

# Home Hospital Program: A Pilot Study

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**OBJECTIVE:** To evaluate the basic safety and feasibility of hospital care at home (Home Hospital (HH)) for treating acutely ill older persons requiring hospitalization.

**DESIGN:** Prospective case series

**SETTINGS AND PARTICIPANTS:** Community-dwelling persons aged 65 and older requiring acute hospital admission for community-acquired pneumonia, chronic heart failure, chronic obstructive airways disease, or cellulitis.

**RESULTS:** Seventeen subjects were treated in HH. One hundred twenty-two could not be enrolled because they presented for admission at times when HH was not operational. Six patients refused to enroll in HH. Subjects treated in HH had comparable clinical outcomes to those treated in the acute hospital and were highly satisfied with HH. Charges for HH care were 60% of those for the acute hospital care.

**CONCLUSIONS:** In this pilot study, HH was safe, feasible, highly satisfactory, and cost-effective for certain acutely ill older persons who required acute hospitalization. *J Am Geriatr Soc* 47:697-702, 1999.

**Key words:** home hospital; home care services

The aggregation of care of acutely ill patients in centralized high-technology hospitals is a relatively recent phenomenon. And although there are relatively few data to suggest that this approach to care has impacted favorably on survival or comfort, the acute hospital is the standard of care for acute medical illness. Unfortunately, while treating older persons, the acute hospital can also injure them. Iatrogenic illness and functional decline are common.<sup>1-5</sup> In addition, the acute hospital is an expensive care venue for payers.

Given these problems, alternative approaches to traditional hospital care are needed. Hospital-based interventions include Acute Care for Elder (ACE) units<sup>6</sup> and subacute or transitional care units,<sup>7</sup> and community-based interventions include PACE (Program for All-Inclusive Care for the Elder-

ly)<sup>8</sup> and mainly home-based case management techniques for patients with chronic illnesses such as congestive heart failure.<sup>9</sup> Such programs improve functional outcomes, reduce hospital length of stay and readmission rates, and improve quality of life.

To the extent that the acute hospital milieu may harm older persons, avoidance of the inpatient setting all together may be sensible if an alternative exists.<sup>10</sup> Home hospital (HH) represents such an alternative. In this HH model of care, all critical elements of hospital care are brought home to the acutely ill patient: physician and nursing care, medicines, and appropriate diagnostic and therapeutic technologies. Although there is evidence of increasing interest in HH in Israel,<sup>11</sup> the UK,<sup>12</sup> and Australia,<sup>13</sup> the focus of these programs has been varied and has included programs to prevent admissions, facilitate early hospital discharge, pediatric programs, mental health programs, and high-technology programs. In addition, these programs have been chiefly nursing-based. We report the results of a safety and feasibility pilot study of a physician-led HH model designed to provide acute hospital level care at home for older persons with specific acute medical illnesses requiring acute hospital care.

## METHODS

The Institutional Review Board of the Johns Hopkins Bayview Medical Center approved the Home Hospital Program study design

### Patients

Patients were eligible for enrollment in HH if they were aged 65 and older; insured by Medicare; lived within a defined catchment area; required an acute hospital admission for one of four target illnesses: community-acquired pneumonia (CAP), an exacerbation of chronic heart failure (CHF), an exacerbation of chronic obstructive airways disease (COAD), or cellulitis; and met previously described medical eligibility criteria for HH.<sup>14</sup>

### The Home Hospital Model

A patient requiring admission for one of the target illnesses was identified in the emergency room or ambulatory site and his or her eligibility status for HH determined. After informed consent for care in HH was obtained from the patient and his or her caregiver, the patient was evaluated by the HH physician and transported home in the company of the HH nurse coordinator. At home, the patient was evaluated again by the HH physician, who completed his assessment and continued to implement appropriate diagnostic and therapeutic measures. The HH physician made at least daily

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home visits and was available 24 hours a day for urgent or emergent visits.

The patient had direct nursing supervision for the initial portion of his or her stay in the HH. The duration of supervision depends on the level of illness acuity, as judged by the physician and nurse; however, in the developmental phase of HH, this period was always at least 24 hours. After the first 24 hours, a Lifeline® device was placed in the home. The nurse coordinator ensured that the team elements were in place and acted as a case manager. Diagnostic studies such as electrocardiograms, radiography and ultrasound, durable medical equipment, intravenous fluids, intravenous antimicrobials and other medicines, and oxygen and other respiratory therapies were provided at home. Diagnostic studies and therapeutics that could not be provided at home, such as computerized tomography, magnetic resonance imaging, endoscopy, were available via brief visits to the appropriate outpatient resource of the acute hospital. A cadre of nurses, aides, and other ancillary staff were designated by a home health agency to work with the HH. Illness-specific HH caremaps, clinical outcomes evaluations, and specific discharge criteria were developed and provided a pathway for care. The patient was followed until stable for discharge, at which time his or her care supervision reverted to the patient's original primary care physician.

#### Patient Accrual

Patient accrual was limited initially by insufficient resources to provide immediate 24-hour nursing coverage, thus missing eligible subjects who presented for admission, especially at night and on weekends. In the final 5 weeks of the study, when a 24 hour, 7-day a week, on-call system for nursing was initiated, subjects were enrolled more rapidly.

#### Data Collection

Data were abstracted from medical records for both acute hospital and HH patients using a standardized instrument for demographics, health status, medication use, laboratory tests, treatments, the hospital course, and health outcomes. Demographics collected included age, gender, race, marital status, living arrangement, and caregiver arrangements. Health status was measured in three ways. First, extensive clinical indicators appropriate to the disease were collected. Second there was a checklist of comorbid conditions occurring commonly in older persons that could have an impact on recovery from their acute condition. Third, a modified version of the Charleson comorbidity index<sup>15</sup> was determined. The index was modified because the database did not contain information about patient history regarding connective tissue disease, peptic ulcer disease, leukemia, lymphoma, or metastatic solid tumor. Medication use was collected and limited to the number of medicines taken on a chronic basis. Treatments were categorized as potentially difficult to do in the home or not difficult. A difficult item to perform in the home was defined as continuous cardiac telemetry, radiological studies such as computerized tomography, magnetic resonance imaging, echocardiogram, or ultrasound, exercise stress test, ventilation perfusion scan, holter monitor, endoscopic procedure, thoracentesis, paracentesis, induced sputum, blood product transfusion, and medicines difficult to administer in the home such as intravenous heparin or intravenous nitroglycerin. The hospital course was characterized as to whether there were emergency

clinical situations or critical complications. An emergency clinical situation was defined as one that required physician evaluation within 30 minutes, such as the development of shortness of breath, hypotension, tachycardia, or other acute change in status, accompanied by a physician note in the medical record. A critical complication was defined as death, transfer to intensive care setting, intubation, or myocardial infarction. Each record was abstracted independently by two reviewers.

Two sources were used to obtain data on charges for care: for hospitalized patients, the hospital billing system; for HH patients, the home health agency billing system as well as the hospital billing system for emergency department use. The same set of charges was documented for each group. For the hospitalized patient, the room charge was used, and for the HH patient, the nursing charges were substituted. Other charges tracked were for medications, procedures and X-rays, supplies and durable medical equipment, laboratory, and therapy. Physician charges were not included for either group.

Satisfaction was assessed using a previously described modification of the Picker Commonwealth Scale.<sup>16</sup> The scale covers domains relating to ease of admission and discharge, interactions with physicians, nurses and other staff, and pain control. For HH patients, two domains were added: comfort/convenience and safety. Four questions were asked to determine overall satisfaction: (1) "How would you rate how well the doctors and nurses worked together?" (2) "Overall, how would you rate the care you received from (Hospital, Home Hospital)?" (3) "Would you choose (Hospital, Home Hospital) again if you had the same medical problem?" and (4) "Would you recommend (Hospital, Home Hospital) to your family or friends if they needed hospital care for a similar condition?"

Caregiver burden was measured with a questionnaire developed to assess whether and what new tasks were performed by a caregiver during the Home Hospital episode and the caregiver's perception of his/her burden of having an acutely ill patient cared for in the home.

#### Statistical Analysis

In addition to data on subjects enrolled in HH, we present data on subjects eligible for HH care but who were missed for enrollment for logistical reasons and were treated in the acute hospital as a quasi-control group. While comparisons with this quasi-control group do not, in fact, represent strictly controlled data, these data allow us to determine whether HH enrollees were comparable to those eligible for HH but cared for in the acute hospital. In addition, such comparisons may allow us to begin to generate hypotheses as to the different process of care that HH may represent. Subjects who declined to enroll in HH were not included in this group for analysis. Those who declined to enroll were similar to those missed for enrollment except that they were more likely to be admitted for COAD ( $P = .001$ ) and had a lower modified Charleson comorbidity score ( $P = .011$ ).

Patient characteristics were compared, based on treatment site, as HH or the acute hospital. The chi-square statistic was used to determine statistically significant differences for categorical variables and two tailed  $t$  tests for continuous variables.

## RESULTS

From September 30, 1996, to February 12, 1998, 478 patients with the target illnesses presented to Johns Hopkins Bayview Medical Center for hospital admission. One hundred and four were ineligible for care in HH because they lived outside the catchment area and/or were not insured by Medicare. Of the remaining 374, 229 (61%) were ineligible for HH care based on previously described medical eligibility criteria.<sup>14</sup> One hundred forty five (39%) were eligible for HH care. Of those eligible for HH care, 17 subjects were enrolled in HH (12% of eligible), 122 were missed for enrollment (84% of eligible), and six (4% of eligible) subjects were eligible for HH but declined to enroll.

The clinical characteristics of the population are shown in Table 1. Compared with patients eligible for HH but not treated in the home hospital setting, HH-treated patients were less likely to be admitted from the emergency department, more likely to live alone, and more likely to be admitted for CHF. There were no differences in other parameters including age, race, sex, average number of medicines used, or modified Charleson comorbidity index.

Table 2 presents details of clinical course and outcomes of patients treated in HH and those who were clinically eligible for HH but were treated in the acute hospital. Similar proportions of subjects in both groups were treated with oxygen therapy, intravenous antimicrobial agents, nebulized bronchodilators, and intravenous fluids. Patients treated at home experienced a mean of  $20 \pm 3.1$  hours of continuous nursing at the start of their care, and received a mean of  $4.4 \pm 1.6$  physician visits and  $3.7 \pm 4.3$  nursing visits. Patients treated in the acute hospital were more likely to have a consultant involved in their care, to have continuous cardiac telemetry, and to have an arterial blood gas obtained. There were no other differences in services received or difficult items performed. The length of stay in the two groups was similar. Two subjects treated in the HH had an emergency clinical situation, as did one subject treated in the hospital. One subject enrolled in the HH requested transfer to the hospital to complete his hospital admission because of continued

symptoms of obstructive pulmonary disease that were slow to respond to treatment. No HH subject had a critical complication.

Table 3 presents data on hospital charges for all patients treated in HH compared with 106 of those eligible for HH but treated in the acute hospital. Charges could not be ascertained for 16 patients treated in the acute hospital. Charges for patients treated in HH were 53% of acute hospital charges when acute hospital patients with a length of stay of 9 days or more are included ( $P = .001$ ) but 60% of acute hospital charges when these outliers are removed from the analysis ( $P = .001$ ).

Table 4 presents data on patient and caregiver satisfaction. Data were available for 16 HH subjects and 15 subjects treated in the acute hospital. There were statistically significant differences favorable to HH in admission procedures, relationship with the doctor, relationship with nurses, discharge procedures, and the overall impression of care.

With regard to caregiver burden associated with participation in HH, 10 of 17 subjects enrolled in HH had caregivers and eight responded to the caregiver burden questionnaire. In general, little burden was attributed by caregivers to having the acutely ill patient at home. Most caregivers reported that helping the patient with activities of daily living required some effort. Three caregivers reported taking on new responsibilities, specifically watching for symptoms of change in condition of the patient. Two caregivers reported having a lot less time to care for themselves, eat, and sleep during the time the patient was acutely ill.

## DISCUSSION

We enrolled 17 older patients who required acute hospital care in a physician-led multidisciplinary HH and demonstrated that it was feasible, safe, and cost-effective. Appropriate patients were selected for, admitted to, and discharged from HH care, and to the extent that clinical outcomes were favorable, appropriate care was provided at home. Satisfaction with the HH model was very high, albeit in a self-selected group of patients. Hospital charges for HH care were ap-

Table 1. Clinical Characteristics of Home Hospital and Acute Hospital Treated Subjects

Characteristic	Home Hospital n = 17 n (%)	Acute Hospital n = 122 n (%)	P Value
Age, years	74.4 $\pm$ 21.1	75.9 $\pm$ 6.8	.716
Women	10 (59)	65 (50)	.456
Race (white)	15 (88)	107 (88)	.981
Admitted from emergency department	5 (29)	103 (84)	.001
Live alone	9 (53)	24 (20)	.003
Mean number of outpatient medicines	7.2 $\pm$ 2.5	6.0 $\pm$ 3.5	.168
Modified Charleson Index	3.7 $\pm$ 2.5	2.9 $\pm$ 2.2	.208
Uses home O <sub>2</sub>	4 (24)	16 (13)	.252
Hospitalized within 1 year of HH admission	2 (12)	30 (25)	.235
Primary admission illness			
CHF	9 (53)	34 (27)	.036
CAP	3 (18)	50 (41)	.063
COAD	3 (18)	21 (17)	.965
Cellulitis	2 (12)	17 (13)	.807

Table 2. Clinical Course and Outcomes of Home Hospital and Acute Hospital Treated Subjects

	Home Hospital n = 17 n (%)	Acute Hospital n = 122 n (%)	P value
Services received			
Sputum gram stain	3 (18)	48 (39)	.082
Sputum culture	3 (18)	50 (41)	.063
Blood culture	3 (18)	59 (48)	.017
Oxygen therapy	13 (77)	97 (80)	.773
Nebulized bronchodilators	6 (35)	54 (44)	.484
Intravenous antimicrobials	11 (65)	83 (68)	.784
Consultation (any)	1 (6)	63 (51)	.001
Length of stay (days)	2.9 ± 1.5	3.4 ± 2.5	.367
Difficult items*	4 (24)	83 (68)	.001
Echocardiogram	1 (6)	21 (17)	.230
Cardiac telemetry	0	26 (21)	.035
Arterial blood gas	0	30 (25)	.021
Emergency clinical situations <sup>†</sup>	2 (12)	1 (1)	.004
Critical complications <sup>‡</sup>	0	1 (1)	.708
Restraints, chemical or physical	0	10 (8)	.220

\* Difficult item was defined as continuous cardiac telemetry, computerized tomography, magnetic resonance imaging, echocardiogram or ultrasound, exercise stress test, ventilation perfusion scan, Holter monitor, endoscopic procedure, thoracentesis, paracentesis, induced sputum, blood product transfusion, and difficult to administer medicines in the home such as intravenous heparin or intravenous nitroglycerin.

<sup>†</sup> Emergency clinical situation was defined as one that required physician evaluation within 30 minutes such as the development of shortness of breath, hypotension, tachycardia, or other acute change in status accompanied by a physician note in the medical record.

<sup>‡</sup> Critical complication was defined as death, transfer to intensive care setting, intubation, or myocardial infarction.

Table 3. Comparison of Charges for Patients Treated in the Home Hospital (HH) (n = 17) with Patients Eligible for HH but Treated in the Acute Hospital (n = 106), by Length of Stay

Length of Stay (days)	Mean HH Charges \$	Number of HH Patients	Mean Acute Hospital Charge \$	Number of Acute Hospital Patients	HH Charges as % of Acute Hospital Charges
1	1650	1	1788	25	0.92
2	1392	2	2447	25	0.57
3	1483	5	3414	21	0.43
4	2455	6	4169	14	0.59
5	2077	1	4678	8	0.44
6	2060	1	6209	7	0.33
8	2708	1	7499	2	0.36
9			9169	1	
10			16205	3	
Overall Mean Charges \$	1966	17	3676*	106	
Overall Mean Charges \$, Outliers <sup>†</sup> Removed	1966	17	3253*	102	

\* P = .001 compared with mean overall HH charges.

<sup>†</sup> >8-day length of stay.

proximately 60% of acute hospital charges for care provided to a similar group of patients. Although hospital charges do not reflect true costs of care, the difference between hospital costs and charges in Maryland is uniquely low compared with other states because of an all-payor system. Charges at the hospital where this study was performed were approximately 20% above costs compared with hospital charges nationally that average approximately 80% above costs.<sup>17</sup>

In regard to care provided, HH patients were less likely to undergo certain hospital procedures than patients treated

in the acute hospital. However, only a controlled trial can determine whether the care provided in HH was not sufficiently intense or the care provided in hospital overly intense. That HH patients were more likely to experience an emergency clinical situation may be a function of this particular HH model. The two emergency clinical situations experienced in the HH group occurred after continuous nursing care had been discontinued, and the HH physician was first call for any urgent situation. Our record review suggested that similar emergency clinical situations occurred in the

Table 4. Comparison of Satisfaction Levels of Patients Treated in the Home Hospital (n = 17) with Patients Eligible for Home Hospital but Treated in the Acute Hospital (n = 15)

Domain	Mean Scores for HH Patients and Caregivers (n = 16)	Mean Scores for Patients Treated in Acute Hospital (n = 15)	P Value
Admission (range, 1-10)	9.9	6.2	.002
Interaction with physician (range, 0-16)	15.5	11.6	.001
Interaction with nurse(s) (range, 0-18)	17.4	14.6	.004
Interaction with staff (range, 0-12)	11.4	10.0	.066
Pain control (range, 0-4; n = 11)	3.4	3.5	.930
Comfort and convenience (range, 0-16)	15.5	NA	NA
Safety (range, 0-2)	1.9	NA	NA
Discharge (range, 0-10)	8.9	5.5	.001
Overall impression (range, 0-10)	9.8	7.7	.006

acute hospital and were handled by nurses in telephone consultation with physicians, thus not reaching the threshold of an emergency clinical situation as we defined it.

Compared with previously described HH models of care,<sup>18-21</sup> ours is unique in several respects. First, it specifically targeted older persons with specific acute medical illnesses for treatment to substitute for an acute hospital admission. Previous studies have often treated a broader range of illness, and it is often difficult to determine if HH care truly represents a substitute for the acute hospital or if it simply provides traditional home care services.<sup>11</sup> Second, it employed previously validated eligibility criteria to select appropriate patients for care and specific care pathways and discharge criteria. Third, it was a multidisciplinary, physician-led intervention that included at least daily physician visits and 24 hour-a-day physician availability. Other models have been primarily nursing-based, some including an initial evaluation by a physician.<sup>19</sup> For patients in the US, there are data to suggest that physician housecalls may be critical in ensuring patient acceptance of treatment of acute illness at home.<sup>16,22,23</sup>

There are several caveats to this work: Although we used patients who were eligible for HH but missed for enrollment as a quasi-control group, these data are uncontrolled and represent a prospective case series of HH patients. Second, this HH was based at a single community-based university hospital and implemented by geriatricians skilled in coordinating and delivering care at home to older persons. This limits our ability to generalize our experience. Third, although the HH was feasible to implement on a pilot basis, our ability to enroll patients was limited. This was attributable to several factors, including inconsistent staffing patterns on our part, inconvenience and lack of incentive for physicians to disrupt their usual admitting routine, and, perhaps, a bias among those in the position to refer patients that HH is not an appropriate model of care for acutely ill older persons. Once we placed a study nurse in the emergency department on a continuous basis, we were able to educate staff appropriately and generate a reasonable patient stream. Fourth, we were unable to generate adequate data on other outcomes that are likely to be of interest, such as functional status and the effect of home hospitalization on iatrogenic illness. Finally, although charges for HH patients were lower than the charges for hospital patients, we did not include efficiency

costs in this pilot study or the cost of identifying patients appropriate for HH.

Despite these limitations, we believe our results support serious consideration of HH as having a place in the health-care system of the future. We believe that a "HH unit" could be based in and function within a medical center or as part of a managed care organization. Such entities would likely be able to generate a sufficient stream of suitable patients to sustain a HH unit and have the ability to provide the home health services that are required to run a home hospital unit. In addition, medical centers and managed care organizations will have the ability to recruit, hire, train, and maintain the staff to support such a unit over the long term. We believe that medical centers and managed care organizations would favor this model as they assume increasing levels of financial risk for older persons whose health care is financed by capitation, especially if comparable clinical outcomes can be obtained while maintaining high levels of patient and caregiver satisfaction. If we extrapolate our experience to the approximately 1.8 million discharges of older individuals from US hospitals with the diagnoses<sup>17</sup> we treated in HH in 1997, we estimate conservatively a savings of \$441 million in national healthcare expenditures. Coupled with the high satisfaction level and equal or better medical outcomes demonstrated in the pilot, HH merits careful consideration in a full-scale demonstration and evaluation. Such a multisite-controlled study of HH in the managed care organization environment is now being planned.

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