Predictors of 30-day post-discharge unplanned readmission in a subacute geriatric ward in Singapore

Christine Yuanxin Chen¹, MBBS, MRCP; Thulasi Chandran², MBBS, FCFP; Pei Ting Tan³, MHS; Vivian Cantiller Barrera¹, MD, GDGRM; Rachelle Tumbokon Tan-Pantanao¹, MD, GDGRM; Quicho Tanya Joy Zapata¹, MD, GDGRM; Thant Zin Tun¹, MBBS, GDGRM; Siti Humaira Binte Mohd Kamil⁴; Josceline Qiao Lin Gan⁴; Kiat Sern Goh¹, MBBS, MRCP

ABSTRACT

Background. Unplanned readmission to hospital is common among older adults and contributes to considerable healthcare costs and hospital-associated complications. We aimed to identify predictors of 30-day post-discharge unplanned readmission among older adults in our subacute geriatric ward, and to determine the prevalence of geriatric syndromes and develop a new predictive model for readmission of subacute geriatric patients.

Methods: Consecutive patients admitted to our subacute geriatric ward between June 2018 and June 2019 were invited to participate. Data collected included patient age, sex, weight, height, race, type of housing, destination upon discharge, functional and frailty status, presence of conduits (urinary catheters and nasogastric tubes), polypharmacy, high-risk medications, healthcare utilisation 6 months prior, laboratory test results, length of hospital stay, Charlson Comorbidity Index, and LACE index. Patients were assessed using the Mini Nutritional Assessment - Short Form, Geriatric Depression Scale, Mini-Mental State Examination, Clinical Frailty Scale, FRAIL scale, modified Barthel Index, hand grip strength, and gait speed. Patients with or without 30-day post-discharge unplanned readmission were compared. Multivariate logistic regression was used to identify independent predictors.

Results: Of 284 patients followed up at 30 days post-discharge, 63 (22.2%) had unplanned hospital readmission within 30 days of discharge, with associated factors being history of myocardial infarction, moderate or severe liver or renal disease, low albumin level, history of emergency department visits, hospitalisation in the preceding 6 months, and discharge to a destination other than home. The prevalence of geriatric syndromes of falls, frailty, and immobility was 62.3%, 64.7%, and 86.6%, respectively. Independent predictors of 30-day post-discharge unplanned readmission were history of hospitalisation in the preceding 6 months (odds ratio=2.62, $p=0.045$) and discharge destination other than home (odds ratio=3.10, $p=0.006$). The area under the receiver operating characteristics curve for the predictive models was between 0.6 and 0.7, and Brier score was around 0.16. The discrimination ability of the models was weak.

Conclusion: History of hospitalisation in the preceding 6 months and not being discharged to home were independent predictors for 30-day post-discharge unplanned readmission.

Key words: Aged; Patient readmission; Risk factors; Subacute care

- ¹ Department of Geriatric Medicine, Changi General Hospital, Singapore
- ² Medical Service, Saint Andrew's Community Hospital, Singapore
- ³ Clinical Trials Research Unit, Changi General Hospital, Singapore
- ⁴ Yong Loo Lin School of Medicine, National University of Singapore, Singapore

Correspondence to: Christine Yuanxin Chen, Department of Geriatric Medicine, Changi General Hospital, Singapore. Email: christine.chen.y.x@singhealth.com.sg

INTRODUCTION

Unplanned readmission to hospital is common among older adults and contributes to escalating healthcare expenditure, hospital bed occupancy, caregiver burden, and poorer quality of life. Predictors of hospital readmission have been used to identify high-risk patients for interventions to minimise adverse health outcome.¹⁻⁸

In 2018, individuals aged ≥ 65 years were involved in 29.8% of all admissions to acute hospitals and 80.8% of all admissions to community hospitals in Singapore.⁹ There is a need to cater for a subset of older patients who have been hospitalised and no longer need acute care, yet would not be suitable for sole rehabilitation. Our subacute ward was set up in a community hospital to accommodate this subset of patients who needed inpatient medical care during the treatment and recovery phase of an acute illness, injury, or exacerbation of a known chronic disease.¹⁰ Patients generally stay for 2 to 4 weeks, and emphasis is placed on achieving rehabilitation goals and early care discharge planning to ensure a smooth discharge to the community. Our subacute ward has 30 beds and receives an average of 33 to 35 new admissions each month. Admissions come from the acute geriatric wards, non-geriatric wards, and the emergency department short-stay unit.

We aimed to identify predictors of 30-day post-discharge unplanned readmission among older adults in our subacute geriatric ward, and to determine the prevalence of geriatric syndromes and develop a new predictive model for readmission of subacute geriatric patients.

METHODS

This prospective study was carried out from June 2018 to June 2019. Consecutive patients admitted to our subacute geriatric ward and consented to participate were recruited. Patients who died during the subacute inpatient stay were excluded. Informed consent was obtained from each patient. If the patient was uncommunicative or unable to give consent, proxy consent was obtained from their next-of-kin. Ethics approval was obtained from the

Singhealth Centralised Institutional Review Board, Singapore (CIRB Ref: 2017/3000).

Data collected from electronic health records included patient age, sex, weight, height, race, type of housing, destination upon discharge, functional and frailty status, the number of medications on discharge, use of high-risk medications (anticoagulants, dual antiplatelet therapy), use of other medications (anxiolytics, insulin, antipsychotics, antidepressants, and diuretics), laboratory test results (serum sodium, haemoglobin, and albumin levels and estimated glomerular filtration rate), the requirement of feeding tubes and urinary catheters during admission, continence status on discharge, length of stay in the acute ward, length of stay during subacute admission, any delay in discharge and reasons, and healthcare utilisation 6 months prior (visit to emergency department and any hospital admission).

Patients were assessed using various instruments. The Mini Nutritional Assessment -Short Form¹¹ comprises six questions on food intake, weight loss, mobility, psychological stress or acute disease, the presence of dementia or depression, and body mass index; scores of ≥ 12 indicate acceptable nutritional status. The Geriatric Depression Scale comprises 15 questions to screen for the presence of depression; scores of ≥ 5 indicate the possible presence of depression. The Mini-Mental State Examination¹² was used to screen for cognitive impairment; the cut-off of normal cognitive function is usually set as 24, although more advanced age and fewer years of formal education may allow for a lower cut-off. The Clinical Frailty Scale¹³ was used by a clinician to interview patients and families to determine their baseline score prior to admission; scores range from 1 (very fit) to 9 (terminally ill) and were categorised as non-frail (1-3), pre-frail (4), and frail (>4) for data analysis. The fatigue, resistance, ambulation, illnesses and loss of weight (FRAIL) scale¹⁴ was used as comparison. The modified Barthel Index¹⁵ was used to assess ability to perform activities of daily living (eg, personal care, mobility, transfers, bathing, and feeding) on admission and at discharge. Hand grip strength¹⁶ was measured by an occupational therapist using the Jamar digital dynamometer, with the arm at right angles and the elbow by the side of the body. Two attempts from each hand were

recorded, with at least 15 s for recovery allowed between each attempt. Gait speed¹⁷ was measured by a physiotherapist for patients who required most standby assistance for ambulation with or without aids. It is the time taken to ambulate 4 metres on a level surface. A taped line was placed 1 metre before and after the 4 metres walkway for acceleration and deceleration. The Charlson Comorbidity Index¹⁸ and the LACE index¹⁹ (length of stay, acuity of admission, Charlson Comorbidity Index, and number of emergency department visits in the preceding 6 months) were generated.

Patients with or without 30-day post-discharge unplanned readmission were compared using Chi squared test or Fisher exact test for categorical variables and independent *t*-test or Mann-Whitney *U* test for numerical variables. Significant variables in univariate analysis were included in the multivariate logistic regression model to identify the independent predictors. Variables with good model fit ($p > 0.05$ in Hosmer-Lemeshow goodness-of-fit test) were further tested for their ability to discriminate the case from non-case using receiver operating characteristics (ROC) curve analysis. ROC analysis was performed to determine the optimal cut-off point of the Youden index in differentiating patients with 30-day post-discharge unplanned readmission. Overall performance of four prediction models was evaluated using the Brier score. Models with different combinations of independent predictors were assessed using the Hosmer-Lemeshow goodness-of-fit test. All models were compared using ROC curve analysis in terms of predicting 30-day post-discharge unplanned readmission. Statistical analysis was performed using SPSS (version 20.0, IBM, Armonk [NY], USA). A *P* value of < 0.05 was considered statistically significant.

RESULTS

Of 400 patients screened, 301 were eligible and consented to participate. Of whom, 284 (94.4%) were followed up at 30 days post-discharge. Of the 284 patients, 252 (89%) were admitted from an acute hospital ward with a median length of stay of 11 days and 30 (10.6%) were from the short stay unit of the emergency department with a median length of stay of 19 days. Of the 284 patients, 63 (22.2%)

had unplanned hospital readmission within 30 days of discharge. Those with or without 30-day post-discharge unplanned readmission were comparable in terms of baseline characteristics (**TABLE 1**).

In univariate analysis, 30-day post-discharge unplanned readmission was associated with a history of myocardial infarction (odds ratio [OR]=1.91, $p=0.035$), the presence of moderate or severe liver or renal disease (OR=3.86, $p=0.010$), the Charlson Comorbidity Index (OR=1.20, $p=0.001$), low serum albumin level (OR=2.02, $p=0.018$), the LACE index (OR=1.18, $p=0.004$), emergency department visits in the prior 6 months (OR=1.77, $p=0.049$), hospitalisation in the prior 6 months (OR=2.42, $p=0.002$), and discharge destination other than home (OR=2.68, $p=0.008$) [**TABLE 2**].

In multivariate logistic regression, independent predictors of 30-day post-discharge unplanned readmission were hospitalisation in the prior 6 months (OR=2.62, $p=0.045$) and discharge destination other than home (OR=3.10, $p=0.006$) [**TABLE 2**].

Hosmer-Lemeshow goodness-of-fit test showed that a model with the LACE index only was a poor fit model ($p=0.003$). Using the Youden Index to determine the optimal cut-off point, sensitivity, specificity, and negative and positive predictive values of the remaining four models are shown in **TABLE 3**. The area under the ROC curve of the four models ranged from 0.6 to 0.7, and the Brier score was around 0.16, which indicated that none of the models had excellent discrimination ability (**FIGURE**).

The prevalence of geriatric syndromes was high: 17.7% for delirium, 30% for dementia (21.2% of whom had moderate to severe dementia), 16.3% for depression, 62.2% for a history of falls, 44.5% for osteoporosis, 41.3% for urinary incontinence, and 86.1% for functional decline.

Based on the FRAIL scale, 7.1% of patients were robust (score of 0), 33.6% were pre-frail (score of 1-2), 40.6% were frail (score of ≥ 3), and 18.7% did not have FRAIL score. Using the Clinical Frailty Scale, 61.1% were frail (score of ≥ 5) and 37.1% were non-frail.

TABLE 1
Patient demographic and clinical characteristics

Parameter	All (n=284)*	30-day post-discharge unplanned readmission		P value
		No (n=221)*	Yes (n=63)*	
Demographic				
Age, y	83.4±7.1 (66-105)	83.7±7.1 (66-105)	82.7±7.2 (69-100)	0.334
Ethnicity				0.236
Chinese	207 (72.9)	163 (73.8)	44 (69.8)	
Malay	59 (20.8)	42 (19.0)	17 (27.0)	
Others	18 (6.3)	16 (7.2)	2 (3.2)	
Sex				0.069
Male	116 (40.9)	84 (38.0)	32 (50.8)	
Female	168 (59.1)	137 (72.0)	31 (49.2)	
Housing type				0.262
Private	30 (10.6)	23 (10.5)	7 (11.1)	
Public (Housing Development Board flats)	243 (86.2)	187 (85.4)	56 (88.9)	
Others	9 (3.2)	9 (4.1)	0 (0.0)	
Own a house				0.412
No	20 (7.3)	14 (6.6)	6 (9.7)	
Yes	253 (92.7)	197 (93.4)	56 (90.3)	
Weight, kg	52.4±13.4 (23.9-96.7)	52.5±13.5 (27.2-96.7)	52.4±13.5 (23.9-96.2)	0.957
Height, cm	152.9±11.3 (98-181)	152.9±10.9 (120-181)	153±12.7 (98-176)	0.978
Body mass index, kg/m²	22.8±6 (12.98-47.27)	22.8±5.7 (13-43.9)	23.3±7 (13.7-47.3)	0.553
Nasogastric tube on admission				1.000
No	278 (97.9)	216 (97.7)	62 (98.4)	
Yes	6 (2.2)	5 (2.3)	1 (1.6)	
Indwelling urinary catheter on admission				0.337
No	268 (94.7)	210 (95.5)	58 (92.1)	
Yes	15 (5.3)	10 (4.5)	5 (7.9)	
Comorbidity				
Charlson Comorbidity Index	3.3±2.6 (0-13)	3±2.4 (0-10)	4.4±3.1 (0-13)	<0.001
Previous myocardial infarct				0.034
No	209 (73.9)	169 (76.8)	40 (63.5)	
Yes	74 (26.1)	51 (23.2)	23 (36.5)	
Cerebrovascular disease				0.376
No	162 (57.3)	129 (58.6)	33 (52.4)	
Yes	121 (42.7)	91 (41.4)	30 (47.6)	
Peripheral vascular disease				0.274
No	257 (90.9)	202 (91.8)	55 (87.3)	
Yes	26 (9.1)	18 (8.2)	8 (12.7)	
Diabetes without complication				0.338
No	248 (87.6)	195 (88.6)	53 (84.1)	
Yes	35 (12.4)	25 (11.4)	10 (15.9)	
Congestive heart failure				0.048
No	242 (85.5)	193 (87.7)	49 (77.8)	
Yes	41 (14.5)	27 (12.3)	14 (22.2)	
Diabetes with end organ damage				0.146
No	217 (76.7)	173 (78.6)	44 (69.8)	
Yes	66 (23.4)	47 (21.4)	19 (30.2)	
Chronic obstructive pulmonary disease				0.761
No	267 (94.3)	208 (94.5)	59 (96.7)	
Yes	16 (5.7)	12 (5.5)	4 (26.3)	

* Data are presented as mean ± standard deviation (range), median (interquartile range), or No. (%) of cases

TABLE 1 (cont'd)

Parameter	All (n=284)*	30-day post-discharge unplanned readmission		P value
		No (n=221)*	Yes (n=63)*	
Mild liver or renal disease				0.566
No	223 (78.8)	175 (79.5)	48 (76.2)	
Yes	60 (21.2)	45 (20.5)	15 (23.8)	
Any tumour				0.562
No	265 (93.6)	207 (94.1)	58 (92.1)	
Yes	18 (6.4)	13 (5.9)	5 (7.9)	
Dementia				0.946
No	220 (77.4)	171 (77.4)	49 (77.8)	
Yes	64 (22.6)	50 (22.6)	14 (22.2)	
Connective tissue disease				0.049
No	281 (99.2)	220 (100.0)	61 (96.8)	
Yes	2 (0.8)	0 (0.0)	2 (3.2)	
AIDS				-
No	283 (100.0)	220 (100.0)	63 (100.0)	
Yes	0 (0.0)	0 (0.0)	0 (0.0)	
Moderate or severe liver or renal disease				0.011
No	267 (94.3)	212 (96.4)	55 (87.3)	
Yes	16 (5.7)	8 (3.6)	8 (12.7)	
Metastatic solid tumour				0.400
No	278 (99.2)	216 (99.5)	62 (98.4)	
Yes	2 (0.8)	1 (0.5)	1 (1.6)	
Medication				
Anti-coagulant drug				0.975
No	225 (79.5)	175 (79.5)	50 (79.4)	
Yes	58 (20.5)	45 (20.5)	13 (20.6)	
Anti-depression drug				0.773
No	215 (75.9)	168 (76.4)	47 (74.6)	
Yes	68 (24.1)	52 (23.6)	16 (25.4)	
Insulin				0.091
No	269 (95.0)	212 (96.4)	57 (90.5)	
Yes	14 (5.0)	8 (3.6)	6 (9.5)	
Diuretics				0.850
No	249 (87.9)	194 (88.2)	55 (87.3)	
Yes	34 (12.1)	26 (11.8)	8 (12.7)	
Had more than 5 medications				0.521
No	14 (5.0)	10 (4.5)	4 (6.3)	
Yes	269 (95.0)	210 (95.5)	59 (93.7)	
Blood test				
Serum sodium, mmol/l	138.8±3.9 (126-149)	139±3.7 (126-147)	138.3±4.8 (127-149)	0.197
Serum creatinine, mg/dl	79 (61-106)	78 (60.3-106.8)	87 (63-106)	0.182
Serum haemoglobin, g/dl	11 (9.8-12.2)	11.1 (10-12.2)	10.2 (9.1-11.8)	0.002
Haemoglobin status				0.075
Normal	79 (27.9)	67 (30.5)	12 (19.0)	
Low	204 (72.1)	153 (69.5)	51 (81.0)	
Serum albumin, g/l	36.2±6.1 (9.2-60)	36.7±6.2 (9.2-60)	34.3±5.9 (17-46)	0.006
Albumin status				0.016
Normal (≥37)	140 (49.8)	117 (53.7)	23 (36.5)	
Low (<37)	141 (50.2)	101 (46.3)	40 (63.5)	
Estimated glomerular filtration rate, ml/min	63.0 (45-81)	65.5 (48.3-81.8)	59 (39-81)	0.145

TABLE 1 (cont'd)

Parameter	All (n=284)*	30-day post-discharge unplanned readmission		P value
		No (n=221)*	Yes (n=63)*	
Scale				
LACE index	12.9±2.7 (5-21)	12.7±2.7 (5-21)	13.8±2.7 (9-19)	0.003
LACE cut-off at 9				0.145
No risk (≤9)	27 (9.5)	24 (10.9)	3 (4.8)	
High risk (>9)	257 (90.5)	197 (89.1)	60 (95.2)	
FRAIL Scale				0.439
Robust (0/5)	20 (8.6)	14 (7.7)	6 (12.5)	
Pre-frail (1-2/5)	96 (41.6)	79 (43.1)	17 (35.4)	
Frail (3-5/5)	115 (49.8)	90 (49.2)	25 (52.1)	
Clinical Frailty Scale				0.455
Non-frail (<4)	52 (18.6)	43 (19.7)	9 (14.8)	
Pre-frail (=4)	54 (19.4)	44 (20.2)	10 (16.4)	
Frail (>4)	173 (62.0)	131 (60.1)	42 (68.8)	
Mini Nutritional Assessment -Short Form				0.687
Normal (12-14)	14 (5.9)	12 (6.5)	2 (3.9)	
At risk for malnutrition (8-11)	107 (45.3)	85 (45.9)	22 (43.2)	
Malnourished (0-7)	115 (48.8)	88 (47.6)	27 (52.9)	
Geriatric Depression Scale				0.983
Score ≥5	103 (47.7)	81 (47.4)	22 (47.8)	
Score <5	113 (52.3)	89 (52.6)	24 (52.2)	
Mini-Mental State Examination				0.859
Score ≥23	68 (28.5)	55 (28.2)	13 (29.5)	
Score <23	171 (71.5)	140 (71.8)	31 (70.5)	
Geriatric syndrome				
Cognitive impairment				0.338
No	203 (71.5)	161 (72.8)	42 (66.7)	
Yes	81 (28.5)	60 (27.2)	21 (33.3)	
Dementia	284	221	63	0.988
No	198 (69.7)	154 (69.7)	44 (69.8)	
Yes	86 (30.3)	67 (30.3)	19 (30.2)	
Behavioural and psychological symptoms of dementia				0.233
No	260 (91.5)	200 (90.5)	60 (95.2)	
Yes	24 (8.5)	21 (9.5)	3 (4.8)	
Delirium				0.389
No	233 (82.0)	179 (81.0)	54 (85.7)	
Yes	51 (18.0)	42 (19.0)	9 (14.3)	
Depression				0.214
No	238 (83.8)	182 (82.4)	56 (88.9)	
Yes	46 (16.2)	39 (17.6)	7 (11.1)	
Falls				0.363
No	104 (37.0)	78 (35.6)	26 (41.9)	
Yes	177 (63.0)	141 (64.4)	36 (58.1)	
Osteoporosis				0.263
No	116 (47.9)	87 (46.0)	29 (54.7)	
Yes	126 (52.1)	102 (54.0)	24 (45.3)	
Frailty				0.353
No	100 (35.3)	75 (33.9)	25 (40.3)	
Yes	183 (64.7)	146 (66.1)	37 (59.7)	
Incontinence				0.635
No	164 (58.2)	129 (58.9)	35 (55.6)	
Yes	118 (41.8)	90 (41.1)	28 (44.4)	

TABLE 1 (cont'd)

Parameter	All (n=284)*	30-day post-discharge unplanned readmission		P value
		No (n=221)*	Yes (n=63)*	
Immobility				0.821
No	38 (13.4)	29 (13.2)	9 (14.3)	
Yes	245 (86.6)	191 (86.8)	54 (85.7)	
Pre-admission condition				
History of emergency department visits in prior 6 months				0.048
No	159 (56.2)	131 (59.3)	28 (45.2)	
Yes	124 (43.8)	90 (40.7)	34 (54.8)	
History of hospitalisation in prior 6 months				0.002
No	171 (60.4)	144 (65.2)	27 (43.5)	
Yes	112 (39.6)	77 (34.8)	35 (56.5)	
Admission and discharge				
Subacute admission from				0.463
Acute ward	253 (89.4)	196 (86.7)	57 (91.9)	
Emergency department short stay unit	30 (10.6)	25 (11.3)	5 (8.1)	
Length of acute stay	11 (7-18)	11 (7-17)	13 (7-21)	0.136
Length of subacute stay	19 (14-27)	19 (14-25.8)	21.5 (15-30)	0.216
Extension of stay beyond 28 days				0.202
No	203 (71.5)	162 (73.3)	41 (65.1)	
Yes	81 (28.5)	59 (26.7)	22 (34.9)	
Reason for extension of stay				0.001
No extension	203 (72.2)	162 (74.0)	41 (66.1)	
Medical	32 (11.4)	20 (9.1)	12 (19.4)	
Rehabilitation	6 (2.1)	6 (2.7)	0 (0.0)	
Social	30 (10.7)	27 (12.3)	3 (4.8)	
Social & Rehabilitation	1 (0.4)	1 (0.5)	0 (0.0)	
Others	9 (3.2)	3 (1.4)	6 (9.7)	
Feeding tube at discharge				1.000
No	279 (98.2)	217 (98.2)	62 (98.4)	
Yes	5 (1.8)	4 (1.8)	1 (1.6)	
Urinary catheter at discharge				0.246
No	266 (93.7)	209 (94.6)	57 (90.5)	
Yes	18 (6.3)	12 (5.4)	6 (9.5)	
Diapers at discharge				0.557
No	149 (52.5)	118 (53.4)	31 (49.2)	
Yes	135 (47.5)	103 (46.6)	32 (50.8)	
Discharge destination				0.006
Not home	38 (13.4)	23 (10.5)	15 (23.8)	
Home	245 (86.6)	197 (89.5)	48 (76.2)	
Functional assessments				
Modified Barthel index on admission	42±17.4 (0-80)	42.9±17.8 (0-80)	39.3±16.4 (5-68)	0.147
Modified Barthel Index at discharge	44.7±23.9 (0-97)	44.7±24.4 (0-97)	44.8±22.6 (7-95)	0.971
Modified Barthel Index efficiency (on discharge – at admission) / length of stay	-0.3 (-0.7-0.0)	-0.3 (-0.8-0)	-0.3 (-0.7-0)	0.794
Gait speed, m/s	0.44 (0.26-0.57)	0.46 (0.31-0.61)	0.36 (0.21-0.45)	0.167
Gait speed, m/s				0.328
<0.8	65 (97.0)	54 (98.2)	11 (91.7)	
≥0.8	2 (3.0)	1 (1.8)	1 (8.3)	
Hand grip strength on admission, kg	10.0 (7-14.3)	10 (7-14.7)	10.6 (7.5-14.1)	0.779
Hand grip strength at discharge, kg	10.5 (7.4-14.7)	10.4 (7.4-14.6)	11.4 (7.6-15.9)	0.491
Change in handgrip strength, kg	0.2 (-0.2-0.7)	0.2 (-0.2-0.7)	0.1 (-0.2-0.6)	0.601
Hand grip strength at discharge in men, kg	14.5 (10.0-18.7)	14.5 (10.1-18.5)	14.7 (8.4-23.4)	0.633
Hand grip strength at discharged in women, kg	9.0 (6.8-12.4)	9.0 (6.6-12.5)	9.6 (7.1-12.7)	0.747

TABLE 2
Factors associated with 30-days post-discharge unplanned readmission

Factor	Univariate analysis		Multivariate logistic regression	
	Odds ratio (95% confidence interval)	p Value	Adjusted odds ratio (95% confidence interval)	p Value
Previous myocardial infarction				
No	Ref		Ref	
Yes	1.91 (1.05-3.48)	0.035	1.73 (0.90-3.36)	0.102
Moderate or severe liver or renal disease				
No	Ref		Ref	
Yes	3.86 (1.39-10.73)	0.010	1.34 (0.58-3.10)	0.491
Charlson Comorbidities Index	1.20 (1.08-1.34)	0.001		
Albumin level				
Normal	Ref		Ref	
Low	2.02 (1.13-3.59)	0.018	1.54 (0.83-2.88)	0.171
LACE Index	1.18 (1.05-1.32)	0.004	1.05 (0.91-1.22)	0.505
Emergency department visits in prior 6 months				
No	Ref		Ref	
Yes	1.77 (1.00-3.12)	0.049	0.76 (0.30-1.96)	0.575
Hospitalisation in prior 6 months				
No	Ref		Ref	
Yes	2.42 (1.37-4.30)	0.002	2.62 (1.02-6.75)	0.045
Discharge destination				
Home	Ref		Ref	
Not home	2.68 (1.30-5.52)	0.008	3.10 (1.38-6.94)	0.006

TABLE 3
Performance of four models in predicting 30-day post-discharge unplanned readmission*

Performance	Model 1	Model 2	Model 3	Model 4
Hosmer-Lemeshow goodness-of-fit test	p=0.324	p=0.734	p=0.753	p=0.974
Sensitivity, %	31/62 (50.0)	42/62 (67.7)	28/62 (45.2)	44/62 (71.0)
Specificity, %	183/216 (84.7)	124/220 (56.4)	188/216 (87.0)	121/219 (55.3)
Positive predictive value, %	31/64 (48.4)	42/138 (30.4)	28/56 (50.0)	44/142 (31.0)
Negative predictive value, %	183/214 (85.5)	124/144 (86.1)	188/222 (84.7)	121/139 (87.1)
Area under the receiver operating characteristics curve (95% CI)	0.70 (0.62-0.78)	0.64 (0.56-0.72)	0.70 (0.62-0.78)	0.69 (0.61-0.76)
Brier score	0.152	0.161	0.152	0.154

* Model 1 includes variables of previous myocardial infarction, moderate or severe liver or renal disease, albumin status, ever visited to emergency department, history of hospitalisation, staying place after discharge, and LACE index; model 2 includes variables of history of hospitalisation, and staying place after discharge; model 3 includes model 1 without LACE index; and model 4 (forward stepwise method) includes variables of previous myocardial infarction, moderate or severe liver or renal disease, history of hospitalisation, and staying place after discharge

DISCUSSION

There have been studies evaluating predictors of readmission from acute hospitals in Singapore.^{1,2,20} Traditional predictive models include the LACE index

and the Charlson Comorbidity Index, but the LACE index was reported to have poor discriminating ability in predicting readmission within 30 days.²¹ In a systematic review of nine studies, risk factors that were associated with hospital readmission included

FIGURE. The area under the receiver operating characteristics curve of four models ranges from 0.6 to 0.7. The discrimination ability of the models was weak.

higher advanced age, male sex, ethnicity, living conditions, impaired health capacity (such as poor overall condition and functional disability), prior admissions, longer length of hospital stays, way of referral, and discharge destination.²²

In the present study, we included other factors such as functional status, presence of geriatric syndromes, frailty status, and other socio-demographic factors that we postulated to be relevant.^{23,24} Multivariate analysis revealed two independent predictors of unplanned readmission within 30 days: hospitalisation in the prior 6 months and discharge destination other than home.

Early discharge care planning and post-discharge support could benefit this high-risk group who already have poorer health and reserve. Early discharge care planning involves a multidisciplinary team, regular family engagement, and community and social services support. In Singapore, there are hospital avoidance programmes where geriatricians and a multidisciplinary team provide support to patients discharged to selected nursing homes.²⁵ These programmes focus on advance care planning and discussions of preferred plan of care to address end-of-life issues. It may be beneficial to broaden

the scope and scale of such programmes to cover all nursing homes in the future. Other programmes include the Hospital to Home Service where at-risk patients are referred for continuing social, nursing, functional, and clinical support post-discharge through a multidisciplinary team.

In the present study, functional and frailty statuses were not independent predictors of 30-day post-discharge unplanned readmission. This may be because our patients were severely dependent (mean modified Barthel Index of 44.7 on discharge) and frail (prevalence of frailty of 62.1%). Hand grip strength of patients was significantly lower than the normative values of older Singaporeans in a cross-sectional study.²⁶ The mean hand grip strength was 10.8 kg to 21.7 kg for men and 7.8 kg to 15.3 kg for women, which are significantly lower than that in the general elderly population.

There are some limitations to our study. The patient population was specific to the subacute geriatric ward of a community hospital, and hence the findings may not be generalisable to all older adults. The sample size was small and may affect the statistical significance of some predictors.

CONCLUSION

30-day post-discharge unplanned readmission was associated with the LACE index, history of myocardial infarction, moderate or severe renal or liver disease, low serum albumin levels, prior healthcare utilisation (emergency department visits and hospitalisations in the 6 months prior to discharge), and discharge destination. Out of these, hospitalisation in the prior 6 months and discharge destination other than home were independent predictors. However, the discriminative ability of our predictive models was weak. Future studies should include a larger sample size in a multicentre setting.

ACKNOWLEDGEMENTS

The authors would like to acknowledge the nursing and allied health team of St. Andrew's Community Hospital for their assistance.

FUNDING

This study is supported by Changi General Hospital,

Singapore and St. Andrew's Community Hospital, Singapore.

DECLARATION

The authors have no conflicts of interest to disclose.

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