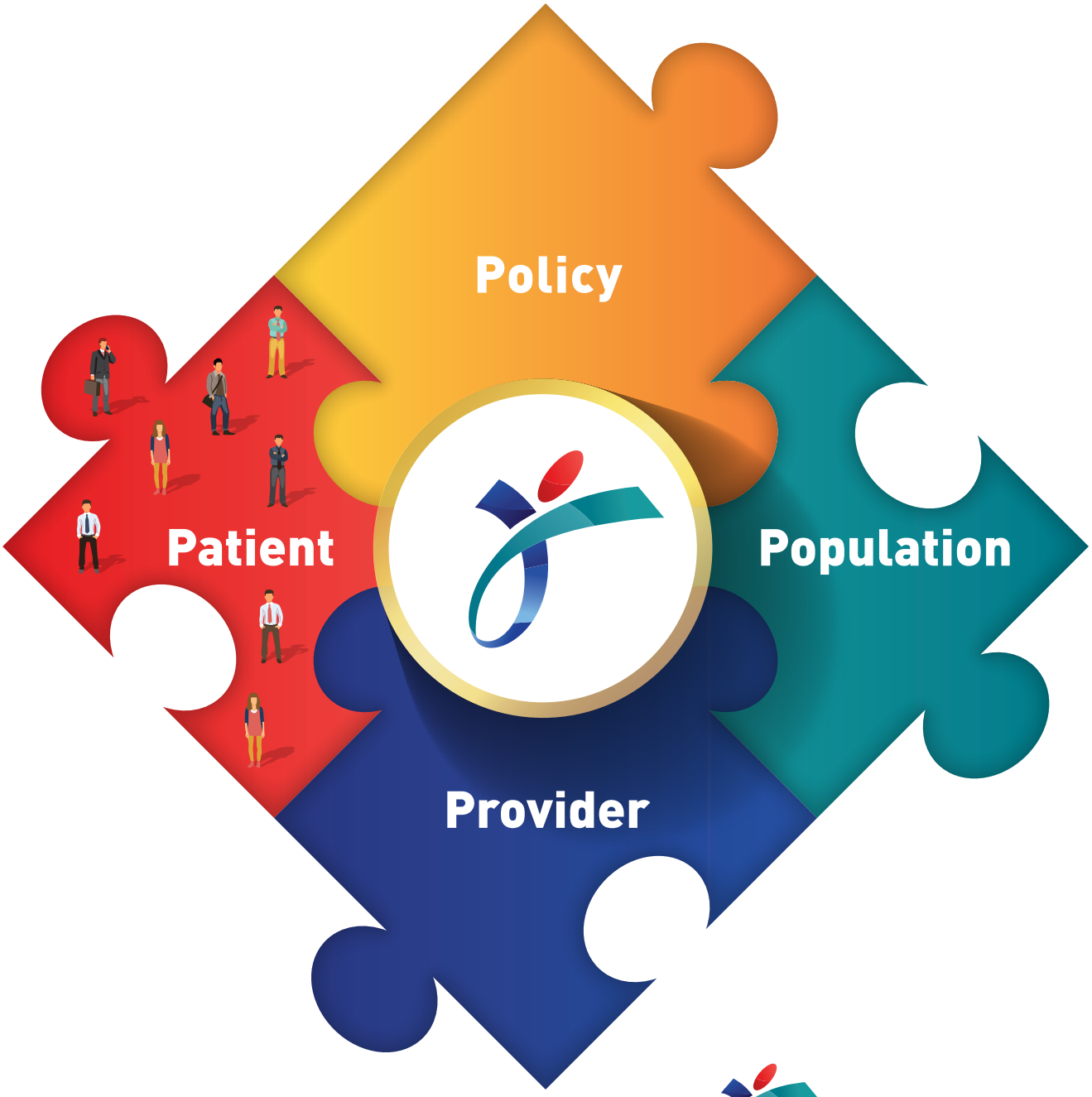
HEALTH SERVICES & OUTCOMES RESEARCH

ANNUAL REPORT | 2018



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The evidence behind your decisions

FOREWORD

In 2018, HSOR continued to *provide the best available evidence* (our first mission) for decision making and knowledge translation; ensuring that new evidence and knowledge are pragmatic, relevant and understood by senior management and clinicians. The year's body of work and priority were in support of measuring population health and population health management programmes. We developed a first-in-Singapore population health index (PHI). It measures a person's health using validated instruments, and validated it against mortality and healthcare utilization. The multiple dimensions within the PHI survey's longitudinal data have resulted in testing alternative instruments to measure health activation, and informed the relationship between nutritional status and physical function and disability. The population-based PHI survey which started in the Central Region was extended to the northern region of Yishun and Woodlands using a validated shortened version of the instrument.

Within the populations we served in the Central and Northern regions, analyses of large scale administrative databases have enabled comparisons of risks, morbidity and outcomes; reaffirming the differences that are driven by a multitude of determinants of health beyond healthcare, e.g. socioeconomic factors. Complementing longitudinal statistical analyses, we used a microsimulation engine to forecast chronic disease and complications trajectories as disease burden forecast and resource allocation policies become increasingly necessary. This was possible with an NMRC HSR grant in collaboration with University of Sydney - *building capacity and advancing knowledge* are equally critical missions of the department to ensure our sustainability.

Programme design, and measuring programme effectiveness and care quality continued. These include the design and the evaluation of pilot initiatives of NHG's Care and Finance transformation efforts, including polyclinics' Chronic Care Plan, Advance Care Planning (ACP) framework development, supporting development of frailty and end-of-life care bundles, evaluation of the framework for inpatient frailty care for geriatric friendly institutions and economic evaluation of home palliative care for advanced dementia patients, automating data flow for analysis of potentially preventable hospital adverse events, and developing a prototype dashboard for cardiologists to monitor quality indicators and outcomes for heart failure patients across hospitals. We also continued with methodological developments for clinical decision support and operational efficiency; e.g. a drug dosing model to support clinical management of patients with thyroid conditions, explored deep learning techniques to improve pharmacy medication errors, and showed the need to have very high predictive power of no-show rates to effect scheduling changes to manage utilization.

This report covers abstracts of the ongoing work. We hope you find them interesting and useful!

Prof Philip Choo
Group Chief Executive Officer
National Healthcare Group

HSOR@NHG

The evidence behind your decisions

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

PATIENT PERSPECTIVE

A FOCUS ON PATIENT CARE THROUGH CLINICIAN-LED INITIATIVES

A MATHEMATICAL MODEL FOR OPTIMAL PERSONALISED ANTI-THYROID DRUG DOSING FOR PATIENTS WITH GRAVES' DISEASE

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Highlights

A personalised medicine model was developed to facilitate optimal drug dosing through a titration regimen treatment for patients with Graves' disease using an ordinary differential equation and mathematical optimisation.

Favorable predicted FT4 accuracy rates can be achieved using a few early patient visit data, instead of using actual FT4 data within a limited tolerance.

Introduction

Graves' disease is the most common cause of hyperthyroidism. It is important that euthyroidism is achieved as soon as possible with the lowest anti-thyroid drug (ATD) dose to minimise side effects and maximise thyroid-specific immunosuppressive effects. However, current clinical practice of ATD treatment titration is arbitrary in nature and based on clinical judgment and preceding thyroid function test (TFT) results. Frequent monitoring by clinicians to find the optimal drug dosage using a trial-and-error strategy is time-consuming and increases costs for patients. For decades, there has been little research on optimising the dose titration of ATDs. Thus, this study seeks to develop a personalised medicine model to facilitate optimal drug dosing through a titration regimen.

Methods

An Ordinary Differential Equation (ODE) was employed to describe a mathematical relationship between the rate of change of free plasma thyroxine (FT4), its output (i.e., synthesis and secretory rate) and decay rates. The thyroid hormone output rate is dependent on ATD dosage. Integration of the ODE will yield the explicit relationship between FT4 concentration and ATD dosage. Individualised parameters in this equation can be obtained after feeding in TFT data from each individual patient. With the ODE and unique parameters, the optimal ATD dosage for each patient to reach the desired target FT4 concentrations for euthyroidism within a specified time interval can be predicted using what-if scenario analysis. A mathematical optimisation model was introduced to estimate the parameters required, i.e., synthesis rate, decay rate, and IC50 (concentration of ATD which reduces FT4 synthesis by half), using a few sets of TFT data from each patient. The estimated parameters were considered to be acceptable if the average predicted FT4 value was within a 4.5 pmol/L tolerance. We analysed 49 patients with different sets of TFT data consisting of drug dosage, time period between consecutive visits and serum FT4. Table 1 shows the mean, standard deviation, median, minimum and maximum of patient review visits, serum FT4, and review interval of the data.

Results

The performances of the model concerning the estimation prediction accuracy rates using different visit data were analysed. As shown in Table 2, the estimated prediction accuracy rate was the highest (83.9%) based on TFT data from the first 5 visits, while it was the lowest (75.0%) with data from the first 4 visits, and 77.1% accuracy rate was achieved with data from the first 3 visits.

Figure 1 shows the predicted FT4 normalisation in 50 days with different drug doses for an individual patient based on the estimations derived by the model using the data from the first 5 visits. It can be seen that the higher the dose, the steeper the FT4 curve in the decline phase. Patients with the lower drug dose would take a longer time to achieve the same FT4 target. These results are in alignment with clinical treatment in practice as expected.

Conclusion

The proposed model can potentially assist clinicians in determining the optimal drug dosage for patients with Graves' disease to achieve a desired FT4 value within a pre-determined time period.

Table 1. Basic statistics of thyroid function test data.

Item	Review visits (times)	FT4 value (pmol/L)	Review interval (days)
Mean (SD)	6.9 (4.7)	20.7 (16.0)	73.5 (33.9)
Median	5	15	70
Minimum	2	1	5
Maximum	24	91	210

Table 2. Comparison of estimation accuracy rates using different data sets.

Data set	First 3 visits	At most first 3 visits	First 4 visits	At most first 4 visits	First 5 visits	At most first 5 visits
No. of patients	48	49	36	49	31	49
No. of patients meeting the tolerance	37	38	27	36	26	35
Accuracy rate	77.1%	77.6%	75.0%	73.5%	83.9%	71.4%

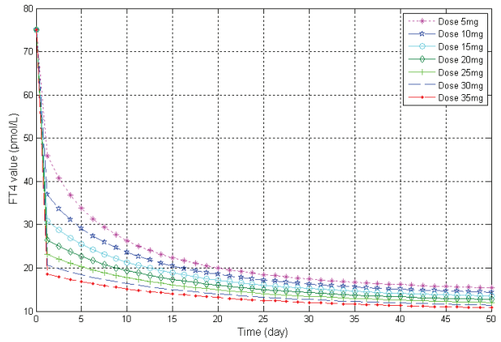

Figure 1. Predicted FT4 curves for different drug dosages with an initial FT4 value of 75 pmol/L.

PREDICTORS OF ALL-CAUSE MORTALITY AMONG CHRONIC KIDNEY DISEASE PATIENTS IN SINGAPORE

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Highlights

Routinely collected administrative data can be modeled to identify predictors of all-cause mortality in diabetic patients with chronic kidney disease.

The model performs well in predicting 1-year and 5-year mortality in diabetic patients with chronic kidney disease.

Introduction

A previous study among diabetes patients with Chronic Kidney Disease (CKD) Stage 3-5 in Singapore found that predictors of mortality were age, male gender, CKD stage, albuminuria, comorbid conditions such as Peripheral Vascular Disease (PVD), Neuropathy and Retinopathy, and use of antiplatelet agents (1).

This study aims to identify predictors of all-cause mortality using data collected routinely in clinical practice and evaluate the accuracy of models to predict death at 1 and 5 years.

Methods

This is a retrospective cohort study of 1,537 CKD Stage 3-5 patients followed-up at Tan Tock Seng Hospital (TTSH) Renal Department from 1 Jan 2009 to 31 Dec 2012. Patients were followed-up till death or 31 December 2017, whichever came earlier, and the outcome of interest was death at 1 year and at 5 years from their first visit to TTSH renal department. Univariate Cox proportional-hazards regression was used to assess the association between each predictor variable and all-cause mortality. Significant variables were then entered into multivariate Cox proportional-hazards regression models for mortality at 1 and 5 years. The level of significance for the univariate regressions were set at $p \leq 0.20$, and backward elimination method of non-significant variables ($p<0.05$) was used for the multivariate models. We then compared the predicted risk of death at 1 year and 5 years to actual deaths to assess model accuracy.

Results

One hundred and sixty-five patients (6.2%) died at the end of 1 year and cumulatively, 876 patients (32.8%) died at the end of 5 years. Variables included in the multivariate model are shown in table 1. The area under the Receiving Operating Curve (ROC) is 0.802 (95% CI, 0.744-0.860) and 0.773 (95% CI, 0.748-0.798) for 1 year mortality (Figure 1) and 5 year mortality (Figure 2) respectively. This shows better prediction for 1-year mortality as compared to 5-year mortality.

Conclusion

This study affirmed the poor prognosis of diabetic CKD patients and the urgency for early intervention to retard progression to later stages of CKD to reduce mortality. The model can be improved by investigating renal-related deaths and validating the model in another population

Table 1. Variables included in the multivariate model

Variables (n=1,537)	Hazard Ratio (95% CI)
Hypertension	2.5 (1.5-4.2)
Urine albumin: creatinine ratio <30 30-299 >=300 Missing	 Reference 1.70 (1.42-2.04) 2.17 (1.64-2.87) 1.63(1.17-2.26)
Age	1.05 (1.04-1.06)
Parathyroid hormone	1.01 (1.00-1.01)
eGFR	0.98 (0.97-0.99)
BMI	0.97 (0.96-0.99)
Serum phosphate	0.90 (0.83-0.98)
Serum albumin	0.5 (0.4-0.6)

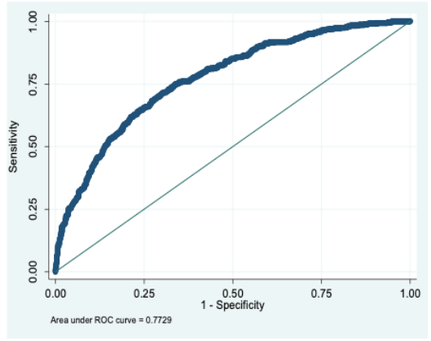


Figure 1. ROC for 1 year death

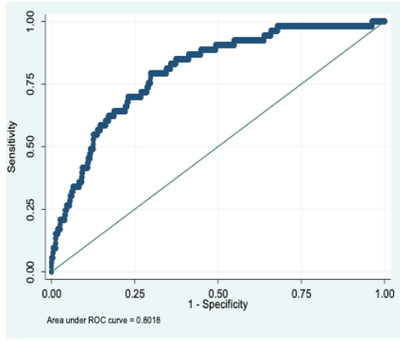


Figure 2. ROC for 5 year death

Reference

1.Ang YG, Heng BH, Saxena N, Liew STA, Chong P-N. Annual all-cause mortality rate for patients with diabetic kidney disease in Singapore. Journal of Clinical & Translational Endocrinology. 2016 2016/06/01/;4:1-6.

PATIENT PERSPECTIVE

VALIDATION OF AN INSTRUMENT TO MEASURE PATIENT ENGAGEMENT AMONG COMMUNITY-DWELLING ADULTS IN SINGAPORE

Ge Lixia, Dr Yap Chun Wei, Palvinder Kaur, Reuben Ong, Dr Heng Bee Hoon

Highlights

The shortened 7-item Altarum Consumer Engagement Measure has good internal consistency and construct validity for use in the Singapore population.

Introduction

A valid and reliable measure is essential to assess patient engagement and to assess its impact on health outcomes and healthcare utilisation. The original 12-item Altarum Consumer Engagement (ACE) Measure assesses engagement in 3 dimensions: Informed Choice, Commitment and Navigation. Our prior work suggested for the removal of informed choice question-items and one navigation question-item for use in the local context. The purpose of this study was to assess the psychometric properties of the shortened 7-item ACE Measure (ACE-7) in the Singapore population.

Methods

Data required was derived from the second follow-up of the National Healthcare Group Population Health Index study conducted in the Central Region of Singapore. A total of 643 community-dwelling adults were sampled.

Construct validity was assessed by: 1) factorial validity using exploratory (EFA) (n=335) and confirmatory factor analysis (CFA) (n=308); 2) hypothesis-testing validity by correlating ACE-7 scores with nutritional assessment score and frequency of activity participation using Pearson correlation; and 3) concurrent validity against the Patient Activation Measure (PAM).

Results

As shown in Table 1, EFA of the ACE-7 items suggested a two-factor solution which explained 60.2% of the variance of: Commitment (44.7%; ACE_1, ACE_3, ACE_5 and ACE_7) and Navigation dimensions (15.5%; ACE_2, ACE_4 and ACE_6) with satisfactory internal consistency (Cronbach's α of 0.77 and 0.65 respectively).

The CFA confirmed the two-factor latent construct of the final scale obtained by EFA. The standardised factor loading for each item onto respective latent constructs is provided in Figure 1. Additionally, the Chi-square test result (x2 (13)=22.6, p=0.05) and goodness of fit indices (CFI=0.97, TLI=0.96, RMSEA=0.05) indicated a good fit between the two-factor model and the observed data.

Hypothesis-testing validity showed that participants with higher ACE-7 scores reported better nutritional status (r=0.09 - 0.25) and higher activity participation frequency (r:0.29 - 0.36). For concurrent validity, ACE-7 scores had moderate to strong association with PAM-13 score (r= 0.53 – 0.63), with ACE-7 scores increasing in tandem with PAM levels (Table 2). Post-hoc testing showed that there were differences in ACE-7 scores between any two PAM activation levels except between levels 1 and 2.

Conclusion

The results showed good internal consistency and construct validity of the 7-item ACE measure. Further research including question-items relevant to the local cultural context to measure the dimension of informed choice is needed to make the ACE Measure more holistic.

Table 1. Factor loadings for two-factor structure

Item	Factor loading	
	Commitment	Navigation
ACE_2. Even when life is stressful, I know I can continue to do the things that keep me healthy.	0.73	-
ACE_4. When I work to improve my health, I succeed.	0.82	-
ACE_7. I can stick with plans to exercise and eat a healthy diet.	0.76	-
ACE_10. I handle my health well.	0.74	-
ACE_3. I feel comfortable talking to my doctor about my health.	-	0.55
ACE_5. I have brought my own information about my health to show my doctor.	-	0.84
ACE_8. I have lots of experience using the health care system.	-	0.84

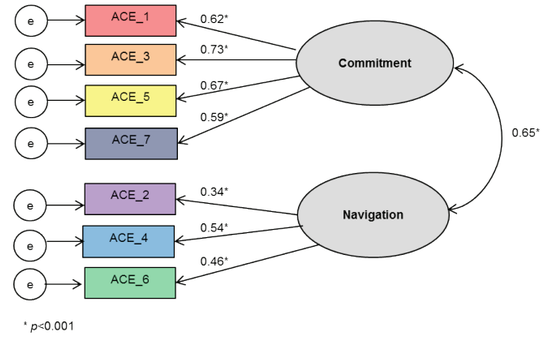


Figure 1. The path diagram for the two-factor CFA model: standardised estimates.

Table 2. ACE-7 subscale and total scores by PAM activation levels (n=562)

PAM \ activation level	n	Commitment (range: 0 – 25)		Navigation (range: 0 – 25)		ACE-7 score (range: 0 – 50)	
		Mean	SD	Mean	SD	Mean	SD
Level 1	38	14.7	3.9	12.1	3.5	26.7	5.7
Level 2	72	16.3	3.2	14.4	2.5	30.7	4.4
Level 3	368	18.5	2.5	16.5	3.3	34.9	4.4
Level 4	84	21.2	2.6	19.6	3.5	40.8	5.5

EMPLOYING ITEM RESPONSE THEORY IN EVALUATING LATE LIFE FUNCTION ITEMS ACROSS INSTRUMENTS OF FUNCTIONAL CAPABILITY

Reuben Ong, Dr Yap Chun Wei, Ge Lixia, Dr Heng Bee Hoon

Highlights

Thematically overlapping questions from the Modified Barthel Index (MBI) and function component of the Late Life Function and Disability Instrument (LLFDI) can be compared using Item Response Theory (IRT).

The MBI and LLFDI share commonalities in measurement constructs.

Introduction

Both the Modified Barthel Index (MBI) and function component of the Late Life Function and Disability Instrument (LLFDI) measure the functional capability of the elderly. There is some overlap in the nature of the questions between both instruments. The aim of the study was to statistically explore the similarities between, and to demonstrate the application of item response theory (IRT) in comparing question items across the instruments. Unlike the commonly used classical test theory (CTT), IRT can reveal performance information for individual questions instead of the tested instrument as a whole.

Methods

The MBI and LLFDI were administered to 593 older adults (aged ≥60) through the 2017 National Healthcare Group Population Health Index survey conducted in central Singapore. Exploratory factor analysis was employed to uncover the factor structure of both instruments combined. To ensure unidimensionality in the IRT model, only questions from both instruments contributing to the principal component were included in an IRT graded response model (GRM). Item difficulty and discrimination parameters were calculated for each question. Discrimination powers of thematically similar questions were then compared.

Results

Eigen values and the scree plot supported a three-factor model measuring functional ability in strenuous, non-strenuous, and self-management activities. The mixture of questions from both instruments loading onto each factor (Table 1) showed that both instruments measure similar constructs. The 23 principal component items, measuring the latent trait (functional ability on non-strenuous activities, Table 1), accounted for 58.3% of the variance and were included in the GRM. Item information curves (example in figure 1) were plotted for each question. Thematically similar LLFDI items had higher discrimination power over their MBI counterparts.

Conclusion

Both instruments overlap and measure similar constructs of functional ability. LLFDI questions delineate individuals better than similar MBI questions. IRT allows comparisons between questions across questionnaires measuring similar constructs and can be utilised to form abridged instruments by selecting question-items with better discrimination.

Table 1. Factor Analysis Loadings*

Question items	Component		
	Non-Strenuous	Self management	Strenuous
MBI			
Hygiene		-.845	
Bathing		-.789	
Feeding		-.948	
Getting On & Off Toilet		-.876	
Stairs	.585		
Dressing		-.750	
Bowells		-.869	
Bladder		-.843	
Chair-bed Transfers		-.677	
Ambullation	.555		
LLFDI			
Open Lid	.808		
Climb stairs using handrail	.731		
Wearing pants	.767		
Run 800m			.775
Use cooking utensils	.870		
Hold a glass of water	.750		
Walk 1.6km with rest			.557
Climb stairs without handrail			.803
Run short distance			.849
Reach overhead	.617		
Sit-stand	.626		
Wear Jacket	.740		
Reach behind	.705		
Step up curb	.804		
Open heavy door	.691		
Open food packet	.906		
Pour from pitcher	.855		
Get in/out of car	.916		
Hiking on uneven ground			.754
Climb 3 flights of stairs using handrail			
Move chair	.693		
Step up stool			.698
Make bed	.635		
Climb stairs carrying load			.814
Bend_over	.693		
Walk around home	.749		
Get up from floor			.531
Wash dishes	.867		
Walk several blocks	.674		
Walk 1.6km without rest			.781
Get on/off bus	.688		
Walk on slippery ground			.580

* Factor loadings less than 0.5 are suppressed

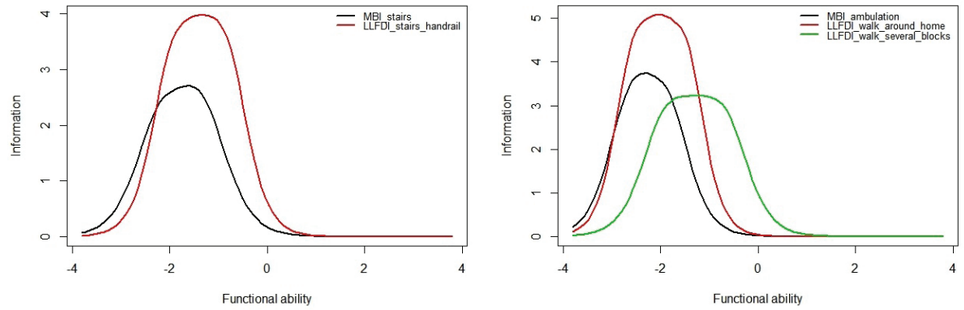


Figure 1. Item Information Curves for Similar Questions

POPULATION PERSPECTIVE

A FOCUS SHIFT FROM HOSPITAL TO POPULATION HEALTH STUDIES TO INFORM PREVENTION AND POST-ACUTE CARE

THE POPULATION HEALTH INDEX

Dr Yap Chun Wei, Ge Lixia, Reuben Ong, Dr Heng Bee Hoon

Highlights

The Population Health Index covers physical, mental, social, risk and healthcare utilization domains, and can provide a benchmark for the health score of the population.

Introduction

It is important to monitor the health of the population in the three National Healthcare Group (NHG) geographical zones (Central, Yishun and Woodlands). A metric was developed to facilitate this as well as to assess population health over time – the Population Health Index (PHI).

Methods

The PHI measures a person's health by taking into account five domains that significantly contribute to health; i.e. physical, mental and social functioning, health-related risk factors and historical healthcare utilisation (Figure 1).

Item Response Theory (IRT) was used to construct a model for each of the five domains. Data for these models was derived from 1,942 participants in a NHG PHI Survey. This survey was conducted in the Central region of Singapore from November 2015 to November 2016. The IRT models were used to determine the domain scores, which were then averaged to determine the PHI score of individuals.

All domain scores and the PHI were subsequently normalised to represent an individual's health percentile relative to the population (0=worst health, 100=best health). A badge representing domain and PHI scores, and its interpretation is shown in Figure 2.

Results

Currently, the PHI and five domain scores can be calculated using a question bank of more than 300 questions from multiple validated instruments. Different subsets of questions could be chosen, depending on the care setting and participant's health conditions, to compute the PHI and domain scores while maintaining their comparability across different people and time. The question bank can be expanded and updated with new questions or instruments through a calibration process. This increases the flexibility of computing the PHI as it is not restricted to a small, defined set of questions like many existing measurement instruments for health.

Another advantage of the PHI is that it allows the identification of deficiencies within each of the five health domains. This facilitates the delivery of appropriate interventions at an individual and population level.

The PHI has been validated with 1-year mortality (AUROC=0.91), frailty (r=-0.563), and future healthcare utilisation (r=-0.421).

Conclusion

It is intended for the use of the PHI on representative population cross-sections to extend to all three NHG geographical zones in the future. The PHI can provide a health score benchmark and initiate longitudinal tracking of the health of the population. Deficient PHI domains in different geographical sub-zones can be identified and appropriate interventions can be planned for and delivered in conjunction with community health and social partners.

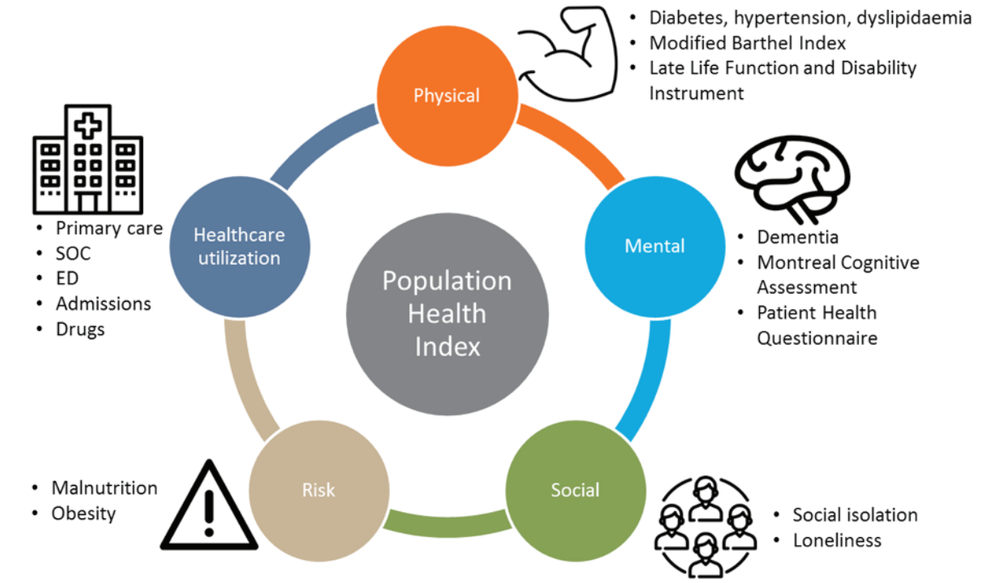
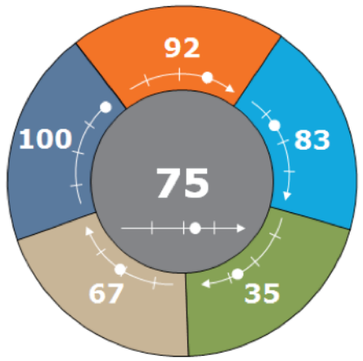


Figure 1: Five health domains of the PHI



Interpretation

- Numbers represent percentile of population
  - This person has a PHI score of 75, which means that his PHI is at the 75th percentile of the population
  - His physical score is at the 92th percentile of the population
- Lines with arrow represent the range of score for the person's age group, gender and race, with the arrow representing maximum score and the tick marks representing 25%, 50% and 75% percentile
- The circle on line represent the percentile of the score for the person's age group, gender and race
  - Although the person PHI score is 75, this is 60th percentile for his age group, gender and race
  - His physical score is at 75th percentile for his age group, gender and race

Figure 2: Badge for the PHI and domain scores

EFFECTS OF CHRONIC DISEASES ON HEALTH-RELATED QUALITY OF LIFE AND SELF-RATED HEALTH AMONG ADULTS IN SINGAPORE

Ge Lixia, Reuben Ong, Dr Yap Chun Wei, Dr Heng Bee Hoon

Highlights

The presence of chronic disease seems to affect the self-rated health of young adults more than other age groups.

Multimorbidity is associated with poorer health-related quality of life and self-rated health in all age groups.

Introduction

It is worthwhile to explore the age effect on the associations between chronic disease and health-related quality of life (HRQoL) and self-rated health (SRH). The aim of this study was to examine the association between the number of chronic diseases and HRQoL and SRH among community-dwelling young (21-44 years), middle-aged (45-64 years), and older adults (65 years and above) in Singapore.

Methods

This study was conducted using the cross-sectional data collected between November 2015 and November 2016 for the Population Health Index (PHI) survey. HRQoL and SRH was measured using the EQ-5D-5L. The medical histories of 17 chronic diseases were obtained by self-report. Multimorbidity was defined as the presence of at least two of the 17 specified chronic diseases. Multiple linear regressions were conducted to examine the associations between the number of chronic diseases and HRQoL and SRH for different age groups.

Results

The sample comprised 1,932 participants. The weighted mean age was 51.3 years (SD=17.2, range 21 – 97). Young adults numbered 646 (36.8%), while 775 (39.1%) were middle-aged, and 511 (24.1%) were older adults. Multimorbidity was reported by 27.8% of participants. The prevalence of multimorbidity was 4.7% in young adults, 28.2% in middle-aged adults, and 62.4% in older adults, respectively.

As shown in Table 1, the proportion of participants with problems in each EQ-5D dimension increased as the number of chronic diseases increased (p<0.001). Middle-aged adults had higher proportion reporting problems in individual EQ-5D domains than young adults, and older adults had the highest proportion. Older adults had lower SRH than young adults (p=0.01).

The presence of a single chronic condition was significantly associated with lower EQ5D index score and SRH in young adults. Multimorbidity is consistently associated with reduced EQ5D index score and SRH in all three age groups (Table 2).

Conclusion

The findings of this study suggest that the presence of one chronic disease has a higher impact on young adults' SRH, compared to other age groups. As multimorbidity is consistently associated with poorer HRQoL and SRH in all age groups, an exploration of the needs of and challenges experienced by individuals with multimorbidity may be necessary to improve their HRQoL and SRH.

Table 1. HRQoL and SRH of the participants by age groups and number of chronic diseases.

EQ-5D domain	Age group			Number of chronic diseases		
	Young (n=646)	Middle-aged (n=775)	Older (n=511)	0 (n=965)	1 (n=403)	≥2 (n=564)
Problems in Mobility, n (weighted %)	5 (0.6)	49 (7.0)	79 (15.2)	12 (1.4)	31 (6.8)	90 (16.2)
Problems in Self-care, n(weighted %)	2 (0.3)	7 (1.1)	36 (6.7)	2 (0.4)	8 (1.5)	35 (5.8)
Problems in Usual activities, n(weighted%)	4 (0.4)	34 (4.4)	71 (14.2)	13 (1.4)	19 (4.0)	77 (13.6)
Pain/discomfort, n(weighted%)	93 (13.8)	161 (21.4)	159 (30.7)	124 (12.6)	91 (24)	198 (33.8)
Anxiety/depression, n(weighted%)	22 (3.2)	37 (4.8)	34 (6.9)	23 (2.2)	21 (5.3)	49 (9.0)
EQ-5D index score, weighted mean ± SD	0.97 ± 0.08	0.94 ± 0.11	0.89 ± 0.17	0.97 ± 0.09	0.94 ± 0.11	0.89 ± 0.17
SRH, weighted mean ± SD	79.2 ± 13.2	78.4 ± 14.1	76.5 ± 15.9	80.6 ± 12.5	76.8 ± 14.4	74.9 ± 16.3

Table 2. Regression coefficients (B, Standard Error) between categorical number of chronic diseases and HRQoL and SRH.

Models	Variables	EQ5D-Index						SRH					
		Young		Middle-aged		Older		Young		Middle-aged		Older	
		B	SE	B	SE	B	SE	B	SE	B	SE	B	SE
	Number of chronic diseases (Ref. No chronic disease)												
Model 1	1	-.03**	.01	-.01	.01	-.05*	.02	-5.45***	1.42	-2.18	1.19	-3.91	2.20
	2	-.04	.02	-.04**	.001	-.06**	.02	-6.62*	2.85	-2.06	1.49	-4.63*	2.09
	3	-.04	.03	-.01	.02	-.05*	.02	-7.97	4.29	-3.40	1.88	-5.68*	2.27
	4+	-1.1*	.04	-.08***	.02	-.14***	.02	-15.17*	6.21	9.69***	2.27	11.48***	2.40
Model 2	Number of chronic diseases (Ref. No or one chronic disease)												
	2+	-.04**	.02	-.05***	.01	-.05**	.02	-6.99**	2.29	-3.07**	1.12	-4.55**	1.46

Note: Adjusted for age group, gender, marital status, ethnicity, education level, employment status, living arrangement and financial status.

*p<0.05, **p<0.01, ***p<0.001

DISEASE PROGRESSION MODELLING USING MICROSIMULATION

Dr Zhu Zhecheng

Highlights

Microsimulation is a suitable modelling technique to simulate the progression of multiple chronic diseases longitudinally at an individual level.

Introduction

The growing healthcare burden related to diabetes and its complications is one of the biggest challenges to the sustainability of the existing healthcare system. Microsimulation is a type of simulation based on a large number of individuals. Each individual has unique characteristics including demographics, socioeconomic status and disease profiling. Microsimulation can model how an individual evolves overtime by following certain rules. This study applies microsimulation to model the disease progression of diabetes and its complications.

Methods

Figure 1 illustrates the one year disease progression network. Each color coded node represents a specific health state ranging from healthy to various complications. Links between nodes represent the possible transition from one state to another within a year.

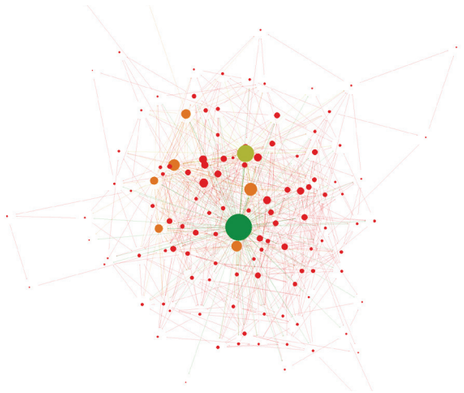


Figure 1. One year disease progression network

Within the framework of microsimulation, three different techniques are applied to model short-term disease progression: Markov chain Monte Carlo (MCMC), logistic regression and multi-label classification. Figure 2 illustrates the process of MCMC. The other two techniques have similar processes.

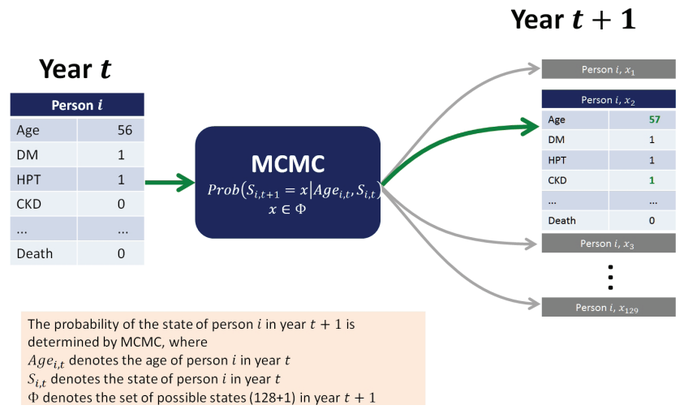
In this study, known patients living in the central region of Singapore were simulated. A one year disease progression network was generated from 2015 to 2016 data. The aforementioned modelling techniques were then used to predict new cases of different diseases of the simulation cohort from 2010 to 2017.

Results

Figure 3 and 4 illustrate the prediction results of the three different techniques. Compared to actual values, all three techniques can predict new cases of individual diseases within reasonable confidence intervals.

Conclusion

Microsimulation is a suitable modelling technique to simulate the progression of multiple chronic diseases longitudinally at an individual level.



The probability of the state of person i in year $t+1$ is determined by MCMC, where
$Age_{i,t}$ denotes the age of person i in year t
$S_{i,t}$ denotes the state of person i in year t
Φ denotes the set of possible states (128+1) in year $t+1$

Figure 2. Markov chain Monte Carlo (MCMC)

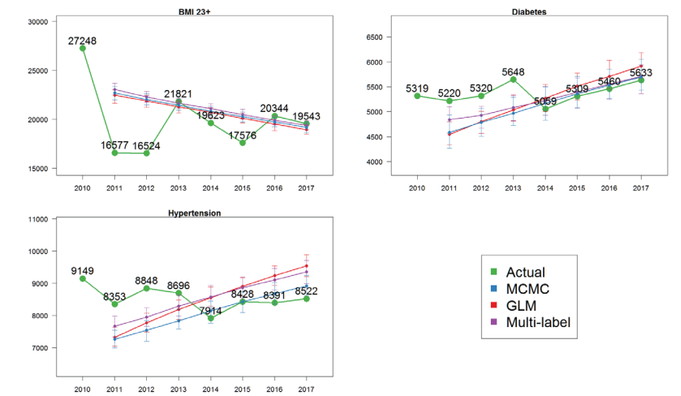


Figure 3. Prediction result part 1

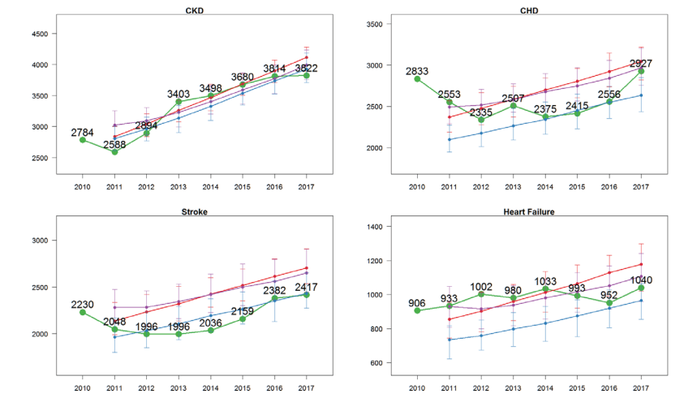


Figure 4. Prediction result part 2

HYPERTENSION AND CARDIOVASCULAR COMPLICATIONS IN CENTRAL AND NORTHERN REGION: A RETROSPECTIVE COHORT STUDY IN SINGAPORE

Daveon Liu Yu Kai, Dr Ang Yee Gary, Teow Kiok Liang, Dr Heng Bee Hoon

Highlights

High concurrence of patients with hypertension, diabetes, dyslipidemia and cardiovascular (CV) complications.

85% of patients newly diagnosed with hypertension have pre-existing medical conditions.

Development of CV complications correlates with increasing age and hypertension.

Introduction

Hypertension is commonly described as a "silent killer" as it can be asymptomatic until a complication develops. Prolonged uncontrolled hypertension increases the risk of cardiovascular (CV) –related morbidity and mortality. Early recognition and treatment is crucial to delay disease progression and complications. This study aims to (1) describe the prevalence of hypertension and CV complications in the central and northern region of Singapore (2) determine the annual hypertension to CV complication transition rate.

Methods

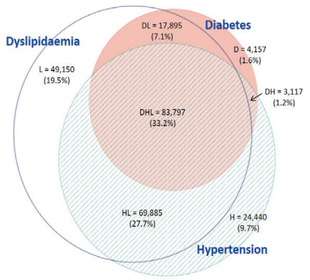
All patients living in the central and northern region of Singapore with hypertension recorded in the National Healthcare Group (NHG) Chronic Disease Management System (CDMS) from 2010 to 2017 were included in this retrospective cohort study. They were followed up until death or the end of the study period (31st December 2017).

To study the transition rate for patients who developed CV complications, patients were segmented into four mutually exclusive categories based on their encounters with NHG institutions in each year. The categories are as follows:

1. Deceased
2. Complications (developed any of the following conditions: chronic kidney disease stages 3A and above, coronary heart disease, acute myocardial infraction or stroke)
3. Stable (neither deceased nor developed CV complications)
4. Unknown (lost to follow up)

Results

From 2010 to 2017, a total of 257,488 patients were registered in CDMS with diagnosis of either diabetes (D), hypertension (H) or dyslipidemia (L). Majority however, has two or more conditions with L being most the prevalent condition followed by H, and D. 33.3% had all 3 conditions.



Distribution of D or H or L in NHG (n=252,448)		
Diabetes Mellitus	108,966	43.2%
Hypertension	181,239	71.8%
Dyslipidaemia	220,727	87.4%

Ministry of Health National Health Survey (Prevalence in SG)	1992	2016/17
Diabetes Mellitus	7.3%	8.6%
Hypertension	16.1%	21.5%
Dyslipidaemia	25.2%*	33.6%

* 2010

Figure 1. Distribution of DHL comorbidity

Table 1. Medical condition of patients with newly diagnosed with hypertension

	All	Previously unknown patients first encounter at NHG			
		ED		NHGP*	
		No.	%	No.	%
2010	3,837	1,410	36.7%	2,216	57.8%
2011	3,538	1,513	42.8%	1,960	55.4%
2012	3,146	1,446	46.0%	1,638	52.1%
2013	2,868	1,291	45.0%	1,538	53.6%
2014	2,366	1,068	45.1%	1,251	52.9%
2015	2,308	993	43.0%	1,278	55.4%
2016	2,105	942	44.8%	1,122	53.3%
2017	**2,189**	**1,078**	**49.2%**	**1,086**	**49.6%**

*HOU, AMK, TPH, WDL, YIS

ED diagnosis	2010 n=1,410	2017 n=1,078
Stroke	14.7%	17.9%
TIA	1.4%	1.6%
Hypertension	11.1%	15.9%
IHD	11.1%	7.7%
Pneumonia	3.4%	4.1%
Head injury	3.7%	3.0%
Dizziness and Giddiness	3.3%	2.7%
Chest pain	3.6%	2.1%
Hypoglycemia	2.0%	1.7%
Infection*	7.1%	1.6%
Headache	0.8%	0.9%
NHGP diagnosis	**2010 n=2,216**	**2017 n=1,086**
Hypertension	58.6%	56.6%
Hyperlipidaemia	10.5%	10.0%
Type II DM	6.3%	7.0%

* Cellulitis, Unspecified infectious and parasitic dis, Cutaneous abscess

Among patients with newly diagnosed hypertension in 2017, 50% were first presented at an Emergency Department with serious complications such as stroke, ischemic heart disease and chest pain

Table 2. Complications annual transition rate

Hypertension only

Stable Patients	n	Mean Age (y)	% 65+	Complications Annual Transition Rate (%)						
				2011	2012	2013	2014	2015	2016	2017
2010	9,929	57.1	29.9%	2.0%						
2011	9,478	57.6	30.7%		1.8%					
2012	9,764	57.7	31.5%			2.4%				
2013	10,330	58.0	32.2%				2.1%			
2014	10,823	58.5	33.9%					2.3%		
2015	11,657	58.7	34.9%						2.6%	
2016	12,616	58.7	34.8%							2.2%

Hypertension + Lipids

Stable Patients	n	Mean Age (y)	% 65+	Complications Annual Transition Rate (%)						
				2011	2012	2013	2014	2015	2016	2017
2010	28,965	61.2	36.5%	3.4%						
2011	28,911	61.8	38.9%		3.2%					
2012	28,967	62.2	40.9%			3.7%				
2013	28,848	62.7	42.5%				3.3%			
2014	28,669	63.2	45.1%					3.1%		
2015	28,564	63.6	46.8%						3.2%	
2016	28,414	63.9	47.7%							**3.6%**

Hypertension + Diabetes

Stable Patients	n	Mean Age (y)	% 65+	Complications Annual Transition Rate (%)						
				2011	2012	2013	2014	2015	2016	2017
2010	955	63.4	47.7%	3.7%						
2011	854	62.8	47.7%		3.3%					
2012	866	63.2	47.6%			4.0%				
2013	857	62.9	47.7%				3.5%			
2014	855	62.6	45.6%					4.5%		
2015	878	62.4	43.6%						4.5%	
2016	900	62.7	45.0%							**4.6%**

Hypertension + Lipids + Diabetes

Stable Patients	n	Mean Age (y)	% 65+	Complications Annual Transition Rate (%)						
				2011	2012	2013	2014	2015	2016	2017
2010	24,658	61.3	37.0%	5.7%						
2011	24,598	61.8	38.9%		5.4%					
2012	24,558	62.2	40.7%			6.4%				
2013	24,532	62.5	42.2%				6.0%			
2014	24,362	62.9	44.1%					5.8%		
2015	24,227	63.2	45.6%						6.0%	
2016	24,050	63.5	46.7%							**6.3%**

The annual rate of transition to CV complications at 6.3% is highest among patients with DHL compared to DH and HL, at 4.6% and 3.6%, respectively.

Conclusion

The high prevalence of hypertension and CV complications remains a burden to the healthcare system. Early recognition and optimal management of risk factors is crucial to delay the onset of CV and cerebrovascular diseases. Healthcare organizations should consider proactive strategies to detect and treat hypertension earlier.

PROVIDER PERSPECTIVE

A FOCUS ON IMPROVING ORGANIZATIONAL PERFORMANCE IN COST, QUALITY, ACCESS

ESTABLISHING A SENIOR FRIENDLY CULTURE OF CARE – EVALUATION OF THE FRAMEWORK FOR THE INPATIENT CARE OF THE FRAIL ELDERLY (FIFE)

Dr Joseph D. Molina, Dr Michelle Jessica Pereira, Dr Tan Thai Lian[1]

[1] Centre for Geriatric Medicine, Tan Tock Seng Hospital

Highlights

Hospital-wide implementation of geriatric principles of care in an elderly-friendly environment is feasible.

Patients in FIFE wards were less likely to suffer pressure ulcers or be on restraints, and enjoyed earlier access to occupational therapy, nutrition screening and dietician referral.

Introduction

While receiving specialty specific care during a hospital admission, the unique needs of frail older patients are often missed. A senior friendly hospital with patient centered geriatric care that promotes independence, participation, self-fulfillment, dignity and quality was envisioned. FIFE aimed to: identify patients at risk so their needs can be swiftly identified and addressed; prevent or minimise complications of hospitalisations through geriatric care principles; facilitate timely discharge planning and appropriate care transition with tight care coordination; and assist in setting care goals especially for those with advanced disease. The FIFE program consists of four key components: (1) development and deployment of Geriatric Resource Nurses and Ward Resource Nurses; (2) establishing a multi-disciplinary Geriatric Comprehensive Assessment and Rehabilitation Evaluation team; (3) continuous geriatric training and education; and, (4) coordination of care transitions. This evaluation assessed the effectiveness of FIFE in providing quality inpatient care, reducing complications and unnecessary utilization of services and, examined the utilisation cost impact.

Methods

Twenty wards were randomized as clusters into FIFE (intervention) and Control. Four medical, 4 surgical and 2 mixed medical-surgical wards each were assigned as FIFE and Control wards. Patients ≥65 years admitted to study wards from August 2016 to October 2017 and who remained at the same ward type throughout their admission were studied. Patient level between-group comparisons were conducted for average length of stay (ALOS), timeliness of referral to allied health, number of geriatric syndromes identified, proportion with discharge services, proportion of those who failed nutrition screening referred to dietician, 7- and 30-day readmission rate, and inpatient utilisation costs. Ward level comparisons were made for physical restraint use, falls and pressure ulcer incidence, and diaper use. Physical restraint use data was collected through random unannounced ward visits. For the other outcomes, data were extracted from case notes, or from administrative databases.

Results

There were 2,084 FIFE and 2,119 Control patients included in the analysis, representing 83.5% and 84.9%, of all patients admitted to FIFE and Control wards at the point of hospital admission, respectively. The groups were similar in terms of age, gender, ethnicity and disease complexity. Aggregate (ward level) results showed that patients admitted to FIFE wards were less likely to be placed on physical restraints (RR = 0.75, 95%CI = 0.59, 0.93) and to develop pressure ulcers (RR = 0.64, 95%CI = 0.41, 0.99), but had a higher average number of diapers used per patient bed-day (difference = 0.082, 95%CI = 0.002, 0.164).

Compared to controls, a significantly greater proportion of FIFE patients were discharged to community hospital (11.3% vs. 2.6%), were found to have one or more geriatric syndromes (5.7% vs. 1.6%), and were discharged with at least one post-discharge service (9.4% vs. 6.5%). More FIFE patients were screened for malnutrition, and of those screened, FIFE patients were more likely to be referred to a dietician than controls (OR = 1.23, 95% CI = 1.07, 1.42). The time taken to be referred to an occupational therapist was shorter for FIFE patients (mean = 2.1 vs. 2.4 days). There were no between-group differences in 7 and 30 day re-admission rates (95% CI for OR = 0.74 – 1.21; and 0.83 – 1.13, respectively).

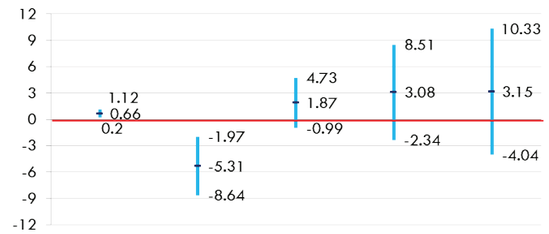
Overall ALOS was significantly longer for FIFE patients (8.6 vs. 7.2 days). After excluding contact precaution wards, and stratifying by discharge disposition, only FIFE patients discharged home were found to have significantly longer ALOS than controls (7.2 vs. 6.6 days). FIFE patients discharged to community hospitals had a significantly shorter ALOS than controls (95% CI of difference = -2.0, -8.6) (Figure 1).

Multivariate subgroup analysis for patients admitted to specialty-matched wards and discharged home showed no significant difference in ALOS between FIFE and controls (95% CI for IRR = 0.85, 1.09).

Multivariate generalised linear models showed that FIFE patients had higher inpatient costs, inclusive of patient-level attributed program costs (IRR = 1.11; 95% CI = 1.04, 1.19). However, there was an increased level of uncertainty surrounding the higher inpatient cost estimates for FIFE patients when clustering of wards was accounted for (IRR = 1.11; 95% CI = 1.01, 1.23).

Conclusion

Results demonstrated the feasibility and effectiveness, and the impact on inpatient utilisation costs of providing medical management consistent with geriatric principles of care beyond the geriatric ward.



*Difference = $ALOS_{Intervention} - ALOS_{Control}$

ΨExcludes patients discharged from Contact Precaution Wards

ϒ"Others" includes discharges to: Welfare Home, Sheltered Home, BSU, TCS, Hospice, KKH, IMH, NUH

Figure 1. 95%CI of the difference* in average length of stay, by discharge dispositionΨ

CAN A NO-SHOW PREDICTION MODEL REDUCE OVERRUN OF OUTPATIENT APPOINTMENTS?

Teow Kiok Liang

Highlights

While predictive analytics have been used to study factors associated with patient no-shows, the operational implementation and benefits of such models have not been clearly illustrated.

Our study simulates the application of a patient no-show model for their impact on a clinic's overrun reduction and tests a range of operational parameters. We find that the no-show prediction accuracy needs to be better than 90% to be impactful for this purpose.

Introduction

Patient no-show is prevalent in outpatient clinics and generally hovers around 20% despite many interventions to reduce it. Researchers have recently started applying statistical and data mining models to predict no-show at the individual patient level to intervene on the high-risk group and reduce the no-show rate, or to 'better manage patient flow'. In this study, we examine the latter and quantify a 'well-managed patient flow' as an outpatient clinic with less 'overrun'. Overrun is when more-than-expected number of patients attend. The aim of this study is to investigate if overrun can be reduced when a no-show prediction model is used to allocate appointments.

Methods

With the prediction model, the appointment slots are partitioned into predicted attendance and predicted no-show. However, as the model is never perfect, we can simulate the actual attendances and therefore overrun probability using a Binomial distribution. Sensitivity analysis considered no-show prevalence ranging from 5% to 35%, no-show prediction accuracy ranging from 70% to 95%, and expected attendance from 5 to 20. The results are compared to that without a prediction model (i.e., a standard no-show probability for each patient). The results are presented in terms of reductions in overrun.

Results

As shown in Table 1, the reduction in overrun with a prediction model is small when the prediction accuracy is 85% or lower, regardless of no-show prevalence and expected attendances. The improvement is more obvious when the prediction accuracy hits 90%, and gives modest improvements at 95% accuracy.

Conclusion

While we can use the prediction model to split the appointments into predicted attendance and predicted no-show, the reduction in overrun is not high, unless the no-show prediction model accuracy is higher than 90%. The benefit of using a no-show prediction model to reduce clinic overrun should not be overstated. However, other applications of no-show model could be explored.

Table 1. Reduction in overrun probabilities with no-show prediction model (Baseline probability of clinic overrun minus probability of clinic overrun with a prediction model)

Expected Attendances	No-show prevalence						
	0.05	0.10	0.15	0.20	0.25	0.30	0.35
No-show prediction accuracy = 80%							
5	0%	10%	9%	7%			
10	6%	5%		0%			2%
15	4%	-2%	0%	1%	3%	4%	
20	3%	5%	2%	3%		1%	
No-show prediction accuracy = 85%							
5	0%	-3%		12%			2%
10	2%		4%	8%	4%	6%	8%
15	3%	7%					3%
20	4%	6%	1%	1%	6%		-1%
No-show prediction accuracy = 90%							
5	0%	6%			7%		9%
10	13%	9%			13%		
15	2%	4%	6%	8%	8%	7%	
20	6%	8%			3%	6%	
No-show prediction accuracy = 95%							
5		22%	16%		21%		21%
10	8%			11%			
15							
20	10%	12%					

Note: Only the cases with similar number of planned attendances between baseline and predicted models are shown. Green cells are instances with improvement, and red cells are those with poorer results.

DEVELOPMENT OF A DASHBOARD TO MONITOR QUALITY INDICATORS FOR HEART FAILURE CARE

Palvinder Kaur, Dr Wong Ching Chiew Raymond[1], Rose Low Shiow Ling[2], Dr Pradeep Paul George

[1] Senior consultant, Department of Cardiology, National University Hospital Heart Centre
[2] Population Health, National Healthcare Group Headquarters

Highlights

A dashboard was developed to monitor heart failure quality indicators using R Shiny analytical tool.

The data visualisation dashboard facilitates quick audits of heart failure quality indicators among seven healthcare institutions in Singapore.

Introduction

Heart failure (HF) is a growing healthcare problem associated with reduced quality of life, poor outcomes and significant financial burden. HF care pathways vary among hospitals in Singapore. The Heart Failure Service Improvement (HFSI) Program identified key quality indicators to measure processes and outcomes across the six restructured hospitals (RHs) and a national heart centre. Nine process indicators and 7 outcomes indicators were identified. We developed a dashboard that allows for quick computation and visualisation of these indicators measured at all the healthcare institutions.

Methods

The HFSI dashboard is an extensible toolkit that uses R software packages for data management and produces visualisations using R/Shiny web server architecture (Figure 1). All relevant data from the seven healthcare institutions were extracted from hospital administrative databases and medical case notes by case managers. The data was entered and stored into REDCap (an online data collection platform), and subsequently loaded into R Studio. Pre-processing of the data was done in the R environment and the relevant statistics were generated for the HFSI quality indicators. Other information such as patient profile and program recruitment statistics were also generated. These automated results were visualised and presented graphically on the R Shiny Dashboard.

Limitations

Recent developments with data protection policies, may limit the access of the dashboard by all intended institutions. Currently, the dashboard is stored in the HSOR shiny server that is linked to the National Healthcare Group (NHG) intranet system. This limits access to institutions within NHG. Alternative data distribution methods are required to ensure data protection requirements are met and enable accessibility of the dashboard to all healthcare institutions in Singapore.

Conclusion

The HFSI dashboard serves as a visual performance scorecard for the hospitals. It enables hospital administrators to track HF quality indicators, allowing easy and efficient identification of indicators that either achieve or did not achieve the expected targets across all healthcare institutions.

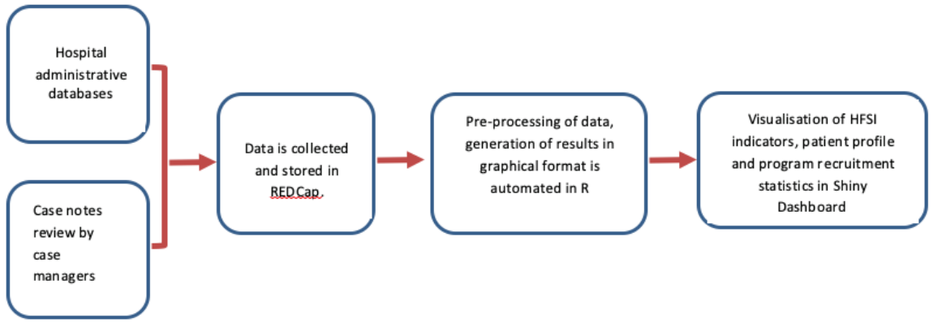


Figure 1. Analytic Architecture of the HFSI dashboard

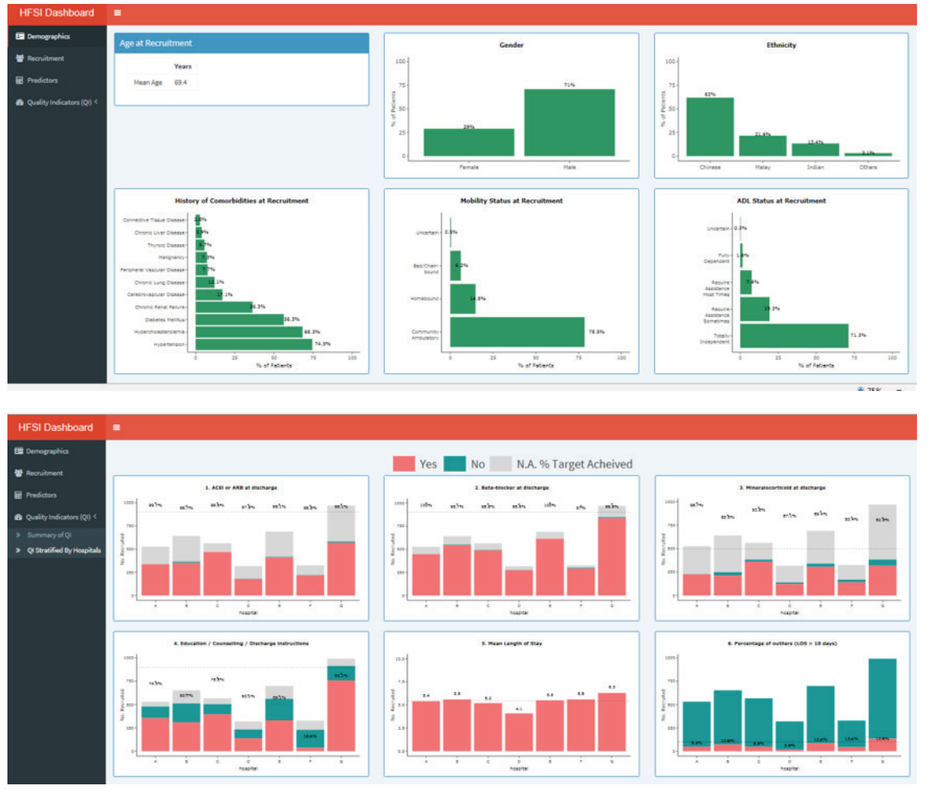


Figure 2. Screenshots of the HFSI Dashboard

A DATA AUTO-TABULATION TEMPLATE FOR AN ADVERSE EVENTS STUDY

Max Wu Binghuang, Dr Pradeep Paul George, Ge Lixia, Palvinder Kaur, Dr Ang Yee Gary, Prof Tai Hwei Yee[1]

[1] NHG Quality Resource Management

Highlights

A MicroSoft® Excel template for auto-tabulation of adverse events data can reduce the turnaround time for the generation of the associated report.

Introduction

Adverse events (AEs) cause direct harm to patients, and also considerable financial burden to the healthcare system. Detection of AEs using the World Health Organisation (WHO) Review Form 1 (RF1) and RF2 questionnaires is commonly performed worldwide. Synthesising the information from these questionnaires involves generating more than 40 descriptive tables and charts. This can be labour-intensive and time-consuming, especially when performing this for multiple healthcare institutions. We have developed a MicroSoft® Excel template for the auto-tabulation of AEs data collected using RF1 and RF2.

Methods

Data collected using WHO RF1 and RF2 was uploaded into an online database (REDCap) for several public healthcare institutions in Singapore. The dataset was exported into a single MicroSoft® Excel spreadsheet and cleansed. Data cleansing involved the detection, removal or correction of errors and inconsistencies due to corruption or inaccurate entry of data.

Tables and chart templates were prepared in MicroSoft® Excel and linked to a master table to facilitate auto-tabulation. This process is depicted in Figure 1.

Results

Required formulas for AEs reporting are now easily read and expressed (Figure 2), as data is not represented in "range" (e.g. "A1:A4") but "headers" (e.g. [Age]; [Gender]) using MicroSoft® Excel tables. Moreover, as data is added or removed to the MicroSoft® Excel table, it automatically expands with the derived data fields calculated.

Figure 3 shows a pivot table on the right with summarised data of "Preventability Category" and "AE Category" in a cross table format. The final template table on the left of the figure 3 then uses the summarised data of the pivot table to form the final reporting table with proper formatting.

Once all template tables have been created, auto-tabulation of future report tables can be achieved by updating the MicroSoft® Excel table with new datasets of the same variables and refreshing all "Queries & Connections" under the "Data" tab.

PROVIDER PERSPECTIVE

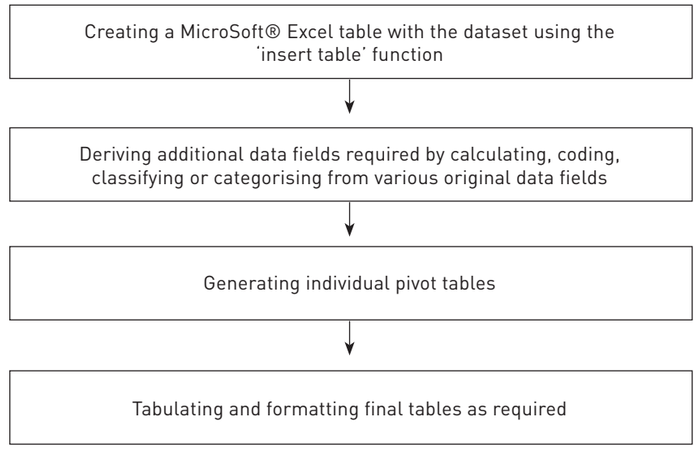


Figure 1. The flowchart of the tabulation process

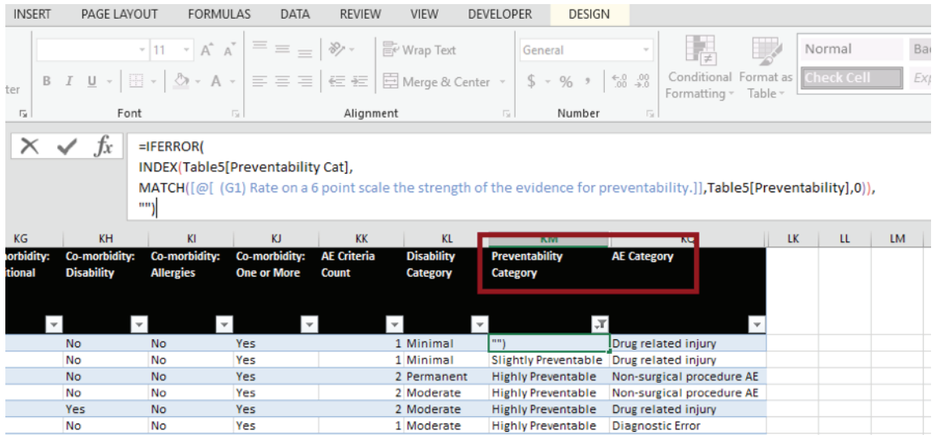


Figure 2. Example of the formula with "headers"

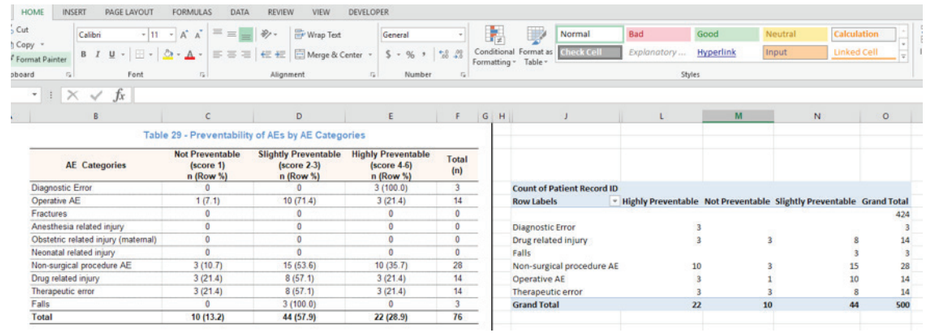


Figure 3. Examples of a pivot table and a final table

ADVERSE EVENTS IN NATIONAL HEALTHCARE GROUP INSTITUTIONS

Dr Pradeep Paul George, Ge Lixia, Palvinder Kaur, Max Wu Binghuang, Dr Ang Yee Gary, Julia Ng Li Min[1], Prof Tai Hwei Yee[1]

[1] NHG Group Quality Resource Management

Highlights

One in seven hospital admissions had an adverse event, of which 81% are potentially preventable.

Introduction

An adverse event (AE) is defined as any unwanted injury to a patient, caused by medical management rather than the disease or patient's own actions. AEs may cause significant harm to patients seeking healthcare. This study aims to determine the prevalence and preventability of AEs at National Healthcare Group (NHG) hospitals.

Methods

This study involved a two-stage review of 500 randomly selected inpatient episodes (identified as "index" admissions) from each of the four NHG hospitals (Tan Tock Seng Hospital, Institute of Mental Health, Khoo Teck Puat Hospital and Yishun Community Hospital) during the calendar year of 2016. The medical records of these admissions were reviewed by a team of specifically trained registered nurses and doctors in two stages using the Review Form 1 (RF1) and Review Form 2 (RF2) respectively to detect harm to patients caused by the inpatient care they received. The RF1 identifies records for presence of 18 specified criteria which indicate a higher likelihood of an adverse event. Records with positive criteria in RF1 would proceed to a second stage review by the doctors using the RF 2 to determine the AEs. No further review was undertaken for negative records of RF1. Patient injury and disability caused by the inpatient care provided during admissions were defined as AEs. All data was collected using an app based cloud storage data collection platform (RedCap).

Results

Two-hundred and eighty four (14.2%) of the admissions were associated with an AE. The rates of AE increased with age (Figure 1). It was higher in patients with disability (20.4%), haematological disorders (20.2%), and infection (19.4%). About 67% of patients with AE suffered minimal disability (recovery within one month), but 5.3% suffered permanent disability or death as a consequence of the AE. Among the nine AE categories shown in Table 1, diagnostic error is associated with the highest rate (9.1%) of permanent disability or death, followed by therapeutic error (7.9%). Admissions with AEs had a longer length of stay by 8.4 days.

About 81% of the AEs were determined to be potentially preventable and more common among the elderly (Table 2). The use of protocol/treatment guidelines and education has been suggested by the AE review team to help reduce the occurrence of AEs.

Conclusion

This study determined the prevalence and preventability of AEs occurring during inpatient admissions in certain public healthcare institutions in Singapore. The findings will help to provide a baseline to guide future interventions to reduce AEs and improve patient safety.

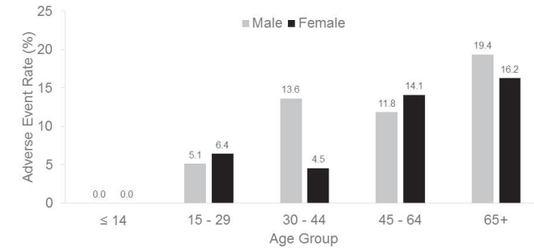


Figure 1. AE Rates by Age Group and Gender

Table 1. Disability of AEs by AE Categories

AE Categories	Minimal (Score 1)	Moderate (Score 2 – 3)	Permanent/ Institutional Care (Score 4 – 7)	Death (Score 8)	Unable to Judge (Score 9)	Total (n)
	n (Row %)	n (Row %)	n (Row %)	n (Row %)	n (Row %)	
Diagnostic Error	2 (18.2)	7 (63.6)	1 (9.1)	0	1 (9.1)	11
Operative AE	18 (46.2)	19 (48.7)	1 (2.6)	1 (2.6)	0	39
Fractures	0	3 (100.0)	0	0	0	3
Anesthesia related injury	0	0	0	0	0	0
Obstetric related injury (maternal)	0	0	0	0	0	0
Neonatal related injury	0	0	0	0	0	0
Non-surgical procedure AE	53 (80.3)	9 (13.6)	3 (4.5)	0	1 (1.5)	66
Drug related injury	46 (85.2)	6 (11.1)	0	1 (1.9)	1 (1.9)	54
Therapeutic error	66 (65.3)	24 (23.8)	2 (2.0)	6 (5.9)	3 (3.0)	101
Falls	6 (60.0)	4 (40.0)	0	0	0	10
Total	**191 (67.3)**	**72 (25.4)**	**7 (2.5)**	**8 (2.8)**	**6 (2.1)**	**284**

Table 2. Preventability of AEs by AE Categories

Age Group	**Preventability**			
	Not Preventable (Score 1) n (Row %)	Slightly Preventable (Score 2-3) n (Row %)	Highly Preventable (Score 4-6) n (Row %)	Total
<= 14	0	0	0	0
15 - 29	6 (60.0)	3 (30.0)	1 (10.0)	10
30 - 44	8 (32.0)	5 (20.0)	12 (48.0)	25
45 - 64	12 (16.0)	33 (44.0)	30 (40.0)	75
65+	27 (15.5)	85 (48.9)	62 (35.6)	174
Total	**53 (18.7)**	**126 (44.4)**	**105 (37.0)**	**284**

POLICY PERSPECTIVE

A FOCUS ON HEALTH POLICY CONCERNS OF STEWARDING RESOURCES SUSTAINABLY AND ACHIEVING NATIONAL OUTCOMES

REGIONAL DISPARITY IN EMERGENCY DEPARTMENT UTILISATION IN SINGAPORE

Dr Sun Yan, Dr Meng Fanwen, Dr Ooi Chee Keong[1] and Dr Ang Hou[1]

[1] Emergency Department, Tan Tock Seng Hospital

Highlights

Singapore's central region has the lowest emergency department utilisation rate compared with the north and west regions among the elderly, while there is no regional disparity among younger population utilisation.

Differing regional public primary healthcare resources does not explain the disparity.

Introduction

It is important for policy makers and healthcare providers to understand the regional disparity in healthcare resource utilisation to better serve population healthcare needs. There are 7 healthcare regions in Singapore (central, east, north, northeast, south, southwest, and west). The study aims to: 1) understand if regional disparity in emergency department (ED) utilisation rates across age groups exists, and 2) explore if the availability of public primary healthcare resources in a region can explain any disparity.

Methods

A cross sectional study was conducted. Study points were the subzone residential areas in the 7 healthcare regions in Singapore. Information collected include: Geographical data of number of public primary care centres, postal codes, subzone, Urban Development Guide Plan (DGP) planning area, and region (Urban Planning Authority); Summarized national ED visits data (Ministry of Health Omnibus); and Population level data like size, gender and age distribution (Department Of Statistics). Supply network analysis was applied to analyze the accessibility of healthcare resources, which is measured by the Visibility Index (VI) in this study. Formula for calculating VI is:

N: number of subzones (DGP areas or postal codes)

M_1: number of hospitals

M_2: number of polyclinics

$d_{n,m}$: distance between the subzone n to a hospital/polyclinic m

Visibility to polyclinics by subzone:

$$VI_n = \frac{\sum_{m=1}^{M_2} \frac{1}{d_{n,m}}}{(N+M_2)+(N+M_2)}$$

Generalized linear regression was used to measure age and gender adjusted regional disparity in ED utilisation rate per 1000 population, and the impact of accessibility of public primary care resources in a region on the ED utilisation rate.

Results

The average ED visits per 1000 population per year were 371 for the elderly (age ≥60) and 454 for the younger population (age<60). Figure 1 shows ED utilisation rates by healthcare regions. Figure 2 depicts the VI across smaller subzones in Singapore. Results of age and gender stratified ED utilisation rates are show in Table 1 for the elderly and in Table 2 for younger population. For the elderly, the central region had lower ED utilisation rate than the north and west region (Table 1a). Increased primary healthcare accessibility increased ED utilisation rate among the elderly (Table 1b). Thus, the regional disparity in ED utilisation among the elderly is not explained

by accessibility of primary healthcare. For the younger population, there was no regional disparity in ED utilisation rate (Table 2a). The results did not change when VI was accounted for (Table 2b). There was no association between accessibility to public primary care resources and ED utilisation rate among the young.

Conclusion

The results suggest that the availability of public primary healthcare resources does not explain the regional disparity for ED utilisation rate among the elderly. Other factors like the availability of private primary healthcare resources, differing ethnic distribution, differences in population health status or lifestyle might be possible causes. Further study is needed to understand what drives the regional disparity in ED utilisation rate among the elderly.

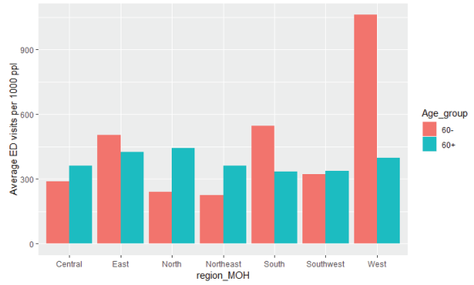


Figure 1. ED utilisation rate by region

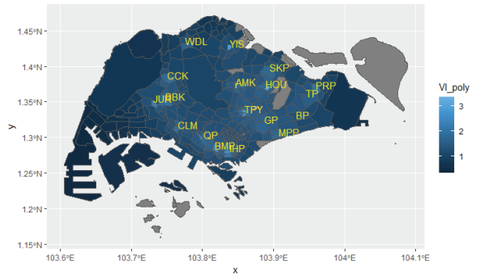


Figure 2. VI by subzone in Singapore

Table 1. ED utilisation rate among the elderly before and after adjusting for VI

Population Age≥60	No VI adjusted (a)			VI adjusted (b)		
Factor	Coef.	Std error	p-value	Coef.	Std error	p-value
Region [Central]						
East	-0.001	0.016	n.s.	0.013	0.016	n.s.
North	0.040	0.017	0.016	0.059	0.017	0.001
Northeast	0.019	0.022	n.s.	0.028	0.021	n.s.
South	0.003	0.013	n.s.	0.002	0.012	n.s.
Southwest	0.007	0.014	n.s.	0.017	0.013	n.s.
West	0.020	0.015	n.s.	0.031	0.015	0.034
Mean age	6%	0.002	0.011	0.004	0.002	0.018
Male %	9%	0.036	<0.001	1.231	0.035	<0.001
VI_poly	-	-	-	0.049	0.012	<0.001

Table 2. ED utilisation rate among younger population before and after adjusting for VI

Population Age≥60	No VI adjusted (a)			VI adjusted (b)		
Factor	Coef.	Std error	p-value	Coef.	Std error	p-value
Region [Central]						
East	-0.027	0.028	n.s.	-0.028	0.028	n.s.
North	-0.012	0.028	n.s.	-0.015	0.029	n.s.
Northeast	-0.026	0.038	n.s.	-0.027	0.038	n.s.
South	0.019	0.021	n.s.	0.019	0.021	n.s.
Southwest	-0.006	0.022	n.s.	-0.008	0.023	n.s.
West	-0.010	0.025	n.s.	-0.011	0.025	n.s.
Mean age	-0.003	0.004	n.s.	-0.003	0.004	n.s.
Male %	1.441	0.029	<0.001	1.440	0.029	<0.001
VI_poly	-	-	-	-0.006	0.021	n.s.

THE IMPACT OF HOME-BASED PALLIATIVE CARE FOR ADVANCED DEMENTIA PATIENTS: WHAT IS THE COST-SAVINGS THRESHOLD?

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Highlights

The average monthly cost of delivering home-based palliative care for advanced dementia patients at end-of-life is approximately SGD$ 2,180 from a provider's perspective.

This estimate remains 20% cost-saving for specific healthcare utilisation costs, inclusive of home-based palliative costs for duration of enrolment, compared to without home-based palliative care.

Introduction

The prevalence of dementia is increasing. Care of advanced dementia (AD) patients at end-of-life is costly. Many AD patients and families prefer to access this care at home. This study aimed to (1) determine the impact of an integrated multidisciplinary home-based palliative care program (Program Dignity) on healthcare utilisation, and (2) estimate the maximum cost of providing this care for AD patients at end-of-life, whilst maintaining cost-savings from a provider's perspective.

Methods

A retrospective cohort study was performed. Deceased AD patients (as of December 2017) who lived in the central region of Singapore, with albumin levels ⩽35g/L, on enteral feeding or diagnosed with pneumonia in the past year prior to enrolment were included in the study. A comparison between patients who were enrolled in Program Dignity and a historical control group was made. Look-back periods of 1-, 3-, 6- and 12-months from death were examined. The emergency attendances, admissions, cumulative length of stay (LOS), and associated utilisation costs were obtained. Program Dignity patients were assumed to incur monthly home-based care costs from enrolment till death and these costs were attributed to their total care costs depending on enrolment duration. Generalised linear models adjusted for age at death, gender, ethnicity, financial assistance status, and Charlson Comorbidity Index scores were used to analyse differences in costs between groups. Program Dignity's average monthly cost was increased incrementally by $10 from 930 in these multiple generalised linear models. Statistically significant (p-value<0.05) cut-offs of 70, 75 and 80% incident rate ratios (IRRs) were used to determine various cost-savings thresholds.

Results

253 Program Dignity and 139 control patients were analysed. 44% of Program Dignity patients were enrolled in the last month of life (mean enrollment period=144 days; SD=165). Except for Program Dignity patients being more medically complex than control patients with higher Charlson Comorbidity Index scores (mean 8.8 SD=2.7 versus mean 7.1 SD=1.9; p<0.001), there were no other between-group differences. Program Dignity patients were less likely to visit the emergency department, be admitted to hospital, and had a lower cumulative LOS for all look-back periods (Table 1). An IRR of 0.78 (Program Dignity versus controls for 1-month look-back, p<0.001) represents a reduction of approximately 8 days on average for cumulative LOS.

The maximum monthly home-based palliative care cost that is cost-saving from a healthcare provider's perspective for a significant 70, 75 and 80% IRRs for 1-, 3-, 6- and 12-months look-back periods are shown in Table 2.

Conclusions

Home-based palliative care for AD can minimise healthcare utilisation and costs during end-of-life, and be economically beneficial from a healthcare provider's perspective despite programmatic costs. Home-based palliative care is a potential cost-effective approach for managing end-of-life care needs of AD patients.

Table 1. Healthcare Utilisation Comparison between Program Dignity and Control Patients

Healthcare Utilisation	Look-back Period	Unadjusted Means ± SD		(95% CI) Reference = control = 1.00
		Program Dignity, n = 253	Control, n = 139	
Emergency Attendances (ORs)	1-month	0.39 ± 0.59	0.73 ± 0.65	0.26 (0.16 – 0.43)
	3-month	1.00 ± 1.03	1.50 ± 1.19	0.35 (0.20 – 0.60)
	6-month	1.62 ±1.50	2.14 ± 1.84	0.37 (0.19 – 0.70)
	12-month	2.45 ± 2.22	3.19 ± 2.62	0.36 (0.15 – 0.85)[+]
Admissions (ORs)	1-month	0.61 ± 0.67	1.07 ± 0.81	0.26 (0.16 – 0.43)
	3-month	1.08 ± 1.06	1.63 ± 1.29	0.36 (0.21 – 0.62)
	6-month	1.63 ± 1.45	2.23 ± 1.95	0.42 (0.22 – 0.80)
	12-month	2.38 ± 2.09	3.24 ± 2.79	0.31 (0.13 – 0.77)[++]
Cumulative Length of Stay (IRRs)	1-month	6.48 ± 8.31	12.01 ± 10.62	0.78 (0.72 – 0.84)
	3-month	15.40 ± 17.68	23.98 ± 22.67	0.76 (0.72 – 0.79)
	6-month	21.64 ± 22.65	33.85 ± 33.05	0.67 (0.64 – 0.70)
	12-month	29.72 ± 27.17	46.86 ± 44.31	0.63 (0.61 – 0.65)

SD = standard deviation; CI = confidence interval; OR = odds ratio; IRR = incidence rate ratio.
[+]p = 0.020; [++]p = 0.011; all other p <0.001.

Table 2. Program Dignity's maximum monthly costs across look-back periods considered

Incident rate ratio thresholds	1-month	3-month	6-month	12-month
70%	$1,880	$1,210	$1,320	$1,610
75%	$2,290	$1,700	$1,860	$2,360
80%	$2,700	$2,180	$2,420	$3,120

POLICY PERSPECTIVE

A NON-INFERIORITY STUDY OF NON-MENTAL HEALTHCARE UTILISATION OUTCOMES FROM CARE MODELS FOR MENTAL HEALTH PATIENTS WITH SPECIFIC COMORBIDITIES

Dr Michelle Jessica Pereira, Dr Joseph D. Molina, Dr Yap Chun Wei, Dr Alvin Lum[1], Ng Bee Lan[1], Prof Chua Hong Choon[1]

[1] Institute of Mental Health, National Healthcare Group

Highlights

Current care models for mental health patients with coexisting diabetes, hypertension or dyslipidaemia have equivalent non-mental healthcare utilisation, but potential non-mental healthcare utilisation cost differences may be demonstrated between models.

Introduction

Mentally ill patients with physical comorbidities have higher morbidity and mortality, but poorer healthcare access. In Singapore, 42.6% of mentally ill patients have a physical comorbidity. There is limited evidence for multimorbid care models in mental health. This study compared non-mental healthcare utilisation and associated costs of different care models for patients in Singapore with coexisting psychiatric and specific non-mental physical conditions of diabetes, hypertension or dyslipidaemia (DHL).

Methods

A retrospective cohort study was performed. Data was acquired from the National Healthcare Group (NHG) Regional Healthcare System (RHS) database. Adult-aged, Singapore residents living in the central region with at least 1 psychiatric outpatient visit at the Institute of Mental Health (IMH) during 2016 and 2017, diagnosed with DHL but without prior DHL care at NHG polyclinics, were tracked for 1 year from their first DHL-tagged visit.

3 groups of patients were compared using a non-inferiority design (Figure 1):

1. General practice (GP) group – Patients who ever visited a GP clinic sited at IMH during the study period. This GP clinic was established in 2016 to cater for IMH patients who, despite being referred to NHG Polyclinics, persistently default DHL care for a variety of reasons. This integrated care model was a response to the public health challenge of multimorbidity amongst mentally ill patients. The GPs at this clinic have post-graduate training in mental health.

2. National healthcare group polyclinics (NHGP) group – Patients who visited any NHG Polyclinic, for any chronic medical condition, two or more consecutive times during the study period. Prior to the IMH GP clinic being in service, all IMH patients with non-mental physical comorbidities were directed to NHGPs for their non-mental healthcare needs.

3. Psychiatrist-only group – Patients who made two or more consecutive psychiatrist outpatient consultations after their first psychiatric outpatient visit during the study period, and have not been characterised as GP or NHGP group patients.

Non-mental healthcare utilisation, comprising of Emergency Department (ED) and specialist outpatient visits, admissions, cumulative length of stay, and associated costs at Tan Tock Seng Hospital (TTSH) were examined. Covariates of demographics (age, gender, ethnicity, financial assistance status), diagnosis status of 7 psychiatric conditions (anxiety, depression, schizophrenia, dementia, alcohol addiction, substance addiction, bipolar disorder), and diagnosis status of additional non-mental chronic medical conditions were extracted and adjusted for in the statistical analyses. Zero-inflated poisson regressions were used to analyse utilisation outcomes, and generalised linear models (gamma family, log link) were employed for costs.

Results

Data from 493 patients was analysed (273 NHGP, 127 psychiatrist-only, 94 GP). All groups had similar ED and specialist outpatient visits, admissions and cumulative length of stay (Figure 2). GP costs were not different to the other groups. Considering an unknown non-inferiority equivalence margin, NHGP patients appeared to incur higher non-mental healthcare costs compared to psychiatrist-only care (mean costs: GP=$818 SD=151 – 1 484; NHGP=$1 229 SD=690 – 1 769; psychiatrist-only =$303 SD=105 – 501).

Conclusion

The current care models for mental health patients in Singapore with specific comorbidities demonstrated equivalent non-mental healthcare utilisation and potential differences in associated costs. Further evaluation of cost-effectiveness is urgently needed by policy makers to promptly facilitate the implementation of cost-effective multimorbid care models to improve healthcare access for this vulnerable and underserved population.

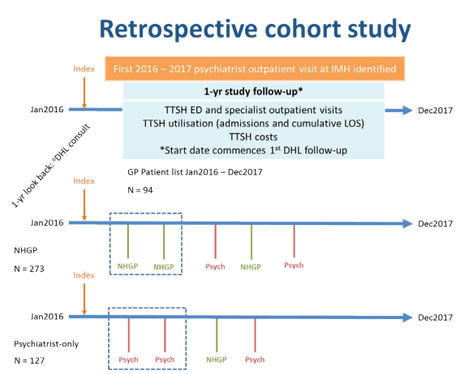

Figure 1. Graphical representation of study design

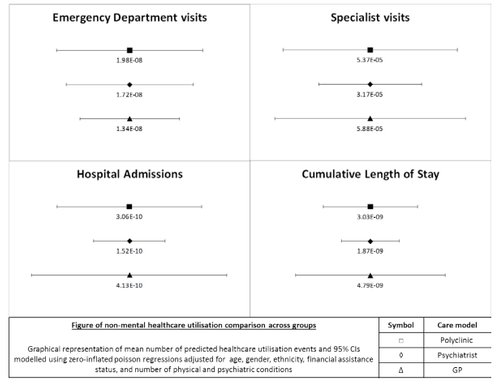

Figure 2. Comparison of utilisation outcomes at TTSH, across groups

COST UTILITY ANALYSIS OF HEARING AID FITTING FOR OLDER ADULTS IN SINGAPORE

Palvinder Kaur, Dr Pradeep Paul George, Palvannan R. K., Chong Sheue Lih[1], A/Prof Lynne Lim Hsueh Yee[1]

[1] ENT Head & Neck Department. National University Hospital, Singapore

Highlights

Hearing aid fitting is cost-effective and improves quality of life of older adults with hearing impairment.

However, long-term cost-effectiveness is dependent on the continuity of usage.

Introduction

Age-related hearing impairment will be a prevalent health problem in ageing societies. The tertiary intervention for age-related hearing loss (HL) is the use of hearing aids (HA). There is limited information on the cost-effectiveness of HA in Singapore. This study assessed the cost-effectiveness of the HA for older adults who visited a community-based mobile hearing clinic (MHC) for HL screening.

Methods

Volunteers were screened for moderate hearing loss at the MHC that provided services such as HL screening, HA fitting and post-audiological rehabilitation. Using a delayed start control design, the subjects were randomised into the immediate start (Fitted) group where HA was fitted immediately or the delayed start (Not Fitted) group where HA fitting was delayed for three months (Figure 1). A 3 month and extrapolated 5 year cost utility analysis (CUA) was used to compare the cost effectiveness of being fitted with HA combined with short-term post-fitting audiological rehabilitation (Fitted) with the routine care group who received no treatment (Not Fitted). The incremental cost effectiveness ratio (ICER) was the primary outcome studied. ICER was computed by taking the ratio of the difference between the total costs and difference between the quality adjusted life years (QALYs) produced by the two groups. Total costs included direct healthcare costs, direct non-healthcare costs and indirect costs (productivity loss of participant and caregiver). Cost incurred at the MHC (Fitted participants only), healthcare utilization and productivity loss due to hearing loss were collected through a survey. Health Utility Index (HUI-3) was used to measure utility (for the computation of QALYs). Cost and utility data were collected three months after the first visit to the MHC.

ICER for a 5-year time frame was calculated with the following assumptions: (1) 70% of participants continued HA usage for 5 years after first fitting, (2) utility gained at 3 months was held constant for 5 years and (3) healthcare utilization incurred at 3 months post HA fitting for both groups was extrapolated for 5 years with a 5% discount rate. Similar scenarios were projected with 50% and 25% HA-users at 5 years. A cost-effectiveness threshold of SGD$50,000 per QALY was used.

Results

There were 264 participants in the Fitted group and 163 participants in the Not Fitted group. Mean age was 69 years (SD=10.8) for both groups. There were no between-group differences in gender, ethnicity, and housing type. At 3 months, HA fitting led to a mean utility increase of 0.12 and an ICER gain of S$42,790/QALY (Table 1). At 5 years, the ICER was S$11,964/QALY with a 30% drop out rate (Figure 2). As lesser individuals continued using their fitted HA, the ICER increased.

Conclusion

HA fitting can be cost-effective and could improve the quality of life of hearing-impaired older individuals within a brief period of device fitting. Long term cost-effectiveness of HA fitting is dependent on its continued usage by older adults with hearing loss.certain public healthcare institutions in Singapore. The findings will help to provide a baseline to guide future interventions to reduce AEs and improve patient safety.

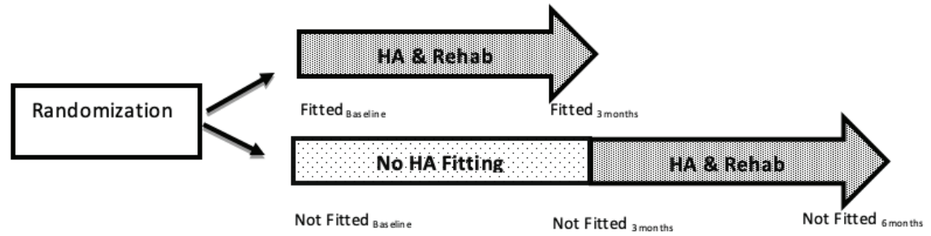

Figure 1. Schematic representation of study design. Cost and QALY outcomes were compared between Fitted and Not Fitted 3 months after first visit to MHC.

Table 1. ICER estimates based on primary data

	Total Cost[1] Fitted	Total Cost[2] Not Fitted	Utility Fitted	Utility Not Fitted	ICER	95% CI[3]
Mean estimates	5041.7	32.6	0.7657	0.6487	42,790	41,117 to 44,736

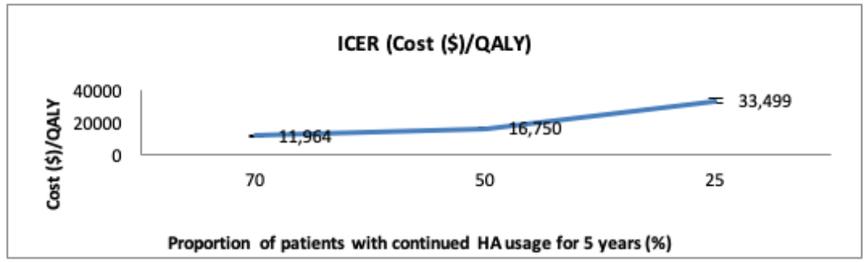

Figure 2. ICER estimates based on hypothetical HA usage (70%, 50% and 25%) at 5 years

ESTIMATING INCIDENCE RATE FROM AGE SPECIFIC PREVALENCE FOR CHRONIC CONDITIONS

Palvannan R. K., Dr Pradeep Paul George, Palvinder Kaur, Chong Sheue Lih[1], A/Prof Lynne Lim Hsueh Yee[1]

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Highlights

Estimating age-specific incidence rates of chronic conditions require longitudinal surveys. We show how age-specific incidence rates have been estimated from a single age-specific cross-sectional survey of prevalence, with certain assumptions.

We show the application in estimating age-specific incidence rates of moderate hearing loss from a cross sectional survey.

Introduction

Epidemiological studies need quantitative measurements of prevalence, incidence, mortality and time-to-event of diseases. This study focuses on estimations of incidence rates from prevalence studies of chronic diseases. Prevalence figures are obtained from cross-sectional surveys. These are usually presented as age-stratified numbers of a population, and are sometimes stratified further by demographic factors (e.g. gender, ethnicity). If the same cohort is successively measured in a longitudinal study, incidence rates (% per year) can be calculated directly. However, if only the age-specific prevalence of chronic conditions in a single cross-sectional survey is available, direct measurement of incidence rates is not possible. Podgor and Leske (1986) suggest a modeling approach which assumes constant age-specific rates and parametric assumptions of time-to-event distributions. They derived the calculations for 2 scenarios: a) mortality rates differ for those with and without a specific chronic condition; and b) the mortality rates do not differ. We used the latter approach when we had to estimate the incidence rate of moderate hearing loss from a single age-stratified cross-sectional population survey that provided prevalence data.

Methods

Equation (1) shows the relationship where there is a difference in mortality and Equation (2) when there is not ($\lambda 1 = \lambda 3$). Note that our interest is to find the incidence rate ($\lambda 2$). Equation (1) has to be solved numerically as there is no closed form expression. Equation (2) is calculated directly when mortality rates do not differ.

P_0 – Prevalence proportion (%) at age x

P_1 – Prevalence proportion (%) at age x+t

λ_1 – Mortality rate among disease free

λ_2 – Disease incidence rate

λ_3 – Mortality rate among those with disease

$$\frac{(1-P_0)P_1 e^{-(\lambda_1+\lambda_2)}}{1-P_1} = P_0 e^{-\lambda_3} + \frac{(1-P_0)\left[e^{-\lambda_3}-e^{-(\lambda_1+\lambda_2)}\right]\lambda_2}{\lambda_1+\lambda_2-\lambda_3}$$

$$\lambda_2 = \log\left(\frac{1-P_0}{1-P_1}\right)$$

The intuition behind the method is based on stock and flow of patients, and the assumption that the time-to-event of disease incidence follows a negative exponential distribution. Also, we assumed no cohort effect (i.e. the incidence risk of a person aged 50-59 today is the same as that of a person of the same age in the future).

Results

We assumed there is little difference in mortality among those with and without moderate hearing loss. Using equation (2), the 10-year incidence risk in the age group 50-59 is 6.0%, where the prevalence of moderate hearing loss among the age group 50-59 and 60-69 is 4.0% and 9.6% respectively. When the prevalence ratio is a small factor as above, it can be seen that incidence risk is approximately 1.062-1 ~ 0.06 (Note Taylor's approximation of log (1+x) ~ x-x2/2+x3/3).

$$\lambda_2 = \log\left(\frac{1-0.040}{1-0.096}\right) = \log(1.062) = 0.060$$

Repeating this for all age groups and adding up, it was estimated that the mean annual incidence rate of moderate hearing loss is about 7.4k patients among those aged 40 and above.

Conclusion

We applied a formula to estimate incidence risks from a single cross-sectional prevalence survey data that was stratified by age. This can be extended to the scenario where there is a difference in mortality due to the chronic condition.

Table 1. Prevalence of moderate hearing loss by age group, from National Health Survey (2010) and estimated incidence rates

Age	40-49	50-59	60-69	70+	40+	60+
Population (2010)^	632,800	551,700	303,500	226,800	1,714,800	530,300
Prevalence proportion (Moderate HL)^^	2.8%	4.00%	9.60%	15.0%*	6.0%	11.9%
Prevalence of Mod HL (patients)	17,718	22,068	29,136	34,020	102,942	63,156
Method						
10-yr incidence prop*	1.2%	6.0%	6.2%	6.2%		
10-yr incidence rate	7,861	33,159	18,693.	14,062		
1-yr incidence rate	786	3,316	1,869	1,406	**7,378**	**3,276**

^ DOS 2015, ^^ National Health Survey 2010, * Podgor M (1986)

Reference

Estimating incidence from age specific prevalence for irreversible diseases with differential mortality. Podgor M. J. and Leske M. C., Statistics in Medicine (5), 573-578 (1986).

PUBLICATIONS

1. **Ang YG.** Reversibility of diabetes mellitus: Narrative review of the evidence. World Journal of Diabetes 2018;9(7):127.

2. **Ge L, Yap CW, Heng BH.** Sex differences in associations between multimorbidity and physical function domains among community-dwelling adults in Singapore. PLOS One 2018;13(5):e0197443.

3. **Ge L, Yap CW, Ong RJ, Heng BH.** Effects of chronic diseases on health-related quality of life and self-rated health among Singapore adults. Nursing and Health Sciences 2018.

4. **Kaur P,** You AX, **George PP, Teow KL,** Wong RCC, Lim CP, **Heng BH,** Saxena N. Effect of Multimorbidity on the Survival of Patients Diagnosed with Heart Failure in Singapore. BMJ Open 2018;8(5):e021291.

5. Chin R*, You AX*, **Meng FW*,** Zhou J, Sim K (*Co-first authors)**.** Recognition of Schizophrenia with Combinatorial Regularized Support Vector Machine and Sequential Region of Interest Selection using Structural Magnetic Resonance Imaging. Scientific Reports 2018;8(1):13858.

6. Chong PH, **Molina JD,** Teo K, **Tan WS.** Paediatric Palliative Care improves patient outcomes and reduces healthcare costs: Evaluation of a home-based program. BMC Palliative Care 2018;17(1):11.

7. **Tan WS,** Bajpai R, Low CH, Ho AHY, Wu HY, Car J. Using routinely collected data to ascertain concordance with Advance Care Planning preferences. Journal of Pain and Symptom Management 2018;56(5):659-66.

8. Jimenez G, **Tan WS,** Virk AK, Low CK, Car J, Ho AHY. Overview of systematic reviews of Advance Care Planning: Summary of evidence and global lessons. Journal of Pain and Symptom Management 2018;56(3):436-59.

9. Wu CX, Hwang CH, **Tan WS,** Tai KP, Lim LKS, Chee TG, Choo YM, Chua GSW**.** Effectiveness of a Chronic Obstructive Pulmonary Disease Integrated Care Pathway Programme in Singapore: A Retrospective Pre-Post Matched-Group Study. BMJ Open 2018;8(3):e019425.

10. **Zhu ZC, Heng BH, Teow KL.** Lifetime trajectory simulation of chronic disease progression and comorbidity development. Journal of Biomedical Informatics 2018;88:29-36.

AWARDS AND GRANTS

Conference Presentation Awards

Singapore Health & Biomedical Congress 2018

Singapore Young Investigator Award (Health Services Research) - Gold

Dr Michelle Jessica Pereira
The impact of home-based palliative care for advanced dementia patients: What is the cost-savings threshold?

Research Grant

TTSH Pitch-for-Fund Program

$10, 000

Dr Michelle Jessica Pereira (Co-Investigator)

Dr Lee Keng Thiam

Tan Tock Seng Hospital Orthopaedic Surgery (Primary Investigator)

Dr Bryan Tan Yijia (Co-Investigator)

Dr Benjamin Ding Tze Keong (Co-Investigator)

A qualitative study of a collaborative model of care between Orthopaedics and Allied care Professionals for the management of knee osteoarthritis

HSOR TRAINING COURSES

18th Healthcare Operations Research Appreciation Course

February 2018
Speakers:
Dr Zhu Zhecheng
Dr Meng Fanwen
Teow Kiok Liang
Palvannan R.K.

The 2-day course will introduce Operations Research concepts with healthcare applications. It will focus on building intuition around theory, walk through illustrative examples and show insights from results that will support and inform decision making. Case studies will show applications of OR techniques as well as the process of problem solving during the engagement with the decision maker.

Introduction to Health Services Research

October 2018
Speakers:
Dr Yap Chun Wei
Dr Sun Yan
Dr Pradeep Paul George
Dr Michelle Jessica Pereira
Dr Joseph D. Molina
Palvannan R.K.

This one-day course will provide an overview of the basic concepts, rationale, general and discipline-specific methods used in carrying out health services research. It will include practical exercises, case studies and examples of real-world HSR projects. The course is designed to cover a broad range of topics at an introductory level. The main objective is to familiarize participants with a repertoire of methods that are often encountered in the conduct of health services re-search. It is hoped that students can use the lessons and material gleaned from this course as a springboard to explore these and other methods in depth for their own efforts in applied research. Essentially an appreciation course, it may also serve as a preparatory module for those interested in attending other more in-depth courses on specific HSR topics.

CONFERENCE PRESENTATIONS

Symposium at the Singapore Population Health Conversation and Workshop, Singapore

1. **Tan WS - Invited speaker**
   Before and beyond effectiveness.
   How do we know if our programme or interventions are effective?
   Evaluation framework and taxonomy (Oral)

Annual Research Meeting, Seattle, USA

2. **Tan WS,** Bajpai R, Ho AHY, Low CK, Cheah J, Wong C, Car J
   End-of-life care preferences in a national sample in Singapore (Poster)

3. **Tan WS,** Bajpai R, Ho AHY, Low CK, Cheah J, Wong C, Car J
   Individual, clinical and system factors associated with home deaths: A national population-based study. (Poster)

4. **Tan WS,** Car J, Lall P, Low CK, Cheah J, Wong C, Ho AHY
   Initiating, implementing and integrating Advance Care Planning: leading the transformation of norms. (Poster)

5. Ho AHY, Lall P, **Tan WS**, Patinadan PV, Wong LH, Dutta O, Pang WS, Low CK, Cheah J, Wong C, Car J
   Sustainable implementation of Advance Care Planning in Asia: An Interpretive-Systemic Framework for National Development. (Poster)

13th Singapore Public Health & Occupational Medicine Conference, Singapore

6. **Ang YG,** Yap CW, Liew IT, Weng WT, Shen P, Lim R, Ooi XY, Liew A
   Predictors of all-cause mortality of Chronic Kidney Disease in Singapore (Oral)

Singapore Health & Biomedical Congress 2018, Singapore

7. **Molina JD - Invited speaker**
   Measurement challenges for population health (Oral)

8. **Sun Y - Invited speaker**
   Cost-effectiveness of inpatient monitoring for paroxysmal atrial fibrillation among ischemic stroke patients (Oral)

9. **Tan WS - Invited speaker**
   Place of death, wish and reality (Oral)

10. **Teow KL - Invited speaker,** Palvannan RK, Zhu ZC, Meng FW
    Using utilization ratios for resource planning (Oral)

11. **Yap CW - Invited speaker**
    Population Health Index (Oral)

12. **Zhu ZC - Invited speaker**
    Lifetime cost simulation for diabetes interventions (Oral)

13. **Pereira MJ,** Yap CW, Tay RY, Yoong JH, Hum A
    The impact of home-based palliative care for advanced dementia patients: What is the cost-savings threshold? (Oral)

14. **Ang YG,** Yap CW, Liew IT, Weng WT, Shen P, Lim R, Ooi XY, Liew A
    Predictors of all-cause mortality of Chronic Kidney Disease in Singapore (Poster)

15. **Ge L,** Yap CW, Kaur P, Ong RJ, Heng BH
    An examination of the associations between patient activation and self-reported health outcomes in community-dwelling adults (Poster)

16. **Ge L,** Yap CW, Ong RJ, Heng BH
    Validation of an instrument to measure patient engagement among community-dwelling adults in Singapore (Poster)

17. **Kaur P,** Palvannan RK, George PP, Chong SL
    Cost Utility Analysis of a Hearing Aid Device for Older Adults in Singapore (Poster)

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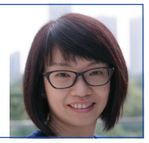

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