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Association of a Bundled Hospital-at-Home and 30-Day Postacute Transitional Care Program With Clinical Outcomes and Patient Experiences

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IMPORTANCE Hospital-at-home (HaH) care provides acute hospital-level care in a patient's home as a substitute for traditional inpatient care. In September 2017, the Physician-Focused Payment Model Technical Advisory Committee recommended implementation of an alternative payment model for a new model of HaH that bundles the acute episode with 30 days of postacute transitional care.

OBJECTIVE To report outcomes of this new payment model for HaH care.

DESIGN, SETTING, AND PARTICIPANTS Case-control study of HaH care patients with a concurrent control group of hospital inpatients recruited from emergency departments (EDs) and residences in New York City from November 18, 2014, to August 31, 2017. HaH patients were 18 years or older with fee-for-service Medicare and acute medical illness requiring inpatient-level care. Control patients met HaH eligibility but refused participation or were seen in the ED when a HaH admission could not be initiated.

EXPOSURES HaH care or inpatient care.

MAIN OUTCOMES AND MEASURES Primary outcomes were acute period length of stay (LOS), all-cause 30-day hospital readmissions and ED visits, admissions to skilled nursing facilities (SNFs), referral to a certified home health care agency, and patient experiences with care. Analyses accounted for nonrandom selection using inverse probability weighting.

RESULTS Among the 507 patients enrolled (mean [SD] age, 74.6 [15.7] years; 68.6% women), data were available on all patients 30 days postdischarge. HaH patients (n = 295) were older than controls (n = 212) and more likely to have a preacute functional impairment. HaH patients had shorter LOS (3.2 days vs 5.5 days; difference, −2.3 days; 95% CI, −1.8 to −2.7 days; weighted $P < .001$); lower rates of readmissions (8.6% [25] vs 15.6% [32]; difference, −7.0%; 95% CI, −12.9% to −1.1%; weighted $P < .001$), ED revisits (5.8% [17] vs 11.7% [24]; difference, −5.9%; 95% CI, −11.0% to −0.7%; weighted $P < .001$), and SNF admissions (1.7% [5] vs 10.4% [22]; difference, −8.7%; 95% CI, −13.0% to −4.3%; weighted $P < .001$); and were also more likely to rate their hospital care highly (68.8% [119] vs 45.3% [67]; difference, 23.5%; 95% CI, 12.9% to 34.1%; weighted $P < .001$). There were no differences in referrals to certified home health agencies.

CONCLUSIONS AND RELEVANCE HaH care bundled with a 30-day postacute transitional care episode was associated with better patient outcomes and ratings of care compared with inpatient hospitalization. This model warrants consideration for addition to Medicare's current portfolio of shared savings programs.

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Invited Commentary
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Hospital-at-home (HaH) care provides acute hospital-level care in a patient's home as a substitute for traditional inpatient care. In observational and randomized clinical trials, HaH care demonstrates clinically important reductions in mortality and iatrogenic complications, better patient and caregiver experience, and reduced costs of care.[1-5] In Australia, where HaH care is reimbursed at the same rates as hospital care, the HaH program is widely used and has obviated new hospital construction.[6] In the United States, HaH care has been adopted in integrated health care systems and the Veterans Affairs health system.[7,8] However, widespread dissemination has been hampered by the absence of a HaH-specific payment mechanism in fee-for-service Medicare.

In September 2017, the Physician-Focused Payment Model Technical Advisory Committee (PTAC) unanimously recommended to the secretary of the US Department of Health and Human Services full implementation of an alternative payment model (APM) for HaH care.[9] In contrast to existing programs, the HaH model considered by the PTAC bundles acute HaH care with a 30-day postacute period of home-based transitional care. Creation of an APM for such a model of HaH care would establish Medicare billing codes, allowing clinicians to bill directly for HaH services and paving the way for broad-scale adoption of the HaH program in the United States. The aim of this study was to evaluate the complete data on clinical outcomes, patient experiences, and safety of this new HaH model.

Key Points

Question What is the association of providing hospital-at-home care bundled with a 30-day postacute period of home-based transitional care with clinical outcomes and patients' experiences compared with traditional inpatient care?

Findings This case-control study with 507 participants found that compared with patients receiving inpatient care, patients receiving hospital-at-home care had shorter length of stay; lower rates of 30-day hospital readmission, emergency department visits, and skilled nursing facility admissions; and better ratings of care. There were no differences in the rates of adverse events.

Meaning Hospital-at-home care bundled with a 30-day episode of postacute transitional care may be a safe and effective alternative to inpatient care for some patients.

Methods

Study Overview

In 2014, the Center for Medicare and Medicaid Innovation (CMMI), of the Centers for Medicare & Medicaid Services, awarded a Health Care Innovation Award to the Icahn School of Medicine at Mount Sinai to demonstrate the clinical effectiveness of HaH care bundled with a 30-day postacute period of home-based transitional care.[10] We compared outcomes of patients participating in the demonstration project and concurrently admitted hospital inpatients who were HaH eligible but refused participation or who were seen in emergency departments (EDs) when a HaH admission could not be initiated. Data collection included interviews for patient characteristics and ratings of care, medical chart and administrative record abstractions, and insurance claims to document diagnoses and health services use. Because these data were used for internal program evaluation and reporting to Medicare, their collection was exempt from Mount Sinai institutional review board (IRB) review, and patient consent was not required. On completion of the CMMI award, we requested and received approval from the Mount Sinai IRB to conduct a retrospective analysis of these data. Data collection for control patients required consent, and procedures for doing so were approved by the Mount Sinai IRB. All these patients provided consent.

Setting and Patients

HaH care clinicians engaged patients from the Mount Sinai Hospital and Mount Sinai St Luke's Hospital EDs from November 18, 2014, through August 31, 2017. Some patients were referred from a clinician's office or from home by physicians of a home-based primary care program. HaH clinicians reviewed the charts of patients listed for inpatient admission then approached them or their proxy, described the program, and completed a history and examination to determine final eligibility status.

Patients were eligible for HaH admission if they were 18 years or older, had fee-for-service Medicare or coverage from a single private insurer that contracted with Mount Sinai for HaH services, and required inpatient admission. Patients were excluded from HaH care if they were clinically unstable, required cardiac monitoring or intensive care, lived in an unsafe home environment, or resided outside of Manhattan.

Initially, eligible admission diagnoses were acute exacerbations of asthma or chronic obstructive pulmonary disease, decompensated congestive heart failure, urinary tract infection, community-acquired pneumonia, cellulitis of the lower extremities, deep venous thrombosis or pulmonary embolism, hypertensive urgency, hyperglycemia, and dehydration. Over time, the number of eligible conditions expanded to 19, representing 65 diagnosis-related groups (DRGs).

Control patients qualified for HaH care but were evaluated in the ED during weekends and between 4 PM and 8 AM on weekdays when HaH clinicians were unavailable to initiate an admission. Research assistants also recruited HaH-eligible patients or their proxies who refused program participation. Following HaH eligibility guidelines, recruiters identified patients in the ED and obtained attending physician approval to approach and screen the patient for eligibility. Two physicians reviewed the medical records of control patients to confirm eligibility.

Patient interviews were conducted at bedside in the ED. Follow-up interviews were conducted by telephone 2 and 4 weeks after admission.

Hospital-at-Home

The episode of HaH care was initiated when a HaH physician or nurse practitioner (NP) wrote the admission note and orders, and the patient was transferred home by ambulance or

taxi service. Once the patient was home, a physician or NP provided home-based acute care services, including physical examination, illness and vital signs monitoring, intravenous infusions (eg, antibiotics, diuretics, fluids for rehydration), wound care, and education regarding the patient's illness. Treatment with the patient's own long-term prescriptions or over-the-counter medications were continued as appropriate. Nurses visited patients once or more a day to provide most of the care, and a physician or NP saw patients at least daily in person or via video call facilitated by the nurse. A social worker visited each patient at least once. Durable medical equipment, phlebotomy, and home radiography were provided as needed.

Patients could be transferred back to the hospital for evaluation in the ED with or without inpatient admission if their condition decompensated or if desired by the patient during the acute care period. Such transfers were termed escalations. Physicians were available 24 hours a day and were certified to direct paramedics who were available for urgent evaluation at any time.

When the patient's acute illness had resolved, the patient was discharged from acute care and provided a discharge summary, and the 30-day postacute period started. During the postacute period, nurses and social workers provided self-management support and coordination of care with primary care clinicians, specialists, rehabilitation, and outpatient testing as needed. Patients could be referred to a certified home nursing agency if warranted and if they qualified. Urgent medical visits were available as needed.

During the 3-year evaluation, the CMMI award covered the costs of services provided during the acute and postacute periods, including subcontracted services. The exceptions were Medicare Part B billable professional services (eg, ED physicians and specialists, postacute primary care) and nonacute medications.

Measures

The primary outcomes were duration of the acute care period (hereafter termed length of stay [LOS]) and the postacute outcomes of 30-day all-cause hospital readmissions or standalone ED visits, transfer to a skilled nursing facility (SNF), and referral to a certified home health care agency. We also assessed patients' ratings of care. LOS was defined from the date the patient was listed for admission by an ED physician to the date the postacute period of care was initiated (HaH patients) or hospital discharge (control patients). If the HaH patient's care was escalated, the final LOS was the sum of the HaH and inpatient LOS. Ratings of care were measured with the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) Survey.[11,12] We included 6 of the 9 domains of HCAHPS that are most salient to care in the home: communication with nurses, communication with physicians, pain management, communication about medicines, discharge information, and overall hospital rating.

Interviewers also documented patient demographics, activities of daily living,[13] and general health (rated poor to excellent). Functional impairment was defined as needing some help or unable to perform 1 or more of 12 activities of daily living.

Data Analysis

We compared characteristics and unadjusted outcomes of HaH and control patients using standard tests of association. LOS was approximately normally distributed and analyzed as a continuous outcome. Readmissions were analyzed as dichotomous outcomes. The HCAHPS Surveys were scored per Center for Medicare & Medicaid Services guidelines.[11] Specifically, we determined the proportion of individuals who gave a top-box rating for the measure (highest possible rating), adjusted for age, education, interview language (Spanish or English), and general health.

To limit bias from nonrandom assignment to HaH care, we used inverse probability weighting (IPW).[14,15] Similar to propensity score methods, IPW summarizes the conditional probability of assignment to a treatment based on available data. We fit a multivariable logistic regression model of HaH participation as the outcome with the following independent variables: age, sex, race, ethnicity, education, insurance type, physical function, general health, and primary admitting diagnosis. We modeled outcomes in logistic or linear regression models, as indicated, with each patient weighted by the inverse of the estimated probability of HaH participation.

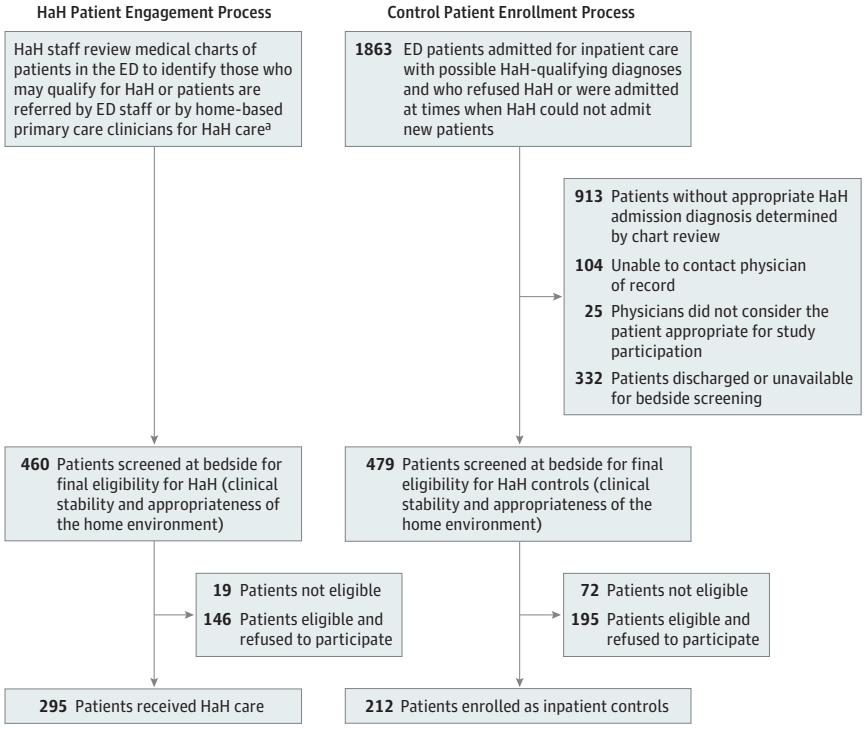
Among HaH patients, more than 10% of data were missing for race and ethnicity (n = 64), physical function (n = 115), and general health (n = 84). To maximize the number of patients in the models, we imputed the missing data using the multiple imputation procedures in SAS (SAS Institute). The probability of missing data for each variable was modeled on HaH participation, age, sex, race and ethnicity, education, Medicaid coverage, preacute physical function and general health, and admitting diagnosis. Because we examined distinct outcomes for our primary analyses, we did not apply a correction for multiple comparisons. Significance for all statistical tests was set at the $P = .05$ level (2 tailed). All analyses were performed with SAS statistical software version, 9.3.

Results

The HaH clinical team approached 460 patients with HaH-qualifying conditions: 19 were ineligible because of clinical instability or concerns about the home environment, 146 refused, and 295 (63.9%) were eligible and agreed to HaH care (**Figure**). The research team identified 1863 potential controls. After initial medical record screenings, obtaining physician consents, and locating the patients, the team conducted bedside eligibility screening with 479 patients; 407 met all eligibility criteria, and 212 (52.1%) agreed to participate as controls (HaH clinician unavailable to evaluate, 90.0%; refused HaH care, 9.6%).

HaH patients were older than controls (mean [SD] age, 76.9 [16.6] vs 71.5 [13.8] years; $P < .001$), less likely to have a college education (20.0% [41] vs 38.3% [77]; $P < .001$), less likely to have Medicare Advantage or private coverage (14.2% [42] vs 26.9% [57]; $P < .001$), and more likely to have 1 or more preacute functional limitations (71.5% [138] vs 55.5% [111]; $P = .001$) (**Table 1**). There were no significant differences by sex, race or ethnicity, or self-reported preacute general health.

Figure. Hospital-at-Home (HaH) and Control Patient Recruitment Flow Diagram



[a] The number of patients reviewed in this step cannot be accurately determined. Engagement of patients in HaH care was conducted in the context of emergency department (ED) workflow, involving discussions between HaH staff and ED physicians to determine suitability of patients for HaH care. In some cases, HaH staff were unable to locate or evaluate suitable patients because those patients were off the floor (eg, undergoing diagnostic imaging). Such cases were not recorded by the HaH staff.

Inverse probability weighting balanced the observable characteristics of the comparison groups.

The 4 most frequent admission diagnoses were urinary tract infections, community-acquired pneumonia, cellulitis, and congestive heart failure. Urinary tract infections were more frequent for HaH than control patients (23.3% [67] vs 13.2% [28]), whereas congestive heart failure was less frequent (11.6% [34] vs 19.8%[42]). LOS was shorter for HaH patients than controls (3.2 days vs 5.5 days; difference, −2.3 days; 95% CI, −1.8 to −2.7 days; $P < .001$). In weighted and adjusted regression analyses, the differences in LOS between HaH and control patients was −2.41 (0.11) ($P < .001$).

HaH patients, compared with controls, were less likely to have 30-day all-cause hospital readmissions (8.6% [25] vs 15.6% [32]; difference, −7.0%; 95% CI, −12.9% to −1.1%; $P = .01$) and 30-day ED revisits (5.8% [17] vs 11.7% [24]; difference, −5.9%; 95% CI, −11.0% to −0.7%; $P = .02$) (**Table 2**). In weighted and adjusted analyses, HaH patients had lower odds of hospital readmission (odds ratio [OR], 0.43; 95% CI, 0.36-0.52; $P < .001$) and ED revisits (OR, 0.39; 95% CI, 0.31-0.49; $P < .001$).

Few HaH patients were transferred to an SNF compared with controls (1.7% [5] vs 10.4% [22]; difference, −8.7%; 95% CI, −13.0% to −4.3%; $P < .001$). This difference remained statistically significant in weighted and adjusted regression analyses (SNF admission, OR, 0.09; 95% CI, 0.07-0.13; $P < .001$). In contrast, a greater proportion of HaH patients were referred to a certified home health care agency (58.3% [172] vs 49.1% [104]; difference, 9.3%; 95% CI, 0.5%-18.1%; $P = .04$), but the difference was not significant in weighted analysis (OR, 1.09; 95% CI, 0.97-1.24; $P = .15$).

HaH patients had higher ratings of care than control patients for communication with nurses and physicians and communication about medicines (**Table 3**) and were more likely to provide the highest rating for overall hospital care (68.8% [119] vs 45.3% [67]; difference, 23.5%; 95% CI, 12.9%-34.1%; $P < .001$) (weighted and adjusted OR, 3.12; 95% CI, 2.63-3.70). Scores for pain management were lower for HaH patients vs controls (weighted and adjusted scores 0.64 vs 0.73; $P = .004$). There were no differences in ratings of discharge information.

In the HaH program, care was escalated to the ED for 3 patients (1.0%) and to inpatient hospital for 33 (12.2%). Few adverse events were reported. Urinary catheter placement occurred for 1.0% [3] of HaH patients and 4.4% [9] of controls (difference, −3.4%; 95% CI, −6.9% to −0.4%; $P = .02$). There were no significant differences for other adverse events (HaH vs control): falls, 1.4% [4] vs 0 (difference, 1.4%; 95% CI, 0.04%-2.7%; $P = .09$); nosocomial infections, 0 vs 1.0% [2] (difference, −1.0%; 95% CI, −2.3% to 0.4%; $P = .09$); and death during the acute period, 0.3% [3] vs 0 (difference, 0.3%; 95% CI, −0.3% to 1.0%; $P = .14$). One death occurred in the HaH model during the acute period of care. The patient had chronic obstructive pulmonary disease, was escalated for acute respiratory distress, and died during inpatient hospitalization.

Discussion

Patients receiving HaH care had shorter acute-period LOS, lower odds of hospital and ED readmissions and SNF admis-

Table 1. Patient Characteristics[a]

Characteristic	HaH (n = 295)	Controls (n = 212)	Unweighted *P* Value	Weighted *P* Value[b]
Age, mean (SD), y	76.9 (16.6)	71.5 (13.8)	<.001	.76
Age, y				
18-64	56 (19.0)	51 (24.1)	.17	.38
65-74	46 (15.6)	67 (31.6)	<.001	.77
75-84	81 (27.5)	55 (25.9)	.70	.58
≥85	112 (38.0)	39 (18.4)	<.001	.86
Female	211 (71.5)	137 (64.6)	.10	.81
Race/ethnicity				
Black, non-Hispanic	59 (22.8)	53 (28.5)	.17	.97
White, non-Hispanic, other	119 (46.0)	72 (38.7)	.08	.44
Hispanic	81 (31.3)	61 (32.8)	.73	.28
Education				
Elementary school	48 (23.4)	35 (17.4)	.13	.10
Any high school	73 (35.6)	62 (30.9)	.31	.12
Any college	41 (20.0)	77 (38.3)	<.001	.24
Any postgraduate education	43 (21.0)	27 (13.4)	.04	.33
Insurance				
Medicare fee-for-service only	132 (44.8)	74 (34.9)	.03	.81
Medicare Advantage or private	42 (14.2)	57 (26.9)	<.001	.49
Any Medicaid[c]	121 (41.0)	81 (38.2)	.52	.55
Preacute impairment of physical function, any	138 (71.5)	111 (55.5)	.001	.61
Preacute general health, poor	135 (62.8)	135 (64.6)	.70	.43
Primary admitting diagnosis			<.001	NA
Urinary tract infection	67 (23.3)	28 (13.2)		
Community acquired pneumonia	56 (19.1)	40 (18.9)		
Cellulitis	44 (15.0)	41 (19.3)		
Congestive heart failure	34 (11.6)	42 (19.8)		
COPD exacerbation	23 (7.9)	18 (8.5)		
Asthma exacerbation	15 (5.1)	20 (9.4)		
Dehydration	31 (10.6)	4 (1.9)		
Deep venous thrombosis	1 (0.3)	8 (3.8)		
Diverticulitis	7 (2.4)	0		
Hyperglycemia	3 (1.0)	5 (2.4)		
Hypertension	0	1 (0.5)		
Other diagnoses[d]	11 (3.8)	1 (2.4)		

Abbreviations: COPD, chronic obstructive pulmonary disease; HaH, hospital-at-home; NA, not applicable.

[a] Unless otherwise indicated, all data are reported as number (percentage) of patients.

[b] Inverse probability weighted.

[c] Any Medicaid includes individuals also having Medicare fee-for-service, Medicare Advantage, and Medicaid managed care plan coverage.

[d] Other primary diagnoses were acute kidney injury (n = 3), bronchitis (n = 2), pyelonephritis (n = 2), colitis (n = 1), chronic inflammatory demyelinating polyneuropathy (n = 1), epididymitis (n = 1), hypoglycemia (n = 1), influenza (n = 1), and pleural effusion (n = 1).

sions, and higher ratings of care than in-hospital patients. Both HaH and in-hospital patients experienced few adverse events.

To our knowledge, this analysis involved the largest number of patients studied in a HaH program[1,7,16,17] but the findings are consistent with prior studies, including randomized trials, which demonstrated positive effects of HaH care on readmissions,[1,18] mortality rates,[1] costs,[1,2,8,19] and patient and caregiver experiences.[1,3,5,7,18] Our study extends this body of work in 2 ways. First, our HaH program accepted patients with a broader set of admitting diagnoses (n = 19) than reported by other programs. Previous HaH programs addressed fewer than 10 clinical conditions. Providing hospital-level care for a broad set of clinical diagnoses enhances value for health care systems and patients because of the flexibility to treat more patients.

Second, our HaH program bundled a 30-day postacute period of home-based transitional care with the acute care episode to improve care coordination, facilitate access, enhance postacute illness self-management, and reduce 30-day readmission rates. Our data show that HaH patients had a lower OR for 30-day hospital readmission vs hospitalized controls. This result compares favorably with 30-day readmissions reported in a meta-analysis of 18 randomized trials of HaH care (0.76; 95% CI, 0.60-0.97; $P = .02$).[1] Although a randomized trial design might have provided a more precise figure for the efficacy of postacute care coupled with HaH care, our findings suggest that this extension of HaH care enhances its effect. Bundling the HaH and transitional care episodes may have also contributed to the lower rates of SNF admissions and higher rates of certified home health care agency referrals observed among HaH patients.

Better outcomes among HaH patients were accompanied by low rates of adverse events, including lower urinary

Table 2. Outcomes of HaH Program Participants vs Controls

Outcome	Raw Values[a]		Models[b]	
	HaH	Controls	Unweighted Difference (SE), d	Weighted[c] Difference (SE), d
Acute length of stay, d	3.2 (2.1)	5.5 (3.4)[d]	−2.3 (0.11)[d]	−2.49 (0.14)[d]
30-Day postacute period			OR (95% CI)	
All-cause hospital readmission	25 (8.6)	32 (15.6)[e]	0.51 (0.40 to 0.65)[d]	0.43 (0.36 to 0.52)[d]
All-cause emergency department visit	17 (5.8)	24 (11.7)[e]	0.47 (0.35 to 0.63)[d]	0.39 (0.31 to 0.49)[d]
Transfer to skilled nursing facility	5 (1.7)	22 (10.4)[d]	0.15 (0.10 to 0.23)[d]	0.09 (0.07 to 0.13)[d]
Certified home health agency referral	172 (58.3)	104 (49.1)[e]	1.45 (1.24 to 1.70)[d]	1.09 (0.97 to 1.24)

Abbreviations: HaH, hospital-at-home; OR, odds ratio; SE, standard error.

[a] Unless otherwise indicated, all data are reported as number (percentage) of patients.

[b] Multiply imputed models, vs control patients; models adjusted for age, sex, race and ethnicity, education, insurance type, impairments in activities of daily living, general health status, and admission diagnosis of congestive heart failure or urinary tract infection.

[c] Inverse probability weighted.

[d] $P < .001$.

[e] $P < .05$.

Table 3. Unadjusted and Adjusted Patient Ratings of Care

Domain	No. of Patients, Raw Scores, Mean (SD)					Weighted and Adjusted Scores, Mean (SD)[a]		
	HaH		Controls		*P* Value[b]	HaH	Controls	*P* Value
Communication with nurses	171	0.93 (0.20)	154	0.79 (0.33)	<.001	0.94 (0.08)	0.81 (0.08)	<.001
Communication with physicians	146	0.93 (0.20)	154	0.83 (0.32)	<.001	0.96 (0.07)	0.84 (0.08)	<.001
Communication about medicines	79	0.87 (0.28)	67	0.67 (0.39)	<.001	0.88 (0.10)	0.69 (0.10)	<.001
Pain management	51	0.59 (0.36)	85	0.71 (0.37)	.06	0.64 (0.16)	0.73 (0.16)	.004
Discharge information	169	0.81 (0.32)	69	0.81 (0.30)	.85	0.80 (0.07)	0.82 (0.07)	.40
Highest overall hospital rating	No. (%)					OR (95% CI)		
	173 (67.8)		69 (45.6)		<.001	3.12 (2.63-3.70)		<.001

Abbreviations: HaH, hospital-at-home; OR, odds ratio.

[a] Inverse probability weighted linear regression models. Models adjusted for age, education, language of interview, and general health.

[b] Wilcoxon rank-sum test.

catheter insertion rates. This finding is notable because urinary catheters are overused in hospitals and associated with infections, functional decline,[20] and death.[21]

As in prior studies,[5,7,8,11,12] HaH patients were more likely to report better experiences with care than inpatients, highlighting the patient-centered nature of the HaH program, which offers choice and the conveniences and comforts of home. Providing an alternative to traditional inpatient acute care is consistent with the growing efforts of US health care systems to adopt patient-centered care delivery strategies.

HaH patients did not rate pain management as highly as did control patients. Some features of the HaH model, such as fewer opportunities to titrate pain medications and more physical activity by patients in their homes,[19] may challenge pain control. Additional research may identify contributors to pain control in HaH care and inform strategies to improve it, if needed.

To date, HaH programs have not enjoyed widespread adoption in the United States despite a record of better clinical outcomes, positive patient experiences, and cost savings of 19% to 38%.[2,8,19] This is largely explained by the lack of fee-for-service payment mechanisms to support them. Medicare has no specific DRG or professional billing codes for HaH services. However, new incentives have arisen in recent years that may renew interest and investment in HaH care, including shared savings with accountable care organizations, Medicare penalties for 30-day readmissions, and the rise of risk contracting with insurers.

The opportunity to propose alternative payment models, authorized under the 2015 Medicare Access and CHIP Reauthorization Act, opened yet another possible door for the HaH model to secure footing among US clinicians. Mount Sinai's application for a HaH APM proposed a bundled payment mechanism that provides for a discounted DRG base payment for the HaH services (acute and 30-day postacute transitional care) and fee-for-service billing for other services, with reconciliation and shared savings on total 30-day spending. Full details of the bundled payment mechanism are included in our PTAC application, which is accessible online.[22]

Limitations

This study has several limitations. First, it was observational and subject to selection bias. We used IPW to address this limitation, but it only accounts for observable measures, so findings may be affected by residual bias. However, HaH patients were older and more likely to have baseline physical impairment than control patients, which would bias outcomes in favor of the controls. Second, some patients were missing data for race and ethnicity, physical function, and general health. We used multiple imputation to replace these data to include all patients in outcome analyses. Third, we had incomplete data on care ratings, and fewer HaH patients completed the HCAHPS than did controls. We are unable to determine the direction of bias arising from the imbalance of missing data on ratings, but the consistent demon-

stration of high levels of satisfaction among HaH patients compared with inpatients suggests that results may not be heavily influenced by nonresponse. Fourth, the sample (n = 507) may have been too small to detect meaningful and statistically significant differences for some outcomes.

Conclusions

Among patients with acute medical illness requiring inpatient-level care, HaH care bundled with a 30-day postacute transitional care episode compared with traditional inpatient care was associated with shorter LOS; lower rates of readmission, ED visits, and SNF admissions; and better ratings of care. Although this was an observational study, these findings are consistent with those of a Cochrane review of randomized trials of HaH services,[3] and they informed the unanimous decision of the PTAC to recommend full implementation of a HaH APM.[9] As health care evolves through a shift in focus to value and patient-centeredness, the HaH program may find increasing appeal among health care systems. The US Department of Health and Human Services could facilitate adoption and implementation of HaH services by approving the HaH APM recommended by the PTAC in September 2017.[9]

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Study concept and design: All authors.
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Invited Commentary

Hospital-at-Home Care Programs—Is the Hospital of the Future at Home?

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Medicare continues to lead the national effort to improve health care value by reforming how clinicians and hospitals are paid. Participation in Medicare's prominent alternative payment models, such as accountable care organizations (ACOs) and bundled payments, has been associated with some promising early results.[1-3] Under new incentives created by the 2015 Medicare Access and CHIP Reauthorization Act, engagement in these and other value-based payment models will continue to increase.

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Recognizing the need for greater diversity in value-based payment approaches, the Medicare Access and CHIP Reauthorization Act also created the Physician-Focused Payment Model Technical Advisory Committee (PTAC), an independent group charged with evaluating new payment models proposed by stakeholders and making recommendations about their merits to the secretary of the US Department of Health and Human Services.[4]

In this issue of *JAMA Internal Medicine*, Federman et al[5] describe an evaluation of the hospital-at-home (HaH) program at Mount Sinai Health System, originally funded in 2014 by the Center for Medicare and Medicaid Innovation to test the impact of hospital care at home plus 30 days of postacute care. The authors also describe a payment model for the HaH program that they proposed to the PTAC. The program evaluation demonstrates that, between 2014 and 2017, patients receiving HaH care had better utilization outcomes (eg, a 7-percentage-point reduction in readmissions and 9-percentage-point reduction in skilled nursing facility admissions) and patient experience ratings compared with control-group patients admitted to the traditional hospital. Study strengths include the relatively large number of eligible clinical conditions (up to 19 conditions representing 65 different diagnosis-related groups) and the inclusion of the postacute period in the scope of service. Cost outcomes were also included and analyzed by a consulting firm using actuarial, not quasiexperimental, methods.

Results from the Mount Sinai program did not consistently corroborate those from prior studies, perhaps due to heterogeneity in several dimensions of HaH programs (eg, design, target clinical populations). Some positive outcomes, such as the average length of stay and changes in patient satisfaction, mirrored those observed in other programs.[6,7] In contrast, other work has not demonstrated lower readmission rates.[8] Federman et al[5] also did not evaluate mortality or long-term outcomes. A recent, small, randomized clinical trial of another HaH program reported some positive findings, and results from a larger follow-up are expected soon.[9]

Unfortunately, an independent evaluation of the Mount Sinai program planned by Medicare has been complicated by concerns about sample size and the ability to identify a valid control group. The challenge of valid controls may arise from the fact that the program selected patients in part based on patient preferences, which could be highly correlated with study outcomes. For example, patients who preferred traditional hospitalization rather than HaH services may have had less social support, thereby increasing their likelihood of requiring readmission or referral to skilled nursing facilities. Additionally, there were clinical differences between the HaH and control groups. Urinary tract infection was more frequent in the HaH group, while congestive heart failure was more frequent in the control group. These 2 conditions can have very different trajectories, management strategies, and care utilization patterns in the acute and postacute settings.

Nonetheless, the authors were able to use the Mount Sinai HaH experience to develop and submit a bundled payment model proposal, called HaH-Plus, to the PTAC in 2017.[10] As proposed, HaH-Plus steps outside of the traditional ACO and bundled payment paradigms by fundamentally reimagining the definition of acute hospital care and payment. In conjunction with technological advancements to deliver high-acuity care outside of the hospital, such a model could have far-reaching implications for care delivery.

The HaH-Plus proposal also raises several important clinical and policy issues that need to be addressed before HaH programs (and the payment models to support them) could be implemented more broadly. First, because a payment model such as HaH-Plus would provide clear incentives to shift patients from hospital to home, quality and safety considerations are paramount. Standards and requirements, similar to