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Where to go if not the hospital? Reviewing geriatric bed utilization in an acute care hospital in Singapore

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Aim: Singapore is one of the fastest-aging countries in the world, and the demand for acute hospital care for older adults is expected to triple in the next 25 years. Hence, it is crucial to understand the opportunities in reducing potentially avoidable bed days (PABD), which are days spent in acute hospitals delivering only non-acute services. We aimed to access the prevalence, causes and consequences of PABD among geriatric patients.

Methods: We examined all hospitalizations from 1 August through 31 December 2013 in the geriatric wards of an acute hospital in Singapore. PABD were identified using a modified Appropriateness Evaluation Protocol. Non-acute services were classified as subacute care, rehabilitative care, long-term care or social care. Hospitalization patterns were determined based on the presence or absence of non-acute services, and multinomial logistic regression was used to determine predictors of different patterns.

Results: Of the 273 bed days used by 254 patients, 49% were potentially avoidable. The most common non-acute services provided were rehabilitative care (19%), subacute care (12%) and long-term care (8%). New acute issues arose after the admission conditions subsided in 2.4% of hospitalizations, 61% of which were nosocomial infections. Being socially at risk as assessed on admission predicted the development of new acute issues (sensitivity = 62%; specificity = 88%).

Conclusions: In the present study, almost half of the bed days were potentially avoidable. New acute issues can arise after PABD, which are dangerous to these frail older adults. Proactive discharge planning and increasing access to intermediate and long-term care services are required to reduce PABD. **Geriatr Gerontol Int 2017; 17: 1575–1583.**

Keywords: appropriateness of hospital use, geriatric patients, health services, hospital-acquired conditions.

Introduction

Like other healthcare systems in this region, such as Hong Kong[1] and Australia,[2] Singapore is experiencing a growing demand for acute care hospital beds. This results from the rapidly growing elderly population who use hospital more frequently and stay longer than younger individuals. The number of hospitalizations of residents aged 65 years and older is estimated to increase by three- to fourfold in the next 25 years if the current utilization pattern remains unchanged in Singapore.[3,4] As building new hospitals is costly and associated with challenges of recruiting and retaining the workforce,[5] there is growing interest in strategies that allow for better use of existing hospital beds.

One strategy for alleviating pressure on hospital capacity is to reduce potentially avoidable bed days (PABD). PABD are defined as days spent in acute hospitals delivering "services that could be rendered in a less costly lower-level institutional or outpatient setting".[6] Most of the previous studies on PABD were carried out in Europe[7–11] or the USA,[12–14] but few in Asia.[15] These studies showed that the prevalence of PABD can vary from 8% to 76%, depending on the contexts and characteristics of the patients examined.

Geriatric patients are high utilizers of hospital care. They are also highly vulnerable to the stress associated with prolonged stays in hospitals, such as nosocomial infections[16] and the emergence of geriatric syndromes.[17] These events can be especially dangerous to geriatric patients, who tend to have complex comorbidities and low physical resilience.[16,18] As such, it is especially important to better understand PABD in this population, which remains unclear as most of the previous studies focused on general medicine patients.

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Therefore, we aimed to carry out a survey of hospital bed utilization to understand the prevalence, causes and consequences of PABD in the geriatric wards of one acute hospital in Singapore.

Method

Reviewing tools

Appropriateness Evaluation Protocol (AEP) is a commonly used utilization review tool with high validity and reliability.[6] We developed a modified version of AEP from the original,[19] and a Dutch version[7] to account for the Singapore context (Table 1). This version was developed through several rounds of discussions and revisions involving two international and nine local specialists in general medicine or geriatric medicine. This version of AEP consists of 18 criteria that represent either services that can only be provided in acute hospitals or unstable conditions of the patients that warrant inpatient monitoring. If none of the criteria were met, a day of stay would be deemed potentially avoidable; and if any of the criteria were met, a day would be deemed unavoidable. The reviewer was not allowed to override the result of the tool in this study, so as to minimize subjectivity. The feasibility of the tool was tested in a pilot study of 30 cases. Interrater reliability was assessed by having two reviewers independently review the case notes and comparing their findings using kappa score.[20] The kappa score was 0.94 (standard error = 0.15).

We developed a structured classification algorithm to determine the types of non-acute services provided during PABD (Fig. 1). Based on the results of the pilot study, we classified services into five categories based on the level of medical expertise required: (i) acute care; (ii) subacute care; (iii) rehabilitative care; (iv) long-term care; and (v) sorting out social issues. We identified 10 subcategories of the non-acute services that are commonly provided to geriatric patients, namely: (i) awaiting inpatient service or consult; (ii) awaiting normalization of leukocyte count, electrolyte or post-voiding residual urine with minimal active management; (iii) medication optimization for diabetes, hypertension or pain; (iv) wound care by wound nurse; (v) inpatient physical therapy, occupational therapy and/or speech therapy; (vi) awaiting community hospital beds; (vii) awaiting nursing home beds; (viii) awaiting community-based long-term care services; (ix) awaiting family's decision on discharge plan; and (x) other reasons. We arranged these categories in a hierarchical manner, so that we only used the service of the highest level for classification if multiple services were provided on the same day. Kappa score was 0.79 (standard error = 0.07) for this service classification algorithm.

Then we classified each episode of hospitalization into one of five mutually exclusive utilization patterns based on the services provided. These five patterns include: (i) acute care only; (ii) acute care followed by subacute care; (iii) acute care (with or without sub-acute care) followed by rehabilitative care; (iv) acute care (with or without sub-acute or rehabilitative care) followed by long-term care; and (v) occurrence of new acute conditions after the admission conditions subsided.

Study population and sampling

The present study population consisted of all hospitalizations in the acute geriatric wards of Khoo Teck Puat Hospital (KTPH) in Singapore from 1 August through 31 December 2013. Khoo Teck Puat Hospital is a public hospital of 590 beds, located in the northern part of Singapore. Public acute care hospitals in Singapore provide care to approximately 80% of the population, and almost all of the middle- and low-income class of the residents who are eligible for government subsidies.

We used bed day instead of individual patient as our primary unit of analysis, so as to avoid overrepresentation of patients with prolonged length of stays (LOS).[19] We aimed to include 100 potentially avoidable bed days in our sample. There were 50–60 beds occupied on each day excluding discharges or mortalities, and our pilot study showed that approximately 50% of bed days were potentially avoidable, therefore we sampled five dates out of the 153-day study period. As bed utilization patterns are likely to be similar on dates adjacent to each other, as the same patients tend to be included on both dates, we divided the 153 days into 10 blocks and sampled 1 day in every other block to maximize intervals between consecutive sampled dates.

Data collection

The first author retrieved medical records of all patients who occupied beds on sampled dates and reviewed all the bed days for each patient in the sampled beds throughout his hospitalization. The first author is an MD/PhD student who have completed all core clinical clerkships (1.2 years' experience in the working environment) in Singapore. The reviewing process was supervised by two of the authors, ARV (specialist in hospital medicine) and CHW (senior consultant in geriatric medicine), and GT (senior resident in internal medicine), who is mentioned in the Acknowledgments section. We evaluated each bed day to determine if it is potentially avoidable with the modified AEP. If the day was potentially avoidable, the reviewer would go through the list of questions in the service classification algorithm (Fig. 1) to ascertain what level of service was provided during that PABD. Patient characteristics that could potentially predict utilization patterns were extracted from the medical record.

Statistical analysis

We calculated proportions of PABD by the numbers of PABD of different levels of services/total number of bed days on sampled dates. We calculated proportions of

Table 1 Modified Appropriateness Evaluation Protocol

	Within 48 h before the day of review
1. Fever of a least 38.5°C rectally or 37.5°C orally).	
2. Transfusion due to blood loss (chronic blood loss requiring routine, intermittent transfusion [e.g. aplastic anemia] does not count)	
3. Ventricular fibrillation or ECG or biomarkers (troponin or CK-MB) evidence of acute ischemia, as stated in progress note or in ECG report.	
4. Acute hematological disorders, significant neutropenia, anemia, thrombocytopenia, leukocytosis, erythrocytosis or thrombocytosis, yielding signs (e.g. ecchymoses or bleeding) or symptoms (e.g. vascular thrombi).	
5. Progressive stroke or spinal cord lesion ("progressive" is judged by the reviewer based on physical examination findings documented in the notes).	
	Within 24 h before the day of review
6. Major invasive procedure in the operation theater.	
7. Inability to void or move bowels post-operations.	
	During the day of review
8. Procedure in operating theater.	
9. Diagnostic procedure carried out (e.g. biopsy, invasive CNS diagnostic procedure). (Routine tests, such as FBC, LFT, are not included unless they are part of the diagnostic process).	
10. IV or epidural administration of fluids and/or medication.	
11. Scheduled for procedure in operating room the next day requiring extraordinary pre-operative consultation or evaluation.	
12. Intake and output measurements for acute or progressive deterioration in function of fluid regulating systems.	
13. Treatment requiring dose adjustments under direct medical supervision daily.	
14. Respiratory care – continuous respirator use for any portion of the day of review OR intermittent use of an IPPV/non-invasive ventilator or any form of O_2 at least 3 times daily (p.r.n. not sufficient) OR nebulizers or endotracheal suction at least 3 times daily.	
15. Major surgical wound that require skilled wound care or drainage that requires checking or emptying every shift.	
16. Close medical monitoring by a nurse under physician's orders or by a doctor at least 3 times daily (vital signs monitoring only does not count).	
17. Isolation of patient with infectious conditions.	
18. Acute altered mental status, not due to alcohol withdrawal (but not simple syncope; e.g. become drowsy, acute seizure to hypoglycemia).	

CK-MB, creatine kinase, muscle and brain; CNS, central nervous system; ECG, electrocardiogram; FBC, full blood count; IPPV, intermittent positive pressure ventilation; LFT, liver function tests.

utilization patterns *in the sample* by the number of different utilization patterns/total number of hospitalizations. To estimate the proportions of utilization patterns *among all hospitalizations during the study period*, we repeated the calculation except for adding a weight of the reciprocal of its LOS to each hospitalization. This is because the probability of including any hospitalizations in our cross-sectional sample is proportional to its LOS. In this way, hospitalizations with longer LOS, which were overrepresented in the sample, received a smaller weight and vice versa. We also calculated the average LOS and average proportions of PABD for different utilization patterns. We used multinomial logistic regression to identify predictors of different utilization patterns. We calculated sensitivity and specificity of the prediction for binary predictors. We carried out parametric receiver operating characteristic analysis for continuous predictors,[21] and reported the C-statistics. Data were documented and prepared for statistical analysis using

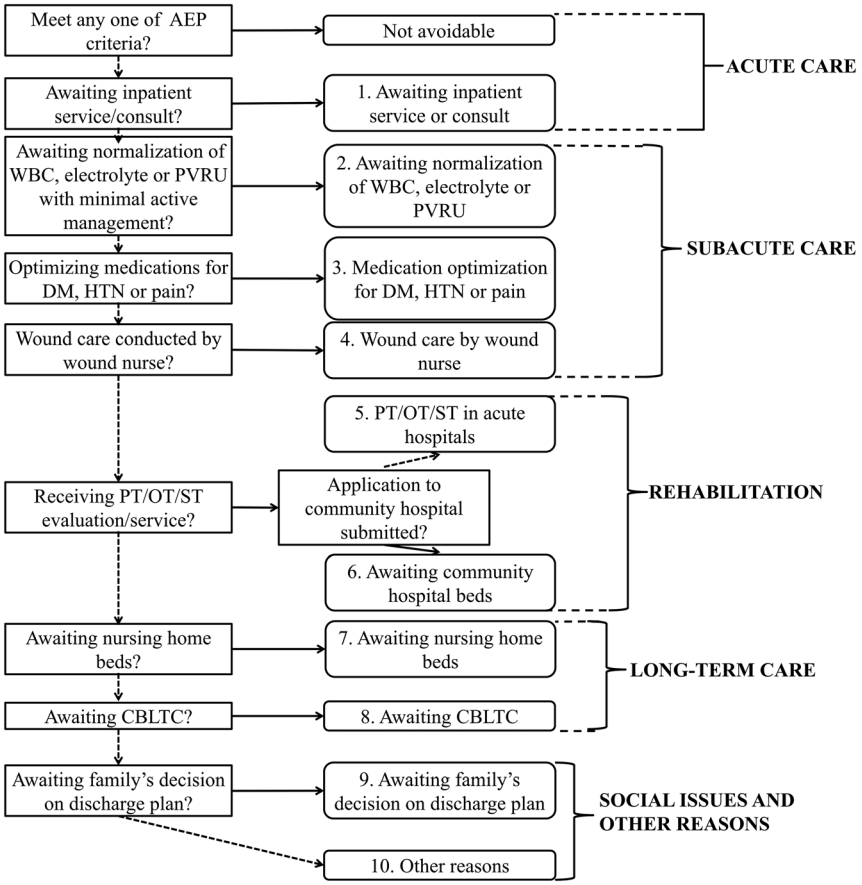

Figure 1 Classification algorithm of level of services provided during potentially avoidable bed days. Boxes on the left side are a series of questions with answers to be determined based on the services provided to the patients on a potentially avoidable bed day. Solid and dashed arrows denote answers of yes or no, respectively. Boxes with round corners represent the 10 categories of services. Brackets and labels on the right of the diagram indicate levels of the services provided. AEP, Appropriateness Evaluation Protocol; CBLTC, community-based long-term care; DM, diabetes mellitus; HTN, hypertension; OT, occupational therapy; PT, physical therapy; PVRU, post-voiding residual urine; ST, speech therapy; WBC, white blood cells.

Excel (2013; Microsoft, Redmond, WA, USA), and statistical analysis was carried out using STATA (13; StataCorp, College Station, TX, USA).

Results

Patient characteristics

Case notes of 268 hospital visits were retrieved and reviewed, and 273 bed days (of 254 unique patients) were included in the analysis after excluding cases that were discharged on sampled dates. As assessed from admission date data, the average age of the patients was 86.6 years. A total of 61% of patients were women. Approximately 20% of all patients had impairments in seeing, hearing or swallowing, or had suboptimal nutrition status. A total of 40% and 50% of patients lost bowel and urinary continence, respectively. A total of 50% of the patients were cognitively impaired, as measured by the Abbreviated Mental Test Score. A total of 80% of the patients were at risk of a pressure sore to various extents. At the time of admission, 15% of the patients were considered as "socially at risk," although this variable mainly captures the unmet caregiver needs, but does not explicitly refer to other aspects of social issues, such as substance abuse or financial stress (Supplemental Table 1). On average, patients experienced a 2-point reduction in their activity of daily living (ADL) status from 3 weeks before hospitalization as measured by the modified Barthel Index (Table 2).

Proportion of bed days that are potentially avoidable

Table 3 shows the proportions of PABD during these bed days. In total, 49.1% (n = 273) of the bed days were deemed potentially avoidable by the tool. A total of 19% and 12.1% of bed days were occupied only for rehabilitative care or subacute care, respectively. These services can be provided in community hospitals or the outpatient setting. A total of 8% and 6.2% of bed days were occupied because of the lack of nursing home beds or discharge plans, respectively. These patients can be managed in nursing homes. A total of 1.8% of the bed days were attributable to delays in inpatient test or specialist consultation.

Table 2 Patient characteristics and association with utilization pattern

n = 268	Patient characteristics, proportion/mean (95% CI)	Associations with utilization pattern, odds ratio[††] (95% CI)				
		Type 1 (acute only)	Type 2 (subacute)	Type 3 (rehabilitation)	Type 4 (long-term care)	Type 5 (new acute issue)
Univariate analysis						
Age	86.6 (85.9–87.4)	1	1 (0.9–1)	1 (0.9–1)	0.9 (0.9–1)	0.9 (0.8–1)
Female	0.61 (0.55–0.67)	1	0.9 (0.5–1.7)	0.6 (0.3–1.3)	0.7 (0.3–1.9)	0.9 (0.3–3)
Vision impairment	0.21 (0.17–0.27)	1	1.3 (0.6–2.5)	0.6 (0.2–1.6)	0.3 (0.1–1.6)	1.0 (0.3–4.2)
Hearing impairment	0.18 (0.14–0.24)	1	1.5 (0.7–3.3)	1.2 (0.5–3.2)	1.6 (0.5–5.1)	1.0 (0.2–5.3)
Speech impairment	0.03 (0.01–0.05)	1	0.4 (0.1–2.1)	0.4 (0.0–3.9)	NA	NA
Dysphasia	0.16 (0.12–0.21)	1	0.5 (0.2–1.1)	0.7 (0.3–1.9)	2.0 (0.8–5.4)	0.7 (0.2–3.6)
Urinary incontinence	0.52 (0.46–0.58)	1	0.9 (0.5–1.6)	0.9 (0.5–1.9)	2.1 (0.8–5.7)	1.1 (0.3–3.5)
Bowel incontinence	0.41 (0.35,0.47)	1	1.3 (0.7–2.3)	0.5 (0.2–1.2)	1.4 (0.6–3.6)	1.8 (0.6–5.8)
Cognitive impairment[†]	0.52 (0.46–0.58)	1	1.3 (0.7–2.3)	0.8 (0.4–1.7)	2.0 (0.8–5.3)	1.7 (0.5–5.7)
Malnutrition	0.22 (0.18–0.28)	1	0.9 (0.4–1.7)	0.7 (0.3–1.8)	0.6 (0.2–2.1)	1.4 (0.4–4.9)
Pressure score risk[‡],						
no risk	0.22 (0.17–0.27)	1	1	1	1	1
at risk	0.42 (0.37–0.49)	1	1.6 (0.7–3.4)	1.1 (0.4–3.0)	1.8 (0.5–6.7)	7.3 (0.9–62.0)
medium risk	0.19 (0.15–0.24)	1	0.9 (0.4–2.1)	1.2 (0.4–3.3)	0.5 (0.1–3.2)	NA
high risk	0.15 (0.11–0.2)	1	0.5 (0.2–1.4)	0.6 (0.2–2.1)	2.1 (0.5–8.4)	2.4 (0.2–,28.7)
very high risk	0.02 (0.01–0.04)	1	1.2 (0.2–8.2)	NA[‡‡]	NA[‡‡]	NA[‡‡]
Social at risk[§]	0.15 (0.11–0.19)	1	10.3* (1.3–81.1)	12.0* (1.4–103.1)	87.3*** (10.3–738.2)	128.0*** (13.3–1234.9)
Reduction in ADL	2.08 (1.72–2.44)	1	1.0 (0.9–1.1)	1.2** (1.0–1.3)	1.0 (0.8–1.2)	1.2 (1.0–1.4)
Multivariate analysis						
Social at risk	0.15 (0.11–0.19)	1	10.4* (1.3–81.8)	10.7* (1.2–92.7)	94.0*** (11.0–802.3)	118.0*** (12.2–1144.8)
Change in ADL	2.08 (1.72–2.44)	1	1 (0.9–1.1)	1.2* (1.0–1.3)	0.9 (0.7–1.1)	1.1 (0.9–1.4)

*$P < 0.05$, **$P < 0.01$, ***$P < 0.001$. [†]Measured with abbreviated mental score (<8 → cognitively impaired); [‡]Measured with Braden scale (>19 → no risk, 15–18 → at risk, 13–14 → medium risk, 10–12 → high risk, <10 → very high risk). [§]Determined with screening questions answered by the caregiver (Supplemental Table 1). [¶]Measured with the modified Barthel Index (including personal hygiene, bathing, toileting, eating, dressing, ambulation, transfers; function in each activity of daily living was labeled as dependent [1], assisted [2] or independent [3]). Reduction in activity of daily living was the difference between that of admission and 3 weeks before admission. [††]Odds ratio is the exponentiated coefficient. It is reported in STATA as the relative risk ratio. [‡‡]NA, not applicable. The coefficients cannot be calcualated due to the abscence of varitations in the independent binary variables among patients having certain utilization patterns.

Table 3 Proportion of potentially avoidable bed days and possible alternative care settings

Services provided	Level of care	Proportion of bed days, % (95% CI)	Possible alternative care setting
Awaiting inpatient service or consult	Acute care	1.8 (0.1–3.6)	NA
Awaiting normalization of WBC, electrolyte or PVRU	Sub-acute	5.9 (2.9–8.8)	Community hospital
Medication optimization for DM, HTN or pain		4.4 (1.8–7)	Primary care physicians
Wound care conducted by wound nurse		1.8 (0.1–3.6)	Community hospital/home nursing
Subtotal		12.1 (8–16.1)	
PT/OT/ST in acute hospitals	Rehabilitation	11.7 (7.7–15.7)	Community hospital/outpatient rehabilitation
Awaiting community hospital beds		7.3 (4.1–10.6)	community hospital
Subtotal		19 (14.2–23.9)	
Awaiting nursing home beds	Long-term care	7.7 (4.3–11)	Nursing home
Awaiting CBLTC		0 (0–0.2)	Community-based long-term care service
Subtotal		7.7 (4.3–11)	
Awaiting family's decision on discharge plan	Social issues	6.2 (3.2–9.3)	Nursing home
Other services		2.2 (0.3–4.1)	NA
Total		49.1 (39.3–58.9)	

n = 273. CBLTC, community-based long-term care; CI, confidence interval; DM, diabetes mellitus; HTN, hypertension; NA, not applicable; OT, occupational therapy; PT, physical therapy; PVRU, post-voiding residual urine; ST, speech therapy; WBC, white blood cells.

Characteristics and predictors of different hospital utilization patterns

Adjusted for the LOS, approximately 40% (*n* = 268) of hospital visits had no PABD, and another 40% of admissions had approximately 50% of their bed days used for subacute care (Table 4). Hospitalizations with delays in discharge as a result of the lack of community hospital or nursing home beds accounted for 11% and 4% of hospitalizations, respectively, and

Table 4 Typology and proportion of individual patient's utilization pattern

Typology	Proportion of cases in the sample, % (95% CI)	Estimated proportion of cases among all admissions, % (95% CI)	Average length of stay, days (95% CI)	Average proportion of PABD during entire hospitalization, % (95% CI)
1. Acute care → discharged/died	27.5 (22.3–32.6)	41.4 (35.7–47.1)	13.5(9.7–17.3)	0 (0–0)
2. Acute care → subacute care → discharged	35.6 (30.1–41.1)	41.9 (36.2–47.6)	16(12.5–19.5)	53.7 (49.7–57.7)
3. Acute care (→ subacute care) → rehabilitation → Discharged	16 (11.7–20.3)	10.7 (7.1–14.3)	27.1(18.6–35.6)	67 (61–73)
4. Acute care (→ subacute care/rehabilitation) → long-term care → discharged	15.4 (11.2–19.6)	3.6 (1.3–5.8)	57.9(45.9–70)	72 (65.8–78.2)
5. Acute care → subacute care/rehabilitation/long-term care → acute care → discharged/died	5.6 (2.8–8.3)	2.4 (0.5–4.3)	36.4(27.4–45.4)	37.6 (28.8–46.4)

n = 268. CI, confidence interval; PABD, potentially avoidable bed days.

their average LOS were approximately 1 month and 2 months, respectively. A total of 2.4% of hospitalizations were associated with new acute issues. A total of 11 out of the 18 new acute issues (61%) were attributable to nosocomial infections, as documented in the case notes. Patients who developed new acute issues stayed on average more than 1 month in the hospital.

Being socially at risk and a reduction of ADL scores were significantly associated with hospitalizations with PABD. Specifically, patients who had unmet caregiver needs were more likely to receive subacute care, rehabilitative care, long-term care or develop new acute issues during hospitalizations as opposed to only receiving acute care for admission conditions with odds ratios of 10.3, 12.0, 87.3 and 128.0, respectively. Reduction of ADL scores by one unit was associated with a 1.2-fold higher likelihood of receiving inpatient rehabilitative care compared with only receiving acute care. These results remained almost unchanged in multivariate regression analysis (Table 2). Being socially at risk alone had 20% sensitivity and 99% specificity in predicting hospitalizations with any PABD. The sensitivity increased to 52% and 62%, respectively, when it was used to predict only hospitalizations with long-term care services or new acute issues, whereas specificity remained as high as 89% and 88%, respectively (Supplemental Table 2). Using reduction in ADL to predict hospitalization with rehabilitative care achieved a C-index of 66% (95% CI 56–76%).

Discussion

In the present study of geriatric patients in Singapore, we found that almost half of the hospital bed days were potentially avoidable. The majority of these bed days were only occupied for services associated with subacute care, rehabilitative care or long-term care, indicating that inadequate intermediate and long-term care services drive potentially avoidable hospital utilizations. Being assessed as socially at risk on admission was predictive of any hospitalizations with PABD, particularity for those with long-term care services and new acute issues. Patients developed new acute issues after PABD. Although these events only occurred in 2.4% of the admissions, they have been shown to be dangerous for frail geriatric patients.[16,18] In addition, this group of patients stayed for more than 1 month on average, occupying beds that could have been used to accommodate patients with more acute needs in a hospital that is almost full (average occupancy rate is greater than 95%).

Our estimate of a PABD rate of 49% is smaller than the 54–61% from previous utilization reviews of geriatrics patients in UK hospitals,[22,23] but higher than the 34% of a USA study.[24] This difference is likely because the community-based intermediate care services, such as rehabilitative and nursing services, are limited in Singapore compared with the USA, but similar to the UK[25] in that some of these services are integrated in the acute care hospitals. Singapore currently has significantly fewer acute care hospital beds per population than the USA (2.18 beds per 1000 populations *vs* 2.83 beds per 1000 populations). The difference in the intermediate and long-term care sector is much more prominent (2.49 beds per 1000 populations *vs* 5.33 beds per 1000 populations; Supplemental Table 3). Although this is a crude comparison without accounting for the difference in the constitution of the population and ways healthcare are provided between the countries (informal long-term care might play a bigger role in Singapore as compared with the USA), the considerable difference highlights the possibility of a lack of intermediate and long-term care services in Singapore. We found that being socially at risk correlates with any hospitalizations with PABD. This suggests that lack of caregiver support can potentially aggravate the delay in discharge as a result of insufficient intermediate care services in the community. This is likely due to two reasons. First, physicians tend to offer patients with poor caregiver support more aggressive intermediate care services for them to achieve a higher level of functional independence before discharge. Second, caregivers experiencing frustrations tend to be passively engaged in discharge planning, leading to a delay in discharge. This is further aggravated by the fact that lower-income families pay less out-of-pocket expenses if the patients stay in an acute care hospital than alternative settings under the current subsidy schemes. This finding highlights the necessity to develop novel services or incentive mechanisms that enhance the caregiver support at home for this group of patients.

The present study is the first utilization review of geriatric patients in Asia. Classifying hospital use into parsimonious patterns and using patient characteristics to predict the patterns are novel attempts. Unlike almost all previous studies, which either lumped all PABD together[7–9] or classified PABD based on the subjective judgment of the reviewers,[26,27] we developed an objective structured algorithm to classify PABD according to the level of services provided during those days. The same approach can be used in other hospitals in Singapore or other countries to better understand the issue of PABD.

The present study had limitations. First, we only examined the data from the geriatrics department of one hospital in Singapore, which could potentially compromise the generalizability of this study. That said, the hospital we examined is not significantly different from other public hospitals in Singapore with respect to patient composition, average LOS or occupancy rate. Therefore,

the findings can reasonably reflect the general situation in Singapore. In addition, the present study was carried out in an Asian society with patients of diverse Asian ethnicities (i.e. Chinese, Malay and Indian), making our study a better reference for future studies in Asia than previous work in the USA or Europe. Second, data from the case notes only allowed us to determine what non-acute services were *provided* during PABD. However, services *provided* might not necessarily equate with services *needed*. Further research is called for to decipher the unmet needs or unnecessary services delivered, which would require a concurrent review of case notes and interviews of patients and clinicians.

The aging population is considered to be a primary challenge to the healthcare system in Asia. There is increasing pressure to provide lower cost high-quality care to the population. Singapore continues to allocate resources to build and staff hospitals effectively in order to provide care to this growing population. With almost half of the bed days in the present study deemed to be potentially avoidable, and the risks associated with hospitalization in this population, the provision of subacute and social care should be increased in Singapore and other countries facing similar challenges.

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Disclosure statement

The authors declare no conflict of interest.

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Supporting information

Additional supporting information may be found in the online version of this article at the publisher's web-site:

Table S1 Screening tool for being socially at risk
Table S2 Performance of being socially at risk as a predictor of different hospital utilization patterns with potentially avoidable bed days
Table S3 Comparison of healthcare facilities between Singapore and the USA