Original Investigation | HEALTH CARE REFORM

Home-Based Primary Care and the Risk of Ambulatory Care–Sensitive Condition Hospitalization Among Older Veterans With Diabetes Mellitus

Samuel T. Edwards, MD; Julia C. Prentice, PhD; Steven R. Simon, MD, MPH; Steven D. Pizer, PhD

IMPORTANCE Primary care services based at home have the potential to reduce the likelihood of hospitalization among older adults with multiple chronic diseases.

OBJECTIVE To characterize the association between enrollment in Home-Based Primary Care (HBPC), a national home care program operated by the US Department of Veterans Affairs (VA), and hospitalizations owing to an ambulatory care–sensitive condition among older veterans with diabetes mellitus.

DESIGN AND SETTING Retrospective cohort study. Patients admitted to VA and non-VA hospitals were followed up from January 1, 2006, through December 31, 2010.

PARTICIPANTS Veterans 67 years or older who were fee-for-service Medicare beneficiaries, were diagnosed as having diabetes mellitus and at least 1 other chronic disease, and had at least 1 admission to a VA or non-VA hospital in 2005 or 2006.

EXPOSURES Enrollment in HBPC, defined as a minimum of 2 HBPC encounters during the study period.

MAIN OUTCOMES AND MEASURES Admission to VA and non-VA hospitals owing to an ambulatory care–sensitive condition, as measured by the Agency for Healthcare Research and Quality's Prevention Quality Indicators in VA medical records and Medicare claims. Outcomes were analyzed using distance from the veteran's residence to a VA facility that provides HBPC as an instrumental variable.

RESULTS Among 56 608 veterans, 1978 enrolled in HBPC. These patients were older (mean age, 79.1 vs 77.1 years) and had more chronic diseases (eg, 59.2% vs 53.5% had congestive heart failure). Multivariable predictors for HBPC enrollment included paralysis (odds ratio [OR], 2.11; 95% CI, 1.63-2.74), depression (OR, 1.99; 95% CI, 1.70-2.34), congestive heart failure (OR, 1.36; 95% CI, 1.17-1.58), and distance from the nearest HBPC-providing VA facility (OR, 0.59; 95% CI, 0.50-0.70 for >10-30 vs <5 miles). After controlling for selection using an instrumental variable analysis, HBPC was associated with a significant reduction in the probability of experiencing a hospitalization owing to an ambulatory care–sensitive condition (hazard ratio, 0.71; 95% CI, 0.57-0.89), with an absolute reduction in the probability of hospitalization of 5.8% in 1 year.

CONCLUSIONS AND RELEVANCE Home-Based Primary Care is associated with a decreased probability of ambulatory care–sensitive condition hospitalization among elderly veterans with diabetes mellitus. In accountable care models, HBPC may have an important role in the management of older adults with multiple chronic diseases.

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Author Affiliations: Author affiliations are listed at the end of this article.

Corresponding Author: Samuel T. Edwards, MD, Section of General Internal Medicine, Veterans Affairs Boston Healthcare System, 150 S Huntington Ave, Bldg 9 (Mail Stop 152G), Boston, MA 02130 (samuel.edwards@va.gov).

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Older adults with multiple chronic diseases are frequently hospitalized owing to fragmented and ineffective outpatient care.[1-3] In 2010, hospitalization of adults 65 years or older with 2 or more chronic diseases cost Medicare more than $100 billion.[4] As the number of older Americans increases,[5] hospital care for older adults will account for a growing share of health care spending. Diabetes mellitus (DM) and DM-related cardiovascular diseases are common conditions in which appropriate ambulatory management can prevent hospitalization.[6-9]

Increasing policy interest exists for reducing preventable hospitalizations through models of comprehensive, longitudinal, and coordinated home care.[10-14] For example, the Independence at Home Demonstration in the Affordable Care Act[15] is a pilot program of multidisciplinary home care that targets Medicare beneficiaries with 2 or more chronic diseases and a recent hospitalization. An established model for such programs is the Veterans Affairs (VA) Home-Based Primary Care (HBPC), which targets veterans with limited mobility, multiple comorbidities, or recurrent emergency department visits and hospitalizations. Early studies[16,17] of HBPC showed reductions in subsequent hospitalization, while other investigations demonstrated mixed effects on rates of hospitalization in different subgroups.[18]

Given increasing interest in the HBPC care model within Medicare, we examined the effect of HBPC enrollment on the probability of having a hospitalization owing to an ambulatory care–sensitive condition (ACSC). To help inform policy makers about the value of HBPC, we studied a population of VA patients targeted by the Independence at Home Demonstration program, specifically patients diagnosed as having 2 or more chronic diseases and having a recent hospitalization.

Methods

The VA Boston Healthcare System Institutional Review Board approved the study protocol, with the requirement of informed consent waived. Home-Based Primary Care is comprehensive, longitudinal care provided by a physician-supervised interdisciplinary team of VA staff in the homes of veterans with complex, chronic, disabling disease for whom routine clinic-based care is not effective.[19] Enrollment criteria for the HBPC program are focused on veterans with various complex conditions requiring coordinated interventions who are high health care users. Targeted veterans typically have 1 or more of the following diagnoses: DM, AIDS, cancer, end-stage liver disease, coronary artery disease, congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), and neurologic disease (Parkinson disease, amyotrophic lateral sclerosis, multiple sclerosis, stroke, or dementia). Care is delivered by an interdisciplinary team of physicians, nurses, social workers, psychologists, rehabilitation therapists, dieticians, and pharmacists. Teams typically meet weekly to develop care plans and arrange appropriate longitudinal home care services.

Study Design and Data Sources

We performed a national retrospective cohort study of HBPC use in older veterans with DM. We used outpatient visit, hospitalization, and pharmacy VA data, as well as Medicare claims, because VA patients often use non-VA facilities, particularly for urgent hospitalizations.[20]

Cohort

We identified all patients who received a VA prescription for DM medication (metformin, any sulfonylurea, any thiazolidinedione, or any formulation of insulin) in 2005 or 2006. We considered the calendar year in which they filled this prescription the baseline year and identified demographics and coexisting conditions from VA and Medicare claims during this year (eFigure in the Supplement). We included veterans 67 years or older who were fee-for-service Medicare beneficiaries and had at least 1 hospitalization in the baseline year. In addition to DM, patients were required to have at least 1 other chronic disease (as listed above) to match the HBPC and Independence at Home Demonstration entry criteria. Patients also had to primarily use a VA medical center that offered HBPC, defined as the VA medical center where they filled their DM prescriptions. Patients were excluded if they lived farther than 500 miles from the nearest VA facility that provides HBPC.

Home-Based Primary Care

We specified the follow-up period as starting at the end of the baseline year (January 1, 2006, or January 1, 2007) and ending on December 31, 2010 (eFigure in the Supplement). We defined HBPC enrollment as a minimum of 2 HBPC encounters during this follow-up period, with the first HBPC encounter occurring within 6 months of the baseline year to ensure that the baseline-measured comorbidities were current at the time of HBPC enrollment. As additional sensitivity analyses, we tested our models using definitions of HBPC enrollment of 1, 3, and 4 HBPC encounters to ensure that the requirement of at least 2 visits did not bias our results. We also tested our models by excluding the first 6 follow-up months among non-HBPC patients to ensure that the 6-month enrollment period did not result in significant immortal time bias.

Risk Adjustment Covariates

Additional control variables computed during the baseline year included patient age, sex, race/ethnicity, and VA service connection status (ie, the presence of disability incurred during military service), which can affect VA benefit eligibility. Comorbidities include 29 indicators for physical and mental health conditions following the methods by Elixhauser et al[21] and 8 indicator variables for the components of the Diabetes Complications Severity Index by Young et al.[22]

Outcome

Our outcome of interest was hospitalization for conditions that could potentially be prevented with timely and appropriate ambulatory care. We used the Agency for Healthcare Research and Quality's Prevention Quality Indicators.[23,24] We analyzed admissions to VA and non-VA hospitals owing to an ACSC in VA and Medicare claims during the follow-up period (eFigure in the Supplement).

Instrumental Variable Analysis

A primary threat to the validity of our analysis is confounding bias. Specifically, patients who enroll in HBPC are likely older and have more coexisting conditions and other unmeasured characteristics that increase the risk of hospitalization. For instance, patients who enroll in HBPC may have more limited mobility or a higher severity of illness that cannot be captured in administrative data. For this reason, we selected an instrumental variable approach for our analysis. This approach identifies differences in treatment that are plausibly random if the instrumental variable (or instrument) predicts exposure to treatment and is unrelated to patient risk and other confounders.[25] The first stage of an instrumental variable analysis isolates the variation in treatment owing to the instrument, and the second stage then estimates the association between this variation in treatment and outcomes. The validity of the approach depends on the strength of the instrument's association with treatment status, the effective randomness of the instrument in relation to risk factors for the outcome, and a lack of independent effect of the instrument on the outcome. Estimates from an instrumental variable analysis reflect the effect of treatment on the marginal patient for whom the instrument is the deciding factor.

As our instrument, we used distance from each veteran's primary residence to the nearest VA facility that provides HBPC because distance from the patient residence to the relevant treatment facility has been used successfully in prior instrumental variable analyses.[26,27] We hypothesized that this distance would be strongly associated with the treatment of interest (HBPC) but effectively random in regard to other risks of hospitalization. While distance to the nearest VA facility has been shown to be associated with admission to a VA hospital,[20,28] we hypothesized that distance to the nearest HBPC-providing VA facility would not be associated with admission to either a VA or non-VA hospital.

To validate our instrument, we initially examined patient characteristics by the median distance from the veteran's residence to the nearest HBPC-providing VA facility to determine if they are randomly distributed. To further validate our instrument, we used a prespecified falsification test.[29] We examined the association between distance to the nearest HBPC-providing VA facility and hospitalization owing to an ACSC in patients who receive care at a VA facility that does not provide HBPC. Because they are not at risk of receiving HBPC, this allows us to test whether an independent association exists between distance to the nearest HBPC-providing VA facility and hospitalizations for ACSCs, which would indicate that our instrument is invalid.

Statistical Analysis

Outcomes were analyzed using a 2-stage discrete time survival model with an instrumental variable. In this method, the unit of analysis is the person-month, and patients are censored after enrollment in Medicare Advantage or at death. The instrumental variable approach estimates a pair of simultaneous equations, first for treatment (HBPC) and second for outcome (hospitalization owing to an ACSC). The first stage is a logistic regression that estimates the odds of HBPC enrollment in a given month based on distance from the veteran's residence to the HBPC-providing VA facility and other covariates. The second stage is a complementary log-log regression that estimates the hazard of an ACSC hospitalization over time, accounting for unobserved confounding from the first stage. Home-Based Primary Care is treated as a time-dependent covariate, while other patient factors are not. Month fixed effects were included to account for seasonal changes in HBPC enrollment and hospitalization during a given calendar year, and year fixed effects were included to account for secular trends. The VA medical center was also included as a fixed effect to account for different likelihoods of HBPC enrollment and hospitalization associated with the use of different VA medical centers. To determine marginal effects at specific intervals, an analogous second-stage logistic regression was performed. Because the outcome equations were nonlinear, we used the 2-stage residual inclusion technique for instrumental variable estimation (eMethods in the Supplement).[30,31] As an additional sensitivity analysis, we performed a typical 1-stage multivariable complementary log-log regression using HBPC as a predictor and hospitalization owing to ACSCs as the outcome (eTable in the Supplement). Analyses were performed using statistical software (STATA version 12.0; StataCorp LP).[32]

Results

Patient Characteristics

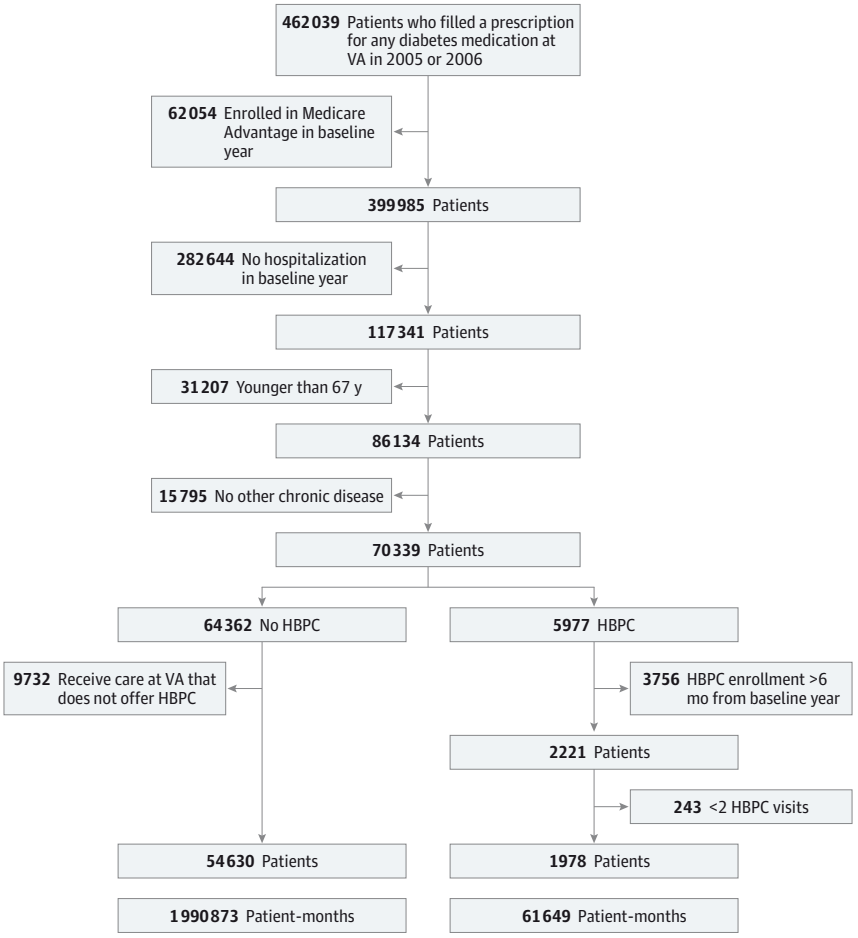
We identified 56 608 veterans with 2 052 522 follow-up person-months for analysis. Of these patients, 1978 enrolled in HBPC, and 54 630 did not (**Figure**). The HBPC patients were older (mean age, 79.1 vs 77.1 years) and more often of black race/ethnicity (20.8% vs 10.9%) (**Table 1**). The HBPC patients had higher DM severity (mean Diabetes Complications Severity Index, 4.8 vs 4.2) and more coexisting conditions, including CHF (59.2% vs 53.5%), COPD (57.8% vs 55.0%), chronic kidney disease (32.2% vs 27.9%), and paralysis (10.6% vs 4.8%). The HBPC patients also had a higher prevalence of mental illness, including psychosis (24.6% vs 13.7%) and depression (32.6% vs 18.3%). Non-HBPC patients were more likely to have cancer (4.3% vs 2.8% for metastatic cancer and 34.6% vs 30.2% for solitary tumor without metastasis). The HBPC patients had a shorter distance from the nearest HBPC-providing VA facility (median, 9.1 vs 29.6 miles) and spent more days in a hospital during the baseline year (median, 13.0 vs 8.0 days).

The proportion of patients who experienced at least 1 hospitalization in 1 year owing to ACSC conditions among HBPC patients (35.4%) was higher than that among non-HBPC patients (22.0%) (Table 1). This suggests significant confounding and reinforces the need for an analytic method that accounts for observed and unobserved confounding.

Predictors of HBPC Enrollment

Older patients (odds ratio [OR], 1.07 per year; 95% CI, 1.06-1.08 per year) and patients of black race/ethnicity (OR, 1.76; 95% CI, 1.45-2.13) were more likely to be enrolled in HBPC (**Table 2**). Neurologic comorbidities were strong predictors of HBPC en-

Figure. Cohort Development of Veterans With Diabetes Mellitus Eligible for HBPC



HBPC indicates Home-Based Primary Care; VA, Veterans Affairs facility.

rollment (OR, 2.11; 95% CI, 1.63-2.74 for paralysis and OR, 1.23; 95% CI, 1.03-1.48 for other neurologic disorders), as were cardiovascular comorbidities (eg, OR, 1.36; 95% CI, 1.17-1.58 for CHF and OR, 1.35; 95% CI, 1.03-1.71 for pulmonary circulatory disorder) and mental health comorbidities (eg, OR, 1.99; 95% CI, 1.70-2.34 for depression and OR, 1.42; 95% CI, 1.18-1.70 for psychosis). Patients with nonmetastatic cancer were less likely to enroll in HBPC (OR, 0.78; 95% CI, 0.67-0.91). Distance from the HBPC-providing VA facility was a strong negative predictor of HBPC enrollment. The farther the veteran's residence was from the HBPC-providing VA facility, the less likely he or she was enrolled in HBPC (eg, OR, 0.59; 95% CI, 0.50-0.70 for 10-30 vs <5 miles and OR, 0.21; 95% CI, 0.16-0.27 for 30-50 vs <5 miles).

Validation of the Instrument

Although we cannot directly test the validity of distance to the nearest HBPC-providing VA facility as an instrument, we can assess its association with observed confounders. The last 3 columns of Table 1 list patient characteristics by the median distance from the nearest HBPC-providing VA facility. As seen when comparing the difference in the last column vs the difference in column 3, the instrument balances the prevalence of known confounders. For example, 32.6% of patients enrolled in HPBC had depression compared with 18.3% of patients not enrolled in HPBC. When patients were assigned to 2 groups based on their being below or at or above the median distance to the nearest HBPC-providing VA facility, approximately 19% of patients in each group had depression. Fewer systematic differences were observed between groups than were observed between HBPC patients and non-HBPC patients, and differences were smaller. Patients who lived farther from a facility offering HBPC and patients who lived closer to a facility offering HBPC had similar DM severity and similar prevalence of pulmonary circulatory disorder, obesity, blood loss anemia, and depression (Table 1). Furthermore, while the proportion of HBPC patients who had a hospitalization owing to an ACSC in 1 year was higher than that among non-HBPC patients, the proportion of patients who had a hospitalization owing to an ACSC in 1 year is balanced by the median distance from the nearest HBPC-providing VA facility, suggesting that distance effectively randomizes the risk of hospitalization.

To further validate our instrument, we performed logistic regression to examine the association between distance to the nearest HBPC-providing VA facility and hospitalizations ow-

Table 1. Patient Characteristics by HBPC Use and by the Median Distance From an HBPC-Providing VA Facility

Variable	No HBPC (n = 54 630)	HBPC (n = 1978)	Difference	Distance From HBPC < 28 Miles (n = 28 201)	Distance From HBPC ≥ 28 Miles (n = 288 407)	Difference
	%					
Age, mean, y	77.1	79.1	2.0	77.3	77.0	−0.3
Male sex	98.5	97.4	−1.1	98.2	98.8	0.6
Race/ethnicity						
White	86.2	76.1	−10.1	81.2	90.4	9.2
Black	10.9	20.8	9.9	15.8	6.7	−9.1
Other	3.0	3.1	0.1	3.0	2.9	−0.1
Diabetes Complications Severity Index, mean	4.2	4.8	0.6	4.3	4.2	−0.1
Congestive heart failure	53.5	59.2	5.7	52.5	54.8	2.3
Pulmonary circulatory disorder	6.4	7.9	1.5	6.5	6.5	0.0
Paralysis	4.8	10.6	5.8	5.4	4.5	−0.9
Other neurologic disorder	16.5	22.1	5.6	17.2	16.1	−1.1
Chronic obstructive pulmonary disease	55.0	57.8	2.8	52.2	58.0	5.8
Chronic kidney disease	27.9	32.2	4.3	29.4	26.8	−2.6
Liver disease	4.1	4.2	0.1	4.5	3.7	−0.8
Metastatic cancer	4.3	2.8	−1.5	4.4	4.1	−0.3
Solitary cancerous tumor without metastasis	34.6	30.2	−4.4	36.1	32.8	−3.3
Obesity	19.4	21.0	1.6	19.2	19.8	0.6
Weight loss	7.9	12.2	4.3	8.5	7.5	−1.0
Fluid or electrolyte imbalance	36.8	45.7	8.9	37.8	36.4	−1.4
Blood loss anemia	5.7	4.3	−1.4	5.5	5.7	0.2
Deficiency anemia	42.3	48.9	6.6	44.2	40.9	−3.3
Alcohol abuse	3.7	4.2	0.5	4.2	3.2	−1.0
Drug abuse	1.0	1.1	0.1	1.2	0.9	−0.3
Psychosis	13.7	24.6	10.9	15.7	12.4	−3.3
Depression	18.3	32.6	14.3	19.0	18.6	−0.4
Distance from HBPC-providing VA facility, median, miles	29.6	9.1	−20.5	10.0	55.3	45.3
Inpatient days in baseline year, median	8.0	13.0	5.0	9.0	8.0	−1.0
≥1 Hospitalizations from an ACSC in 1 y	22.0	35.4	13.4	22.2	22.5	0.3

Abbreviations: ACSC, ambulatory care–sensitive condition; HBPC, Home-Based Primary Care; VA, Veterans Affairs.

ing to ACSCs in patients who primarily used a VA facility that did not provide HBPC and hence were not at risk of HBPC enrollment. We observed no significant association between distance to the nearest HBPC-providing VA facility and ACSC hospitalizations in this population. The ORs (95% CIs) among 356 653 person-months for the distance from an HBPC-providing VA facility were as follows: 1 [Reference] for less than 5 miles, 1.02 (0.86-1.20) for 5 to 10 miles, 1.06 (0.92-1.23) for greater than 10 to 30 miles, 1.14 (0.98-1.32) for greater than 30 to 50 miles, 1.02 (0.88-1.19) for greater than 50 to 100 miles, and 1.16 (0.96-1.38) for greater than 100 miles. In addition to demographics and comorbidities, the model included the Diabetes Complications Severity Index, month and year, VA service connection status, and VA facility.

ACSC Hospitalizations

The effects of HBPC and selected covariates on ACSC hospitalizations are summarized in **Table 3**. Home-Based Primary Care was associated with a significant reduction in the probability of having 1 or more hospitalizations owing to an ACSC over time (hazard ratio [HR], 0.71; 95% CI, 0.57-0.89). The baseline probability of 1 or more hospitalizations owing to an ACSC in 12 months for the entire cohort was 28.2%. Hence, the isolated effect of HBPC was to reduce this baseline probability from 28.2% to 22.4%, a 5.8% absolute reduction in hospitalization for ACSCs. Other significant predictors of ACSC hospitalizations included CHF (HR, 1.83; 95% CI, 1.78-1.87), COPD (HR, 1.68; 95% CI, 1.64-1.72), pulmonary circulatory disorder (HR, 1.22; 95% CI, 1.17-1.27), depression (HR, 1.15; 95% CI, 1.11-1.18), and metastatic cancer (HR, 1.14; 95% CI, 1.06-1.22]). Nonmetastatic cancer was inversely associated with hospitalization owing to an ACSC (HR, 0.94; 95% CI, 0.92-0.96), as was weight loss (HR, 0.95; 95% CI, 0.91-1.00).

Discussion

In this national study of the effect of VA HBPC among veterans with DM, we found that HBPC enrollment was associated with a 5.8% absolute decrease in the probability of ACSC hos-

Table 2. Selected Multivariable Predictors of HBPC Enrollment[a]

Variable	Odds Ratio (95% CI) Among 2 049 838 Patient-months
Age, per year	1.07 (1.06-1.08)
Male sex	0.97 (0.61-1.53)
Race/ethnicity	
Black	1.76 (1.45-2.13)
Other	0.98 (0.65-1.50)
Diabetes Complications Severity Index	1.12 (1.08-1.16)
Congestive heart failure	1.36 (1.17-1.58)
Pulmonary circulatory disorder	1.33 (1.03-1.71)
Paralysis	2.11 (1.63-2.74)
Other neurologic disorder	1.23 (1.03-1.48)
Chronic obstructive pulmonary disease	1.30 (1.14-1.49)
Chronic kidney disease	0.89 (0.75-1.04)
Liver disease	0.92 (0.65-1.32)
Metastatic cancer	1.04 (0.67-1.62)
Solitary cancerous tumor without metastasis	0.78 (0.67-0.91)
Obesity	1.44 (1.23-1.69)
Weight loss	1.17 (0.94-1.47)
Fluid or electrolyte imbalance	1.19 (1.03-1.37)
Blood loss anemia	0.75 (0.53-1.07)
Deficiency anemia	1.20 (1.05-1.39)
Alcohol abuse	0.64 (0.45-0.91)
Drug abuse	0.66 (0.35-1.23)
Psychosis	1.42 (1.18-1.70)
Depression	1.99 (1.70-2.34)
Distance from HBPC-providing VA facility, miles	
<5	1 [Reference]
5 to 10	0.85 (0.71-1.02)
>10 to 30	0.59 (0.50-0.70)
>30 to 50	0.21 (0.16-0.27)
>50 to 100	0.10 (0.07-0.14)
>100	0.03 (0.01-0.09)

Abbreviation: HBPC, Home-Based Primary Care.

[a] Other factors in the model include the Elixhauser comorbidities, cardiac arrhythmia, valve disease, hypertension, peptic ulcer disease, AIDS, rheumatoid arthritis, and hypothyroidism, as well as month, year, service connection, and Veterans Affairs (VA) facility.

Table 3. Change in the Probability of 1 or More Hospitalizations Owing to an ACSC Associated With HBPC Enrollment and Other Patient Characteristics After Controlling for Unobserved Confounding[a]

Variable	Hazard Ratio (95% CI)	Absolute Change in the Probability of Hospitalization in 1 Year, % (95% CI)
HBPC	0.71 (0.57 to 0.89)	−5.8 (−9.3 to −2.3)
Age, per year	1.01 (1.01 to 1.02)	0.3 (0.2 to 0.3)
Male sex	1.07 (0.97 to 1.18)	1.5 (−0.4 to 3.3)
Black race/ethnicity	1.16 (1.13 to 1.21)	3.4 (2.6 to 4.2)
Other race/ethnicity	1.13 (1.06 to 1.21)	2.5 (0.9 to 3.9)
Diabetes Complications Severity Index	1.04 (1.03 to 1.04)	0.7 (0.6 to 0.8)
Congestive heart failure	1.83 (1.78 to 1.87)	12.0 (11.4 to 12.5)
Pulmonary circulatory disorder	1.22 (1.17 to 1.27)	4.4 (3.4 to 5.4)
Paralysis	1.06 (1.00 to 1.11)	1.2 (0.1 to 2.4)
Other neurologic disorder	1.01 (0.98 to 1.04)	0.3 (−0.4 to 1.0)
Chronic obstructive pulmonary disease	1.68 (1.64 to 1.72)	10.1 (9.6 to 10.6)
Chronic kidney disease	0.98 (0.95 to 1.00)	−0.4 (−1.0 to 0.2)
Liver disease	0.98 (0.92 to 1.04)	−0.4 (−1.7 to 0.9)
Metastatic cancer	1.14 (1.06 to 1.22)	2.8 (1.1 to 4.4)
Solitary cancerous tumor without metastasis	0.94 (0.92 to 0.96)	−1.3 (−1.8 to −0.7)
Obesity	0.97 (0.95 to 1.00)	−0.6 (−1.2 to 0.0)
Weight loss	0.95 (0.91 to 1.00)	−1.0 (−1.9 to −0.1)
Fluid or electrolyte imbalance	1.18 (1.15 to 1.21)	3.5 (3.0 to 4.1)
Blood loss anemia	1.03 (0.98 to 1.08)	0.6 (−0.5 to 1.7)
Deficiency anemia	1.05 (1.03 to 1.08)	1.1 (0.5 to 1.6)
Alcohol abuse	0.98 (0.92 to 1.04)	−0.4 (−1.7 to 0.8)
Drug abuse	1.10 (1.00 to 1.21)	2.2 (0.0 to 4.3)
Psychosis	1.01 (0.98 to 1.04)	0.3 (−0.4 to 1.0)
Depression	1.15 (1.11 to 1.18)	3.0 (2.4 to 3.7)

Abbreviations: ACSC, ambulatory care–sensitive condition; HBPC, Home-Based Primary Care.

[a] Other factors in the model include the Elixhauser comorbidities, cardiac arrhythmia, valve disease, hypertension, peptic ulcer disease, AIDS, rheumatoid arthritis, and hypothyroidism, as well as month, year, service connection, and Veterans Affairs facility.

pitalization in 1 year. This effect is similar in magnitude to that of having a serious medical condition such as COPD or pulmonary hypertension. In addition, we determined that predictors of HBPC enrollment included paralysis, the medical conditions CHF and COPD, and mental health disorders such as psychosis and depression, suggesting that these conditions may be important targets for home care models.

Consensus is growing that our current health system does not meet the needs of older adults with multiple chronic diseases.[1,14,33] Current incentives foster uncoordinated care, high hospital use, and recurrent medical intervention. New models of chronic care could deliver more cost-effective, patient-centered care by integrating patient perspectives, recognizing the challenge of living with disability, integrating long-term services and support, and focusing on maintaining quality of life and independence. Home-Based Primary Care represents one approach to providing a comprehensive suite of services tailored to the needs of older homebound patients. Other care models for older adults include the Program of All-Inclusive Care for the Elderly,[34,35] based on centrally provided adult day health, and Geriatric Resources for the Care of Elders,[36,37] which also provides interdisciplinary team-based care in the home. While the goals of such comprehensive care models are multidimensional, our study demonstrated that HBPC succeeds in the important dimension of hospitalization owing to an ACSC.

This finding has important policy implications with the ongoing implementation of the Patient Protection and Affordable Care Act. Under the act, hospitals and physician groups are increasingly responsible for overall cost of care. In the Medicare Hospital Readmissions Reduction Program, hospitals are

penalized for readmission of a patient within 30 days for selected medical conditions.[38] Also, accountable care organizations are eligible to share in cost savings, if they can reduce the costs of caring for their attributed population below a preset target based on historical spending.[39] Because a small proportion of patients are typically responsible for a large proportion of hospitalizations and costs, these programs create strong incentives for hospitals and physician groups to focus efforts on reducing hospitalization rates of their highest-risk patients. Home-Based Primary Care may offer a tool to achieve this goal.

Our work is consistent with prior investigations of HBPC and extends those findings in several ways. Early investigations of VA HBPC were small, pre-post analyses.[16] The challenge with this study design is that results may be driven by regression to the mean. In other words, if a patient is enrolled in a new care model at a peak of use, it is likely that utilization will subsequently decrease, regardless of the type of care received. In our study, we had a contemporaneous control group with which we were able to compare HBPC patients, and we used an instrumental variable approach that enabled us to control for patient selection. The largest study[18] of HBPC to date was a randomized trial that showed mixed results regarding reductions in hospitalization in different subgroups. Some significant differences exist between that trial and our present work. First, our study focused on a specific patient population targeted by the Medicare Independence at Home Demonstration program, specifically patients with 2 or more chronic diseases and a recent hospitalization. Overall, we studied a cohort that was older and had higher prevalence of chronic diseases such as CHF and COPD than the prior study.[18] Second, the prior trial tested the efficacy of the HBPC care model in 4 VA medical centers, while our work describes the effectiveness of the VA HBPC program nationally in all VA facilities that offer HBPC. While more heterogeneity likely exists in our study in the way the HBPC program is administered, it demonstrates the effectiveness of a national policy of longitudinal home care, rather than the efficacy of implementing a care model in a few medical centers.

Our study also used distance to the nearest relevant VA facility as an instrumental variable to study the effect of a VA program on the use of care inside and outside of the VA. It is well recognized that many veterans use non-VA providers for a proportion of their care,[20] and results of studies[40,41] suggest that increased fragmentation of care between VA and non-VA sites is associated with lower quality of care. The implementation of the Patient Protection and Affordable Care Act has the potential to affect veterans' use of health care,[42] and this statistical technique could be used to study changes in VA, Medicare, or Medicaid policy on dual use of VA and non-VA services.

Our work has several limitations. First, as an observational study, unobserved confounding could be a threat to validity if unknown associations exist between our instrument and hospitalization owing to ACSCs. For instance, if a shorter distance to the nearest HBPC-providing VA facility is also associated with a higher density of hospitals, then this may be associated with a higher rate of hospitalization. Our demonstration of balanced patient factors by the median distance from an HBPC-providing VA facility and the negative falsification test result minimize this concern. Second, VA users are 95% male, have a lower mean socioeconomic status, and have a higher prevalence of certain conditions than the average Medicare beneficiary, which could limit the generalizability of our findings. Third, this is a study of a VA-specific care process. Given the efforts to implement similar care models within Medicare, the HBPC model has the potential to be applied more broadly. Fourth, our work does not demonstrate what elements of HBPC are responsible for this observed reduction in hospitalization, but this could be explored with further research.

Conclusions

In conclusion, among veterans with DM, one other chronic disease, and a recent hospitalization, enrollment in HBPC is associated with a 5.8% absolute reduction in the probability of an ACSC hospitalization in 1 year. Programs such as HBPC may have an important role in the cost-effective, patient-centered treatment of older adults.

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Author Affiliations: Section of General Internal Medicine, Veterans Affairs Boston Healthcare System, Boston, Massachusetts (Edwards, Simon); Massachusetts Veterans' Epidemiology Research and Information Center, Veterans Affairs Boston Healthcare System, Boston (Edwards); Harvard Medical School, Boston, Massachusetts (Edwards, Simon); Healthcare Financing and Economics, Veterans Affairs Boston Healthcare System, Boston, Massachusetts (Prentice, Pizer); Boston University School of Medicine and School of Public Health, Boston, Massachusetts (Prentice); Division of General Internal Medicine, Brigham and Women's Hospital, Boston, Massachusetts (Simon); Northeastern University, Boston, Massachusetts (Pizer).

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Study concept and design: Edwards, Simon, Pizer.
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Organization and Implementation Research, Bedford Veterans Affairs Hospital, Bedford, Massachusetts), J. Michael McWilliams, MD, PhD (Department of Health Care Policy, Harvard Medical School, Boston, Massachusetts), James Rudolph, MD (Geriatric Research Education and Clinical Center, Veterans Affairs Boston Healthcare System, Boston, Massachusetts), and Melissa Wachterman, MD, MPH (Section of General Internal Medicine, Veterans Affairs Boston Healthcare System, Boston, Massachusetts) reviewed an early draft of the manuscript. Donglin Li, MPH, at Healthcare Financing and Economics, Veterans Affairs Boston Healthcare System, Boston, Massachusetts, provided programming support.

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