing and prioritise the shorter queue where possible.

Finally, the transaction data showed that service times for Pick-&-Pack and Dispensing remained stable throughout the day. However, demand variability (inflow) was significant. As shown in Figure 1, the MSV cases came with greater peak-and-trough, i.e., greater variability, than the Non-MSV cases. If we were to split the MSV and Non-MSV cases to different locations, the results showed that 2.5 more staff at the shop floor would be

required to maintain the same waiting time. The reason was that MSV cases had higher variability and the split would lose economies of scale.

Figure 1 – Arrival patterns of MSV and Non-MSV cases

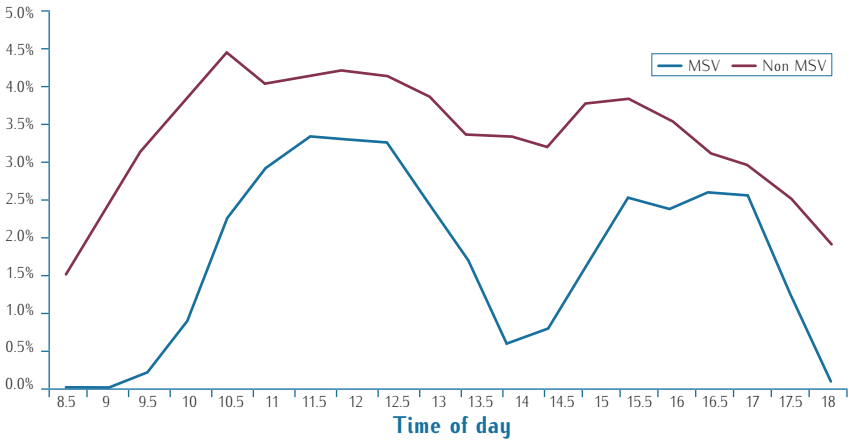
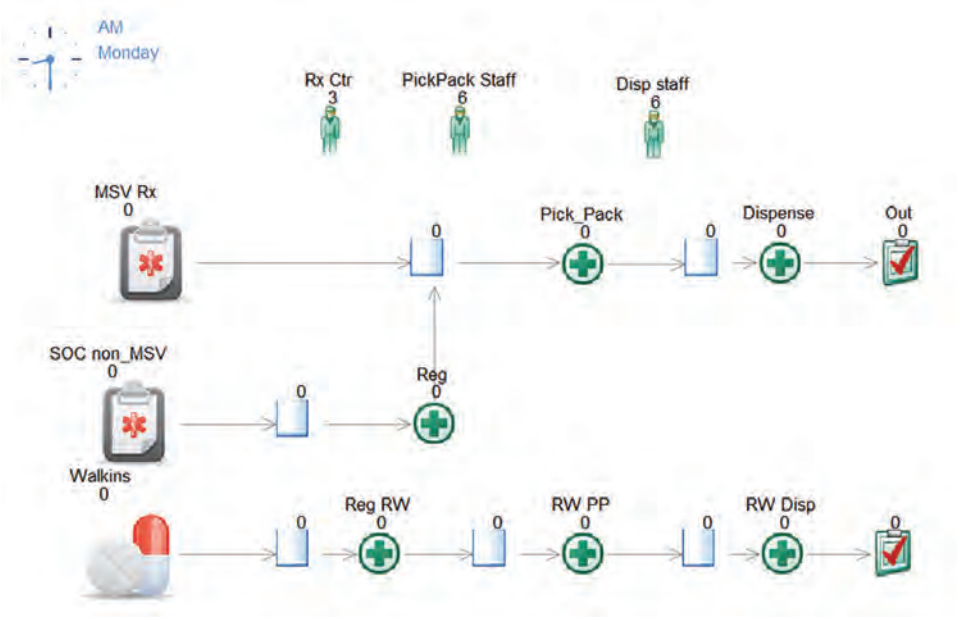


Figure 2 – Computer simulation model of pharmacy queue



CONCLUSION

The simulation model allowed one to test out options before implementation. Given the same amount of resources, splitting the patients into 2 groups would increase waiting time. This option should be considered only if there were other constraints like space and additional manpower would be available. In other words, if manpower remains constant, it will not be an efficient model to relocate the Non-MSV group to another.

The analysis provided guidelines for the floor manager to test out manpower deployment plan for the various service points. During the implementation, other constraints were discovered and the guidelines evolved, showing an example of PDCA tool being used. Follow up work included using the model to test out different resource allocations between short and long prescriptions.

EMERGENCY DEPARTMENT (ED) HIGH UTILISERS: BURDEN AND RISK FACTORS

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BACKGROUND

Frequent visits to Emergency department (ED) cause excessive strain on hospital resources. It is usually a signal of poorly managed chronic physical illness, social services issues, poorly managed mental health or substance abuse. These ED high utilisers are usually individuals whose complex physical, behavioural, and social needs are not well met through a fragmented health care system. As a result, they seek care moving from one hospital emergency department to another, from inpatient admission to readmission or institutionalisation. Evidence from literature shows that many of these ED visits is preventable through tailored intervention programmes. A deeper understanding of ED frequent visitors (FVs) could help healthcare providers identify these patients' needs and target right intervention to prevent them from becoming high utilisers. There was little evidence available in Singapore on this. In order to address the gap, this study aimed to describe the significant burden placed on the health care system from ED high utilisers; and to identify the risk factors significantly associated with the risk of being high ED utilisers.

METHODS

All patients who visited TTSH ED in 2015 were included in the study. ED high utilisers were defined as patients who had at least 5 ED visits in a year. Data were extracted from the hospital information system. Variables collected included: demographics, chronic conditions, social economic status as approximated by housing type and marital status, behavioural factors like alcohol abuse, discharge against advice or absconding. Descriptive analysis was applied to describe the burden. Kaplan-Meier analysis was applied to study the time from 1st ED visit to the time of becoming a high utiliser. Random effect logistic regression was applied to study the adjusted effect on being a high utiliser by all potential risk factors. Random intercept was added to address the individual specific effect.

RESULTS

There were about 115K patients who visited TTSH ED in 2015. Among them, 2.1% became high utilisers. They utilised 11.1% of all ED visits; 14.3% of all emergency admissions and 11.9% of total patient days. In 2015, each high utiliser had a mean of 3.1 emergency admissions, 0.3 day surgeries, 5.1 SOC visits and 7.5 ED visits. They utilised 22.7 hospital bed days, and their gross cost in TTSH in 2015 was 22,000 SGD. (Table 1)

ED high utilisers overlapped with frequent inpatient admitters, about 50.0% of all ED high utilisers became frequent admitters. By Kaplan-Meier analysis, among patients who become high utilisers, the mean time from 1st ED visit to the 5th ED visit was 5.4 months; the mean time from the 1st ED visit to the 3rd emergency admission was 3.8 months. After controlling for other covariates, the factors significantly associated with high ED utilisers were: being male, from a lower socioeconomic status, those with more chronic conditions, and patients who discharged against advice (DAA) or absconded. (Figure 1)

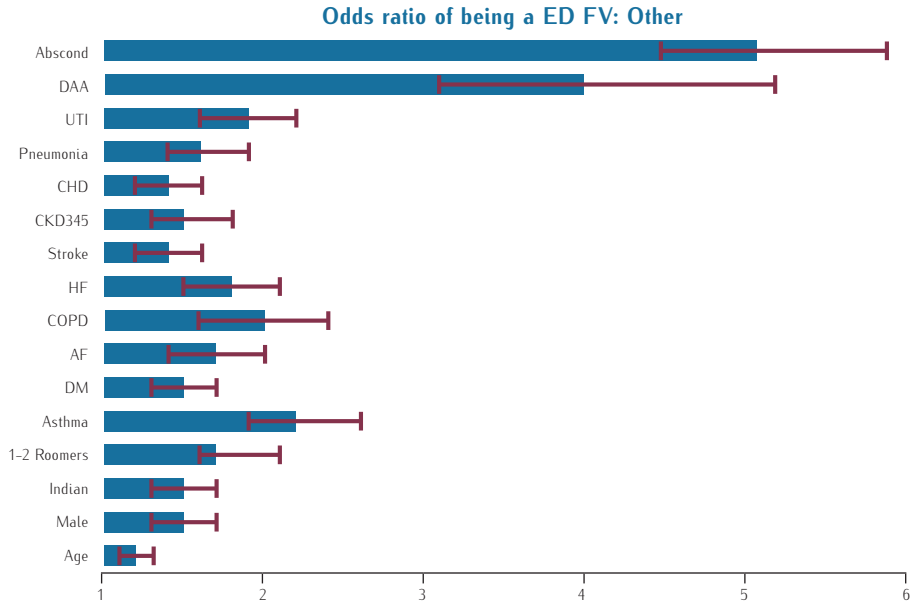
CONCLUSION

ED high utilisers' burden to healthcare system has been described and the patients' risk factors have been studied. Observations from this study are helpful on designing or targeting the right interventions for the right population. Various social, clinical, and mental intervention programmes at TTSH ED have been recommended to high risk patients to prevent them from becoming high utilisers.

Table 1 – Average and total utilisation and cost by ED high utilisers in 2015

	Average utilisation/cost		Total utilisation/cost	
	ED FVs	Others	ED FVs	Others
EM admission	3.1	0.4	7,427	43,812
Day surgery	0.3	0.1	629	13,551
SOC	5.1	1.9	12,225	210,738
ED	7.5	1.3	17,934	137,464
TLOS (patient days)	22.7	3.5	54,240	393,713
Gross cost in TTSH (S$)	22.0K	4.1K	52.5M	453.1M
Gross cost in NNJ (S$)	22.9K	4.5K	54.7M	496.0M

Figure 1 – Adjusted odds ratios and their confidence intervals for being high ED utilisers



SIMULATING OPERATIONAL IMPACT OF UNIVERSAL SCREENING FOR METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS AT THE EMERGENCY DEPARTMENT ON BED WAIT TIME FOR ADMISSION IN AN ACUTE HOSPITAL

Palvannan R.K., Teow Kiok Liang, Ethel Kan[1], Ong Poon Kin[1], Samuel Tiang[1], Dr Ooi Chee Kheong[1]
[1]Tan Tock Seng Hospital, Emergency Department

BACKGROUND

In 2011, universal screening for Methicillin-resistant Staphylococcus aureus (MRSA) colonisation and cohorting (isolation) was implemented in Tan Tock Seng Hospital (TTSH) to reduce in-hospital colonisation acquisition and infection rate. TTSH has wards that have four or more beds in each room, so active isolation is relevant.

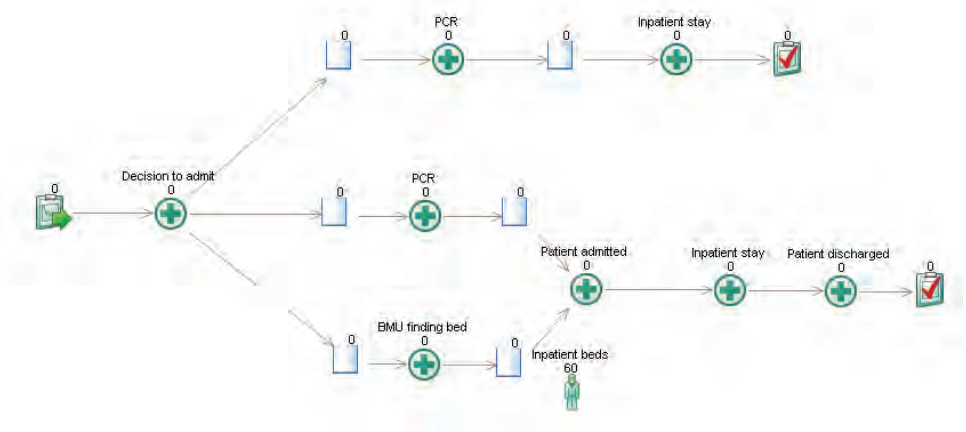
All patients including those admitted through the Emergency Department (ED) were screened for MRSA colonisation. Once the patients were admitted to the wards, swabs were taken and cultured for MRSA. The laboratory takes 24 to 48 hours to cultivate the culture and return results. If the cultures were tested positive, the colonised patients were transferred to MRSA wards, to further reduce transmission of colonisation through healthcare workers during the hospital stay.

In 2011, the mean bed wait time for admission from the ED was 2.7 hours (median=2.1 hours). There were two challenges with testing by culturing: long exposure during the 24 to 48 hours to healthcare workers, and reduced transfer to MRSA wards of colonised patients due to refusal. To address these, in 2012 rapid screening before admission was done using Polymerase Chain Reaction (PCR) method at the ED before admission. PCR takes 1.5 hours. The Bed Management Unit (BMU) looks for a suitable bed after the PCR test is complete, so bed request is done after PCR completion. It is expected that the total patient waiting time will increase by the PCR processing time when done this way, as it is a serial process. To reduce wait time, it was suggested to work in parallel ie., if BMU were to start processing the bed request, when the decision to admit is made at the same time when the PCR starts, then the impact on overall patient wait time will be less.

METHODS

We compared serial and parallel processing using Discrete Event Simulation (DES). Figure 1 is the flow model comparing the two streams. The top stream (current process) is the serial process where PCR is done followed by bed request. The bottom stream is the simulated parallel process where, while the patient is doing PCR, BMU has received and acts on the request for a bed.

Figure 1 – Comparison of serial and parallel workflows



In the model, the activity 'BMU finding bed' is modelled to require the 60 beds as resources. It is released at 'Patient discharged' node. 'Inpatient stay' is the stay in bed (mean 7 days). Both serial and parallel processes were simulated with copies of the same random stream to reduce variation in sampling.

RESULTS

Using parallel processing was a good intuitive suggestion. Seen as a fork-and-join queue and assuming the 2 random variables X (PCR) and Y (waiting time) to be concurrent activities, we arrive at the conclusion that the worst case time will be $E[MAX(X,Y)] < E(X) + E(Y)$. With X ~ Deterministic (1.5 h) and Y ~ Negative exponential (mean = 2.7 h), the worst case time will be 3.0 h which would be lesser than the series process will be 4.2 h (2.7h + 1.5h).

However, the DES results showed that the waiting time during parallel processing will be the same as serial processing (4.2 hours). This is because at steady state, the discharge time of the patient, which is the time at which the bed is available, is independent of the bed request time and PCR completion rate.

'Waiting for bed' is not a service provided that can be done with benefits of parallel processing. In communicating to a targeted audience, creating an Excel sheet with row wise entries of patients' bed request time, service and PCR time to simulate will be insightful as the discharge process will have to be simulated independently.

CONCLUSION

In theory, working in parallel will have a wait time of at least 3.0 hours. However, simulation shows that it may be as high as 4.2 hours, which is the same as serial processing. It will be interesting to have empirical results of parallel processing.

PROJECTS

HEALTH & WELFARE ECONOMICS

SEGMENTATION OF PRIMARY CARE PATIENTS BY ANNUAL COST

Palvannan, R.K.

BACKGROUND

The aim is to segment primary care patients into groups with distinct and homogeneous annual direct medical gross cost using demographic and chronic disease variables. There are 3 approaches: combinatorial counting (which is too numerous), statistical regression methods (equations with adjusted mean cost of each variable) and machine learning (decision tree). The decision tree method merges patients into groups such that group mean cost is different from one another and cost variation within each group is small. Trees are visual, intuitive to understand as segments 'can be seen' and translatable to rules.

METHOD

Using cross sectional administrative data, we identified patients (n=271,188) who had contact with 3 central region polyclinics in 2015 (Hougang, Ang Mo Kio or Toa Payoh polyclinics). Their total healthcare cost in the 3 regional hospitals (NUH, AH, TTSH) and 9 NHGP polyclinics in the same year is computed. An explanatory decision tree is built using CHAID (Chi-squared Automatic Interaction Detector) algorithm in IBM SPSS Modeler 14.0.

RESULTS

Order of variables. Figure 1 shows patient population characteristics (box) and cost segmentation. The annual mean cost per patient in 2015 is $1.33k, with significant variation (s.d. = $5.2k). It is split into 2 arms such that the difference in cost between the 2 groups is large (distinct) and the variance within groups is small (homogeneous) using F-statistic. On the right red arm are patients with heart failure with the highest annual mean cost of $10.3k and who form 1.3% (n=3,415) of the patients. On the left blue arm, are the rest of the patients without heart failure who cost $1.2k and form 98.7% of the patients. Next the patients without heart failure are divided further into 2 groups: with and without hypertension and then by those with and without Medifund history and so on.

Prevalence. All groups may have other conditions also, for example, among the 1.3% of patients with heart failure, 61% have diabetes and 92% have hypertension (not shown in chart), so the percentages are not prevalence (see box for disease prevalence). For a stark example, we see that the lipid arm shows 10.8%, while lipids prevalence is 41%, as patients with dyslipidemia are likely to be distributed among the right hypertensive arm.

General observations. Excluding heart failure patients who are serious and costly, it's insightful to note that the rest of the 98.7% patients are divided into hypertensive and non-hypertensive arms. The hypertensive arm contains the cardiovascular complications i.e. stroke, CKD 3+ and CHD. Diabetes is found below and on both sides of hypertensive/non-hypertensive arms. If we divide patients into diabetic/non-diabetic groups first it will result in a less distinct and heterogeneous group based on cost compared to hypertension. Ordering hypertension over diabetes could be counter-intuitive or a construct of the study design and method. Following hypertension, patients with a history of Medifund usage is the 3rd variable to be split, showing the importance of socio-economic needs. As we move to the left side of the tree, we see healthier segments i.e. 51% of the NHGP patients with no known chronic conditions and also note large undifferentiated segments.

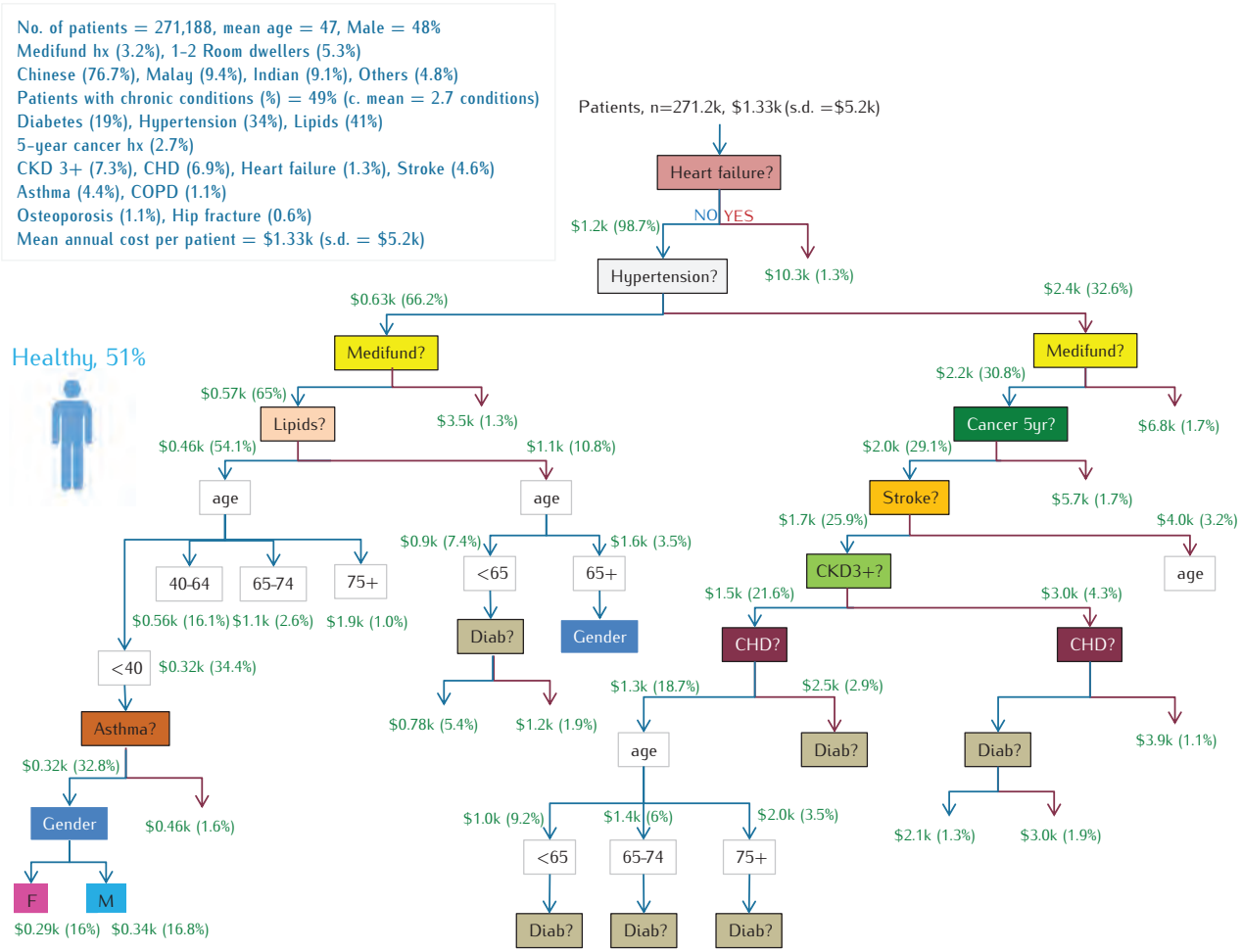
Segments. Every path to a leaf node is potentially a cost homogeneous segment of patients. The tree can be 'rolled up' depending on purpose. We can stop at identifying CKD3+ segment (4.3%, $3k) or stratify further and identify CDK3+ with CHD (1.1%, $3.9k). Granted, both groups do not have heart failure, Medifund usage history, 5-year history of cancer, or stroke but have hypertension and possibly other conditions. Note that the tree can be further elaborated with finer segments.

Disadvantages. The tree structure may change when data is changed, similar to change in regression coefficients, but more perceptible. And the mean cost is not directly comparable with the adjusted mean cost effect in the regression equation.

CONCLUSION

Segmenting patients first by hypertensive/non-hypertensive over diabetic/non-diabetic patients shows better cost homogeneity using a decision tree method. As a method, the decision trees are a visual and collapsible approach to segment patients by homogeneous cost, and a way to address combinatorial complexity of multiple diseases. It complements the familiar regression analysis and is a tool for further exploration.

Figure 1 - Segmentation of primary care patients using annual cost (2015)



BURDEN OF WET AGE RELATED MACULAR DEGENERATION AND ITS ECONOMIC IMPLICATIONS IN SINGAPORE IN THE YEAR 2030

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BACKGROUND

This study aimed to provide an estimate of the prevalence of wet age related Macular Degeneration (AMD) in Singapore in the year 2030. This projection will give healthcare administrators and policymakers an understanding of the expected number of AMD patients and will help in planning appropriate care provision and build health services capacity to cater to the increasing healthcare demand in the years to come.

METHODS

The number of AMD patients aged 40 to 79 years from all Singaporeans was estimated using prevalence rates from a local study, and using the United Nations population projections for Singapore to 2030. Age-specific mortality was accounted for. Additionally, two main scenarios were presented:

A. Projected number of wet AMD cases if the patients were not taking preventive anti-oxidant vitamins (AREDS formulation)
B. Projected number of wet AMD cases if the patients were taking preventive anti-oxidant vitamins (AREDS formulation)

Based on these scenarios, a growth model-based approach was used to estimate the economic burden. The number of QALYs gained as a result of improvement in visual acuity due to anti-VEGF treatment was also computed for the two scenarios. Additionally, since no local data was available on the progression of Categories 3 (extensive intermediate drusen, Geographic Atrophy (GA) not involving the center of the macula, or at least 1 large druse) and 4 AMD patients (advanced AMD or visual acuity less than 20/32 due to AMD in one eye) to wet AMD and on the uptake of anti-oxidant vitamins in Singapore, scenario based projections were made. The additional scenarios provided a range for the prevalence projection and associated economic burden of wet AMD to the year 2030.

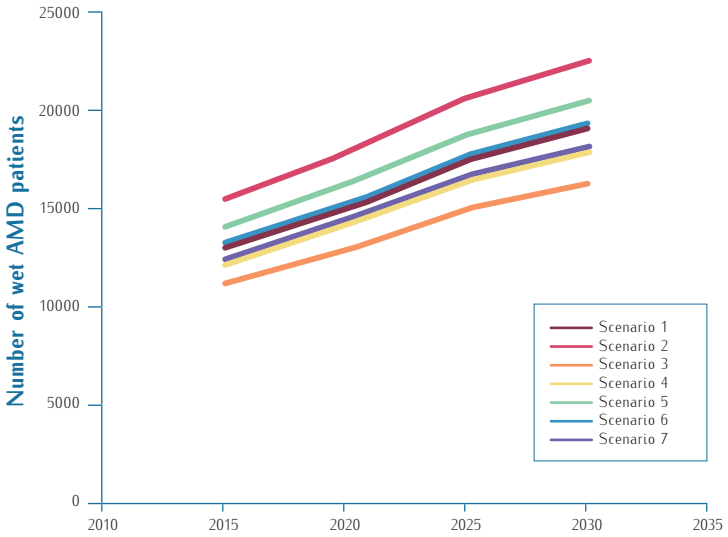
The seven additional scenarios considered were:

Scenario 1: Lower limit of progression rate (0.234), (no AREDS formulation)
Scenario 2: Upper limit of progression rate (0.296), (no AREDS formulation)
Scenario 3: Lower limit of progression rate (0.186), (with AREDS formulation)
Scenario 4: Upper limit of progression rate (0.214), (with AREDS formulation)
Scenario 5: Only 25% of the patients receive AREDS formulation
Scenario 6: Only 50% of patients receive AREDS formulation
Scenario 7: Only 75% of patients receive AREDS formulation

RESULTS

An estimated growth of 42% in the number of wet AMD cases is expected by the year 2030. The estimated economic burden of wet AMD in 2030 with scenario A and B is 203.1M SGD and 162.9M respectively. The QALYs gained as a result of improved VA from wet AMD treatment ranged from 10114.4 to 14058.8 over a 5 year period for the 2030 cohort. The projected prevalence of wet AMD based on Scenarios 1 to 7 is given in Figure 1.

Figure 1 – Projected prevalence of wet AMD patients based on Scenarios 1 to 7



CONCLUSION

The burden of wet AMD can be reduced by regular prescription of anti-oxidant vitamins and use of anti-VEGF treatment. Appropriate measures to build healthcare capacity and plan for this expected surge in patients should be a priority in Singapore.

ECONOMIC ANALYSIS OF STAR PALS PROGRAMME ON PAEDIATRIC PATIENTS AT THE END-OF-LIFE

Kelvin Teo Wee Sheng, Tan Woan Shin, Joseph Antonio D. Molina, Chong Poh Heng[1], Chan Mei Yoke[2], Koh Pei Lin[3]
[1]HCA Hospice Care
[2]KK Women's and Children's Hospital, Children's Cancer Centre
[3]National University Health System, National University Cancer Institute

BACKGROUND

The number of adult palliative end-of-life care programmes in Singapore has grown over the last decade. However, palliative care for paediatric patients has only started to receive the attention it rightfully deserves. Star PALS (Paediatric Advance Life Support) is a home-based paediatric palliative care programme implemented by HCA Hospice Care. The programme offers a variety of services to patients aged 19 years and below who suffer from life-limiting medical conditions. Our objective was to evaluate the economic impact of Star PALS programme compared to standard palliative care for paediatric patients.

METHODS

The number of AMD patients aged 40 to 79 years from all Singaporeans was estimated using The economic analysis utilised a retrospective cohort design comparing costs between Star PALS and Controls (comprised patients of National University Hospital (NUH) and KK Women's and Children's Hospital (KKH) who were eligible for Star PALS but never received home-based palliative services).

We analysed cost from the health system perspective by including costs of Star PALS services (home care, home allied health, medi-minders and programme fixed cost), length of hospitalisation, emergency department visits, and specialist and allied health visits. Per-patient costs between the two groups measured were analysed over the last 12-month, 6-month, 3-month and final month of life. Incremental costs were estimated using recycled predictions from the multivariate generalised linear model.

RESULTS

The final sample comprised 71 Star PALS cases and 67 Controls. In comparison to the Star PALS group, Controls were younger with fewer Singaporeans and more KKH patients (Table 1). Star PALS demonstrated per-patient cost savings of $175k at 12-month, $151k at 6-month, $116k at 3-month and $72k at 1-month prior to death (Table 2). The main cost savings came from fewer hospitalisations contributing 16% to 38% reduction over the final year of life (Figure 1).

Table 1 – Baseline demographic and characteristics

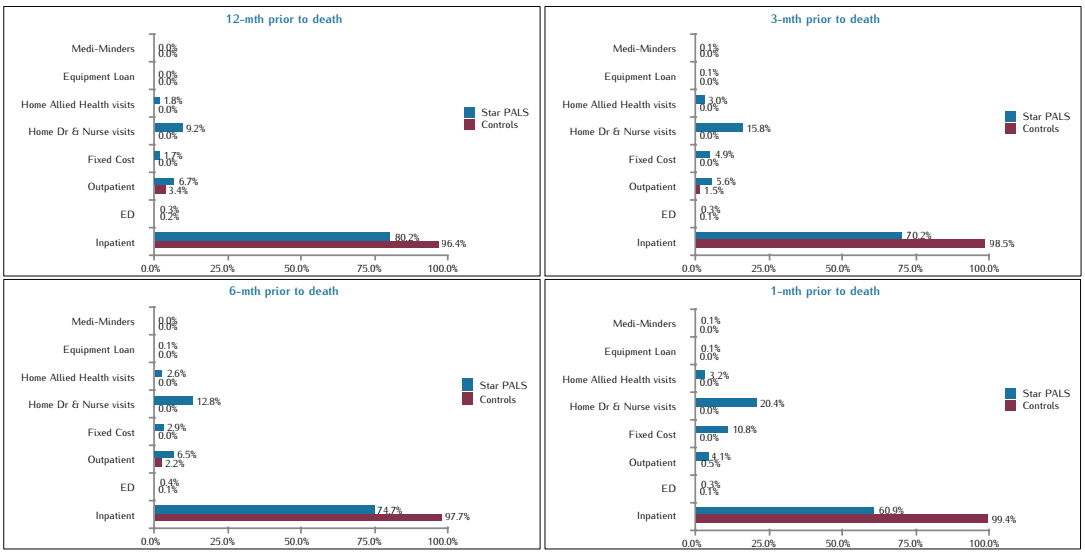
	Star PALS n = 71	Control n = 67	p value
Age at death (years)			
Mean (sd)	12.2 (6.9)	6.3 (6.3)	.000*
Gender			.079
Male, no. (%)	45 (63.4)	41 (61.2)	
Female, no. (%)	26 (36.6)	26 (38.8)	
Ethnicity			.037*
Chinese, no. (%)	41 (58.6)	35 (52.2)	
Malay, no. (%)	24 (34.3)	16 (23.9)	
Indian, no. (%)	2 (2.9)	3 (4.5)	
Others, no. (%)	3 (4.3)	13 (19.4)	
Residency Status			.000*
Singapore Resident, no. (%)	35 (49.3)	9 (13.4)	
Non-Resident, no. (%)	36 (50.7)	58 (86.6)	
Referral Source			.011*
KKH, no. (%)	34 (47.9)	44 (65.7)	
NUH, no. (%)	30 (42.3)	23 (34.3)	
Others, no. (%)	7 (9.9)	0 (0.0)	
Cause of Death			.698
Neoplasms, no. (%)	32 (45.1)	28 (41.8)	
Others, no. (%)	39 (54.9)	39 (58.2)	

Table 2 – Multivariate analysis of direct healthcare cost: Star PALS vs. Control group

Months prior to death	Rate ratio (CI)	Mean incremental cost
12-month	0.30 (0.20, 0.45)*	-$175k (-$186k, -$164k)
6-month	0.22 (0.16, 0.33)*	-$151k (-$159k, -$143k)
3-month	0.18 (0.13, 0.25)*	-$116k (-$121k, -$111k)
1-month	0.13 (0.09, 0.18)*	-$ 72k (-$ 76k, -$ 69k)

Reference group: Control
Adjusted for: Age at death, ethnicity, residency status & referral source

Figure 1 – Cost proportions between Star PALS and Controls



CONCLUSION

This study demonstrated substantial savings associated with a paediatric end-of-life programme. Given that families increasingly wish to bring their children home at the end-of-life, our study sheds light on the impact of a palliative care programme on the health system. These results could assist policymakers and healthcare providers in their decision-making on the allocation of healthcare resources.

PROJECTS

RESEARCH DESIGN & METHODOLOGIES

VIRTUAL REALITY ENVIRONMENTS FOR HEALTHCARE PROFESSIONAL EDUCATION

Dr Nakul Saxena, Dr Bhone M Kyaw[1], Dr Jitka Vseteckova[2], Dr Charoula K Nikolaou[1], Dr Pradeep Paul George, Kenneth Teck Kiat Lim, Dr Parvati Dev[3], Dr Andrzej Kononowicz[4], Dr Italo Masiello[4], Dr Lorainne Tudor Car[5], Dr Nabil Zary[4], Prof Josip Car[1,5]

[1] Nanyang Technological University, Lee Kong Chian School of Medicine, Health Services and Outcomes Research Programme

[2] The Open University, United Kingdom

[3] Innovation in Learning Inc., California, United States of America

[4] Karolinska Institutet, Department of Clinical Science and Education, Sweden

[5] Imperial College London, School of Public Health, London

BACKGROUND

Adequately trained healthcare professionals (HCPs) are essential to ensure uniform access to health services and to achieve universal health coverage. In 2013, the World Health Organisation (WHO) estimated a shortage of approximately 7.2 million healthcare professionals worldwide, and this shortage is expected to reach 12.9 million by 2035. It has therefore become essential to focus effort and resources on developing and implementing strategies that can lead to an increase in both the number of health care workers and the quality and relevance of their training.

Virtual Reality Environments (VREs) are simulated counterparts of a real world that can help users experience situations that would normally be difficult in the real world. VREs help in gaining practical knowledge and experience in a simulated environment. This review aimed to assess the gain in knowledge, improvement in skills, and the participants' attitude toward and satisfaction with VRE-based e-Learning interventions.

METHODS

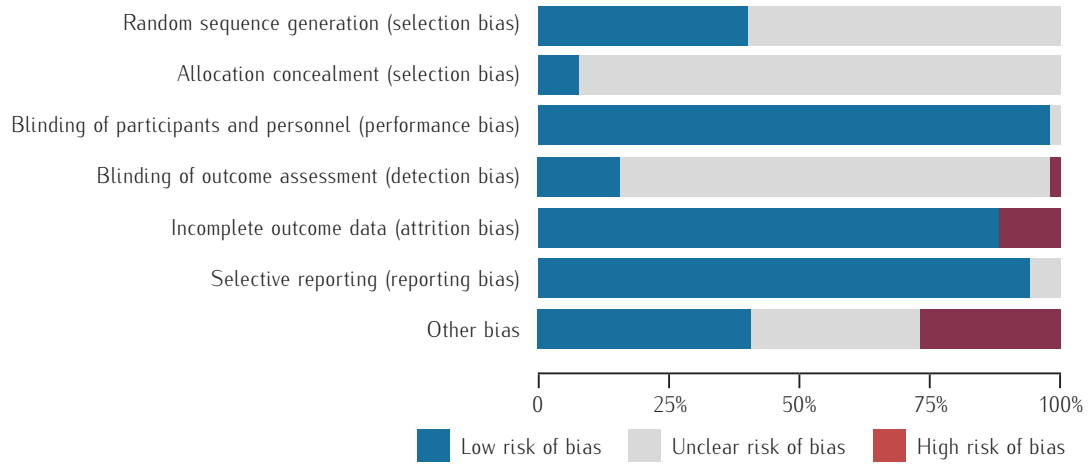
A systematic review, in accordance to the Cochrane Database of Systematic Review guidelines, was conducted to synthesise the evidence on VREs as potential e-Learning interventions for healthcare professional education. Both pre- and post-registration healthcare professionals were considered. Only studies that were designed as randomised controlled trials were included.

RESULTS

Our search strategy retrieved 21,846 unique references. 60 studies were identified as potentially eligible for inclusion. Of these, six studies were excluded at full-text screening stage and 19 were identified as studies awaiting classification subject to further information. Finally, 34 studies were included for analysis. All studies were conducted in high income countries. None of the included studies were published prior to 2004.

Figure 1 shows the graphical representation of the risk of bias for the 34 included studies. Overall, eight studies were deemed as low risk of bias.

Figure 1 – Risk of bias for included studies



Knowledge: Eighteen studies reported that VRE was significantly better than the control group in terms of knowledge gain. One study reported that the control group was better, and eight studies reported no significant differences in knowledge gain between intervention and control groups.

Skills: Six studies reported that the intervention was significantly better than the control group for skills acquisition. One study reported that the control was better, and seven studies reported no significant differences between intervention and control groups.

Attitude: Four studies reported significant differences in attitude while two studies reported no significant differences in attitude. Two others studies reported no comparison being made between intervention or control groups.

Satisfaction: Two studies reported significant differences in satisfaction towards the intervention group, three studies reported no differences, and another three studies reported no comparison made. Two studies reported unclear differences for satisfaction between the intervention and control.

CONCLUSION

VRE-based e-Learning interventions provide a good learning tool for HCPs within specific subgroups. Since the quality of the included studies was not high and meta-analysis for most interventions was not feasible due to high heterogeneity, it was difficult to conclude whether VRE-based interventions indeed improve knowledge, skills, attitude and satisfaction of HCPs. Cost information, unintended effects and patient-related outcomes need to be further assessed to get a comprehensive picture of the effectiveness of VRE as an e-Learning tool for HCPs.

ONLINE E-LEARNING FOR POST-REGISTRATION HEALTHCARE PROFESSIONALS – A BIBLIOGRAPHIC ANALYSIS OF THE LITERATURE

Dr Pradeep Paul, Dr Olena Zhabenko[1], Elicia Toon[1], Nakul Saxena, Kenneth Teck Kiat Lim, Dr Lorainne Tudor Car[2], Dr Nabil Zary[3], Prof Craig Lockwood[4], Prof Josip Car[1,5,6]

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[4]Implementation Science, The University of Adelaide, Adelaide, Australia

[5]Global eHealth Unit, Department of Primary Care and Public Health, School of Public Health, Imperial College London, London, UK

[6]Department of Family Medicine, Faculty of Medicine, University of Ljubljana, Ljubljana, Slovenia

BACKGROUND

Online e-Learning such as continuing medical education (CME) and continuing professional development (CPD) has been used widely as a mode to train the healthcare workforce and to enhance patient care. This study is a bibliographic analysis of literature on this topic.

METHODS

A systematic review is underway to synthesise evidence on online e-Learning for healthcare professionals (HCPs). MEDLINE (Ovid), EMBASE (Elsevier), Cochrane library (Wiley), PsyINFO (Ovid), ERIC (Ovid), CINAHL (Ebsco) and Web of Science Core Collection (Thomson Reuters) were searched for studies on online e-Learning for post-registration professionals from 1990 to 2015. Only randomised controlled trials (RCT) or cluster RCTs were included.

RESULTS

Of the 2,668 articles included for full text screening, 252 fulfilled our inclusion criteria. 55% of these articles were published in the last 5 years, and the number of articles increased by 278% from 2004 to 2014. The years 2012 (n=43) and 2013 (n=35) had the highest number of articles. The 252 included articles were published in 172 journals, of which 43 journals published two or more articles.

Table 1 shows the top 10 journals in online e-Learning for post-registration HCP training. Majority of these studies were conducted among doctors (52%) and nurses (26%) and were published in the surgical (8%), paediatric (8%), emergency medicine (5%) and nursing journals (5%). Among the doctors, 58% were physicians, 17% surgeons, 15% paediatricians, 5% each from obstetrics and gynaecology, and psychiatry.

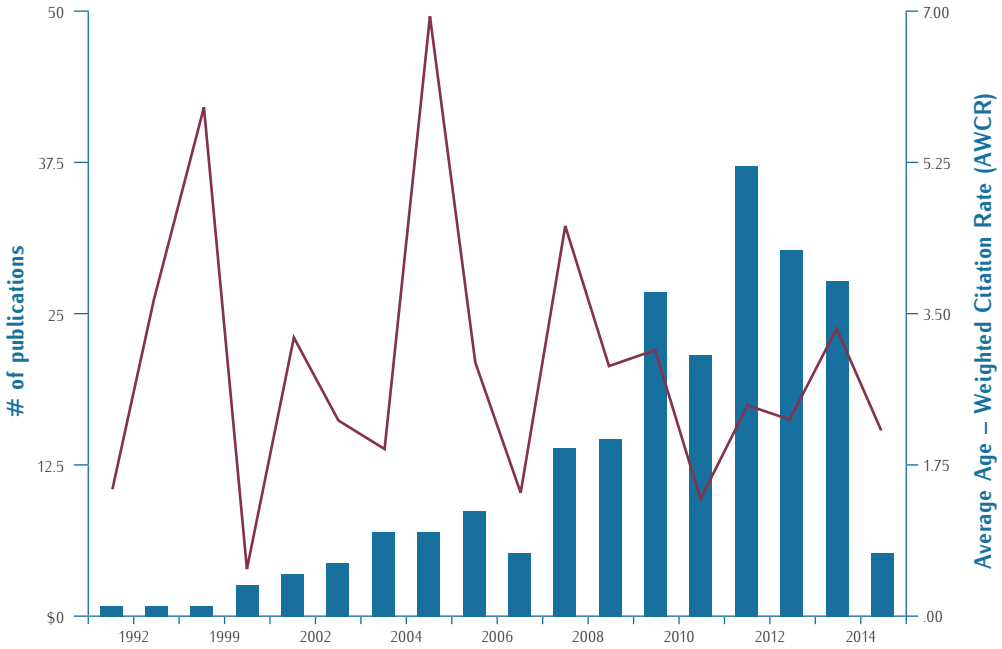
Table 1 – Top 10 journals in online e-Learning for post-registration HCP training

Rank	Journal	Citations	No. of articles published	Average citations / year	Impact Factor*
1	Medical Education	372	3	10.73	3.12
2	The Journal of School Nursing	148	1	3.67	0.72
3	Journal of General Internal Medicine	145	3	5.34	3.45
4	Family Medicine	134	4	4.50	0.85
5	American Journal of Preventive Medicine	103	2	3.28	4.53
6	Behaviour Research and Therapy	98	2	7.69	3.40
7	Journal of Pelvic Medicine and Surgery	93	2	5.88	
8	Annals of Surgery	90	5	3.46	8.34
9	Academic Medicine : Journal of the Association of American Medical Colleges	83	4	1.87	3.06
10	Trials	82	1	7.45	1.73

* as of 3 September 2015

Figure 1 shows the average age-weighted citation rate for articles on e-Learning for post-registration HCPs. Age-weighted citation rate (AWCR) measures the number of citations to an entire body of work, adjusted for the age of each individual paper.

Figure 1 – No. of publications and their average age-weighted citation rate



CONCLUSION

There is a substantial body of evidence on the use of online e-learning for training post-registration professionals, specifically doctors. However, its effectiveness and quality of evidence is yet be ascertained.

CLASSIFICATION AND PATTERN RECOGNITION OF SCHIZOPHRENIA BRAIN MAGNETIC RESONANCE IMAGING USING REGULARISED SVM

Alex You Xiaobin, Dr Meng Fanwen, Rowena Chin Hui Zhi[1], Sum Min Yi[1], Dr Heng Bee Hoon, Adj. A/Prof Sim Kang[1]

[1] Institute of Mental Health, Department of Adult Psychiatry/Early Psychosis Intervention

BACKGROUND

Schizophrenia is a complex psychiatric disorder characterised by hallucinations, delusions, emotional disturbances and cognitive dysfunction. Conventionally, the diagnosis of schizophrenia is primarily dependent on the clinician's evaluation of reported symptoms and behavioural assessment. With recent advances in machine learning and the development of neuroimaging technology, it is necessary to study classification and pattern recognition of brain Magnetic Resonance Imaging (MRI) for people with mental disorders by employing these techniques.

In this study, we aimed to improve existing support vector machine (SVM) to classify brains of patients with schizophrenia against healthy controls and develop new approaches to identifying the key anatomical features in a disordered brain.

METHODS

A total of 212 participants were recruited. Of which, 141 patients (97 males and 44 females) diagnosed with schizophrenia according to the Diagnostic and Statistical Manual of Mental Disorders, 4th edition (DSM-IV), were recruited from the Institute of Mental Health. We first introduced a spatial and anatomical regularised SVM to schizophrenia MRI. The coefficients obtained by the model were used to identify the key regions of interest (ROI) in classifying schizophrenia brains against healthy controls. We developed a sequential ROI selection process for feature selection with anatomical interpretability. To study prediction accuracy with the features of selected ROIs, we tested a training set of 127 patients and validated on a testing set of 85 patients, in comparison with the full cerebrum.

RESULTS

Analysis showed 1.13 million entries of the coefficients derived from SVM model approximately follow a Gaussian distribution. The positive coefficients indicated that higher intensity of the respective voxels tend to lead to a positive classification (schizophrenia), while in the case of negative coefficients, lower intensity tend to lead to a positive classification. Basic statistics of the coefficients are demonstrated in Table 1.

Table 1 – Statistics of SVM Coefficients

Mean	Median	Min	Max	Range	Std
-4.61	-4.49	-43.15	28.39	71.54	8.69

By applying the sequential ROI selection algorithm to the underlying 64 ROIs altogether, it yielded 64 selection paths as illustrated in Figure 1. Regardless of the choice of initial ROI, the selection paths tended to have almost identical sequential pattern. The different initial ROIs only shifted small part of each selection path while retaining similarity in the rest. The common sequential pattern among all selection paths revealed the general significance of each ROI in the classification. An optimal subset of 7 selected ROIs was identified by selecting the group of ROIs that yield highest training accuracy, as shown in Table 2.

Figure 1 – 64 Smoothed Selection Paths

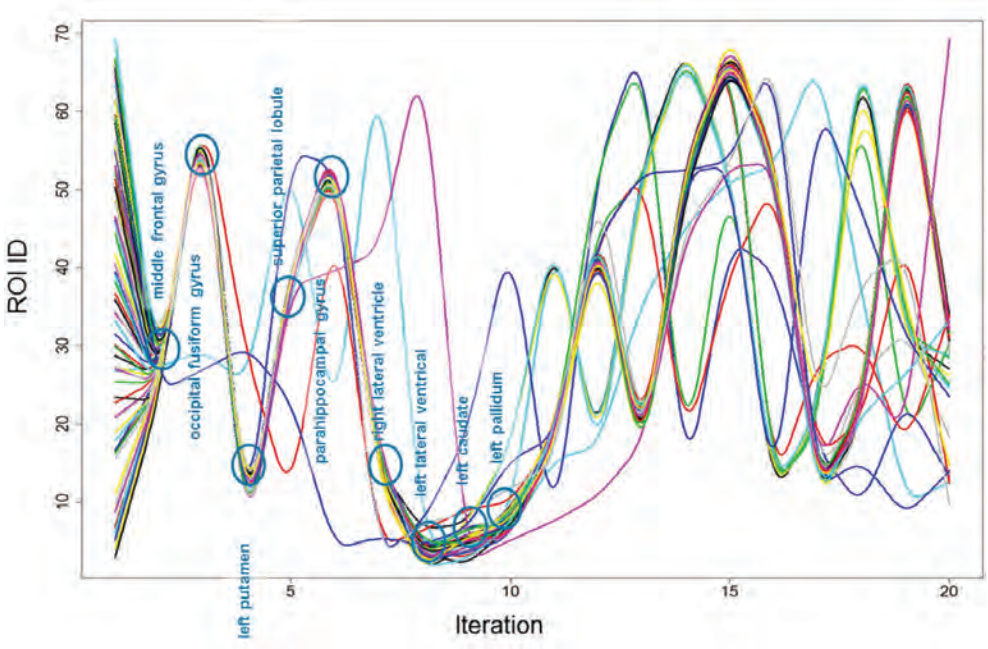


Table 2 – List of Selected 7 ROIs

Iteration	New ROI added in the subset	Accuracy(%)	Cumu.Vol. Size(%)
1	occipital fusiform gyrus	77.51	1.28
2	middle frontal gyrus	79.47	5.29
3	inferior frontal gyrus; pars opercularis	84.15	6.32
4	superior temporal gyrus; anterior division	87.23	6.71
5	superior frontal gyrus	90.06	10.70
6	left thalamus	91.14	11.61
7	left lateral ventricle	92.04	12.43

We studied the model performance in prediction comparing with the full cerebrum. The selected 7 ROIs achieved a high accuracy as high as 89.4% in classification in the validation set, about 6% higher than the full cerebrum model. The results partially reflected the information of selected ROIs suffices to make a prediction with a satisfying accuracy.

CONCLUSION

To better classify schizophrenia brains against healthy controls and identify the key anatomical features in disordered brain, we applied SVM with regularization to analyse the neuroimaging brain MRI data, and proposed a sequential ROI selection process for feature selection with anatomical interpretability with 7 ROIs identified as the optimal subset. The obtained results inform physicians with important information that may be used particularly in early diagnosis and subsequent treatment on patients.

PUBLICATIONS

Original Articles

1. *Loh PT, Toh MPHS,* ***Molina JAD****, Vathsala A.* Ethnic disparity in prevalence of diabetic kidney disease in an Asian primary healthcare cluster. Nephrology 2015; 20 (3): 216-223.

2. ***Saxena N****,* ***You XB****,* ***Zhu ZC****,* ***Sun Y****,* ***George PP****,* ***Teow KL****, Chong PN, Sim J, Wong JEL, Ong B, Foo HJ, Soh EF, Tham L,* ***Heng BH****, Choo P.* Singapore's regional health systems – A data driven perspective on frequent admitters and cross-utilization of healthcare services in three systems. The International Journal of Health Planning and Management 2015. DOI: 0.1002/hpm.2300

3. ***Saxena N****,* ***George PP****,* ***Heng BH****, Lim TH, Yong SO.* Cost effectiveness of anti-oxidant vitamins plus zinc treatment to prevent the progression of intermediate age-related macular degeneration. A Singaporean perspective. Indian Journal of Ophthalmology 2015; 63: 516-523. DOI: 10.4103/0301-4738.158533

4. ***Meng F****,* ***Teow KL****, Ooi CK,* ***Heng BH****, Tay SY.* Analysis of patient waiting time governed by a generic maximum waiting time policy with general phase-type approximations. Health Care Management Science 2015; 18 (3): 267-278.

5. ***Meng F****, Qi J, Zhang M, Ang J, Chu S, Sim M.* A robust optimization model for managing elective admission in a public hospital. Operations Research 2015; 63 (6): 1452-1467.

6. ***Meng F****, Ooi CK, Soh CKK,* ***Teow KL****,* ***Palvannan R.K****.* Quantifying patient flow and utilization with patient flow pathway and diagnosis of an emergency department in Singapore. Health Systems. DOI: 10.1057/hs.2015.15

7. ***Pradeep Paul George****,* ***Palvannan R.K****.,* ***Teow KL****,* ***Zhu ZC****,* ***You Alex****,* ***Saxena N****, Singh V, Tham L, Choo WJP, Chong PN, Sim HJ, Wong EL, Ong KC, Soh F, Foo HJ,* ***Heng BH****.* Setting up a regional health system database for seamless population health management in Singapore. Proceedings of Singapore Healthcare.

8. ***Sun Y****,* ***Heng BH****, Tay SY, Tan B.* Unplanned 3-day re-attendance rate at Emergency Department and hospital's bed occupancy rate. International Journal of Emergency Medicine 2015; 8:32.

9. *SH Lee,* ***Sun Y****.* Detection and predictors of paroxysmal atrial fibrillation in acute ischemic stroke and transient ischemic attack patients in Singapore. Journal of Stroke and Cerebrovascular Diseases, 2015 Sep; 24 (9), 2122-7.

Protocol

10. *Wu CX,* ***Tan WS,*** *See RCK, Yu W, Kwek LSL, Toh MPHS, Chee TG, Chua GSW.* A matched-group study protocol to evaluate the implementation of an Integrated Care Pathway programme for chronic obstructive pulmonary disease in Singapore. BMJ Open 2015; 5 (1): e005655.

Letter

11. ***Saxena N.*** Virtual reality environments for healthcare professional education. Annali dell'Istituto Superiore di Sanità 2015; 51 (1): 1-2.

AWARDS & GRANTS

Conference Presentation Awards

Singapore Health & Biomedical Congress 2015, Singapore
October 2015

Singapore Young Investigator Award – Gold (Health Services Research)
Kelvin Teo Wee Sheng
Predicting 72-hour re-attendance among COPD patients at the emergency department

Training Awards

NHG Healthcare Manpower Development Programme

Dr Zhu Zhecheng *(Operations Research)*
School of Medicine, University of Western Sydney, Australia

Research Grants

MOH HSR NIG Grant

Evaluation of treatment strategies in prevention of stroke and coronary heart disease among Type 2 diabetic patients using Markov decision process
Dr Meng Fanwen (*PI*)
Dr Sun Yan (*Co-investigator*)
A/Prof Melvin Leow Khee Shing, TTSH, Duke-NUS & SICS (*Co-investigator*)
Amount: $119,856

MOE Academic Research Fund (ACRF) Tier 1 Grant

Optimal control of surgery waiting lists
Asst Prof He Shuangchi, NUS (*PI*)
Dr Meng Fanwen (*Collaborator*))
Amount: $160,000

TRAINING & EDUCATION

14th Healthcare Operations Research Appreciation Course

August 2015
Speakers: ***Dr Meng Fanwen***
Dr Zhu Zhecheng
Palvannan RK
Teow Kiok Liang

Operations Research (OR) techniques are useful to determine the best course of action of a decision problem under limited resources. The science is in the maths and algorithms for addressing decision problems. Its an art as success in all the phases that precede and succeed the solution of a mathematical model, depends largely on the creativity and personal abilities of the decision maker. The 2-day course introduced OR concepts with healthcare applications. The focus was on building intuition around theory, walking through illustrative examples and demonstrating insights from results that will support and inform decision making.

Healthcare Operations Research Appreciation Workshop

November 2015
Speakers: ***Teow Kiok Liang***

This 1-day workshop was organised for healthcare professionals from the National University Health System. Case studies were used to show applications of OR techniques as well as the process of problem solving during the engagement with the decision maker. Participants also learned how to frame a problem using queuing concepts and simulation, optimisation framework, systems thinking and system dynamics.

CONFERENCE PRESENTATIONS

JULY	**Institute for Operations Research and the Management Sciences (INFORMS) Healthcare, Tennessee**

1. **Palvannan RK**, Rafman H, Teo E, Ang T, Ng BL, Lau N, Esuvaranathan K, Sim J
   Setting 'optimal' utilisation targets for elective operating theatres

2. **Palvannan RK**, **Teow KL**, Kan E, Ong PK, Tiang S, Ooi CK
   Simulating operational impact of universal screening for MRSA at the emergency department on bed wait time for admission in an acute hospital

AUGUST	**10th Singapore Public Health & Occupational Medicine Conference, Singapore**

3. **Ang YG**, **Saxena N**
   Mortality outcomes of antihypertensive drugs

OCTOBER	**Singapore Health & Biomedical Congress 2015, Singapore**

4. **Saxena N**, Bhone MK, Lim KTK, **George PP**, **Heng BH**, Car J
   Virtual reality environments for pre- and post-registration health professional education. What's the evidence base?

5. **Meng F**, **Sun Y**, Leow MKS
   Optimal Treatment Strategies in Prevention of Stroke and Coronary Heart Disease among Type 2 Diabetic Patients Using Markov Decision Process

6. **Teo KWS**, **Tan WS**, **Ng CWL**, **George PP**, Yeo C, Tan KAW, Ali NN, Chew AP, Low KY, Ng K, Tan C, Chong MS
   An economic evaluation of dementia care in the primary care setting

7. **Teo KWS**, **Teow KL**, **Meng F**, Ooi CK, Tay SY
   Predicting 72-hour re-attendance among COPD patients at the emergency department

8. **Ng CWL**, **George PP**, **Teo KWS**, **Tan WS**, Yeo C, Tan KAW, Ali NN, Chew AP, Low KY, Ng K, Tan C, Chong MS
   Dementia care in primary care – Effectiveness in comparison to specialist care

9. **George PP**, Bhone MK, **Saxena N**, Lim KTK, **Heng BH**, Car J, Lockwood C
   Online eLearning for post-registration healthcare professionals – A bibliographic analysis of the literature

10. **Molina JAD**, Chan WL, **Heng BH**, Ramason R
    Integrated Hip Fracture Care Pathway – Programme Year 2 evaluation results

11. **Teow KL**
    Using 'Gravity' based models for facility planning

NOVEMBER **International Society for Pharmacoeconomics and Outcomes Research (ISPOR) 18th Annual European Congress, Milan**

12. **Molina JAD**, Ismail NH, **Heng BH**, Leong IYO
    Effectiveness of a community-based falls prevention programme for the elderly

13. **Teo KWS**, **Tan WS**, **Ng CWL**, **George PP**, Tan K, Chong MS
    Primary care dementia clinic reduces societal cost of dementia: A cost-utility analysis

7th Asian Association for the Study of Diabetes (AASD) Scientific Meeting and Annual Scientific Meeting of the Hong Kong Society of Endocrinology, Metabolism and Reproduction, Hong Kong

14. Ang G, **Heng BH**
    Annual progression rates of chronic kidney disease stages 3A, 3B and 4 to end-stage renal disease in diabetes patients in Singapore

DECEMBER **9th Health Services & Policy Research Conference, Melbourne**

15. **Sun Y**, **George PP**, **Heng BH**, Tay SY
    Does higher bed occupancy rate (BOR) affect 3-day ED unplanned reattendance rate?

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. **Dr Ang Yee Gary**
MBBS, MPH, Dip (Family Med), GDMH, Dip (Family Practice Dermatology)
Associate Consultant

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

5. **Ge Lixia**
BMed (Nursing), MSc (Physiology)
Research Analyst

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

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

8. **Lim Teck Kiat Kenneth**
BCom (Hons Class 1)
Research Analyst

9. **Dr Lin Lee Kai**
MSc (Economics), PhD (Economics)
Research Analyst

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

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

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

13. **Palvannan R.K.**
BEng, MEng (Industrial 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. **Teo Wee Sheng Kelvin**
BA (Economics) (Magna Cum Laude), MA (Economics)
Senior Research Analyst

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

19. **Dr Yap Chun Wei**
PhD
Principal Research Analyst (Data Science)

20. **20. You Xiaobin Alex**
BEcon (Statistics), MSc (Statistics)
Statistician (Data Science)

21. **Dr Zhu Zhecheng**
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