Home ward bound: features of hospital in the home use by major Australian hospitals, 2011–2017

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The known: Hospital in the home (HIH) is a safe, effective, and acceptable alternative to in-hospital care. Data on its broad impact on the Australian health system are limited.

The new: During 2011–2017, 80 167 HIH admissions comprised 3.7% of hospital admissions. Median length of stay was longer for HIH admissions, but they were less likely to involve re-admission or death. HIH admission numbers grew more rapidly than overall admission numbers (3.1% v 1.6% per quarter).

The implications: Australian hospital care delivered as HIH is growing, and its use could be extended to clinical areas in which it is not currently employed.

Abstract

Objective: To describe uptake of hospital in the home (HIH) by major Australian hospitals and the characteristics of patients and their HIH admissions; to assess change in HIH admission numbers relative to total hospital activity.

Design: Descriptive, retrospective study of HIH activity, analysing previously collected census data for all multi-day hospital inpatient admissions to included hospitals during the period 1 January 2011 – 31 December 2017.

Setting, participants: Nineteen principal referrer hospital members of the Health Roundtable in Australia.

Main outcome measures: HIH admissions by diagnosis-related group (DRG); patient and admission characteristics.

Results: 80 167 of 2 185 421 admissions to the 19 hospitals included HIH care, or 3.7% (95% CI, 3.6–3.7%) of all admissions. Median length of stay for admissions including HIH (7.3 days; IQR, 3.1–14 days) was longer than that for those that did not (2.7 days; IQR, 1.6–5.1 days). For HIH admissions, the proportion of men was higher (54.4% v 45.9%), the proportion of patients who died in hospital was lower (0.3% v 1.4%), and re-admission within 28 days was less frequent (2.3% v 3.6%). The 50 DRGs with greatest HIH activity encompassed 65 811 HIH admissions (82.1%), or 8.4% (95% CI, 8.4–8.5%) of all admissions in these DRGs. HIH admission numbers grew more rapidly than non-HIH admissions, but the difference was not statistically significant.

Conclusions: HIH care is most frequently provided to patients requiring hospital treatment related to infections, venous thromboembolism, or post-surgical care. Its use could be expanded in clinical areas where it is currently used, and extended to others where it is not. HIH activity is growing. It should be systematically monitored and reported to allow better overview of its use and outcomes.

The core aim of the hospital in the home (HIH) concept is to provide the skills, technologies, and support needed for treating patients at home who would otherwise require admission to hospital.[1] This principle has underlain the establishment and growth of HIH in Australia since 1994 and its funding at levels closer to those of hospital than community care; in Victoria, HIH comprises about 5% of inpatient activity.[2,3] Adoption of the HIH model has been facilitated by favourable funding arrangements; in most Australian states it is categorised as inpatient care, and hospitals are correspondingly reimbursed for providing it.

Many studies and some systematic reviews have reported the safety, clinical benefits, acceptance, and cost-effectiveness of HIH for patients with certain conditions.[4–13] However, hospital or health system level data regarding the influence of HIH on overall hospital activity are limited. An opportunistic study in Jerusalem found that hospitalisations of health fund members over 65 years of age increased in number after a large acute home-based program was closed.[14]

The studies included in meta-analyses of HIH care have often been small, and many were initiation studies; that is, studies in newly established units, or involving new systems within units. Further, the variety of models and providers of HIH complicate systematic review. Comprehensive, multi-site, long term HIH database analyses have been few.

As investment in HIH care in Australia has been considerable, it would be valuable to examine where HIH activity has been undertaken. Its implementation depends on skills and technologies that enable the acute treatment of certain clinical conditions at home, as well as its acceptance by hospital clinicians.

Our study aimed to describe the uptake of HIH by major Australian hospitals and the characteristics of patients and their HIH admissions. Our secondary aim was to assess the change in the number of HIH admissions over 7 years relative to total hospital activity. We sought to provide a broad overview of the impact of HIH in a national health system in which it is particularly prominent.

Methods

We undertook a descriptive, retrospective study of HIH activity, analysing previously collected hospital activity census data.

Data source

The Health Roundtable (https://home.healthroundtable.org) is a Sydney-based non-profit organisation of 90 health services and 177 hospitals in Australia and New Zealand. It receives, analyses, and publishes information about member services, and assists identify how operational practices can be improved by collaboration, benchmarking, and networking of health organisations and their clinicians and executives.

We analysed hospital inpatient activity data submitted to the Health Roundtable by member hospitals in Australia. These data are identical with those forwarded to state health authorities for funding and management purposes, and to the Independent Health Pricing Agency for determining cost weights.

In order to reduce variability related to hospital size, we restricted our analysis to data from principal referrer hospitals, defined by the Australian Institute of Health and Welfare as providing a very broad range of services and having very large patient volumes; most have intensive care, cardiac surgery, neurosurgery, and infectious diseases units, as well as 24-hour emergency departments.[15,16] Hospitals were de-identified in the dataset by the Health Roundtable before it was provided to the authors.

Data analysed

We analysed hospital, HIH status, and diagnosis-related group (DRG) data for multi-day admissions during the period 1 January 2011 – 31 December 2017; same day admissions were excluded. Patient sex and age, lengths of stay for HIH and non-HIH admissions, mortality during admission, re-admission within 28 days, and complexity of medical condition were included in the dataset. Hospitals were included if they provided at least two years' data; DRGs were included if data for at least 100 events and two years' data were available.

As HIH is not uniformly applied across all areas of hospital activity, we restricted our main analysis to HIH activity in the 50 DRGs in which the proportions of admissions including an HIH component (ie, admissions in which patients spent at least part of the episode as HIH patients) were greatest.

Pure hospital in the home admissions

Pure HIH admissions were defined as admissions with no more than 0.25 days of non-HIH care; that is, all or almost all inpatient care was provided as HIH care.

Changes in hospital in the home activity

To examine relative changes in HIH activity over the study period, data on admissions for the 50 DRGs with greatest HIH activity were aggregated by 3-month periods and compared separately with total hospital activity data for the same 50 DRGs and with total hospital activity data for all DRGs. Only data from hospitals providing 7 complete years of data were included in this analysis.

Statistical analysis

Time variables are summarised as medians with interquartile ranges (IQRs), as the data were skewed; categorical variables are summarised as numbers and proportions with 95% confidence intervals (CIs) calculated using the normal approximation to the binomial distribution. The statistical significance of differences between HIH and non-HIH admissions was assessed in a fixed effects regression model adjusted for correlation of repeated observations within hospital.

Mean quarterly changes in the number of patients classified as HIH patients in each DRG at each hospital were estimated by linear regression;[17] the outcome was the number of patients classified as HIH patients and the only predictor was year quarter. The models were fitted within a generalised estimating equation (GEE) framework and adjusted for clustering within hospital, with an autoregressive correlation structure and robust variance estimator.[18] Absolute change in the number of HIH patients was estimated in linear models; the mean quarterly change in the number of all admissions was estimated in a similar model.

The mean proportional change per quarter in the number of admissions in each DRG at each hospital was estimated in Poisson regression models similar to the linear models, but including a log-link function and assuming a Poisson distribution of number of events by quarter.

Statistical analyses were performed in R 3.4.2; GEEs were fitted with the *geeglm* function in the *geepack* library.

Ethics approval

Ethics approval was sought from the Epworth Health Care Human Research and Ethics Committee. Approval was also granted by the Board of the Health Roundtable (Approval for Research Activities by Member Organisations).

Results

Sample population

Data on 2 221 091 hospital admissions from 20 principal referrer hospitals with HIH activity were provided by the Health Roundtable. One hospital provided data only for 2017 and was excluded (15 223 admissions). After excluding DRGs with fewer than 100 episodes and incomplete episodes, data for 2 185 421 hospital admissions to 19 hospitals across 96 DRGs were available.

There were 80 167 HIH admissions (3.7% of all admissions; 95% CI, 3.6–3.7%). The median length of stay for admissions including an HIH component (7.3 days; IQR, 3.1–14 days) was longer than for those that did not (2.7 days; IQR, 1.6–5.1 days). The median length of stay as an HIH inpatient was 5.0 days (IQR, 2.0–9.0 days). The age distribution of patients with HIH admissions differed from that of non-HIH patients, with a smaller proportion aged 0–34 years and a larger proportion aged 50–79 years. The proportion of men was higher for HIH care than non-HIH care (54.4% *v* 45.9%). The proportion of patients who died in hospital was lower for HIH than non-HIH care (0.3% *v* 1.4%), and re-admission within 28 days was less frequent (2.3% *v* 3.6%). The proportion of conditions coded as complex (category A) was higher for HIH than non-HIH admissions (36.1% *v* 35.4%) (Box 1).

Diagnosis-related groups with greatest hospital in the home activity

DRGs were ranked according to the proportion of patients who spent some time in HIH care (Supporting Information). Fifty DRGs encompassed 65 811 HIH admissions (82.1% of all HIH admissions; 95% CI, 81.9–82.4%) (Box 2), or 8.4% (95% CI, 8.4–8.5%) of all 780 549 admissions for these DRGs.

Pure hospital in the home admissions

A total of 30 901 HIH admissions (38.5% of all HIH admissions) had non-HIH components of 0.25 days or less (Supporting Information).

Change in hospital in the home activity

Data from the seventeen hospitals that provided data for each year of the study period were included in our analysis of change in HIH activity (Box 3). For the 50 DRGs with greatest HIH activity, the number of HIH admissions increased by a mean 3.1% (95% CI, 1.7–5.1%) per quarter; the overall number of admissions in these DRGs increased by a mean 1.6% (95% CI, 1.3–1.9%) per quarter.

Discussion

Our large study of national hospital activity measured both HIH and non-HIH activity by DRG in 19 hospitals across Australia,

1 Baseline characteristics of patients and their admissions, by hospital in the home (HIH) status

Characteristic	Hospital in the home (any)*		$P^{\dagger}$
	No	Yes	
Number of admissions	2 105 254	80 167	
Length of stay (days), median (IQR)	2.7 (1.6–5.1)	7.3 (3.1–14)	< 0.001
Hospital length of stay (days), median (IQR)	2.7 (1.6–5.1)	0.7 (0.3–5.1)	< 0.001
HIH length of stay (days), median (IQR)	NA	5.0 (2.0–9.0)	
Age group (years)			< 0.001
0	258 522 (12.3%)	1432 (1.8%)	
1–16	82 051 (3.9%)	2103 (2.6%)	
17–34	412 148 (19.6%)	10 071 (12.6%)	
35–49	262 886 (12.5%)	12 231 (15.3%)	
50–64	332 435 (15.8%)	19 399 (24.2%)	
65–79	447 053 (21.2%)	23 254 (29.0%)	
80 or more	310 159 (14.7%)	11 677 (14.6%)	
Sex			< 0.001
Women	1 138 142 (54.1%)	36 550 (45.6%)	
Men	967 112 (45.9%)	43 617 (54.4%)	
Type of admission I			< 0.001
Emergency	1 315 761 (62.5%)	41 725 (52.0%)	
Planned	671 204 (31.9%)	35 534 (44.3%)	
Unassigned	118 289 (5.6%)	2908 (3.6%)	
Type of admission II			< 0.001
Medical	1 624 251 (77.2%)	62 638 (78.1%)	
Surgical	372 336 (17.7%)	15 592 (19.4%)	
Other	108 667 (5.2%)	1937 (2.4%)	
Died in hospital			< 0.001
No	2 075 354 (98.6%)	79 912 (99.7%)	
Yes	29 900 (1.4%)	255 (0.3%)	
Re-admitted within 28 days			< 0.001
No	2 030 109 (96.4%)	78 328 (97.7%)	
Yes	75 145 (3.6%)	1839 (2.3%)	
Complexity of medical condition			< 0.001
Category A	745 614 (35.4%)	28 930 (36.1%)	
Other	1 359 640 (64.6%)	51 237 (63.9%)	

IQR = interquartile range; NA = not applicable. * That is, admission included a period of hospital in the home care. † Generalised estimating equations. ◆

where HIH interventions are more prominent than in most health systems. Our findings offer useful insights into the features of HIH activity and its impact on hospital activity for hospital planners, both locally and overseas.

The median length of hospital care was greater in our study for HIH patients and was associated with reduced mortality and lower rates of re-admission. HIH may itself contribute to this finding, but it is also likely that HIH is selected when longer admissions are anticipated. Apart from initial severity of disease or slowness to respond to treatment, HIH may also be preferred because of factors such as age, obesity, diabetes, immunosuppression, living in residential care, or previous admissions for similar indications. Similarly, HIH may contribute to better outcomes, but patients for whom good outcomes are expected are probably preferred candidates for acute home-based care.[12]

The 50 DRGs with greatest HIH activity included infections, venous thromboembolism, cancer, and major surgical procedures. While HIH was involved in 3.7% of all multi-day hospital admissions, the rate was 8.4% for conditions for which HIH care is more suitable (or accepted), a considerable proportion of hospital workload, activity, and reimbursement. Our analysis indicates
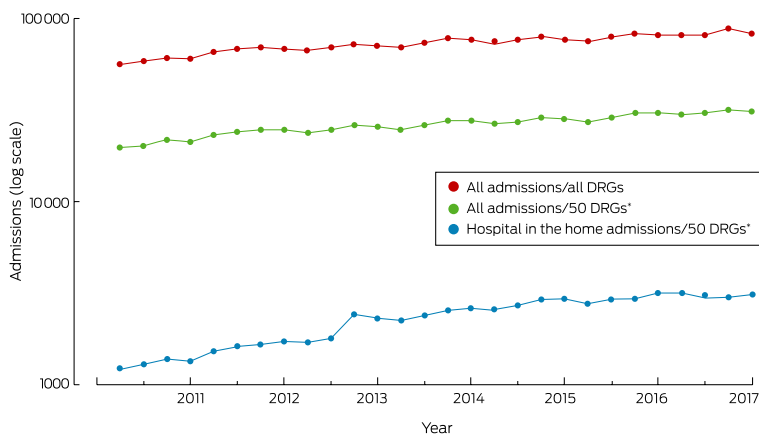
2 The fifty diagnosis-related groups with the largest proportions of admissions including hospital in the home (HIH) care

Diagnosis-related group		Admissions		
		Total	HIH	HIH proportion (95% CI)
	Total number of admissions	780 549	65 811	
I67	Septic arthritis	1356	453	33.4% (30.9–35.9%)
I64	Osteomyelitis	4182	1317	31.5% (30.1–32.9%)
F63	Venous thrombosis	7856	2469	31.4% (30.4–32.5%)
G60	Digestive malignancy	11 174	3361	30.1% (29.2–30.9%)
F61	Infective endocarditis	1653	494	29.9% (27.7–32.1%)
Z63	Other follow-up after surgery or medical care	5543	1429	25.8% (24.6–26.9%)
J64	Cellulitis	63 575	13 488	21.2% (20.9–21.5%)
E60	Cystic fibrosis	9111	1714	18.8% (18.0–19.6%)
I73	Aftercare of musculoskeletal implants or prostheses	4337	774	17.8% (16.7–19.0%)
H61	Malignancy of hepatobiliary system and pancreas	8141	1365	16.8% (16.0–17.6%)
T64	Other infectious and parasitic diseases	6673	1056	15.8% (14.9–16.7%)
E61	Pulmonary embolism	13 230	2011	15.2% (14.6–15.8%)
I12	Miscellaneous musculoskeletal procedures for infection or inflammation of bone and joint	11 667	1706	14.6% (14.0–15.3%)
B68	Multiple sclerosis and cerebellar ataxia	4977	679	13.6% (12.7–14.6%)
T01	Infectious and parasitic diseases with major general interventions	10 732	1192	11.1% (10.5–11.7%)
E63	Sleep apnoea	22 534	2467	10.9% (10.5–11.4%)
J06	Major procedures for breast disorders	12 810	1368	10.7% (10.1–11.2%)
T61	Postoperative and post-traumatic infections	11 215	1101	9.8% (9.3–10.4%)
J60	Skin ulcers	4126	404	9.8% (8.9–10.7%)
I72	Specific musculotendinous disorders	6870	646	9.4% (8.7–10.1%)
R02	Other neoplastic disorders with major general interventions	3858	355	9.2% (8.3–10.1%)
B72	Nervous system infection except viral meningitis	3919	360	9.2% (8.3–10.1%)
F06	Coronary bypass without invasive cardiac investigation	19 031	1601	8.4% (8.0–8.8%)
K01	General interventions for diabetic complications	6215	521	8.4% (7.7–9.1%)
J12	Lower limb procedures with ulcer or cellulitis	2668	220	8.2% (7.2–9.3%)
F04	Cardiac valve procedures with cardiopulmonary bypass pump without invasive cardiac investigation	15 927	1311	8.2% (7.8–8.7%)
J63	Non-malignant breast disorders	2185	160	7.3% (6.2–8.4%)
I04	Knee replacement	22 057	1599	7.2% (6.9–7.6%)
R60	Acute leukaemia	10 755	736	6.8% (6.4–7.3%)
L67	Other kidney and urinary tract disorders	19 329	1295	6.7% (6.3–7.1%)
T60	Septicaemia	31 253	2055	6.6% (6.3–6.9%)
J67	Minor skin disorders	7461	395	5.3% (4.8–5.8%)
G11	Anal and stomal procedures	11 986	631	5.3% (4.9–5.7%)
I03	Hip replacement	25 986	1367	5.3% (5.0–5.5%)
Z64	Other factors influencing health status	15 715	775	4.9% (4.6–5.3%)
E71	Respiratory neoplasms	12 613	593	4.7% (4.3–5.1%)
J08	Other skin grafts and debridement procedures	13 094	582	4.4% (4.1–4.8%)
Q62	Coagulation disorders	5114	225	4.4% (3.8–5.0%)
D66	Other ear nose mouth and throat disorders	11 128	484	4.3% (4.0–4.7%)
J11	Other skin subcutaneous tissue and breast procedures	6379	272	4.3% (3.8–4.8%)

Continues

2 Continued

Diagnosis-related group		Admissions		
		Total	HIH	HIH proportion (95% CI)
L63	Kidney and urinary tract infections	53 124	2135	4.0% (3.9–4.2%)
F75	Other circulatory disorders	24 992	1002	4.0% (3.8–4.3%)
X63	Sequelae of treatment	21 045	782	3.7% (3.5–4.0%)
E42	Bronchoscopy	9521	337	3.5% (3.2–3.9%)
E65	Chronic obstructive airways disease	53 478	1857	3.5% (3.3–3.6%)
P66	Neonate admission weight 2000–2499 g without significant general intervention or ventilation for 96 h or more	12 814	438	3.4% (3.1–3.7%)
E62	Respiratory infections and inflammations	76 476	2478	3.2% (3.1–3.4%)
X06	Other procedures for other injuries	19 043	574	3.0% (2.8–3.3%)
G48	Colonoscopy	18 006	526	2.9% (2.7–3.2%)
K60	Diabetes	23 615	651	2.8% (2.5–3.0%)

3 Quarterly admissions to 17 Australian principal referrer hospitals, 2011–2017

* Fifty diagnosis-related groups (DRGs) with the largest proportions of admissions including hospital in the home (HIH) care. ◆

that HIH is a generalist hospital intervention, drawing from the inpatient workload of several specialties, but the impact of HIH on the inpatient management of infectious diseases was particularly notable. This may reflect the technical and organisational capacity to deliver a wide range of antimicrobial treatments safely and efficiently at home, or greater acceptance of the role of HIH among infectious diseases specialists.

We found that the traditional hospital stay was brief or even absent for more than one-third of all admissions including an HIH component, perhaps because patients were admitted to HIH directly from hospital emergency departments or rapid assessment units, by general practitioners or hospital outpatient services, or from other hospitals. While there are clinical, risk management, and logistic challenges associated with this approach to HIH care, it may benefit patients and the health system in general.

Some DRGs with higher levels of HIH activity were surprising. The inclusion of colonoscopy (HIH component, 2.9%) and bronchoscopy (3.5%) in the top 50 DRGs for HIH may reflect the need to manage peri-procedural anticoagulation in some patients. The inclusion of sleep apnoea (10.9%) is even more difficult to explain, and suggests that hospitals may code an outpatient service as an inpatient service; HIH is open to such manipulation in the absence of clear guidelines and auditing.

HIH activity grew during the study period, the number of patients increasing at almost twice the rate for all admissions. Although the difference was not statistically significant, it shows that HIH is an important feature in the expansion of hospital capacity and activity in Australia, and the community should be aware that more acute hospital services are likely to be delivered as HIH care in future.

On the other hand, our study has highlighted the fact that HIH activity can be increased both in areas where HIH already works as well as in others in which it does not yet play a prominent role, including the treatment of cardiac failure and of cancer and its complications. For many conditions, the technical and organisational capacity to deliver acute care is available, but the patients may be generally more unstable during their admission, or HIH is currently not broadly accepted by clinicians in these specialty groups.

Limitations

Bias is possible even in a primarily descriptive analysis such as ours. Coding is subject to local and regional variation, and can be influenced by clinician interpretation and reimbursement models and incentives. The generalisability of our findings to all principal referrer hospitals in Australia is subject to several caveats. In Western Australia and Tasmania, HIH activity is probably not recorded as inpatient hospital admissions (personal communication, Kate Tynan, Health Roundtable, 18 October 2018). Several mainland hospitals are not members of the Health Roundtable and could not be included in the dataset. As we could not identify the included hospitals, we could not assess differences between the hospitals that were or were not included in our analysis. Without information about the HIH models of the included hospitals, we could not assess their relationship with differences in activity and other outcomes.

Our study was possible because HIH is delivered in most Australian states by hospitals, and because these hospitals report

activity data. When HIH is delivered by non-hospital organisations, there is a risk of fragmentation (or even lack) of comprehensive activity reporting. It is important for recognising, developing, and evaluating HIH (in Australia and overseas) that a comprehensive dataset of HIH activity be maintained.

Conclusion

The funding and organisational effort required to establish and support HIH is considerable, and policymakers in acute health and hospital services need to be convinced of its tangible benefits for both patients and health systems. We found that HIH plays an important and growing role in care for patients with a range of hospital diagnoses. The challenge for health systems is to expand its role further and, more importantly, to carefully determine clinical areas in which HIH may be useful but is currently unused. As with specialist intensive care and emergency medicine, introduced during the 1960s, HIH could develop into a non-organ-specific hospital specialist service with a significant and lasting impact on hospital services, organisation, and funding.

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Supporting Information

Additional Supporting Information is included with the online version of this article.