Substitutive Hospital at Home for Older Persons: Effects on Costs

Kevin D. Frick, PhD; Lynda C. Burton, ScD; Rebecca Clark, BA; Scott I. Mader, MD; W. Bruce Naughton, MD; Jeffrey B. Burl, MD; William B. Greenough, III, MD; Donald M. Steinwachs, PhD; and Bruce Leff, MD

Objective: To compare the cost of substitutive Hospital at Home care versus traditional inpatient care for older patients with community-acquired pneumonia, exacerbation of chronic obstructive pulmonary disease, exacerbation of congestive heart failure, or cellulitis.

Study Design: Prospective nonrandomized clinical trial involving 455 community-dwelling older patients in 3 Medicare managed care health systems and at a Department of Veterans Affairs medical center.

Methods: Costs were analyzed across all patients, within each of the separate health systems, and by condition. Generalized linear models controlling for confounders and using a log link and gamma family specification were used to make inferences about the statistical significance of cost differences. *t* Tests were used to make inferences regarding differences in follow-up utilization.

Results: The costs of the Hospital at Home intervention were significantly lower than those of usual acute hospital care (mean [SD], $5081 [$4427] vs $7480 [$8113]; $P < .001$). Laboratory and procedure expenditures were lower across all study sites and at each site individually. There were minimal significant differences in health service utilization between the study groups during the 8 weeks after the index hospitalization. As-treated analysis results were consistent with Hospital at Home costs being lower.

Conclusions: Total costs seem to be lower when substitutive Hospital at Home care is available for patients with congestive heart failure or chronic obstructive pulmonary disease. This result may be related to the study-based requirement for continuous nursing input. Savings may be possible, particularly for care of conditions that typically use substantial laboratory tests and procedures in traditional acute settings.

(Am J Manag Care. 2009;15(1):49-56)

For author information and disclosures, see end of text.

Hospital at Home is a model of care that provides hospital-level care to a patient in his or her home and substitutes entirely for an acute hospital admission.[1] Several secular trends favor the development of this model. First, the Institute of Medicine found that the emergency medicine system is in crisis in part because emergency departments are unable to find inpatient hospital beds to send acutely ill patients.[2,3] Second, population and disease burden projections suggest that the supply of available acute hospital beds is not increasing at a rate sufficient to keep pace with national acute care needs.[4] Third, Hospital at Home avoids the potentially hazardous effects of inpatient care such as functional decline,[5] delirium,[6] and other iatrogenic illnesses.

Controversy persists regarding the clinical and economic effectiveness of Hospital at Home.[7,8] Many models studied to date have been for early discharge of surgical patients rather than for substitutive care, and all previous studies have been in countries with single-payer healthcare systems. Cost implications of substitutive Hospital at Home from the perspective of third-party payers in the United States may be qualitatively different.

We have demonstrated that substitutive Hospital at Home care in the United States was clinically feasible, efficacious, and associated with reductions in complications, greater patient satisfaction, higher caregiver satisfaction, and lower caregiver stress.[5,9,10] We also reported summary data on lower third-party payer costs for Hospital at Home patients.[5] The aim of this study was to make more detailed comparisons of third-party payer costs in providing substitutive Hospital at Home care versus traditional acute hospital care for older patients with acute medical illness. The primary hypothesis was that total costs would be lower for Hospital at Home patients. Specifically, procedure, room, and hospital (not physician) costs were hypothesized to be lower.

METHODS

Study Design

The Hospital at Home National Demonstration and Evaluation Study has been described in detail previously.[5] The study was a prospective nonrandomized clinical trial conducted in 2 consecutive 11-month phases. In the first (observation) phase, Hospital at Home–eligible patients were followed up through usual acute hospital care. In the second (intervention) phase,

In this issue
Take-away Points / p55
www.ajmc.com
Full text and PDF
Web exclusive
eAppendix Tables 1 to 3

all Hospital at Home–eligible patients were offered Hospital at Home care. A randomized controlled trial was precluded because of regulations related to Medicare managed care.

The study was conducted at 3 sites. Univera Health and Independent Health, in Buffalo, New York (hereafter, Buffalo), are Medicare managed care plans that operate in an independent practice association model. The Fallon Health Care System, in Worcester, Massachusetts (hereafter, Fallon), operates a not-for-profit Medicare managed care plan and the Fallon Clinic, a for-profit multispecialty physician group that provides care on a capitated basis to Medicare managed care beneficiaries. The Portland Veterans Affairs Medical Center, in Oregon (hereafter, PVAMC), is a quaternary care and teaching facility.

Patients and the Hospital at Home Model of Care

Eligible patients were community-dwelling persons 65 years and older residing within a specific catchment area who required acute hospital admission for an exacerbation of chronic obstructive pulmonary disease (COPD) or chronic heart failure (CHF), for community-acquired pneumonia, or for cellulitis. Patients requiring acute hospital admission for one of the target conditions and who met previously validated Hospital at Home eligibility criteria were included.[11] The most common reasons for medical ineligibility were uncorrectable hypoxemia, suspected myocardial ischemia, and the presence of an acute illness that required hospital admission other than the target illness. Patients were identified in an emergency department or at an ambulatory site at times when Hospital at Home could admit patients (usually between 6 AM and 8 PM). After informed consent was obtained, patients were transported home via ambulance. Patients were evaluated by a Hospital at Home physician in the emergency department or shortly after arrival at home. A Hospital at Home nurse met the ambulance at home and provided initial direct one-on-one care for a mean of 16.9 hours. After direct nursing supervision, the patient had intermittent nursing visits at least daily. Patients were not required to have a caregiver in the home, and if a caregiver was available, there was no requirement that the caregiver provide assistance or care to the patient. A Lifeline medical alert device (Philips Electronics North America Corporation, Andover, MA) was placed in the home of any patient who did not have a caregiver present in the home. The Hospital at Home physician made at least daily home visits and was available at all times for urgent visits. Nursing and other care components such as durable medical equipment, oxygen therapy, skilled therapies, and pharmacy support were provided by a partner Medicare-certified home health agency and for some services (eg, home radiology) by independent contractors. Diagnostic studies such as electrocardiography, radiology, intravenous fluids, intravenous antimicrobial agents and other medicines, oxygen, and other respiratory therapies were provided at home.

Cost Data

Third-party payer cost data were obtained from each of the 3 study sites. The PVAMC provided costs based on a standard Veterans Affairs stepdown cost accounting approach. Buffalo provided charges, as well as a cost-to-charge ratio for hospital facility costs. Fallon provided allowable hospital charges at the level of the admission. Data from all sites include all resources used for patient care for inpatient settings and for Hospital at Home care. There is no reason to suspect that any single costing method would systematically favor the intervention.

Subtotals of costs were used for hypothesis testing. Hospital facility costs are separated from physician costs. Physician costs are divided into emergency department costs and non–emergency department costs. This is particularly relevant because the Hospital at Home admissions primarily originate in the emergency department. Hospital costs are also categorized based on UB-92 codes that Medicare and other third-party payers use for grouping charges.[12] The groups were emergency (emergency department and clinic), room (all types of room charges), skilled nursing (only applicable to Hospital at Home patients), medications (any pharmacy or medication), laboratory tests and procedures (laboratory, pathology, imaging, cardiology, and pulmonary function), and other hospital charges.

We also considered postdischarge follow-up care and readmission. Ascertaining whether the medical reason for follow-up utilization was related to the index admission to Hospital at Home was a nontrivial matter. Therefore, we gathered data on all hospitalizations, emergency department visits, skilled nursing facility admissions, and home healthcare visits. We were limited to comparing quantities of postdischarge utilization because the care could be obtained at facilities other than those involved in the study.

Costs were compared for all patients in the observation and intervention groups, by site, and by condition across sites. Given the different costing methods and slight variations in implementation, comparisons by site are most valid. There were insufficient patients to make comparisons by condition by site.

Data on 286 observation patients and 169 intervention patients were collected between November 2000 and September 2002. Consumer price index data indicate that inflation during that time was more than 15% for hospital and related services and more than 6% for professional services. Costs were inflation adjusted to the end of the intervention period. Total costs in

Table 1. Inflation-Adjusted Costs by Site According to Components of Costs in the Intent-to-Treat Analysis[a]

	Cost, Mean (SD), $							
	Total		Buffalo		Fallon		PVAMC	
Variable	Observation (N = 286)	Intervention (N = 165)[b]	Observation (n = 56)	Intervention (n = 38)	Observation (n = 135)	Intervention (n = 47)	Observation (n = 95)	Intervention (n = 80)
Total	**6650** (7491)	**4382** (4236)[c]	**7629** (7773)	**4972** (6633)	**6949** (8590)	**4632** (3903)	**5647** (5278)	**3954** (2717)[d]
Components of Total Costs								
Emergency department	324 (214)	320 (316)	240 (184)	614 (454)[c]	452 (192)	349 (235)[c]	193 (147)	164 (111)
Room[e]	2604 (2489)	1215 (1992)[c]	3229 (2988)	947 (2002)[c]	1967 (1782)	1253 (1337)[f]	3141 (2815)	1321 (2296)[c]
Skilled nursing[g]	0	617 (825)	0	778 (844)	0	279 (712)	0	738 (830)
Medications	605 (1109)	468 (512)	1297 (2174)	755 (825)	377 (557)	287 (293)	520 (390)	438 (340)
Laboratory tests and procedures	1292 (1688)	604 (953)[b]	1292 (1669)	588 (965)[d]	1742 (1986)	1088 (1307)[d]	654 (831)	327 (486)[f]
Other hospital charges	1824 (4083)	1158 (1925)[c]	1571 (2461)	1289 (3568)	2411 (5430)	1377 (1431)	1139 (1992)	966 (682)

PVAMC indicates Portland Veterans Affairs Medical Center.
[a]Variables controlled for in the model include age, being male, being white, living alone, Acute Physiology and Chronic Health Evaluation II score, number of comorbidities, activities of daily living limitations at baseline, and Instrumental Activities of Daily Living limitations at baseline.
[b]There were 4 observations without data indicating how costs were divided. Therefore, the total does not equal the total hospital costs in Table 3.
[c]$P \leq .001$.
[d]$P \leq .05$.
[e]Most were from patients who were actually treated in a hospital but who were included with those treated at home in the intent-to-treat analysis.
[f]$P \leq .01$.
[g]No statistical tests were conducted for this category because the costs are necessarily greater when allowing Hospital at Home care to be provided.

the initial results study[5] were reported in 2002 dollars; they will be reported in the same year's dollars herein for consistency.

Statistical Analysis

Although we present means and standard deviations, inferences of statistically significant differences were made based on the results of a generalized linear model using a log link and gamma family specification in STATA 9.1 (StataCorp LP, College Station, Texas).[13] When using all observations, we included age, being male, being white, living alone, the Acute Physiology and Chronic Health Evaluation (APACHE) II score, number of comorbidities, activities of daily living limitations at baseline, and Instrumental Activities of Daily Living limitations at baseline as explanatory variables. In the regressions using subsets of the whole data set (by site, by primary diagnosis, or as treated), we included only age, lives alone, and the APACHE II score. Despite the large number of comparisons, we did not adjust the *P* value denoting statistical significance but interpret the set of results together. Inferences regarding the statistical significance of differences in utilization during the 8 weeks after the index hospitalization were made based on the results of *t* tests.

The primary investigations were intent-to-treat analyses comparing all observation phase patients with all intervention phase patients. These results provide a conservative estimate of the potential differences because some patients at each site received usual hospital care during the intervention period. Some patients refused to receive Hospital at Home care. For others, admission occurred at times when Hospital at Home was not open for admissions; standard hours were between 6 AM and 8 PM. The numbers who consented to data collection at each site during the intervention phase were 42 patients in Buffalo, 47 patients at Fallon, and 80 patients at PVAMC; the numbers who received Hospital at Home care were 30 patients, 10 patients, and 44 patients, respectively. Given the numbers who did not receive Hospital at Home and to allow for secular changes in care between the two 11-month periods, we also conducted secondary analyses using as-treated data limited to the intervention period. Given the potential for selection bias, the intent-to-treat and as-treated analyses bound the potential effect of Hospital at Home.

RESULTS

Demographic characteristics are given in **eAppendix Table 1**, available at **www.ajmc.com**. There are few statistically significant differences between the observation and intervention groups; the difference in APACHE II scores was not clinically significant. During the intervention period, pa-

Table 2. Inflation-Adjusted Costs by Site According to Components of Costs in the Intent-to-Treat Analysis[a]

Variable	Cost, Mean (SD), $							
	Total		Buffalo		Fallon		PVAMC	
	Observation (N = 286)	Intervention (N = 169)	Observation (n = 56)	Intervention (n = 42)	Observation (n = 135)	Intervention (n = 47)	Observation (n = 95)	Intervention (n = 80)
Total	**7480** (8113)	**5081** (4427)[b]	**8521** (8428)	**5574** (6554)	**7576** (9058)	**5419** (3974)	**6729** (6307)	**4624** (3128)[b]
Components of Total Costs								
Hospital	6650 (7491)	4378 (4188)[b]	7630 (7773)	4902 (6312)	6949 (8590)	4632 (3902)	5647 (5278)	3954 (2717)[c]
Physician	830 (873)	704 (429)	891 (802)	673 (362)	627 (608)	786 (432)	1082 (1131)	670 (457)[c]
Components of Physician Costs								
Emergency department physician	111 (157)	154 (181)[c]	241 (241)	143 (139)[c]	61 (122)	272 (272)[b]	105 (76)	89 (60)
Non–emergency department physician	719 (853)	550 (390)[d]	650 (778)	529 (340)	566 (573)	514 (301)	977 (1131)	581 (458)[d]

PVAMC indicates Portland Veterans Affairs Medical Center.
[a]Variables controlled for in the model include age, being male, being white, living alone, Acute Physiology and Chronic Health Evaluation II score, number of comorbidities, activities of daily living limitations at baseline, and Instrumental Activities of Daily Living limitations at baseline.
[b]$P \leq .001$.
[c]$P \leq .05$.
[d]$P \leq .01$.

tients treated at home had higher mean levels of comorbidity, as reflected in the Charlson score.

Table 1 gives the results of an intent-to-treat analysis of total hospital costs and UB-92–based groupings. Emergency department costs were statistically significantly higher when Hospital at Home care was available in Buffalo but were lower under the same conditions at Fallon. In contrast, room charges are statistically significantly lower ($P < .01$ for all) when combining data across all sites and at each site. The mean (SD) costs for skilled nursing range from $279 ($712) at Fallon to $778 ($844) at Buffalo. Laboratory and procedure expenditures are statistically significantly lower across all sites and at each site ($P < .05$ for all). Room costs were nonzero for those who were in the Hospital at Home group because some patients received usual hospital care and because 2 patients started their care in Hospital at Home but required transfer to the acute hospital to complete their care. Combining data from all sites, the mean (SD) length of stay during the observational period was 4.9 (9.9) days, and the length of stay during the intervention period was 3.2 (2.5) days.

Table 2 gives an intent-to-treat comparison of total costs (hospital and physician combined), separate hospital and physician costs, and separate emergency department and non–emergency department physician costs. Total costs of the Hospital at Home intervention were statistically significantly lower than those of usual hospital care during the observation period (mean [SD], $5081; $P < .001$). Only one of the individual sites had statistically significantly lower total costs during the intervention period, although all 3 sites had total costs that were lower. As hypothesized, across all sites hospital costs were more than $2000 lower among those who were treated when Hospital at Home care was available ($P < .001$). The PVAMC was the only site with statistically significantly lower costs for both hospital and physician components of the total. The results for subcomponents of physician costs were as expected for comparisons using individuals across all sites. Emergency department physician costs were statistically significantly higher among patients who received care when Hospital at Home care was available ($P < .05$). Non–emergency department physician costs were statistically significantly lower when combining data across sites ($P < .01$). Other than for emergency department physician costs, site-specific comparisons mimicked the overall comparison or were not statistically significant. Emergency department physician costs were statistically significantly lower in Buffalo and statistically significantly higher at Fallon, while they were not statistically significantly different at PVAMC. This variability may be the result of how different emergency departments are managed.

Table 3 is similar to Table 1, but the columns represent conditions rather than sites. Room costs and laboratory test and procedure expenses during the intervention phase were

Table 3. Inflation-Adjusted Costs by Condition According to Components of Costs in the Intent-to-Treat Analysis[a]

Variable	Cost, Mean (SD), $							
	Pneumonia		Congestive Heart Failure		Chronic Obstructive Pulmonary Disease		Cellulitis	
	Observation (n = 89)	Intervention (n = 53)[b]	Observation (n = 71)	Intervention (n = 37)	Observation (n = 92)	Intervention (n = 46)[b]	Observation (n = 34)	Intervention (n = 29)[b]
Total	**6761** (6451)	**5272** (6036)	**6399** (6643)	**3310** (2118)[c]	**6500** (7305)	**4293** (3806)[d]	**7287** (11471)	**4262** (2309)
Components of Total Costs								
Emergency department	310 (185)	280 (295)	296 (223)	339 (309)	340 (208)	385 (373)	379 (274)	269 (253)
Room	2863 (3071)	1620 (2526)[d]	2712 (2683)	801 (1421)[c]	2259 (1708)	989 (1625)[c]	2632 (2123)	1361 (1976)[c]
Skilled nursing[e]	0	476 (764)	0	496 (518)	0	743 (915)	0	828 (1040)
Medications	704 (786)	534 (707)	616 (1883)	266 (198)	543 (643)	479 (439)	489 (508)	587 (414)
Laboratory tests and procedures	1345 (1578)	777 (987)[f]	1252 (1293)	514 (652)[c]	1258 (1909)	548 (1166)[f]	1332 (2091)	490 (833)[d]
Other hospital charges	1538 (2094)	1585 (2978)	1523 (2352)	894 (838)[d]	2100 (4692)	1149 (1447)	2455 (7669)	727 (588)

[a]Variables controlled for in the model include age, living alone, and Acute Physiology and Chronic Health Evaluation II score.
[b]Four patients had missing data for the division of hospital costs. This accounts for the difference in total numbers and the difference in total hospital costs compared with other tables.
[c]$P \leq .001$.
[d]$P \leq .05$.
[e]No statistical tests were conducted for this category because the costs are necessarily greater when allowing Hospital at Home care to be provided.
[f]$P \leq .01$.

statistically significantly lower than those during the observation phase for each condition.

Table 4 is analogous to Table 2 in the same way that Table 3 is analogous to Table 1. The direction of comparisons is similar across all 4 conditions for total costs and for separate hospital and physician costs. However, the differences are not always statistically significant. The hospital component of costs is statistically significantly different in 2 cases, while the physician component is never significantly different. The emergency department physician cost component is greater for patients when Hospital at Home care was available, although only one difference was statistically significant ($P < .001$) for patients with COPD.

eAppendix Table 2 (available at **www.ajmc.com**) summarizes the results in Table 1 across all sites using an as-treated analysis. These results suggest that in part the intervention costs were lower in Table 1 because the costs of patients who received usual hospital care were lower in the intervention period. However, the room and laboratory test and procedure costs were so much lower that the differences were statistically significant in the as-treated analysis. The group treated in the hospital had a longer mean (SD) length of stay (3.5 [2.8] days) compared with the group treated at home (2.8 [2.1] days).

Table 5 and eAppendix Table 3 (available at **www.ajmc.com**) summarize health service utilization during the 8 weeks following the index hospitalization. In the 2 tables, only one comparison is statistically significant at $P < .05$. In all comparisons, differences are small.

DISCUSSION

Total costs seem to be lower when substitutive Hospital at Home care is available than when only traditional acute hospital care is available for patients with CHF or COPD but not for patients with community-acquired pneumonia or cellulitis. This finding may be a result of the research study–based requirement for prolonged continuous nursing input. Laboratory and procedure costs were lower and total costs were no higher when Hospital at Home was available. Results were robust across sites and conditions.

The study was not a randomized controlled trial, and it is possible that cost savings came at the expense of patient care. However, previous results showed no difference between Hospital at Home and acute hospital care in illness-specific quality measures, as well as lower rates of medical complications for Hospital at Home.[5] An inference from the present study is that patients treated in the acute hospital may receive unnecessary laboratory tests and procedures because of their geographic proximity to them. This phenomenon has been observed for other high-technology procedures.[14,15] In this study, the cost difference for community-acquired pneumonia was small and not statistically significant; possibly be-

Table 4. Inflation-Adjusted Costs by Condition According to Components of Costs in the Intent-to-Treat Analysis[a]

	Cost, Mean (SD), $							
	Pneumonia		Congestive Heart Failure		Chronic Obstructive Pulmonary Disease		Cellulitis	
Variable	Observation (n = 89)	Intervention (n = 54)	Observation (n = 71)	Intervention (n = 37)	Observation (n = 92)	Intervention (n = 48)	Observation (n = 34)	Intervention (n = 30)
Components of Physician Costs								
Emergency department physician	142 (172)	182 (247)	104 (165)	151 (136)	98 (145)	166 (163)[b]	79 (120)	85 (72)
Non–emergency department physician	783 (967)	617 (518)	729 (804)	498 (289)	676 (860)	461 (225)[c]	645 (600)	633 (419)
Components of Total Costs								
Physician	925 (977)	799 (580)	833 (819)	649 (302)	774 (890)	628 (278)	724 (619)	718 (425)
Hospital	6761 (6451)	5273 (5979)	6399 (6643)	3310 (2118)[b]	6500 (7320)	4300 (3725)[c]	7287 (11,471)	4209 (2287)
Total	**7686** (7250)	**6072** (6331)	**7232** (7329)	**3959** (2337)[b]	**7274** (7958)	**4928** (3809)[c]	**8011** (11,789)	**4927** (2548)

[a]Variables controlled for in the model include age, living alone, and Acute Physiology and Chronic Health Evaluation II score. The total hospital costs do not sum to the totals in Table 2 in all cases because of a few patients for whom only total hospital charges were available.
[b]$P \leq .001$.
[c]$P \leq .05$.

cause limited technology is used for diagnosis and treatment. In contrast, the diagnosis and treatment of COPD and CHF involve substantial technology, and the difference in costs was statistically significant for these conditions.

Although the in-hospital treatment costs were lower during the intervention phase, the Hospital at Home costs were even lower, suggesting that the availability of such services has the potential to reduce overall costs even when not all patients can be enrolled or choose to use the services. This was true in spite of a consistent finding not favoring Hospital at Home, namely, higher emergency department costs. Compared with observation patients, intervention patients spent an additional mean of 0.9 hours in the emergency department.[5] Hospital at Home cost savings were sufficient to offset the costs of providing extra emergency department care and a substantial amount of initial one-on-one continuous nursing supervision. In the future, as Hospital at Home moves from research to a program model, we anticipate that the requirements for prolonged initial one-on-one continuous nursing will decrease and will result in a more favorable cost profile.

Several studies of costs of Hospital at Home care have been published previously. Some of these studies have examined models focusing on early discharge, often for treatment of surgical patients,[16-22] or have been a combination of early discharge and substitutive Hospital at Home investigations.[23-26] Results of these studies have been mixed, although most findings suggest lower costs for Hospital at Home.

Fewer studies have focused on substitutive Hospital at Home care. In a randomized trial of substitutive Hospital at Home for first uncomplicated acute ischemic stroke, costs

Table 5. Utilization by Site During 8 Weeks Following Index Hospitalization

	No. of Visits or Events, Mean (SD)							
	Total		Buffalo		Fallon		PVAMC	
Variable	Observation (N = 286)	Intervention (N = 169)	Observation (N = 56)	Intervention (N = 42)	Observation (N = 135)	Intervention (N = 47)	Observation (N = 95)	Intervention (N = 80)
Emergency department	0.23 (0.66)	0.22 (0.57)	0.05 (0.23)	0.05 (0.31)	0.19 (0.70)	0.17 (0.43)	0.40 (0.72)	0.34 (0.71)
Skilled nursing	0.15 (0.47)	0.18 (0.50)	0.16 (0.53)	0.24 (0.48)	0.23 (0.56)	0.36 (0.74)	0.02 (0.14)	0.04 (0.25)
Home health	1.80 (3.50)	1.78 (5.07)	2.57 (6.07)	1.33 (2.68)	1.73 (2.48)	3.21 (8.84)	1.44 (2.51)	1.18 (1.91)
Hospitalizations	0.28 (0.59)	0.27 (0.55)	0.13 (0.33)	0.45 (0.71)[a]	0.30 (0.60)	0.28 (0.50)	0.34 (0.66)	0.18 (0.47)

PVAMC indicates Portland Veterans Affairs Medical Center.
[a]$P \leq .01$.

Take-away Points

The availability of substitutive Hospital at Home care was associated with apparently lower costs for the care of patients with exacerbation of chronic obstructive pulmonary disease or with exacerbation of congestive heart failure in 3 Medicare managed care settings and at a Department of Veterans Affairs medical center.

- Laboratory and procedure costs were lower with Hospital at Home care.
- Costs were lower for patients with chronic obstructive pulmonary disease or congestive heart failure but not for patients with community-acquired pneumonia.
- Utilization in the 8 weeks following discharge were no different when Hospital at Home care was available.

were reduced by approximately 40% for Hospital at Home patients; total costs, including the costs of rehabilitation, were comparable to those of usual hospital care that included only part of the rehabilitation costs.[27] An Australian randomized trial of substitutive Hospital at Home for medical patients found approximately 50% cost savings and no differences in clinical outcomes.[28] Compared with these studies, our study is unique in that the length of stay for patients in our Hospital at Home more closely paralleled the length of stay for patients in acute care hospitals. In addition, ours is the first such study (to our knowledge) to be performed in multiple healthcare systems with different payment structures and to demonstrate reasonably consistent results.

This investigation was not intended to be a cost minimization study because the results of usual care and Hospital at Home were not identical. However, several previous economic evaluations were cost minimization studies.[20,24,29] If the only outcome criterion was that the results should not be worse than those of usual care, the present study could be interpreted as a cost minimization study indicating that Hospital at Home costs less to achieve similar results. Otherwise, the present study could be interpreted as a cost consequence study indicating that Hospital at Home care costs less and provides outcomes that are at least as positive across several dimensions.

This study has limitations. Patients were not randomly assigned to treatment, and differences between study groups may be due to selection bias. However, we used a highly conservative intent-to-treat type of analysis, which may have attenuated the reported economic advantages of Hospital at Home. In addition, the model studied was a research model that used mandatory costly initial one-on-one nursing care. As the model moves into a dissemination phase, it is likely that fewer patients will require that level of care, and this may also improve the cost profile of the model. Although patients may be more satisfied with high-quality care that is less costly to the healthcare system, patients may experience some economic costs in Hospital at Home that they would not experience in the acute care hospital. For example, the additional costs for food, laundry, heating, and lighting that the patient incurs at home are not accounted for in this study but should be explained to patients. The sample size was not large for any of the sites or for any of the conditions. Furthermore, the 3 sites used different methods to assign costs to the quantities of care that were provided. Although there are some difficulties in comparing Veterans Affairs and non–Veterans Affairs costs,[30] the consistency of the direction of comparison and the multiple statistically significant results support the conclusion that the cost savings that can be achieved more than offset the increased operating costs.

In addition to economic costs of care, the costs of care in terms of potential burdens placed on family members need to be considered in a model such as Hospital at Home. Unlike other Hospital at Home models described in the international literature,[23,28] our model did not require that patients have a family member available or, if a family member was available, that he or she provide any service to Hospital at Home. Our previous work demonstrated that caregivers found Hospital at Home to provide more satisfying care from their standpoint[9] and that Hospital at Home care was associated with less stress than that experienced by family members of patients treated in the acute care hospital.[31]

Decision makers contemplating the implementation of a Hospital at Home program would ultimately need to consider not only the operating costs but also the startup costs and the potential for reimbursement. Payers would seem to benefit from finding a way to reimburse this type of care, for which no standards of reimbursement exist in the dominant fee-for-service Medicare system. Future implementation should consider the need for a substantial number of patients to make Hospital at Home economically viable and should consider targeting this type of care to patients for whom there is a large amount of discretionary care provided by physicians or by the use of laboratory tests and procedures. Even if Hospital at Home does not save money on a case-by-case basis, providing such care may still result in economic and systems improvements for a healthcare delivery system. Economic advantages can be achieved if inpatient beds opened up as a result of providing Hospital at Home care could be filled by more profitable patients, and systems improvements may be accrued by making additional inpatient beds available and by reducing the burden on emergency departments.

The results reported in our earlier work[5,9,10] and in this study suggest that high-quality hospital-level care can be provided to older patients in their homes as a substitute for traditional inpatient care and that this is economically fea-

sible. As the availability of beds in internal medicine services becomes limited and as patients continue to demand to be treated more like informed consumers, policy makers and hospital strategic planners will need to consider the viability of a Hospital at Home option for the health of patients and healthcare delivery systems.

Author Affiliations: Johns Hopkins Bloomberg School of Public Health (KDF, LCB, RC, WBG, DMS, BL), Baltimore, MD; Portland Veterans Affairs Medical Center (SIM) and Oregon Health and Science University (SIM), Portland, OR; State University of New York (WBN), Buffalo; Fallon Clinic (JBB), Worcester, MA; and Johns Hopkins School of Medicine (WBG, BL).

Funding Source: This study was supported by grant 98309-G from the John A. Hartford Foundation of New York and was supplemented at Portland Veterans Affairs Medical Center by Department of Veterans Affairs New Clinical Initiative Program grant 99-027a.

Author Disclosure: The authors (KDF, LCB, RC, SIM, WBN, JBB, WBG, DMS, BL) report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (KDF, LCB, JBB, WBN, WBG, DMS, BL); acquisition of data (KDF, LCB, RC, WBN, DMS, BL); analysis and interpretation of data (KDF, LCB, RC, WBG, DMS, BL); drafting of the manuscript (KDF, LCB, BL); critical revision of the manuscript for important intellectual content (KDF, WBN, WBG, BL); statistical analysis (KDF, LCB, RC); provision of study materials or patients (SIM, WBN, JBB); obtaining funding (LCB, WBN, BL); administrative, technical, or logistic support (LCB, WBN, BL); and supervision (WBG).

Address correspondence to: Kevin D. Frick, PhD, Johns Hopkins Bloomberg School of Public Health, 624 N Broadway, Rm 606, Baltimore, MD 21205. E-mail: kfrick@jhsph.edu.

REFERENCES

1. Leff B, Montalto M. Home hospital: toward a tighter definition [letter]. *J Am Geriatr Soc.* 2004;52(12):2141.

2. Institute of Medicine. IOM report: the future of emergency care in the United States health system. *Acad Emerg Med.* 2006;13(10):1081-1085.

3. Wilber ST, Gerson LW, Terrell KM, et al. Geriatric emergency medicine and the 2006 Institute of Medicine reports from the Committee on the Future of Emergency Care in the U.S. Health System. *Acad Emerg Med.* 2006;13(12):1345-1351.

4. Derlet RW, Richards JR. Overcrowding in the nation's emergency departments: complex causes and disturbing effects. *Ann Emerg Med.* 2000;35(1):63-68.

5. Leff B, Burton L, Mader SL, et al. Hospital at Home: feasibility and outcomes of a program to provide hospital-level care at home for acutely ill older patients. *Ann Intern Med.* 2005;143(11):798-808.

6. Caplan GA, Coconis J, Woods J. Effect of hospital in the home treatment on physical and cognitive function: a randomized controlled trial. *J Gerontol A Biol Sci Med Sci.* 2005;60(8):1035-1038.

7. Leff B. Acute care at home: the health and cost effects of substituting home care for inpatient acute care: a review of the evidence. *J Am Geriatr Soc.* 2001;49(8):1123-1125.

8. Shepperd S, Iliffe S. Hospital at Home versus in-patient hospital care. *Cochrane Database Syst Rev.* 2005;(3):CD000356.

9. Leff B, Burton L, Mader S, et al. Satisfaction with Hospital at Home care. *J Am Geriatr Soc.* 2006;54(9):1355-1363.

10. Leff B, Burton L, Mader SL, et al. Comparison of stress experienced by family members of patients treated in Hospital at Home with that of those receiving traditional acute hospital care. *J Am Geriatr Soc.* 2008;56(1):117-123.

11. Leff B, Burton L, Bynum JW, et al. Prospective evaluation of clinical criteria to select older persons with acute medical illness for care in a hypothetical home hospital. *J Am Geriatr Soc.* 1997;45(9):1066-1073.

12. Sacchetti A, Harris RH, Warden TM, Moakes ME. Utility of UB-92 data for monitoring emergency department performance improvement. *J Healthc Qual.* 2001;23(2):26-28, 33.

13. Kilian R, Matschinger H, Löeffler W, Roick C, Angermeyer MC. A comparison of methods to handle skew distributed cost variables in the analysis of the resource consumption in schizophrenia treatment. *J Ment Health Policy Econ.* 2002;5(1):21-31.

14. Wennberg JE, Fisher ES, Skinner JS. Geography and the debate over Medicare reform. *Health Aff (Millwood).* 2002;(suppl Web exclusives):W96-W114.

15. Fisher ES, Wennberg JE. Health care quality, geographic variations, and the challenge of supply-sensitive care. *Perspect Biol Med.* 2003;46(1):69-79.

16. Hollingworth W, Todd C, Parker M, Roberts JA, Williams R. Cost analysis of early discharge after hip fracture. *BMJ.* 1993;307(6909):903-906.

17. Farnworth MG, Kenny P, Shiell A. The costs and effects of early discharge in the management of fractured hip. *Age Ageing.* 1994;23(3):190-194.

18. O'Cathain A. Evaluation of a Hospital at Home scheme for the early discharge of patients with fractured neck of femur. *J Public Health Med.* 1994;16(2):205-210.

19. Hensher M, Fulop N, Hood S, Ujah S. Does hospital-at-home make economic sense? Early discharge versus standard care for orthopaedic patients. *J R Soc Med.* 1996;89(10):548-551.

20. Coast J, Richards SH, Peters TJ, Gunnell DJ, Darlow MA, Pounsford J. Hospital at Home or acute hospital care? A cost minimization analysis. *BMJ.* 1998;316(7147):1802-1806.

21. Jester R, Hicks C. Using cost-effectiveness analysis to compare Hospital at Home and in-patient interventions, part 1. *J Clin Nurs.* 2003;12(1):13-19.

22. Jester R, Hicks C. Using cost-effectiveness analysis to compare Hospital at Home and in-patient interventions, part 2. *J Clin Nurs.* 2003;12(1):20-27.

23. Stessman J, Ginsberg G, Hammerman-Rozenberg R, et al. Decreased hospital utilization by older adults attributable to a home hospitalization program. *J Am Geriatr Soc.* 1994;44(5):591-598.

24. Shepperd S, Harwood D, Gray A, Vessey M, Morgan P. Randomized controlled trial comparing Hospital at Home care with inpatient hospital care, II: cost minimization analysis. *BMJ.* 1998;316(7147):1791-1796.

25. Campbell H, Karnon J, Dowie R. Cost analysis of a hospital-at-home initiative using discrete event simulation. *J Health Serv Res Policy.* 2001;6(1):14-22.

26. Ram FS, Wedzicha JA, Wright J, Greenstone M. Hospital at Home for patients with acute exacerbations of chronic obstructive pulmonary disease: systematic review of evidence [published correction appears in *BMJ.* 2004;329(7469):773]. *BMJ.* 2004;329(7461):e315.

27. Ricauda NA, Tibaldi V, Marinello R, et al. Acute ischemic stroke in elderly patients treated in Hospital at Home: a cost minimization analysis. *J Am Geriatr Soc.* 2005;53(8):1442-1443.

28. Board N, Brennan N, Caplan GA. A randomized controlled trial of the costs of hospital as compared with hospital in the home for acute medical patients. *Aust N Z J Public Health.* 2000;24(3):305-311.

29. Jones J, Wilson A, Parker H, et al. Economic evaluation of Hospital at Home versus hospital care: cost minimization analysis of data from randomized controlled trial. *BMJ.* 1999;319(7224):1547-1550.

30. Hendricks AM, Remler DK, Prashker MJ. More or less? Methods to compare VA and non-VA health care costs. *Med Care.* 1999;37(4 suppl VA):AS54-AS62.

31. Leff B, Burton L, Mader S, et al. Stress experienced by family members of patients treated in Hospital at Home compared with traditional acute hospital care. *J Am Geriatr Soc.* 2008;56(1):117-123. ■