

# Medical model for hospital in the home: effects on patient management

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## Abstract

**Objective:** To evaluate the effects of a change to a medical model for hospital in the home (HITH).

**Design and setting:** This was a retrospective pre- and post-intervention study in the Royal Melbourne Hospital HITH between 28 March 2002 and 29 March 2006. The intervention was daily review, by medical staff, of all patients in their homes. 159 patients with cellulitis or deep venous thrombosis (DVT) admitted to HITH in the pre-intervention period were matched with patients admitted in the post-intervention period.

**Main outcome measures:** HITH length of stay (LOS), scheduled and unscheduled hospital review rates (during the HITH admission), and hospital admission rates.

**Results:** Post-intervention, median LOS decreased (6 v 5 days [ $P=0.03$ ]). There were also significant reductions in scheduled and unscheduled review rates (40.9 v 1.3 reviews/100 patients [ $P<0.001$ ] and 15.7 v 4.4 reviews/100 patients [ $P=0.001$ ], respectively) and hospital admission rates (10.7 v 3.8 admissions/100 patients [ $P=0.02$ ]). Although there was no difference in adverse event rates between the two periods (3.1 v 2.5/100 patients [ $P=0.50$ ]), there was a significantly greater complication rate post-intervention (57.2 v 92.4/100 patients [ $P<0.001$ ]).

**Conclusion:** The medical model resulted in significant improvements in process measures and clinical endpoints among patients with cellulitis and DVT.

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## What is known about the topic?

The management of patients in Hospital in the Home (HITH) facilities has been extensively studied. However, these studies have examined a “nurse model” where only nursing staff visit the patient.

## What does this paper add?

This paper found that a “medical model”, where a doctor visited the patient, was associated with significantly decreased HITH length of stay and scheduled or unscheduled reviews.

## What are the implications for practitioners?

The “medical model” may be associated with some savings in resource utilisation and may reduce the load of public hospitals. However, the use of a doctor may be associated with increased expense and cost–benefit analyses are recommended.

IN 1994, HOSPITAL IN THE HOME (HITH) was introduced in Australia, driven by efforts to improve the efficiency of hospital bed management. Its development has been supported by studies that have reported lower running costs,<sup>1–5</sup> less confusion,<sup>5</sup> fewer urinary and bowel complications,<sup>5</sup> decreased nosocomial infection and greater patient satisfaction.<sup>5–7</sup>

The range of conditions treated by HITH and the evidence supporting its efficacy and safety are growing. HITH is safe and effective for patients with cellulitis,<sup>7–10</sup> deep venous thrombosis (DVT),<sup>4,11</sup> pulmonary embolism (PE)<sup>12,13</sup> and pneumonia.<sup>6</sup> While minor complications are common among HITH patients, few adverse event (AEs) result from HITH management<sup>14</sup> and mortality rates are low.<sup>7,8,14,15</sup>

In the common HITH nurse model, nurses administer treatment in the patients' homes and medical review is undertaken at the parent hospital, after a defined period or when problems arise. Accordingly, management decisions (including discharge from HITH) and the detection and management of complications and AEs may be delayed.

Also, hospital review may be inconvenient for patients and associated with resource issues for outpatient (OP) and emergency departments (EDs).

HITH programs with dedicated medical practitioners solely responsible for HITH patients are becoming more common as there is recognition of the need for close medical supervision.<sup>6,12,16</sup> In 2004, because of the perceived inefficiencies in the Royal Melbourne Hospital (RMH) HITH nurse model, a medical model was developed. In addition to usual visits by HITH nursing staff, the medical model included a senior medical officer, dedicated only to the HITH program, who visited all HITH patients daily at home and managed their entire care. This included progress evaluation, surveillance for complications, drug regimen rationalisation, and decisions regarding management duration and discharge from HITH. It was believed that this medical model would result in a range of improvements in process and clinical endpoints. The aim of this project was to compare process measures and outcomes of patients (with selected common conditions) managed before and after the introduction of the medical model.

## Methods

This was a retrospective pre- and post-intervention study undertaken at the RMH, a 320-bed adult tertiary referral hospital. The study compared the outcomes of patients admitted to HITH during pre-intervention (existing nurse model, 28 March 2002 to 28 March 2004) and post-intervention (medical model, 29 March 2004 to 29 March 2006) periods. The study was authorised by the Human Research and Ethics Committee of the RMH.

The RMH HITH manages patients who reside mainly to the north and west of the hospital and within 40 minutes by car (about 20 km). Patients with cellulitis and DVT comprise the large majority of casemix although patients with PE, pyelonephritis, pneumonia and atrial fibrillation are being increasingly admitted.

The study intervention (medical model) comprised a Medical Director with administrative and clinical responsibilities, and a registrar (initially part- then full-time) with clinical responsibilities.

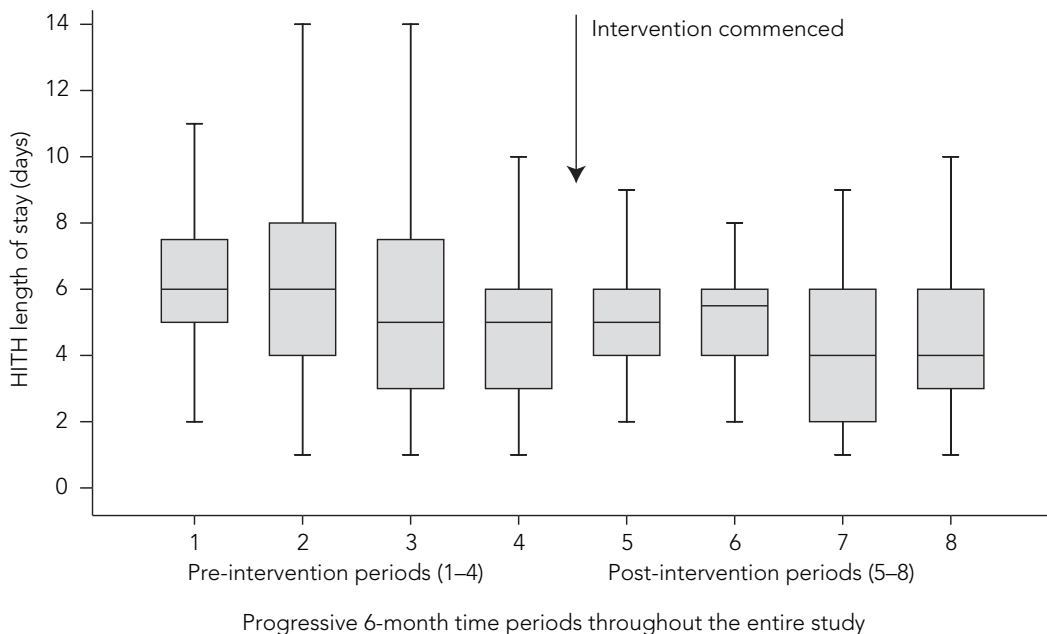
### I Conditions treated during the pre- and post-intervention periods

	Pre-intervention (n=159)	Post-intervention (n=159)
Cellulitis		
Head and neck	2	2
Upper limb	16	16
Lower limb	88	88
<b>Total</b>	<b>106</b>	<b>106</b>
DVT		
Below knee	31	31
Above knee	22	22
<b>Total</b>	<b>53</b>	<b>53</b>

Patients referred from the ED, wards, OP or general practitioners were admitted to the Hospital in the Home Unit (HHU). The HHU medical staff were responsible for all HHU patients, 24 hours a day and, at any one time, about 1.0 full-time equivalent of clinical medical staffing was available. They undertook home visits daily (7 days per week) and were responsible for all decisions regarding admission, discharge and treatment regimen. Intravenous line management, wound dressing, international normalised ratio (INR) measurement and drug administration remained the responsibility of visiting HITH nursing staff. In the pre-intervention period, patients with DVT had an INR calculated 4 days after commencing warfarin and then every 2 days until within the therapeutic range. For most patients, blood was analysed with a CoaguCheck machine (Roche Diagnostics Ltd) and the RMH haematology laboratory registrar was responsible for all warfarin dosing. In the post-intervention period, most patients had daily INR laboratory testing and all had their warfarin dosed by HITH medical staff.

Patients were suitable for inclusion if they were admitted to RMH HITH between 28 March 2002 and 28 March 2004 (pre-intervention) or 29 March 2004 and 29 March 2006 (post-intervention), were referred from the ED, OP or GPs, spent <24 hours in the hospital, and had a

## 2 Median hospital in the home (HITH) length of stay as a function of progressive 6-month time periods



primary diagnosis of either cellulitis (requiring intravenous antibiotics) or lower limb DVT (requiring clexane and warfarin). Patients were excluded if they had been readmitted to HITH with the same illness event or if, in the post-intervention period, a treating unit other than HHU had any part in patient management.

The RMH HITH patient database was accessed to identify patients for enrolment. The database was culled so that only patients who met the study entrance criteria remained. In the pre-intervention period, there were 171 and 78 patients with cellulitis and DVT, respectively, who met the criteria. In the post-intervention period, there were 319 and 127 patients, respectively. Using a computer-generated list of random numbers, 159 patients admitted during the pre-intervention period were selected. These were matched (age  $\pm 5$  years), gender, diagnosis [cellulitis, lower limb DVT], body part affected) with 159 patients admitted during the post-intervention period.

The primary outcomes were HITH length of stay (LOS), and scheduled and unscheduled hos-

pital review rates (ED and/or OP). The secondary outcomes were hospital admission rates, AEs and complications. An AE was defined as "an unintended injury or complication that results in disability, death or prolonged hospital stay and is caused by health care management" and a complication was defined as "an undesirable outcome that occurs during management of the condition, but does not cause disability, death or prolonged hospital stay".<sup>14</sup>

A data collection document was designed specifically for the study. Data regarding HITH length of stay, hospital reviews, readmission rates and mortality were extracted from the HITH and the RMH ED electronic databases. An explicit review of the patients' medical charts was undertaken to retrieve data relating to the nature of unplanned admissions, after-hours call out, transfer times from the ED, AEs and complications. The principal investigator (AT) undertook all chart reviews. The other investigator (DT) re-examined random selections of 10% of charts and 10% of the case data uploaded to the study database. Both investi-

### 3 Hospital reviews and returns post HITH discharge

	Pre-intervention (n=159)	Post-intervention (n=159)	Rate difference (95%CI)	P value
Scheduled reviews				
No.	65	2		
Rate/100 persons	40.9	1.3	39.6 (29.5 to 49.7)	<0.001
Unscheduled reviews during HITH admission				
No.	25	7		
Rate/100 persons	15.7	4.4	11.3 (4.3–18.3) to	0.001
Unscheduled post-HITH reviews*				
No.	20	18		
Rate/100 persons	12.6	11.3	1.3 (–6.3 to 8.9)	0.44

\* Within 30 days of HITH discharge.

gators reviewed the charts of all patients thought to potentially have suffered an AE. A final determination was made after discussion of each case.

In order to demonstrate a decrease in the mean HITH length of stay from 6 days (pre-intervention) to 5 days (post-intervention), at least 141 patients had to be enrolled in both the pre- and post-intervention periods (SD, 3 days; level of significance  $P < 0.05$ ; power 0.8). The outcomes were compared using the Mann–Whitney  $U$  test and the Normal ( $Z$ ) test. SPSS<sup>17</sup> and EpiCalc<sup>18</sup> statistical software were used for all analyses.

## Results

One-hundred and fifty-nine pre-intervention patients were matched to 159 post-intervention patients. There were 92 males (57.9%) and 67 females (42.1%) in each period. The mean patient age was 57.5 years (SD, 18.5 years) in both periods.

There were 106 patients with cellulitis and 53 patients with DVT in each period (Box 1). For the primary outcomes, there were significant differences between the pre- and post-intervention periods. The median HITH LOS in the pre- and post-intervention periods were 5 and 6 days, respectively (Mann Whitney  $U$  test,  $P = 0.003$ ). Box 2 describes the time series of median HITH LOS with values for 6-month periods throughout the entire study (periods 1–4 = pre-intervention,

periods 5–8 = post-intervention). Despite a gradual trend downwards over time, the median LOS during period 6 (post-intervention) was greater than those of periods 3 and 4 (pre-intervention).

In the post-intervention period, the numbers of scheduled and unscheduled reviews were significantly fewer than during the pre-intervention period (Normal [ $Z$ ] test,  $P = 0.001$ ) (Box 3). There was no difference between the periods in the number of returns to hospital within 30 days post HITH discharge. Among the patients with unscheduled reviews, there was a trend towards fewer patients in the pre-intervention period requiring admission (Normal [ $Z$ ] test,  $P = 0.64$ ) (Box 4). Overall, however, there was a significantly greater hospital admission rate during the pre-intervention period (10.7 versus 3.8 admissions per 100 patients; rate difference 6.9 [95% CI, 1.0–12.8]; Normal [ $Z$ ] test,  $P = 0.02$ ).

### 4 Outcomes of unscheduled reviews

	Pre-intervention (no. [%])	Post-intervention (no. [%])
Admitted to hospital	17 (68.0%)	6 (85.7%)
Attended emergency department only	8 (32.0%)	1 (14.3%)
Total	25 (100%)	7 (100%)

**5 Adverse events and complications during the HITH admission**

	Pre-intervention ( <i>n</i> =159)	Post-intervention ( <i>n</i> =159)	Rate difference (95% CI)	<i>P</i> value
<b>Adverse events*</b>				
No.	5	4		
Rate/100 patients	3.1	2.5	0.6 (-3.1 to 4.3)	0.50
<b>Complications</b>				
Intravenous cannula tissue	19	24		
Wound complication	1	16		
Phlebitis	16	15		
Intravenous cannula dislodged	4	14		
Drug reaction	1	11		
Hyper/hypotension	11	9		
Nausea	1	6		
Bruising/haematoma/bleeding	4	7		
Hyper/hypoglycaemia	2	4		
Non-specific symptoms	3	4		
Diarrhoea/constipation	3	3		
Pain problem	2	3		
Unable to cannulate	6	2		
Intravenous cannula failure	3	2		
Intravenous cannula haematoma	2	1		
Miscellaneous	13	26		
No.	91	147		
Rate/100 patients	57.2	92.4	35.2 (16.2 to 54.2)	<0.001

\* Over-anticoagulation necessitating interruption in warfarin dosing and delay in establishing therapeutic levels.

All AEs were related to over-anticoagulation and there was no significant difference in AE rates between the two periods (Box 5). Significantly more complications were recorded in the post-intervention period (Normal [Z] test,  $P < 0.001$ ). The majority of complications were related to intravenous (IV) cannulae problems. The largest differences between the two groups were mainly in wound complications, “IV dislodged”, drug reactions and nausea. No deaths occurred during the HITH admission periods or within 30 days post HITH discharge.

## Discussion

This study is the first to report the effect of having doctors directly managing HITH patients with cellulitis and DVT in their own homes. The pre-

intervention median LOS (6 days) was similar to the mean LOS reported in other nurse model studies (range, 5.6–6.5 days).<sup>8,10,15,19</sup> However, our medical model was associated with a decreased LOS. This is consistent with the finding of Ioannides-Demos et al<sup>10</sup> that more frequent medical reviews result in decreased LOS. Our median LOS showed a downward trend throughout the study period, with a slight increase towards the middle of the post-intervention period. It is not known if this downward trend would have occurred in the absence of the intervention. Notably, important potential confounders (management protocols, drug regimens, in- and outpatient facilities/practices) remained unchanged over the entire study period. Others, however, (staff experience, HITH patient selection, overall health care system change) are less

easily measured and may have impacted upon the results. Notwithstanding the possibility of confounding, the decreased median LOS associated with the medical model could amount to savings in resource utilisation given the large numbers of patients with cellulitis and DVT managed in HITH.

The medical model resulted in significant reductions in hospital reviews. Pre-intervention, scheduled reviews were usually to assess progress or to discharge the patient. Although patients with DVT usually did not have a scheduled review, a recent study indicates that they sometimes have PE diagnosed during the HITH admission.<sup>13</sup> This hints at the importance of regular medical review for these patients.

The main reasons for unscheduled reviews were AEs or complications. Our rate of unscheduled reviews in the pre-intervention period (15.7%) was consistent with the rate of 15.3% reported by Donald et al.<sup>8</sup> Hence, the unscheduled review rate in the post-intervention period (4.4%) was lower than that published elsewhere.

The unplanned admission rates (7.8%–8.7%) reported in other studies<sup>5,14</sup> were slightly lower than our pre-intervention rate (10.7%). However, admission rates reported elsewhere,<sup>7,8</sup> for patients with cellulitis were slightly higher (12.0%–15.3%). Hence, the admission rate in the medical model (3.8%) was considerably less than the rates reported elsewhere.

With lower review rates, the medical model has the advantage of decreased OP and ED resource utilisation. With the increasing demand for these services, any intervention to decrease their use is welcome. Although not examined, it is conceivable that a reduction in reviews may also impact favourably upon patient satisfaction, time for rest, and transport costs, logistics and discomfort.

The AE rates in this study were low and comparable with that of an earlier RMH study.<sup>14</sup> It is not surprising that all AEs were related to INR stabilisation. While the sample size precludes any meaningful conclusions being drawn about uncommon AEs, there is no indication that the differences in INR measurement and warfarin dosing impacted on AE rates.

The complication rates in both study periods (57.2 and 92.4 per 100 patients) considerably exceeded that reported by Liu and Taylor (33.1 per 100 patients).<sup>14</sup> These differences may have related to variations in quality of documentation, management practices and the broader range of patients enrolled in the Liu and Taylor study. Of more importance is the unexpected significantly greater complication rate associated with the medical model in the present study. This was most apparent in differences in the number of wound complications (abscess formation, blistering, necrosis) and drug reactions (despite no change in antibiotic regimens). Possible reasons for this finding are numerous. Firstly, the medical staff may have maintained sicker or more complicated patients in HITH who would have been sent for review in the pre-intervention period. Secondly, there may have been differences in reporting between the two study periods. Pre intervention, some documentation comprised “care plans”, with tick-box format, that may have precluded documentation of minor complications. Post intervention, medical in addition to nursing records may have resulted in more complete documentation. Finally, it is possible that the increased complication rate did result from other changes in patient management, for example, more frequent review of wounds.

This study has important limitations. Potential process confounders have been mentioned above. Although well matched for age, gender and diagnosis, the patient groups may have differed in other important confounders (eg, comorbidities, severity of disease). Measurement bias, with inaccurate data, may have resulted from the retrospective study design. Incomplete or poor documentation will have impacted adversely on determination of the AE and complication rates, resulting in underestimations. The presence of real AEs and complications was also often difficult to determine. In particular, a complication was recorded if any sign and/or symptom consistent with a complication was documented. This may have resulted in the overestimation of the complication rate and the recording of complications of little clinical sig-

nificance. Incorrect dates and inconsistent entry of diagnosis in the HITH database may have led to some patients being inadvertently excluded from the study. Due to strict adherence to the inclusion criteria of “transfer within 24 hours”, some patients may have been included or excluded erroneously. Although cellulitis and DVT are both very common HITH conditions, there are others that were not examined. The relatively small patient numbers (making matching difficult) and the fact that there was no provision for some conditions to be admitted to HITH in the pre-intervention period precluded the inclusion of some of these (eg, PE).

It is recommended that other HITH units consider the introduction of the medical model. If a medical model were to be introduced elsewhere, it is recommended that a prospective, randomised, controlled trial be undertaken whereby patients are block-randomised (by diagnosis) to existing or medical models. This design would provide stronger evidence as to the apparent advantages of the medical model and would allow cost–benefit analyses to be undertaken. Such analyses are vital to determine if resource savings associated with the medical model outweigh the expense of HITH medical staffing. Further investigation should investigate other outcome measures including patient and staff satisfaction, logistical considerations, and impact upon the hospital ED and OP departments.

## Conclusion

The HITH medical model, where a doctor is directly involved and visits patients at home, is associated with reductions in HITH LOS, and hospital review and admission rates. The model results in no changes in unexpected post HITH reviews and AE rates. Although it is associated with a greater complication rate, most complications were easily managed in the HITH setting. Further investigation of the medical model is recommended to determine if the apparent resource savings outweigh the expense of HITH medical staffing.

## Competing interests

The authors declare that they have no competing interests.

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