

Treating acutely ill patients at home: Data from Singapore

Stephanie Q Ko ¹*MBBS*, Joel Goh ²*PhD*, Yee Kian Tay ³*MN*, Norshima Nashi ¹*MBBS*, Benjamin MY Hooi ¹*MBBS*, Nan Luo ⁴*PhD*, Win Sen Kuan ⁵*MBBS*, John TY Soong ^{1,9}*PhD*, Derek Chan ¹*BA*, Yi Feng Lai ^{6,7,8}*MPH*, Yee Wei Lim ⁹*PhD*

ABSTRACT

Introduction: Hospital-at-home programmes are well described in the literature but not in Asia. We describe a home-based inpatient substitutive care programme in Singapore, with clinical and patient-reported outcomes.

Methods: We conducted a retrospective cohort study of patients admitted to a hospital-at-home programme from September 2020 to September 2021. Suitable patients, who otherwise required hospitalisation, were admitted to the programme. They were from inpatient wards, emergency department and community nursing teams in the western part of Singapore, where a multidisciplinary team provided hospital-level care at home. Electronic health record data were extracted from all patients admitted to the programme. Patient satisfaction surveys were conducted post-discharge.

Results: A total of 108 patients enrolled. Mean age was 67.9 (standard deviation 16.7) years, and 46% were male. The main diagnoses were skin and soft tissue infections (35%), urinary tract infections (29%) and fluid overload (18%). Median length of stay was 4 (interquartile range 3–7) days. Seven patients were escalated back to the hospital, of whom 2 died after escalation. One patient died at home. There was 1 case of adverse drug reaction and 1 fall at home, and no cases of hospital-acquired infections. Patient satisfaction rates were high and 94% of contactable patients would choose to participate again.

Conclusion: Hospital-at-home programmes appear to be safe and feasible alternatives to inpatient care in Singapore. Further studies are warranted to compare clinical outcomes and cost to conventional inpatient care.

Ann Acad Med Singap 2022;51:392-9

Keywords: Home-based, hospital-at-home, hospital care, internal medicine, public health

INTRODUCTION

Inpatient hospitalisation is the conventional strategy to care for acutely ill patients. However, demand for hospital beds and clinical manpower is escalating as populations age, and hospitals are expensive to build and run.¹ There is increasing recognition of the risk of hospitalisation from potent nosocomial infections^{2,3} (exacerbated by the COVID-19 pandemic), and hospital-acquired deconditioning.^{4,5} In response, healthcare systems across Australia, Europe and the

US have developed hospital-at-home (HaH) models of care⁶ over the last few decades.⁷⁻⁹

HaH is now well established as a less costly way to substitute inpatient care with comparable clinical outcomes.¹⁰⁻¹⁷ HaH programmes comprise “early-discharge HaH”,¹³ where patients start their stay in hospital wards and complete the remainder of their treatment at home; and “admission avoidance HaH”¹² where patients are admitted to a HaH service directly from an emergency department or primary care. HaH

¹ Department of Medicine, National University Hospital, Singapore

² NUS Business School, National University of Singapore, Singapore

³ Regional Health Service, National University Health System, Singapore

⁴ Saw Swee Hock School of Public Health, National University of Singapore, Singapore

⁵ Emergency Medicine Department, National University Hospital, Singapore

⁶ MOH Office for Healthcare Transformation, Singapore

⁷ Department of Pharmacy, Faculty of Science, National University of Singapore, Singapore

⁸ Department of Pharmacy, Alexandra Hospital, Singapore

⁹ Department of Medicine, Yong Loo Lin School of Medicine, National University of Singapore, Singapore

Correspondence: Dr Stephanie Q Ko, Department of Medicine, National University Hospital, 1E Kent Ridge Road, Singapore 119228.

Email: stephanie_ko@nuhs.edu.sg

CLINICAL IMPACT

What is New

- To the best of our knowledge, this study is the first in Singapore to report that hospital-at-home programmes are a safe and feasible alternative to traditional inpatient care.
- Our findings describe clinical outcomes of this patient population.

Clinical Implications

- The study supports the need to continue developing hospital-at-home as an alternative for inpatient hospitalisation.
- The data can inform policy-making efforts to fund such alternative strategies for inpatient hospitalisation in Singapore as the population ages and demand for hospital beds increases.

teams are multidisciplinary, comprising doctors, nurses, pharmacist and therapists caring for patients via home visits, administration of intravenous therapy and simple investigations, with round-the-clock access to doctors.

However, there are no HaH programmes in Asia reported in the literature, and inpatient hospitalisation is the only and familiar option to clinicians, patients and their families. Singapore has a favourable landscape for the development of HaH, from a compact built environment, to the rising acceptance of telehealth,^{18–20} and the popularisation of transitional home care services.^{21–23} Nationally, there is a policy approach towards “ageing-in-place”²⁴ and shifting care “beyond hospital to community”.¹⁰ The examination of HaH in Singapore would provide insights into the feasibility of this model in a multiethnic population to whom the care model would be unfamiliar.

This study aimed to describe the development of a home-based inpatient substitutive service; and describe the patient demographics, clinical outcomes, patient-reported outcomes and activity, and cost.

METHODS

Intervention

The National University Hospital is a 1,200-bed tertiary acute care hospital and Alexandra Hospital is a 300-bed general hospital in western Singapore. The western part of Singapore has an estimated population of 920,000 at a density of 4,577 persons per square kilometre,²⁶

with the furthest housing district only 15km from either hospital.

We developed inclusion and exclusion criteria by reviewing recently published literature that detailed eligibility criteria^{14–16,27} and applying them to our local context. We included all patients who required ongoing hospitalisation rather than selecting specific diagnosis, to enable us to identify common diagnosis groups suitable for HaH in this study. Other inclusion criteria were: Singaporeans/permanent residents aged 21 years or older, and residence in the western part of Singapore (with predefined area codes). We excluded patients based on 4 criteria. (1) Clinical criteria were: pregnant (National Early Warning Score^{28–30} >2) at screening; on oxygen (due to limitations in logistics of short-term home oxygen delivery); acute psychosis or suicidal intent; needed negative pressure isolation; anticipated to deteriorate; planned endoscopy/blood transfusion/cardiac stress test/surgery/interventional radiology; required frequent drug monitoring; ongoing specialist review; required blood sugar monitoring for patients unable to self-monitor; needed parenteral controlled drugs; and had acute myocardial infarction within the last 5 days. (2) Social criteria were: no access to meals, phone, bed, fridge or table, or did not think house was suitable. (3) Functional criteria: included required but lacked available and willing caregiver; and more than 2 weeks of intensive rehabilitation anticipated. (4) Safety criteria were: unable to obtain venous access; current or former intravenous drug user; and history of violence to healthcare workers. Patients with or suspected to have COVID-19 infection were excluded.

We included both early discharge and admission avoidance models in this study. Early discharge patients were identified by screening all patients admitted to the acute medical unit³¹ (a short stay medical unit specialising in quick diagnosis and disposition), general medical and cardiology wards on weekdays from 21 September 2020 to 30 September 2021, and Alexandra Hospital general medical wards from 1 January to 30 September 2021. Admission avoidance patients were identified by screening emergency department boarders at National University Hospital (patients waiting for a bed at 8am) from the 3rd month of the study and accepting referrals from the community nursing team or specialist outpatient clinics. Following discussion with the patients’ primary consultant physician, suitable patients were approached and reviewed by the HaH doctor to confirm that they met inclusion and exclusion criteria. Family members were contacted if patients did not have the capacity to give consent, or upon patient’s request.

Patients who agreed to participate were transported home by ambulance if they were in a hospital. The HaH nurse visited patients on the same day to explain the programme details, care plan, vital signs monitoring and how to call the helpline for assistance. Nurses educated patients or their caregivers on how to use thermometers, blood pressure machines and pulse oximeters for monitoring, and how to receive teleconsultations if required. Intravenous therapy was delivered to patients via nursing home visits at a maximum of 3 times a day. A doctor reviewed patients by home visit or over videoconsultation at least once daily. Physiotherapists and occupational therapists conducted home visits as clinically indicated. Where required, blood samples were drawn in the patient's home and brought back to the hospital laboratory for processing. If imaging was required, patients were transported to and from the hospital by ambulance. If patients had caregivers, they were not required to play any roles apart from their baseline caregiving duties. When patients fit conventional discharge criteria, they were discharged from the programme to the hospital's existing post-discharge transitional care programme.

The programme was staffed by one attending physician, one nurse, one pharmacist and one programme coordinator. The bed capacity was 3. After office hours, the attending physician manned an on-call phone, but all nursing and physician visits were performed by a private healthcare provider. Handovers were done over multidisciplinary team meetings at the start and end of weekdays (mix of in-person and over videoconference).

Patients were not required to pay for the HaH component of care as part of the programme.

Programme evaluation

All patients admitted to the HaH programme from 21 September 2020 to 30 September 2021 were included in this analysis. As part of ongoing monitoring of programme outcomes and patient satisfaction, we collected data on patient demographics, diagnosis, healthcare utilisation and post-discharge outcomes. This study is a retrospective review of the patient outcomes, with the aim of using the results to plan a prospective controlled study.

Patient demographics and outcomes

Patient demographics, utilisation measures and clinical outcomes were extracted from the electronic health record system. Clinical outcomes were 30-day unplanned readmission rate, inpatient and 30-day mortality rate, and rate of escalation back to hospital care during the

HaH episode. Safety outcomes were rate of venous thromboembolism, falls, hospital-acquired infections, adverse drug reactions and pressure ulcers during the treatment period at home. Rate of acquisition of methicillin-resistant *Staphylococcus aureus* was not measured. Additional demographics including housing type as a proxy for socioeconomic status³² (private housing as the top band, followed by public housing: 5-room flats, 3–4 room flats and 1–2 room flats), language spoken, presence of a live-in domestic helper, Barthel index,³³ self-reported health state, EQ-5D^{34(p5)}, a 3-question health literacy questionnaire³⁵ and mini-cog³⁶ were collected prior to transfer home as part of routine programme evaluation.

Patient reported outcome measures and patient satisfaction surveys

Post-discharge, the standard hospital patient satisfaction survey adapted from the Care Quality Commission, Picker Institute and National Research Corporation Inpatient Core Questionnaire, and EQ-5D questionnaire were conducted where possible. Patients were also asked what out-of-pocket cost they would be willing to pay for the programme in relation to standard inpatient costs.

Sample size

The study was predefined to last for a fixed duration, so all patients admitted during this period were included in the study. The outcomes of this study would be used to estimate sample sizes for further prospective evaluation work.

Statistical analysis

Descriptive statistics were used to analyse patient characteristics and health outcomes. Categorical variables are presented as frequencies and percentages. Continuous variables are presented as means with standard deviations, except for length of stay that is presented as median with interquartile range. Differences in EQ-5D were compared using two-tailed t-tests. All data analysis were done in SPSS Statistics version 21 (IBM Corp, Armonk, US).

Ethics

This study was approved by the local institutional review board National Healthcare Group Domain Specific Review Board (Ref 2021/00037). As this was a retrospective study of data routinely collected for monitoring of programme outcomes, informed consent was waived.

RESULTS

From 21 September 2020 to 30 September 2021, 16,578 patients were screened, of whom 382 (2.3%) met inclusion and exclusion criteria. The main exclusion criteria were for clinical reasons 10,988 (66.3%), comprising clinically unstable condition 3,174 (19.1%) and awaiting additional imaging 3,625 (21.8%) (Fig. 1). Of the patients who were approached, 108 (28.3%) agreed to be enrolled into the HaH programme. Of these admissions, 2 patients were admitted twice and 1 patient was admitted 3 times. The main reason for rejection was that either patients or their family preferred patients to receive care in the hospital. Majority 80 (74%) of admissions were classified as “early-discharge HaH”, and 28 (26%) of admission were considered “admission avoidance HaH”.

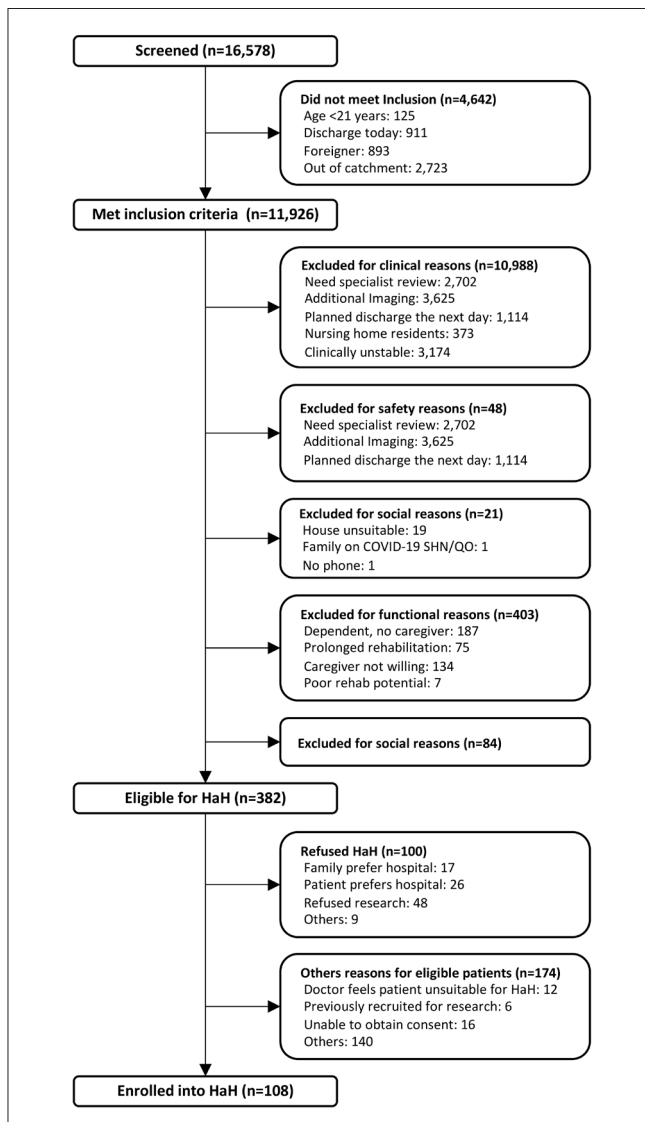


Fig. 1. Flow diagram of recruitment process.

HaH: hospital-at-home; QO: quarantine order; SHN: stay home notice

Patient demographics

The mean age of the recruited patients was 67.9 years and 50 (46.2%) were male. Of these, 73 (67.5%) were Chinese, 27 (25%) Malay and 6 (5.5%) Indian. A large majority 86/95 (90%) lived with family members and 33/95 (35%) had domestic helpers at home (Table 1). The most common diagnoses were skin and soft tissue infections (35%), urinary tract infection (30%) and fluid overload (18.5%). Thirty-seven (34%) patients were admitted from general medicine wards, 33 (30.5%) from the acute medical unit, 17 (15.7%) from community nursing teams, and 13 (12%) from the emergency department. The mean Charlson Comorbidity Index was 4.1 (standard deviation 2.8).

Table 1. Baseline characteristics

	n=108 ^a
Age, mean (SD), years	67.9 (16.7)
Male, no. (%)	50 (46.2)
Ethnicity, no. (%)	
Chinese	73 (67.5)
Malay	27 (25.0)
Indian	6 (5.5)
Others	1 (0.9)
Diagnosis, no. (%)	
Skin and soft tissue infection	38 (35.1)
Urinary tract infection	32 (29.6)
Fluid overload	20 (18.5)
Gastroenteritis	6 (5.5)
Rhabdomyolysis	5 (4.6)
Others	4 (3.7)
Pneumonia	3 (2.8)
Charlson Comorbidity Index, mean (SD)	4.1 (2.8)
Clinical Frailty Scale, mean (SD)	3.9 (2.3)
Admitting source, no. (%)	
Early discharge	80 (74.0)
General Medicine/Geriatric Medicine	37 (34.2)
Acute medical unit	33 (30.5)
Cardiology	6 (5.5)
Renal	4 (3.7)
Admission avoidance	28 (25.9)
Community	17 (15.7)
Emergency department	13 (12.0)
Specialist outpatient clinic	2 (1.9)
Cognitive impairment, no. (%)	35/93 (38)
Employment, no. (%)	
Unemployed/retired	64/95 (67)
Full time work	18/95 (19)
Part time work	8/95 (8)
Self-employed	5/95 (6)
Residence type, no. (%)	
Private	16/95 (17)
Public 5-room flat	22/95 (23)
Public 3–4 room flat	49/95 (52)
Public 1–2 room flat	8/95 (8)

Table 1. Baseline characteristics (Cont'd)

	n=108 ^a
Cohabitants, no. (%)	
Lives with family	86/95 (90)
Lives with friends/tenants	4/95 (4)
Lives with domestic helper only	4/95 (4)
Lives alone	1/95 (2)
Domestic helper present, no. (%)	33/95 (35)
Education level, no. (%)	
No formal education	16/95 (17)
Primary or secondary	53/95 (56)
A level, diploma or graduate	26/95 (27)
English as primary language, no. (%)	25/95 (26)
Adequate health literacy, no. (%)	29/90 (32)
I-ADL independent, no. (%)	37/94 (39)
Barthel Index, mean (SD) (n=95)	77.8 (32.8)
Self-reported baseline health state, no. (%)	
Excellent	5/95 (5)
Very good	8/95 (8)
Good	38/95 (40)
Fair	30/95 (32)
Poor	14/95 (15)

I-ADL: instrumental activities of daily living; SD: standard deviation

^a Unless otherwise stated, as not all patients responded to admission surveys

Home-based interventions

The most common intervention was intravenous therapy (Table 2), whereby 76 (70.3%) patients received intravenous antibiotics and 19 (17.5%) intravenous diuretics. All patients were reviewed by programme doctors and nurses daily. External nursing provided scheduled nursing visits for 66 (61.1%) patients, and unscheduled after hours visits for 4 patients (3.7%). Nine (8.3%) patients had at least one home physiotherapy visit. Four patients were brought back to hospital for scans: 1 computed tomography scan, 1 magnetic resonance imaging scan and 2 ultrasound scans. Forty-nine (45%) of the patients received blood tests at home.

Patient outcomes

The median length of stay in HaH was 4 days with a total of 582 bed days. The median length of stay prior to HaH transfer was 2 days. With a 3-bed capacity and no weekend admissions, the overall bed occupancy rate was 49.1% (Table 3).

The overall rate of escalation to acute hospital was 7 (6.5%). The indications were failure to respond to intravenous antibiotics (2 patients); and fall requiring rehabilitation, anaphylaxis, first onset seizure, hypotensive episode and desaturation (1 patient each,

Table 2. Home-based interventions

	n=108
Reviews, no. (%)	
HaH doctor (daily)	108 (100)
HaH nurse (daily)	108 (100)
HaH physiotherapist	9 (8.3)
HaH pharmacist	6 (5.6)
HaH dietician	2 (1.8)
HaH speech therapist	2 (1.8)
External nursing provider, planned	66 (61.1)
External nursing provider, unplanned	4 (3.7)
Investigations, no. (%)	
Blood test (at home)	49 (45)
Electrocardiogram (at home)	2 (1.85)
Imaging (in hospital)	4 (3.7)
Specialist clinic (in hospital)	2 (1.8)
Treatment, no. (%)	
IV antibiotics	76 (70.3)
IV diuretics	19 (17.5)
IV (others)	13 (12.0)

HaH: hospital-at-home

Table 3. Clinical and patient-reported outcomes

	n=108 ^a
Length of stay, median (IQR), days	
Pre-transfer to HaH (for early discharge)	2 (1–3)
HaH only	4 (3–7)
Total	4 (5–9.5)
Re-utilisation, no. (%)	
30-day emergency department re-attendance	19 (17.6)
30-day hospital readmission	17 (15.7)
Mortality, no. (%)	
Inpatient mortality	2 (1.8)
Died after transfer back to hospital	1 (0.9)
Died at home during HaH admission	1 (0.9)
30-day mortality	4 (3.7)
Escalation to acute hospital, no. (%)	7 (6.5)
Patient safety outcomes, no. (%)	
Venous thromboembolism	0
<i>Clostridioides difficile</i> infection	0
New pressure ulcer	0
New catheter-associated urinary tract infection	0
Inpatient falls	1 (0.9)
Adverse drug reactions	1 (0.9)
Patient reported outcomes	
Overall experience out of 10, mean (SD), n=80	9.0 (1.5)
Would overall recommend experience to others, no. (%)	72/77 (94)
Patient reported activity, no. (%)	
Spent more time walking around at home than in hospital	54/81 (66)
Spent less time lying down at home than in hospital	67/81 (83)
Had better sleep quality at home than in hospital	64/81 (79)

HaH: hospital-at-home; IQR: interquartile range; SD: standard deviation

^a Unless otherwise stated, as not all patients responded to post-discharge surveys

respectively). The inpatient mortality rate was 2 (1.8%): 1 patient died during the HaH treatment period, an end-of-life patient wished to die at home, and another patient died after escalation to hospital for hypotension. Two other patients died within 30 days of admission, both of whom were referred for home-based end-of-life care after discharge. The 30-day readmission rate was 15.7%.

There were 2 major patient safety events—one was an adverse drug reaction (anaphylaxis) with haemodynamic instability, and the other was a fall. There were no incidences of hospital acquired infections or pressure ulcers (Table 3). Both patients were in the early discharge cohort, transferred back to hospital, and were discharged well from hospital several days later.

Eighty-one (75%) patients responded to the post-discharge survey. Overall patient satisfaction was high (Appendix A in online Supplementary Material of this article), with 94% recommending their experience to others with a mean rating of 9.0/10 for overall experience. Almost two-thirds of patients reported that they walked around more at home than in hospital, 83% of patients reported that they spent less time lying down at home than in the hospital, and 79% of patients reported that their quality of sleep was better at home than in hospital. There was an improvement from 0.45 to 0.58 in the EQ-5D index score after 14 days compared to upon enrolment ($P=0.001$) (Appendix B in online Supplementary Material).

Out of the patients who responded to the post-discharge survey, 79 (97.5%) responded that they would opt for HaH care again if the cost were lower than hospital care. If the cost were similar to hospital care, 55.6% would opt for the programme, and if the cost were more expensive than hospital care, 16.4% would choose HaH.

DISCUSSION

To our knowledge, this study is the first description of a HaH service in Asia to provide inpatient substitutive care to otherwise hospitalised adults, we suggest that a HaH programme is a feasible and safe alternative to inpatient hospitalisation for selected patients.

The rate of patient safety incidents reported in our study is similar to other programmes;¹⁶ however, due to the lower numbers in this study, it is difficult to compare with standardised hospital rates. Our hospital readmission rate is comparable to a meta-analysis of HaH among patients with a mix of conditions.¹³ Similar to our findings, patient experience and satisfaction is known to be high in HaH programmes^{13,37} due to the familiarity of environment and greater rapport between patients and providers. Other

studies have also reported improvements in sleep quality and increased mobility.¹⁶

This study also identified several challenges that may limit the expansion of HaH care model in countries without established HaH programmes.

First, our eligibility rate of 2.3% was much lower than a recent Australian study suggesting that 11.1% of hospital admission could be cared for by HaH.³⁸ Our exclusion criteria were more conservative, such as excluding patients on supplemental oxygen, but the most common reasons for exclusion were awaiting of radiologic imaging and specialist review. This highlights that apart from organising care in the home, new HaH programmes will need to work closely with ward-based workflows to optimise eligibility and flow of patients into HaH programmes in order to scale.

Second, 28% of our patients approached for home hospitalisation agreed to be enrolled. This was lower than that reported in Australia (around half)³⁸ and the US (66.9%).¹⁵ The response may reflect patients' and caregivers' unfamiliarity with the care model, but could also suggest that hospitals are culturally seen as a preferred site of treatment. Other local studies have suggested that some patients "expect everything to be done by nurses".³⁹ Patients may prefer to recover in an environment where everything is done for them, and caregivers or family members may view hospitalisation as a form of respite. Furthermore, the majority of the patients enrolled in the HaH programme did not live alone, although living alone was not an exclusion criterion. This may suggest that HaH programmes in Asia may be accepted differently by patients, where the family and cohabitants play a major role in medical decision-making. These preferences may present a potential barrier to scalability, both in Singapore and other communities with multiethnic Asian populations, and the role of caregivers and domestic helpers in HaH will need to be explored in further studies.

Third, our brief willingness-to-pay analysis suggests that developing payment models that are equivalent to inpatient care is a priority for sustaining a HaH programme. If the out-of-pocket component were more than what they would otherwise pay if hospitalised, 85.8% of our patients would have not accepted home hospitalisation. In Singapore, government subsidies, health insurance and health savings account result in low out-of-pocket expenses for inpatient care.^{40,41} This is in contrast to outpatient/community care, with more modest subsidies, restricted insurance coverage and use of medical savings account, thereby translating into higher out-of-pocket costs. Such schemes may financially

incentivise inpatient hospitalisation. Strategies to achieve inpatient financing for HaH—such as the new Acute Hospital Care at Home Program by the Centers for Medicare & Medicaid Services in the US launched in 2020⁴²—is likely to be the most financially sustainable long-term strategy. Aiming to achieve cost neutrality for out-of-pocket costs should therefore be a key priority for sustaining HaH programmes.

Our study has limitations. First, as a single-arm study, we were unable to directly compare outcomes between HaH and hospital-based care. However, the results from this study lay the foundation for further prospective comparative studies. Second, only utilisation but not cost is included in this analysis. Finally, we recognise that different Asian healthcare systems may have unique considerations that could create different challenges for HaH, such as in Hong Kong where private/public services and hospital/community services operate as more independent entities that are not integrated, or where there are urban-rural disparities and geographical challenges in the provision of healthcare such as in larger countries like Malaysia and Indonesia.⁴¹

CONCLUSION

Although providing hospital care at home may be a foreign concept to hospitals, providers and patients throughout Asia, our study suggests that it can be acceptable to a select group of patients, and delivered with a low rate of adverse events, while achieving high patient satisfaction rate. We identified 3 key challenges to developing and scaling home hospitalisation: optimising inpatient flows to increase eligibility rates; shifting mindsets of patients to accept the home as an alternative to staying in hospital; and developing strategies to enable patients to pay for HaH at a rate equivalent to inpatient care. Further studies are warranted to conduct prospective comparative studies on clinical and cost effectiveness. Qualitative studies will be helpful to comprehend patient and caregiver perspectives to better understand the benefits and worries that home hospitalisation brings to different Asian communities.

Funding

This work was supported by strategic funds from the National University Health System and a research grant from Ministry of Health Office for Healthcare Transformation. J Goh's research is supported by a start-up grant from the National University of Singapore (R-314-000-110-133).

Acknowledgements:

The authors thank all multidisciplinary team members of NUHS@Home, Department of Medicine, National University Heart Centre and Emergency Medicine of National University Hospital, Department of Medicine of Alexandra Hospital and Speedoc.

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