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ORIGINAL ARTICLE

Unplanned hospitalisations among subsidised nursing home residents in Singapore: Insights from a data linkage study

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ABSTRACT

Introduction: Hospitalisations can pose hazards and may not be an appropriate care setting for frail nursing home (NH) residents. Few studies have quantified the extent of NH resident hospitalisations in Singapore, hence we aimed to address this knowledge gap by studying characteristics of unplanned hospitalisations over a 1-year period.

Method: This was a retrospective cohort study of 9922 subsidised residents across 59 NHs in Singapore, with analysis using administrative healthcare data. Key measures included inpatient admission and emergency department visit rates, final discharge diagnoses and estimated costs. We examined correlates of inpatient admissions with a multivariable zero-inflated negative binomial regression model incorporating demographics, institutional characteristics and Charlson Comorbidity Index.

Results: There were 6620 inpatient admissions in 2015, equivalent to 2.23 admissions per 1000 resident days, and the majority were repeat admissions (4504 admissions or 68.0%). Male sex (incidence rate ratio [IRR] 1.23), approaching end-of-life (IRR 2.14), hospitalisations in the past year (IRR 2.73) and recent NH admission within the last 6 months (IRR 1.31–1.99) were significantly associated with inpatient admission rate. Top 5 discharge diagnoses were lower respiratory tract infections (27.3%), urinary tract infection (9.3%), sepsis (3.1%), cellulitis (1.9%) and gastroenteritis (1.1%). We estimated the total system cost of admissions of subsidised residents to be SGD40.2 million (USD29.1 million) in 2015.

Conclusion: We anticipate that unplanned hospitalisation rate will increase over time, especially with an increasing number of residents who will be cared for in NHs. Our findings provide a baseline to inform stakeholders and develop strategies to address this growing problem.

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Keywords: geriatric medicine, healthcare utilisation, hospitalisation, nursing homes, retrospective study

CLINICAL IMPACT

What is New

- This study is among the first to provide system-level data for the hospitalisations of subsidised nursing home residents across Singapore.
- Findings underscore the extent of hospitalisations, and could inform policymaking or guide resource allocation and quality improvement efforts.

Clinical Implications

- As the most common causes of hospitalisations are related to infections, strategies for improvement include proactive risk assessment, preventive care, early detection and management.
- Anticipatory care, including strengthening palliative care and promoting advance care planning, should also be encouraged.

INTRODUCTION

Hospitalisations pose hazards and safety risks to nursing home (NH) residents who may be frail, cognitively impaired, suffering from multimorbidities and physically dependent,[1] with propensity to develop adverse outcomes such as functional, psychological or cognitive decline, iatrogenic complications, and be subjected to over-investigation.[2] There is an imperative for health systems to reduce hospitalisations in this group, not only for cost containment but also to reduce the risk of harm.[3]

Between 6.8% and 45.7% of residents in NHs were hospitalised for various time periods of follow-up, based on a systematic review of 21 studies across

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the US, Canada, China and 4 European countries.[4] In Singapore, few studies have quantified the extent of NH resident hospitalisations at the health system level. One study in 2003 examining referrals from community step-down facilities (including NHs) to a single hospital emergency department (ED) noted that a high proportion of visits (82%) resulted in hospital admission, with the most common complaints being shortness of breath, fever and falls. However, the study did not assess whether the ED visits were appropriate.[5] A more recent study within 1 NH reported an inpatient admission rate of 1.53 per 1000 resident days, citing pneumonia, urinary tract infection (UTI) and sepsis as the most common reasons for admissions.[6]

Hence, our key objectives were to bridge this knowledge gap and establish baseline data by describing the characteristics and correlates of hospitalisations of NH residents in Singapore, which would inform stakeholders in developing strategies to reduce unplanned hospitalisations among this vulnerable group.

METHOD

We present a retrospective cohort study, analysing hospitalisations of NH residents from 1 January 2015 to 31 December 2015 using administrative healthcare data. We focused our analysis on unplanned hospitalisations (i.e. excluding planned admissions, for instance, for elective procedures). Ethics approval was granted by the National Healthcare Group Domain Specific Review Board (2017/00115).

Data sources

Access to administrative healthcare data was granted by the Ministry of Health (MOH). We obtained billing and subvention data from 4 datasets: Intermediate and Long-Term Care Information System (ILTC-IS2G) for long-term care utilisation, Casemix and Subvention (C&S) dataset for inpatient admissions, Emergency Department (ED) dataset for ED visits as well as death data from the Registry of Births and Deaths through the Immigration and Checkpoints Authority. Only residents who received subsidies or resided in NHs, which received operating subvention from MOH, were included in the analysis. Data for private or unsubsidised NH residents were not available.

Data extraction was performed by an MOH-approved vendor, and anonymisation was carried out by the same vendor by replacing the resident's National Registration Identity Card number or Foreign Identification Number with a project unique identifying number (PUIN). The different datasets were linked using deterministic rules via the PUIN.

Study cohort

The study cohort consisted of all prevalent, publicly-subsidised NH residents in Singapore, identified through service codes from the ILTC-IS2G dataset. We assessed that the data from ILTC-IS2G were fairly representative of the entire NH resident cohort, as more than 90% of residents are publicly subsidised and their billing and subvention records were comprehensively captured. Based on referral and placement criteria, NH residents were (1) aged 16 years and above; (2) semi-ambulant, wheelchair- or bed-bound; (3) required long-term skilled nursing care and/or assistance in activities of daily living; and (4) had no available or competent caregiver or have exhausted alternative care arrangements.

All NHs were licensed by MOH and classified according to their operator status. Of the 59 NHs, 33 were licensed as NHs operated by voluntary welfare organisations, i.e. charity or faith-based organisations, 22 NHs by private or for-profit organisations under the MOH NH Portable Subsidy Scheme and 4 under the Build-Own-Lease Scheme where the government bore infrastructural costs and conducted an open tender for operators to run these homes. Twelve NHs were operated by private organisations, and residents with short-term respite stays of fewer than 30 days were excluded from the analysis.

NH residents who had at least 1 hospital admission to 1 of 7 public hospitals and a tertiary medical centre in Singapore were identified through inpatient episodes in the C&S dataset and entered into the study. Data on admissions to private hospitals were unavailable.

Measures

Demographics and baseline characteristics

Demographic data included age group, sex, ethnicity and per-capita household income which was used to determine government subsidy bands (a proxy indicator for socioeconomic status). Comorbidities were identified from the C&S dataset using diagnoses coded with the International Classification of Diseases, 10th edition with clinical modification (ICD-10CM). We then applied an earlier developed algorithm to derive the Charlson Comorbidity Index (CCI) using the ICD-10CM codes,[7] with a 3-year look-back period of both primary and secondary diagnoses.

Length of residence, remaining lifespan and end-of-life (EoL)

The follow-up period was from 1 January 2015 to 31 December 2015, or to the latest hospital admission within the year 2015 for hospitalised residents, whichever was earlier. We computed the NH length of residence from the date of admission into the NH to the date of discharge or death for decedents, or to 31 December 2015 for non-decedents. Remaining lifespan was calculated using the time interval to the date of death for decedents. We then created an EoL indicator using the definition of remaining lifespan of 1 year or less, based on guidelines developed by the National Strategy for Palliative Care Implementation Taskforce.[8]

Unplanned hospitalisation measures

These included the rate of ED visits and inpatient admissions per 1000 resident days (in which the resident days are calculated as the number of residents multiplied by the length of residence during the follow-up period). For ED visits and its outcome, we reported the triage status according to the Patient Acuity Category Scale (PACS) as defined by MOH.[9] For inpatient admissions, we included length of stay (LOS), discharge outcome, intensive care unit (ICU) utilisation and readmissions within 3, 15 and 30 days from the index admission. All inpatient admissions included in the analysis had at least a 24-hour LOS and 24-hour separation between consecutive admissions. ICD-10CM codes were used to identify final principal discharge diagnoses.

Healthcare costs

The healthcare system cost was the patient bill, including government subsidies, while the out-of-pocket (OOP) cost was computed as the patient bill after deducting the government subsidies. All costs were recorded in SGD.

Statistical analysis

Summary statistics were reported using frequencies for categorical variables and mean with standard deviation (SD) or median with interquartile range for continuous variables. Comparisons were made using independent sample t-tests for means and Pearson's chi-square test for proportions between groups with the normality assumption met.

We examined factors associated with inpatient admissions using a zero-inflated negative binomial regression model, and used the likelihood ratio test for over-dispersion to assess model fit. Patient-level characteristics included in the model were age group, sex, ethnicity, per-capita household income, length of residence in NH, the EoL indicator, CCI indicators and prior hospitalisation in the past 1 year; while facility-level predictors were NH operator type, bed capacity and an indicator for multi-site providers. We reported the incidence rate ratio (IRR), measuring the relative difference in incidence rates of the exposed group to the comparator group, with 95% confidence interval (CI). Unless otherwise stated, statistical significance was taken as $P<0.05$.

All statistical analyses were conducted using Stata software version 14.1 (StataCorp LLC, College Station, TX, US).

RESULTS

Cohort characteristics

Data from 9922 unique residents across 59 NHs were analysed (Table 1). Compared with those without hospitalisations, residents who had at least 1 inpatient admission were more likely to be male, approaching the EoL or deceased within the study period (all $P<0.001$). They were older, had shorter length of residence in the NH and higher comorbidity burden, with significantly higher proportions of comorbidities in all CCI indicators except AIDS/HIV.

Hospital utilisation

ED visits

A total of 7821 ED visits were recorded in 2015, equivalent to 2.63 visits per 1000 resident days (Table 2). The vast majority of ED visits (94.5%) were triaged as P1 (requiring resuscitation) or P2 (critical care) cases on PACS, and more than 81% of ED visits resulted in inpatient admission.

Inpatient admissions

Multiple inpatient admissions were common: averaging 1.8 admissions per resident per year, and ranging from 1 admission (58.1%) to >10 admissions per resident (0.3%), with the highest being 16 admissions by a single resident. "Frequent admitters" (i.e. residents who had 3 or more admissions within 12 consecutive months as defined by MOH) formed 18.8% of the cohort, but contributed to 42.5% of total admissions. The average LOS per episode was 7.8 days (median 6 days). Moreover, 5.6% of the cohort had prolonged LOS exceeding 21 days.

Readmissions

We further analysed non-risk-adjusted readmission rates. A total of 1252 readmissions (18.9% of total admissions) occurred within 30 days from the index admission. Of these, 760 (11.5% of total or 60.7%

Table 1. Baseline characteristics of nursing home residents in 2015.

Demographic characteristic	Total n=9922		With admission in 2015 n=3645		Without admission in 2015 n=6277		*P* value[a]
	n	%	n	%	n	%	
Age group (years)							
60 and below	1092	11.0	347	9.5	744	11.9	<0.001
61–70	1867	18.8	618	17.0	1249	19.9	
71–80	2535	25.6	930	25.5	1605	25.6	
81–90	3011	30.4	1224	33.6	1787	28.5	
Above 90	1402	14.1	526	14.4	877	14.0	
Sex							
Male	4963	50.0	2018	55.4	2947	47.0	<0.001
Ethnicity							
Chinese	8413	84.8	3051	83.7	5357	85.3	0.010
Malay	813	8.2	311	8.5	483	7.7	
Indian	519	5.2	203	5.6	313	5.0	
Others	165	1.7	80	2.2	112	1.8	
PCHI (subsidy band)[b]							
SGD700 and below (75%)	8734	88.0	3160	86.7	5574	88.8	<0.001
SGD700–1000 (60%)	608	6.1	227	6.2	381	6.1	
SGD1101–1600 SGD (50%)	393	4.0	185	5.1	208	3.3	
SGD1601–1800 SGD (40%)	70	0.7	31	0.9	39	0.6	
SGD1801–2600 SGD (20%)	109	1.1	38	1.0	71	1.1	
Length of residence in NH (years), mean (SD)	3.88 (4.03)	NA	3.70 (3.80)	NA	3.98 (4.15)	NA	<0.001
CCI, mean (SD)	3.0 (2.8)	NA	3.7 (3.0)	NA	2.5 (2.6)	NA	<0.001
Residents approaching EoL	754	6.3	475	13.0	279	4.4	<0.001
Died in 2015	1424	14.4	1041	28.6	383	6.1	<0.001
CCI indicators	**Total n=8534**		**With hospitalisations n=3645**		**Without hospitalisations n=4709[c]**		***P* value**
	n	%	n	%	n	%	
Myocardial infarction	930	11.1	580	15.9	350	7.4	<0.001
Congestive heart failure	760	9.1	433	11.9	327	6.9	<0.001
Peripheral vascular disease	414	5.0	264	7.2	150	3.2	<0.001
Cerebrovascular disease	2329	27.9	1108	30.4	1221	25.9	<0.001
Dementia	2597	31.1	1259	34.5	1338	28.4	<0.001
Chronic pulmonary disease	569	6.8	351	9.6	218	4.6	<0.001
Rheumatic disease	58	0.7	34	0.9	24	0.5	0.021
Peptic ulcer disease	214	2.6	118	3.2	96	2.0	0.001

Table 1. Baseline characteristics of nursing home residents in 2015. (Cont'd)

Demographic characteristic	Total n=9922		With admission in 2015 n=3645		Without admission in 2015 n=6277		*P* value[a]
	n	%	n	%	n	%	
Mild liver disease	340	4.1	181	5.0	159	3.4	<0.001
Moderate or severe liver disease	50	0.6	31	0.9	19	0.4	0.009
DM without complications	1733	20.7	988	27.1	745	15.8	<0.001
DM with complications	2708	32.4	1364	37.4	1344	28.5	<0.001
Hemiplegia or paraplegia	1120	13.4	529	14.5	591	12.6	0.001
Renal disease	1708	20.5	1011	27.7	697	14.8	<0.001
Any malignancy	506	6.1	306	8.4	200	4.3	<0.001
Metastatic solid tumour	187	2.2	124	3.4	63	1.3	<0.001
AIDS/HIV	15	0.2	7	0.2	8	0.2	0.812

AIDS/HIV: acquired immunodeficiency syndrome/human immunodeficiency syndrome; CCI: Charlson Comorbidity Index; DM: diabetes mellitus; EoL: end-of-life (with remaining lifespan of 1 year or less); NA: not applicable; NH: nursing home; PCHI: per-capita household income; SD: standard deviation

[a] *P* values reflect the differences between those with inpatient admissions in 2015 and those without inpatient admissions. The chi-squared test was used to compare differences in frequencies, while the independent-sample t-test was used to compare means.

[b] Only publicly subsidised individuals (subsidy band >0%) are included in the analysis.

[c] As the CCI was computed based on available International Classification of Diseases, 10th edition with clinical modification codes from the C&S dataset, residents without any hospitalisations in the 3-year look-back period to 2012 would not have any records for computation, hence there is a possibility that these figures are underestimated. Missing values were replaced by zeros.

Table 2. Hospital utilisation characteristics.

Characteristics	n	%
ED visits		
Total no. of ED visits (including ED observations)	7821	NA
Total NH resident bed days	2,975,148	NA
No. of residents with ED visits, % of total	4145	39.5
Mean no. of visits per resident (of those with visits)	1.89	NA
ED visit rate per 1000 resident days	2.63	NA
Priority status[a]		
P1 (resuscitation)	2661	34.0
P2 (critical care)	4731	60.5
P3 (ambulatory)	426	5.5
P4 (non-emergency)	NA[b]	NA
Outcome of ED visit		
Admitted or transferred to another institution[c]	6352[d]	81.2
Discharged with outpatient follow-up	1365	17.5
Death/death on arrival	69	0.9
Unclassified	35	0.5

Table 2. Hospital utilisation characteristics. (Cont'd)

Characteristics	n	%
Inpatient admissions		
Total no. of inpatient admissions	6620	NA
No. of residents admitted, % of total	3645	36.7
No. of admissions per resident (of those with admissions)		
Mean	1.82	
Median (IQR)	2 (1–4)	
Admission rate (all-cause) per 1000 resident days	2.23	
No. of residents		
with 1 admission	2116	58.1
with 2 admissions	844	23.2
with 3 admissions	343	9.4
with 4 admissions	165	4.5
with 5–10 admissions	167	4.6
with >10 admissions	10	0.3
No. of admissions by "frequent admitters"	2816	42.5
Hospital LOS		
Mean LOS per inpatient admission (days, SD)	7.8 (8.4)	
Median LOS (days, IQR)	6 (3, 9)	
Mean LOS per resident in 2015	14.1	
LOS categories per inpatient admission		
1–3 days	1899	28.7
4–7 days	2430	36.7
8–14 days	1524	23.0
>14 days	767	11.6
≥21 days ("long stayers")	367	5.6
Discharge outcome		
Step-down (i.e. back to NH)	4138	62.5
Follow-up at SOC[e]	1122	17.0
Death	700	10.6
Discharged	600	9.0
Others	60	0.9
ICU utilisation (n=60)		
ICU average length of stay (days, SD)	3.7 (4)	NA
By ICU discharge outcome		
Others/step-down care	26	43.3
Death	19	31.7

Table 2. Hospital utilisation characteristics. (Cont'd)

Characteristics	n	%
Follow-up at SOC	10	16.7
Others/unclassified	5	8.3
Readmissions		
No. of 30-day readmissions, % of total admissions	1252	18.9
No. of 15-day readmissions, % of total admissions	760	11.5
Readmissions within 72 hours of discharge, % of total admissions	227	3.4

ED: emergency department; ICU: intensive care unit; IQR: interquartile range; LOS: length of stay; NA: not applicable; NH: nursing home; SD: standard deviation; SOC: specialist outpatient clinics

[a] Priority classification is made at the point of triage at the ED, using the Patient Acuity Category (PAC) status defined by MOH.
[b] Due to restrictions on data confidentiality, aggregate counts/values with frequencies less than 5 are not released by MOH.
[c] This refers to other public/restructured hospitals, community hospitals or short-stay units.
[d] The figures here differ from the earlier number of hospital admissions in Table 2 as they include direct inpatient admissions or admissions from SOCs.
[e] SOCs refer to specialist care in hospitals or tertiary medical centres delivered in an outpatient setting.

of 30-day readmissions) were within 15 days of discharge. A total of 227 readmissions (3.4% of total) occurred within only 72 hours post-discharge.

ICU utilisation

A small proportion (0.9%, n=60) of admissions included an ICU stay, and there were 24 direct admissions to ICU from ED.

Discharge outcomes

While the majority of hospitalised residents were discharged to step-down care (i.e. back to NH, 62.5%) or with outpatient follow-up (17.0%), 10.6% of admissions (n=700) had death as the discharge outcome. Of the ICU admissions, 31.7% (n=19) had death as the discharge outcome.

Principal causes of inpatient admission

Infections were among the top final principal discharge diagnoses in 2015 (Table 3), with lower respiratory tract infections (including pneumonia 20.5%, aspiration pneumonitis 4.0% and other lower respiratory infections 2.8%), UTI (9.3%), sepsis (3.1%), cellulitis (1.9%) and gastroenteritis/colitis (1.1%) ranking among the top 10. Cumulatively, the top 10 final principal discharge diagnoses accounted for almost half of all admissions.

By diagnostic categories grouped by ICD-10CM codes, we observed that respiratory conditions (J00-J99), which included infections as well as exacerbations of chronic respiratory illnesses, and genitourinary tract disorders (N00-N99) were the top 2 categories (33.0% and 11.2%, respectively); followed by "ill-defined injuries" (S00-T98, 9.1%) which include complications arising from prosthetic devices such as urinary catheters; and other infectious diseases (A00-B99, 7.5%) and digestive tract diseases (K00-K93, 7.4%).

Falls or traumatic injuries leading to head injury (1.1%), peritrochanteric fracture (0.6%) and neck of femur fractures (0.6%) accounted for <3% of all admissions. Other chronic conditions also accounted for a relatively small proportion of primary discharge diagnoses, mainly from acute and chronic complications of diabetes mellitus and cardiovascular disease.

Cost of hospitalisations

The total system cost of hospitalisations of NH residents was SGD40,247,000 in 2015 (USD29,164,000) or approximately 11% of public expenditure on NHs in financial year 2015 (SGD360 million, or USD261 million).[10] Total OOP was approximately SGD12,630,000 (USD9,152,000; 31.4% of system cost of hospitalisations).

The mean cost of inpatient admissions ("system cost") of NH residents was SGD6100 per episode in 2015 (SD: SGD6700), of which slightly under a third of the system cost was borne by the resident and family/next-of-kin through OOP costs (mean OOP: SGD1900, SD: SGD2000). This translated to an average system cost of SGD780 (or SGD245 in OOP) per inpatient bed-day (Table 4).

Multivariable modelling

Men had a significantly higher incidence rate (IRR 1.23, 95% CI 1.10–1.37) of inpatient admission, and hospitalisation rate of residents who were approaching EoL was more than twice than those who had not approached EoL (IRR 2.14, 95% CI 1.86–2.46) (Table 5). Furthermore, the hospitali-

Table 3. Final principal discharge diagnoses[a] by International Classification of Diseases, 10th edition with clinical modification codes.

ICD-10 code	Top 30 final principal discharge diagnoses	n	%	Cumulative %[b]
J18.9	Pneumonia, unspecified	1356	20.5	20.5
N39.0	Urinary tract infection, site not specified	616	9.3	29.8
J69.0	Pneumonitis due to food and vomit	264	4.0	33.8
A41.9	Sepsis, unspecified	204	3.1	36.9
J22	Unspecified acute lower respiratory infection	183	2.8	39.6
T83.5	Infection due to prosthetic device, implant in urinary system	158	2.4	42.0
L03.1	Cellulitis of other parts of limb	128	1.9	43.9
S09.9	Unspecified injury of head	73	1.1	45.0
A09.9	Gastroenteritis and colitis of unspecified origin	72	1.1	46.1
K92.2	Gastrointestinal haemorrhage, unspecified	64	1.0	47.1
I50.0	Congestive heart failure	64	1.0	48.1
J06.9	Acute upper respiratory infection, unspecified	63	1.0	49.0
E11.7	Type 2 diabetes mellitus: multiple complications	58	0.9	49.9
K59.0	Constipation	57	0.9	50.8
E14.6	Unspecified diabetes mellitus: other specified complications	53	0.8	51.6
E11.6	Type 2 diabetes mellitus: other specified complications	52	0.8	52.4
J44.0	COPD with acute lower respiratory infection	51	0.8	53.1
I63.9	Cerebral infarction, unspecified	41	0.6	53.7
R50.9	Fever, unspecified	41	0.6	54.4
G40.9	Epilepsy, unspecified	41	0.6	55.0
S72.1	Pertrochanteric fracture	41	0.6	55.6
E14.7	Unspecified diabetes mellitus: with multiple complications	39	0.6	56.2
E14.2	Unspecified diabetes mellitus: with renal complications	38	0.6	56.8
A41.5	Sepsis due to other Gram-negative organisms	36	0.5	57.3
J45.9	Asthma, unspecified	34	0.5	57.8
E11.2	Type 2 diabetes mellitus: with renal complications	32	0.5	58.3
E11.0	Type 2 diabetes mellitus: with coma	32	0.5	58.8
S72.0	Fracture of neck of femur	31	0.5	59.2
R29.6	Tendency to fall, not elsewhere classified	30	0.5	59.7
I21.4	Acute subendocardial myocardial infarction	29	0.4	60.1
ICD-10 chapter	**Title of ICD-10 chapter**	**N**	**%**	**Cumulative %**
J00-J99	Diseases of the respiratory system	2186	33.0	33.0
N00-N99	Diseases of the genitourinary system	742	11.2	44.2
S00-T98	Injury and poisoning	600	9.1	53.3
A00-B99	Infectious and parasitic diseases	495	7.5	60.8

Table 3. Final principal discharge diagnoses[a] by International Classification of Diseases, 10th edition with clinical modification codes. (Cont'd)

ICD-10 code	Top 30 final principal discharge diagnoses	n	%	Cumulative %[b]
K00-K93	Diseases of the digestive system	488	7.4	68.1
E00-E90	Endocrine, nutritional and metabolic diseases	466	7.0	75.2
I00-I99	Diseases of the circulatory system	414	6.3	81.4
R00-R99	Symptoms and signs not elsewhere classified	325	4.9	86.3
L00-L99	Diseases of the skin and subcutaneous tissue	295	4.5	90.8
G00-G99	Diseases of the nervous system	148	2.2	93.0
C00-D48	Neoplasms	130	2.0	95.0
M00-M99	Diseases of the musculoskeletal system and connective tissue	123	1.9	96.9
F00-F99	Mental and behavioural disorders	81	1.2	98.1
D50-D89	Diseases of blood and blood-forming organs	44	0.7	98.8
H00-H59	Diseases of the eye and adnexa	34	0.5	99.3
Z00-Z99	Factors influencing health status	32	0.5	99.8
H60-H95	Diseases of the ear and mastoid process	14	0.2	100

COPD: chronic obstructive pulmonary disease
[a] Obtained from the Casemix & Subvention (C&S) dataset for inpatient admission episodes.
[b] Percentages may not add up due to rounding.

Table 4. Average system cost and out-of-pocket for inpatient admissions.

Characteristic	Result, SGD
System cost per admission	
Mean (SD)	6079.65 (±6675.24)
Median (IQR)	4210.23 (2547.84–7233.96)
90th percentile	12,146.63
OOP per admission	
Mean (SD)	1907.82 (±1956.66)
Median (IQR)	1397.81 (852.33–2277.88)
90th percentile	3677.19

IQR: interquartile range; OOP: out-of-pocket; SD: standard deviation; SGD: Singapore dollar
Note: All costs are recorded in 2015 Singapore dollars.

sation rate of residents who had prior hospitalisations in the past year was nearly 3 times that of residents without any hospitalisations (IRR 2.73, 95% CI 2.38–3.12). Age group, ethnicity and per-capita household income differences, which were statistically significant in the univariate analysis, became non-significant.

Compared with those who had been admitted to NH for more than 5 years, residents admitted within 3 months to NH had higher hospitalisation rate (IRR 1.99, 95% CI 1.62–2.45) followed by those within 4–6 months (IRR 1.31, 95% CI 1.11–1.55).

NH operator type, "chain" operator status (organisations operating multiple sites or branches) and bed capacity were not significantly associated with the hospitalisation rate.

DISCUSSION

Our findings highlighted the impact of unplanned hospitalisations among NH residents in Singapore.

Table 5. Factors associated with hospital admissions,[a] using multivariable zero-inflated negative binomial regression model.

Characteristic	Crude IRR	95% CI for IRR	*P* value
Age group (years)			
60 and below	(ref)	NA	NA
61–70	0.95	0.82–1.11	0.551
71–80	0.93	0.80–1.09	0.353
81–90	0.94	0.79–1.12	0.487
Above 90	0.91	0.76–1.09	0.305
Sex			
Male	1.23	1.10–1.37	**<0.001**
Ethnicity			
Chinese	(ref)	NA	NA
Malay	0.96	0.86–1.09	0.538
Indian	0.92	0.77–1.09	0.315
PCHI (subsidy band)			
SGD700 and below	(ref)	NA	NA
SGD701–1100	1.18	0.80–1.73	0.401
SGD1101–1600	1.33	0.98–1.79	0.064
SGD1601–1800	1.15	0.85–1.57	0.358
SGD1801–2600	1.15	0.88–1.50	0.319
Length of residence in NH			
>5 years	(ref)	NA	NA
0–3 months	1.99	1.62–2.45	**<0.001**
4–6 months	1.31	1.11–1.55	**0.001**
7–9 months	1.05	0.88–1.25	0.597
10–12 months	0.93	0.79–1.10	0.411
1–2 years	0.84	0.74–0.96	**0.010**
2–5 years	0.90	0.79–1.01	0.075
NH licensing type			
VWO	(ref)	NA	NA
PNH	1.11	0.88–1.38	0.385
BOL	1.07	0.82–1.38	0.618
Organisations operating NHs in multiple sites ("chain" operator)	1.20	0.97–1.49	0.087
NH capacity			
<100 beds	(ref)	NA	NA
100–149 beds	0.75	0.53–1.05	0.093
150–249 beds	0.87	0.68–1.10	0.248
≥250 beds	0.89	0.70–1.15	0.381

Table 5. Factors associated with hospital admissions[a]: multivariable zero-inflated negative binomial regression model. (Cont'd)

Characteristic	Crude IRR	95% CI for IRR	*P* value
Residents approaching EoL	2.14	1.86–2.46	**<0.001**
CCI indicators			
Myocardial infarction	1.43	1.26–1.62	**<0.001**
Congestive heart failure	1.15	1.01–1.31	**0.041**
Peripheral vascular disease	1.47	1.22–1.76	**<0.001**
Cerebrovascular disease	1.26	1.13–1.40	**<0.001**
Hemiplegia-paraplegia	1.06	0.92–1.23	0.404
Diabetes mellitus (without complications)	1.49	1.32–1.68	**<0.000**
Diabetes mellitus (with chronic complications)	0.99	0.88–1.11	0.862
Dementia	1.43	1.31–1.56	**<0.001**
COPD	1.54	1.41–1.79	**<0.001**
Renal disease	1.43	1.29–1.59	**<0.001**
Mild liver disease	1.30	1.07–1.57	**0.007**
Moderate-severe liver disease	1.14	0.80–1.63	0.469
Any malignancy	1.44	1.24–1.68	**<0.001**
Metastatic solid tumour	1.14	0.89–1.44	0.300
Prior history of hospital admission in past 1 year	2.73	2.38–3.12	**<0.001**

[a] *P* values in bold denote statistically significant result $P<0.05$.
BOL: build-own-lease; CCI: Charlson Comorbidity Index; CI: confidence interval; COPD: chronic obstructive pulmonary disease; EoL: end-of-life; IRR: incidence rate ratio; NA: not available; NH: nursing home; PCHI: per-capita household income; PNH: for-profit organisations under the MOH NH Portable Subsidy Scheme; VWO: voluntary welfare organisation

NH residents (about 36.7% of the cohort) were hospitalised at a rate of 2.23 inpatient admissions per 1000 resident days in 2015, approximating to a crude rate of 667.2 admissions per 1000 residents, which was almost twice the rate of 292.9 (females)–347.6 (males) per 1000 for the general older population aged 65 & above.[11] The volume of hospitalisations is expected to increase with the growing number of NH places (in tandem with a rapidly ageing population), which has reached 18,157 beds at the end of 2022,[12] and is planned to almost double to 31,000 beds by 2030.[13] This would be further compounded by the changing demographics of NH residents who are expected to be older, with greater frailty and multi-morbidity burden, and closer to the EoL.

Residents with higher hospitalisation rates were men, those with comorbidities and approaching the EoL, those with history of prior hospital admission(s) in the preceding year, and those recently admitted to the NH (0–6 months) as compared with residents with longest stay of more than 5 years. The impact of sex differences,[4] multi-morbidity[14] and EoL[15] on hospital utilisation are well documented in previous studies. Approaching the EoL as a correlate for unplanned hospitalisations also emphasises the importance of advance care planning (ACP) and palliative care provision in NHs, which aim to protect such residents from unnecessary and often futile hospitalisations which do little to improve quality of life or even prolong survival.

Unsurprisingly, most cases necessitating hospitalisation among NH residents were related to infections (lower respiratory tract infections, UTI, cellulitis and gastroenteritis), which are also leading causes of morbidity and mortality in the same population.[16] These contrast with the overall top 10 conditions of hospitalisation across all age groups in Singapore, where accidents, poisoning and violence (8.2%), cancer (6.0%), pneumonia (3.0%), ischaemic heart disease (3.1%) and intestinal infectious diseases (2.6%) ranked among the top conditions.[17] Risk factors for such infections in the NH population include frailty, high functional dependency, polypharmacy, low vaccination rates,

long-term nasogastric tube feeding and urinary catheterisation.[18] These are common clinical issues in the NH care setting and could serve as potential targets for intervention. National infection prevention and control guidelines issued by the MOH could serve as guidance for NHs to put in place basic precautions and prevention measures including surveillance, environmental controls and vaccinations in the long-term care setting.[19] Many older residents may also have underlying dysphagia of varying degrees, which predisposes them to repeated aspiration and hence pneumonia, emphasising a focus on early detection and management.

Another factor which could contribute to hospitalisations is the management of care transitions,[20] where recent admissions into an NH pose significant risks of re-hospitalisation during this phase. Newly admitted residents may have relatively less stable health conditions immediately following discharge from the hospitals, and together with lack of familiarity with the residents' care needs initially, this could leave the NH to manage such complex care needs exceeding their capabilities. Recent hospitalisations also increase susceptibility of infections which may lead to rehospitalisation.

Our findings on the readmissions also call upon the current model of care in NHs to be reviewed. There is a need to adopt a more proactive mode to assess and anticipate crises early and manage them pre-emptively before hospitalisation. It is also imperative that, to manage "unnecessary" or "preventable" transfers to hospitals, NH staff be upskilled and equipped to manage certain acute and subacute conditions effectively on site, or consider reskilling or job redesigning to manage the increasingly complex NH population and improve continuity of care.

Systematic reviews, which studied "potentially avoidable hospitalisations (PAH)", have found components of initiatives that could potentially reduce the burden of hospitalisation, including enhancing primary and geriatric care in the NH, palliative care,[21,22] the use of nurse practitioners or physician assistants to enhance the medical care[23] and programmes or interventions for early identification and evaluation of acute changes in a resident's condition.[24]

Anticipatory care in the form of ACP and goals of care setting should also be encouraged in the NHs, especially in partnership with hospitals and hospices where it could be initiated. For residents who may be at EoL, palliative care should be made available in the NHs. To this end, programmes involving collaborations between hospital care teams and NHs, such as Project Care that integrates geriatric care, ACP and upskilling of NHs to manage common EoL symptoms should be scaled up significantly.[25] The recently published National Strategy for Palliative Care by the MOH also calls for general palliative care models to be developed in NHs, combined with systematic screening and timely identification of residents who would benefit from specialist care.[26]

Strengths and limitations

To the best of our knowledge, this is the first study describing the extent of unplanned hospitalisations of a large cohort of NH residents across Singapore. It establishes a comprehensive baseline that could inform and guide various stakeholders on strategies to reduce unplanned hospitalisations and therefore reduce harm and healthcare costs.

Our focus on subsidised residents could introduce selection bias. However, as mentioned earlier, we minimised bias by including data from all subsidised residents from public administrative databases with a high coverage (>90% of entire cohort). Due to the retrospective cohort design of this study, we were unable to assess causality of the factors identified, and the impact of ongoing interventions that could impact hospitalisation rates. Notably, the data sources we used and the multivariable model we developed did not allow for more detailed analysis of clinical factors associated with hospitalisations, such as functional impairment, implementation of ACP, mood and cognition, and health stability. Notably, there were a large amount of missing baseline clinical information (15.8%, n=1568) from the cohort that did not have hospital admissions due to the lack of records. In prospective studies, reduced physical function, polypharmacy and malnutrition in NH residents were associated with increased risk of hospitalisations.[18] Future studies could characterise these factors using comprehensive assessment tools, such as the interRAI LTCF.[27] Other facility- or systems-level factors may also have an impact, such as the overall quality of care in NHs, the impact of staffing ratios or skills mix of NH staff,[28] and the role of incentives and public health policies to influence hospitalisations in other comparable healthcare systems which were not assessed in this study. Additional studies are needed to better understand these factors in Singapore. Finally, we also acknowledge the limited generalisability of our findings to NH populations beyond Singapore given our study cohort.

CONCLUSION

With the rising numbers of NH residents, reduction of hospitalisations should be a key metric for the long-term care sector to target for quality improvement. Our findings suggest the need for a multipronged approach involving various stakeholders that include the following strategies: identify those at higher risk of hospitalisations, enhance capabilities of NHs for early detection and management of acute conditions on-site, strengthen palliative care and ACP, and improve care transitions to the NH. It also calls for a need to transform care models in the NH towards that of a preventative focus.

Ethics statement

The study was approved by the National Healthcare Group Domain Specific Review Board (2017/00115).

Declaration

The author(s) declare there are no affiliations with or involvement in any organisation or entity with any financial interest in the subject matter or materials discussed in this manuscript.

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