

Original Article

Improving Value of Care for Older Adults With Advanced Medical Illness and Functional Decline: Cost Analyses of a Home-Based Palliative Care Program



Christina Y. Chen, MD, James M. Naessens, ScD, Paul Y. Takahashi, MD, Rozalina G. McCoy, MD, Bijan J. Borah, PhD, Lynn S. Borkenhagen, DNP, APRN, CNP, Ashley K. Kimeu, APRN, CNP, Ricardo L. Rojas, BA, Matt G. Johnson, MPH, Sue L. Visscher, PhD, Stephen S. Cha, MS, Bjorg Thorsteinsdottir, MD, and Gregory J. Hanson, MD

Division of Community Internal Medicine (C.Y.C., P.Y.T., R.G.M., B.T., G.J.H.), Mayo Clinic, Rochester, Minnesota; Certified Nurse Practitioners (L.S.B., A.K.K.), Mayo Clinic, Rochester, Minnesota; Division of Health Care Policy and Research (J.M.N., R.G.M., B.J.B.), Mayo Clinic, Rochester, Minnesota; Robert D. and Patricia E. Kern Center for the Science of Healthcare Delivery (J.M.N., B.J.B., M.G.J., S.L.V.), Mayo Clinic, Rochester, Minnesota; Division of Biomedical Statistics and Informatics (R.L.R., S.S.C.), Mayo Clinic, Rochester, Minnesota; and Mayo Center for Palliative Medicine (G.J.H.), Mayo Clinic, Rochester, Minnesota, USA

Abstract

Context. Identifying high-value health care delivery for patients with clinically complex and high-cost conditions is important for future reimbursement models.

Objectives. The objective of this study was to assess the Medicare reimbursement savings of an established palliative care homebound program.

Methods. This is a retrospective cohort study involving 50 participants enrolled in a palliative care homebound program and 95 propensity-matched control patients at Mayo Clinic in Rochester, Minnesota, between September 1, 2012, and March 31, 2013. Total Medicare reimbursement was compared in the year before enrollment with the year after enrollment for participants and controls.

Results. No significant differences were observed in demographic characteristics or prognostic indices between the two groups. Total Medicare reimbursement per program participant the year before program enrollment was \$16,429 compared with \$14,427 per control patient, resulting in \$2004 higher charges per program patient. In 12 months after program enrollment, mean annual payment was \$5783 per patient among participants and \$22,031 per patient among the matched controls. In the second year, the intervention group had a decrease of \$10,646 per patient; the control group had an increase of \$7604 per patient. The difference between the participant group and control group was statistically significant ($P < 0.001$) and favored the palliative care homebound program enrollees by \$18,251 (95% CI, \$11,268–\$25,234).

Conclusion. The Mayo Clinic Palliative Care Homebound Program reduced annual Medicare expenditures by \$18,251 per program participant compared with matched control patients. This supports the role of home-based palliative medicine in delivering high-value care to high-risk older adults. *J Pain Symptom Manage* 2018;56:928–935. © 2018 American Academy of Hospice and Palliative Medicine. Published by Elsevier Inc. All rights reserved.

Key Words

High-risk elder, homebound, palliative care

Introduction

Effectively caring for chronically ill and frail patients with complex comorbidities is a resource-intensive

task. In any year, the top 5% of the U.S. Centers for Medicare & Medicaid Services (CMS) beneficiaries with high costs account for roughly 50% of all health

Address correspondence to: Christina Y. Chen, MD, Division of Primary Care Internal Medicine, Mayo Clinic, 200 First St SW, Rochester, MN 55905, USA. E-mail: chen.christina@mayo.edu

Accepted for publication: August 16, 2018.

care spending.¹ About 50% of these expenditures will return to average levels in the next year after recovery from a discreet high-cost health event. Of the other frail patients, approximately 10% will die in the subsequent year.^{2,3} In addition, 40% of the patients will have persistently high-level spending (annual health care expenditures, $\geq \$17,500$ per person) because of chronic debilitating conditions such as dementia, frailty, functional dependency, multimorbidities, and mental illness.^{2,3} These persons have ongoing acute and long-term needs and high health care utilization. Yet, they often are not eligible for hospice and may desire selective life-extending therapies. They frequently rely on the acute care system, including emergency department (ED) visits and hospitalizations, to manage their illnesses—in part because they have limited function and no meaningful alternatives.⁴ A substantial fraction of this health care utilization is potentially preventable. Indeed, frail older adults with high-cost care account for nearly 45% of the total potentially preventable CMS spending.⁵ Moreover, high-intensity hospital-based treatment may be inconsistent with patient preferences in the medical setting of advanced illness and may contribute to patient suffering.^{6–8} Health care organizations have sought opportunities to improve the value and the patient centeredness of care for these heterogeneous and medically complex persons.

Home-based palliative care^{9–12} is an example of an innovative care delivery platform that can provide patient-centered care for those with serious and life-limiting illness and functional impairment, with emphasis on symptom management and improvement in quality of life. Unlike hospice programs, palliative homebound programs can offer selective life-extending therapy to patients who either desire them or are not predictably dying in the next six months. We previously have described a palliative care homebound program (PCHP) implemented within our health care delivery system that significantly decreased the number of hospitalizations (33% intervention vs. 92% control, $P < 0.001$) and length of hospital stay (reduced by 5.13 days) while effectively addressing advance care directives.¹³ These data were consistent with other published programs that reduced acute visits, length of hospital stays, and skilled nursing facility stays while meeting the patient's goals of care and decreasing overall health care expenditures.^{10–14} They provide reliable evidence of the positive effect of home palliative care on health outcomes and quality of care; yet, more work is needed to study the cost-effectiveness.¹⁵ Herein, we describe a cost analysis of the Medicare reimbursement savings of a home-based palliative care program implemented at Mayo Clinic. The PCHP used risk stratification methods to improve the value of care

provided to a persistently high-risk cohort of older homebound adults who incur high-cost care.

Methods

Study Design and Participants

This retrospective matched cohort study evaluated changes in estimated Medicare payments before and after enrollment of frail, older adults into the PCHP. It compared study patients with a propensity score-matched control group that received usual care. The study was carried out at Mayo Clinic in Rochester, Minnesota. The center's section of Employee and Community Health provides longitudinal primary care to persons residing within a local catchment area, Mayo Clinic employees, and primary medical support for 10 area skilled nursing facilities.

The study cohort involved 54 patients initially enrolled in PCHP between September 1, 2012, and March 31, 2013, as previously described.¹³ Each PCHP patient was propensity score-matched with two control patients identified through the electronic database for program eligibility but not enrolled because of program capacity. To obtain controls, all patients eligible for the Care Transitions Program (CTP) who were not enrolled in the PCHP program (excluding refusals) had medical record reviews and Lee mortality prognosis scores were calculated. The CTP is a preexisting program designed to provide transitional care to frail, older adults with high readmission risk scores in their home setting during critical points of transitions from different health care settings.¹⁶ Propensity scores matched using a "greedy" algorithm, balanced age, sex, program eligibility, and mortality prognosis index between the two cohorts. Demographic, utilization, economic, and follow-up mortality data were obtained from administrative electronic databases. Diagnostic and mortality risk scores were obtained from the EMR through manual extraction. The electronic data were verified, and calculation of mortality scores was checked twice for accuracy during the manual abstraction. DNR status was not used for matching; however, additional analysis was undertaken to determine the impact of DNR/DNI status on the results. Control patients continued their usual care and care coordination offered outside of program responsibilities. This study was approved by the institutional review board and follows requirements of the Strengthening the Reporting of Observational Studies in Epidemiology guidelines.

Palliative Care Homebound Program

The PCHP has been described in detail in a pilot study focused on its clinical outcomes.¹³ Briefly, it is a specialized palliative care service delivered to eligible primary care patients with advanced medical illness

and limited life expectancy. The program is administered by an interdisciplinary team (IDT) led by five certified palliative care physicians and two certified palliative care APRNs, in addition to several certified geriatricians and geriatric APRNs, social workers and community health workers, RN care coordinators, and pharmacists. At the time of enrollment, each patient is assigned to an IDT led by a palliative care physician. The IDT meets weekly for systematic case review to develop a care plan concordant with the wishes of the patient and the family. Scheduled and acute home visits are provided by the IDT physicians, APRNs, community health workers, and the primary care provider (PCP) if they so desire. In most circumstances, the PCP completely transfers care to the program IDT, remaining available as needed. On occasion, the care remains collaborative between PCP and IDT, though the vast majority of visits are still done in the home with an IDT member. Telephonic care coordination is provided by an RN member of the IDT. Care is focused on quality of life including protocols for symptom assessment (Edmonton Symptom Assessment Score), chronic disease evaluation and management, medication reconciliation, patient and caregiver illness education and contingency planning, sequential advance care planning, safety and mobility assessment, community resource liaison, and caregiver support. The IDT is responsible for daily direct care and care coordination with the PCP and consultative practices. This service is provided during Monday-to-Friday working business hours without night or weekend coverage.

Enrollment criteria are age ≥ 60 years; community dwelling; homebound, defined as taxing effort required to leave the home because of physical or cognitive limitations; and advanced medical illness defined by high utilization and a high four-year mortality risk using standardized risk assessment tools. Eligible patients had elder risk assessment (ERA) scores of greater than 15, and either four-year mortality score greater than 13 or a three-year mortality score greater than 5 as noted below.

1. ERA score greater than 15 that places patients in the upper decile for risk of hospitalization, ED visits, skilled nursing facility placement, and death in the coming two years¹⁷; AND
2. Lee four-year mortality index score greater than 13, predicting a 64% risk of death within four years¹⁸; OR
3. Carey three-year mortality index score >5 , predicting a 55% risk of death within three years.¹⁹

Patients were referred by the PCP either directly, or through our Care Transitions Program administered by the same IDT, or by the hospital Palliative Care Consulting Service. Patients were DNR/DNI at the

time of referral or as a consequence of the initial consultation and discussion of goals of care by the IDT. For those patients coming through our CTP, they typically have had several advance care planning discussions during their four to 12 weeks in the program.

Primary Outcome: Medicare Reimbursement

Estimated Medicare reimbursement was calculated using 2014 fee schedules based on services billed by Mayo Clinic, inclusive of the PCHP, for the 12 months before program enrollment through the 12 months after enrollment. Similar time frames were used for control patients. For each control, the analysis was started on the date that their matched PCHP patient met qualification criteria for the intervention. To be included in the analysis, cases and controls needed to have qualification dates within six months of each other. National Medicare fee schedules were used to estimate reimbursement for provider services (Part B), Medicare Severity Diagnosis-Related Group payments for inpatient hospital stays, and Ambulatory Payment Classification payments for hospital outpatient stays.

Data and Statistical Analysis

A “difference-in-differences” approach²⁰ was used to estimate and test the change before and after enrollment for program participants against the annual change in Medicare reimbursements for matched controls using a generalized linear model with a log-link and gamma distribution for the error term. CIs were based on bootstrapped standard errors. An additional model was developed to adjust for variables significantly different between cases and controls at baseline: congestive heart failure (CHF) and dementia. Additional analysis was done to determine the impact of DNR/DNI status. The previous performed analysis was repeated on the subset of matched sets where both the case and the control(s) were both DNR/DNI. The adjusted DID analysis was repeated on all cases, and controls and the DNR/DNI status was incorporated as an additional covariate. Descriptive data were produced, which show the pre-enrollment and postenrollment and difference data separately by DNR/DNI status. Survival was compared with log-rank test. Other baseline comparisons between patients and controls were based on two-sample t-test or Wilcoxon rank-sum test for skewed variables.

Results

Study Population

Of the 54 PCHP enrollees and 108 control patients eligible for inclusion in the study, four PCHP enrollees

and 13 controls were excluded because of subsequent denial by these patients for health record use in research (two enrolled patients and five controls); dates of matching more than six months apart (two enrolled patients and four controls); or loss of matching case to control in analysis (four controls). Their baseline characteristics are summarized in Table 1. Fifty patients enrolled in PCHP and 95 matched controls comprised the study population. The two groups were balanced in accordance with demographic characteristics, prognostic indices, and body mass index. Advance care planning was addressed for nearly all patients (96%) in the intervention group. As previously described,¹³ the PCHP group had a greater proportion with moderate-to-advanced dementia; the control group had more cases of CHF (62% vs. 40%). Inpatient and ED visits were adjusted for CHF and dementia severity (Table 2). The other comorbidities showed no differences between the two groups.

Annual Medicare Expenditures

During the year preceding enrollment, the PCHP cohort had greater health care use and Medicare payments than the matched control group. Total Medicare reimbursement per patient during the year before PCHP enrollment was \$16,429.29 compared with \$14,426.78 per control patient, for baseline charges that were nearly \$2003 more per PCHP patient (Table 3). In the 12 months after program enrollment, mean annual Medicare payment was \$5782.85 per PCHP patient compared with \$22,031.21 per control patient. These results show that the PCHP group

had a \$10,646.44 decrease per patient compared with the control group, which had a \$7604.43 increase per patient in the second year. After adjustment for differences between the two groups in rates of CHF and dementia, the difference in differences (DID) estimate of the mean health care expenditures between PCHP patients and control patients was statistically significant and favored the expenditures of PCHP enrollees by a mean (95% CI) of \$18,250.87 (\$11,267.60–\$25,234.13). This mean difference did not significantly change ($P > 0.05$) for the subset of patients ($N = 35$) and controls ($N = 49$) who were matched as DNR/DNI, with an adjusted DID mean estimate of \$18,010.21 (\$8996.42 to \$27,023.99) favoring the intervention group (Table 4). Most of the savings occurred in Medicare Part A, consistent with the reduction of hospitalization rates demonstrated by the program.¹³ In our subset, mean hospital days per year decreased from 9.9 to 6.6 days for PCHP enrollees and increased from 7.5 to 9.2 days for matched controls. Table 5 provides descriptive information on payments per site of care for PCHP patients and controls. Although most of the difference occurred among hospital inpatient services, both groups had payment decreases among the other sites of care.

Survival

Figure 1 shows the one-year survival curve for enrollees and controls of 56.0% and 71.6%, respectively. The difference in overall survival was significant ($P = 0.02$). The Kaplan-Meier estimated mean (95% CI) between groups was different at three months

Table 1
Baseline Patient Characteristics and Summary of Outcomes

Characteristic	Patients ^a (N = 145)		PValue
	Control Group (n = 95)	PCHP Group (n = 50)	
Age, mean (SD), yrs	86.7 (6.5)	87.4 (6.5)	0.58
Gender			0.92
Female	54 (56.8)	28 (56.0)	
Male	41 (43.2)	22 (44.0)	
ERA score, mean (SD)	19.5 (3.6)	18.2 (6.5)	.20
Lee four-year mortality index score, mean (SD)	16.1 (2.1)	16.4 (1.9)	.33
BMI, mean (SD)	26.9 (6.5)	24.7 (5.1)	.25
Resuscitation status (DNR or DNI)	49 (51.6)	48 (96.0)	<.001
Comorbid conditions			
Dementia			<.001
Advanced	6 (6.3)	19 (38.0)	
Moderate	23 (24.2)	23 (46.0)	
Mild	37 (38.9)	7 (14.0)	
None	29 (30.5)	1 (2.0)	
DM	28 (29.5)	17 (34.0)	.46
CHF	59 (62.1)	20 (40.0)	.01
Stroke	21 (22.1)	11 (22.0)	.78
COPD	32 (33.7)	14 (28.0)	.34
Cancer	15 (15.8)	7 (14.0)	.75
Advance care documentation	65 (66.3)	49 (96.0)	<.001

PCHP = palliative care homebound program; ERA = elder risk assessment; BMI = body mass index; DNR = do not resuscitate; DNI = do not intubate; DM = diabetes mellitus; CHF = congestive heart failure; COPD = chronic obstructive pulmonary disease.

^aValues are presented as number and percentage of patients unless specified otherwise.

Table 2
Inpatient and ED Visits Adjusted for Congestive Heart Failure and Dementia Severity

Visit	PCHP Group, Mean (SD)		Control Group, Mean (SD)	
	Before Enrollment	After Enrollment	Year 1	Year 2
Inpatient admit	2.22 (1.59)	1.42 (0.90)	2.04 (1.39)	2.26 (1.41)
Inpatient LOS	9.88 (8.06)	6.63 (6.73)	7.67 (6.82)	9.48 (7.70)
ED admit	1.44 (0.70)	1.31 (0.48)	1.82 (1.18)	1.28 (0.58)

ED = emergency department; PCHP = palliative care homebound program; LOS = length of stay.

but became parallel at six months. No substantial difference in survival was apparent in the subsequent six months.

Discussion

A PCHP for high-risk frail older adults reduced overall health care expenditures by 65% per patient per year. By contrast, propensity-matched patients who did not receive this intervention had a 53% increase in health care costs reflecting their predictably advancing illness.

Our program enrolled those with serious chronic disease who did not desire or were not eligible for hospice care, either because they desired certain life-extending interventions or because their life expectancy exceeded six months. The PCHP was efficiently administered by a highly specialized interdisciplinary team within a primary care division of an integrated health care delivery system, and thus, it can be generalized to other clinical settings and patient populations with similar resource.

To date, most PCHPs focus on patients in the last year of life. Brumley et al.¹⁰ studied 297 terminally ill patients with a life expectancy of 12 months or less, a hospital visit at least once within the previous year, and a score of 70% or less on the Palliative Performance Scale. Patients were randomly assigned to a PCHP that provided symptom relief and an array of support services rather than usual care. The average cost per day incurred by palliative care recipients (\$95.30) was significantly less than for group members receiving usual care (\$212.80) based on an internal health maintenance organization costing methodology.

Lustbader et al.¹² studied 651 homebound frail older adults with advanced chronic disease. Among the patients, 82 were enrolled in a homebound palliative medicine program (median duration enrollment, 56 days); the other 569 patients received usual care. The cost per patient during the final three months of life was \$12,000 less with home-based palliative care than usual care (\$20,420 vs. \$32,420; $P = 0.0002$). This difference was largely driven by a 35% reduction in Medicare Part A expenditure (\$16,892 vs. \$26,171; $P = 0.0037$). Similarly, Kerr et al.²⁰ reported on a home-based palliative care program through an open referral process, demonstrating cost savings in the last three months of life of \$6804 per member per month for the palliative care program vs. \$10,712 for usual care and greater hospice admission (70% vs. 25%). Finally, Cassel et al.²¹ analyzed the Sharp HealthCare transitions program using a matched cohort of 178 decedents enrolled for at least the last six months before death and 515 controls. They demonstrated that the program had a net reduction in costs per participant per month in the final six months of life that ranged from \$2690 for dementia to \$4258 for cancer, a reduction that was statistically significant only in the final two months and was associated with avoidance of hospitalization.

These studies emphasize cost savings in the last year of life and in early transition to hospice. Aldridge and Kelley¹ have demonstrated that interventions directed toward persons in their last year of life likely generate smaller cost savings than interventions that target beneficiaries with chronic conditions and functional limitations who have persistently high costs, given the

Table 3
Difference-in-Differences Analysis of Medicare Payments per Patient per Year Between PCHP and Control Groups

Group	Year 1, Mean (SD)	Year 2, Mean (SD)	Year 2 Minus Year 1, ^a Mean (SD)
PCHP ($n = 50$)	\$16,429.29 (\$17,858.99)	\$5782.85 (\$7208.20)	-\$10,646.44 (\$17,354.32)
Control ($n = 95$)	\$14,426.78 (\$14,402.09)	\$22,031.21 (\$17,134.58)	\$7604.43 (\$22,203.71)
Difference in Differences, PCHP Minus Control			
Adjustment	Mean	Bootstrap SE	95% CI
Unadjusted	-\$18,449.91	\$3569.09	-\$11,454.62 to -\$25,445.20
Adjusted by CHF and dementia	-\$18,250.87	\$3562.95	-\$11,267.60 to -\$25,234.13

PCHP = palliative care homebound program; CHF = congestive heart failure.

^aAfter enrollment minus before enrollment.

Table 4
Difference-in-Differences Analysis of Medicare Payments per Patient per Year Between PCHP and Control Groups Having DNR Status

Group	Year 1, Mean (SD)	Year 2, Mean (SD)	Year 2 Minus Year 1, ^a Mean (SD)
PCHP (<i>n</i> = 35)	\$17,792.22 (\$19,987.24)	\$6557.59 (\$7876.89)	−\$11,234.63 (\$19,428.55)
Control (<i>n</i> = 49)	\$13,899.72 (\$13,888.98)	\$20,675.29 (\$15,627.71)	\$6775.58 (\$20,765.75)
Difference in Differences, PCHP Minus Control			
Adjustment	Mean	Bootstrap SE	95% CI
Unadjusted	−\$18,010.21	\$4797.78	−\$8606.738 to −\$27,413.68
Adjusted by CHF and dementia	−\$18,010.21	\$4598.955	−\$8996.422 to −\$27,023.99

PCHP = palliative care homebound program; DNR = do not resuscitate; CHF = congestive heart failure.

^aAfter enrollment minus before enrollment.

substantially smaller size of the end-of-life population and the limited time for cost reduction. When combined, serious illnesses, functional dependency, and hospital or skilled nursing facility stay in the preceding year identify a population with an annual 47% chance of hospital admission, 28% chance of death, and an average of \$30,828 in annual Medicare expenditures.²²

Our risk stratification methods share similar elements and stratification results. Using the ERA and Lee four-year mortality index scores together, we identified a control population whose average annual expenditures rose from \$14,427 in Year 1 to \$22,031 in Year 2: identifying a population with persistent high illness burden who may not be predicted to die in the coming year and who may be facing several years of high health care utilization and cost that can be reduced by a PCHP. The one-year survival of the intervention cohort of 56% and the control cohort of 72% are consistent with the persistent high-risk population (so-called Category C) defined by Kelley et al.²² Moreover, the difference in survival between enrollees and controls appears to occur within the first six months, after which survival curves are parallel. This outcome likely reflects illness severity referral bias as evidenced by the higher baseline costs of the intervention group. Apart from that, goal concordant care often results in patient choice to focus on quality of life over life-extending interventions which may result in excessive treatment burden for small increments of life extension in the setting of poor performance status. The survival curves in the second six months are virtually the same and may better

reflect the similar outcomes in patients of similar illness severity.

The central elements to successful home-based programs appear to be frequent in-person interaction, care coordination, comprehensive geriatric assessment, skillful application of palliative care, and round-the-clock access.¹² Mayo Clinic's PCHP shares many of these elements, with its robust interdisciplinary team that performs a protocol-based assessment and management scheme, frequent advanced practice registered nurse contact, and telephonic contact by a registered nurse care coordinator and with a program that emphasizes timely acute symptom management. This strategy leads to high-quality patient-centered care, as observed in the reduction in preventable hospital days—3.3 days less in the intervention group (from 9.9 to 6.6 days) compared with 1.7 days more in the control group (from 7.5 to 9.2 days) in the subsequent year. Moreover, ED and outpatient visit burdens are reduced, a change reflected by reduced charges in the intervention cohort of the present study. Finally, advance care planning was discussed 96% of the time on at least one occasion (and usually many more occasions) as a function of our intervention protocol, thereby ensuring that patient-centered goals of care were pursued early in the care course. These patient-centered outcomes fulfill several elements of the Outcomes Measures Hierarchy described by Porter.²³ Delivery of improved patient-centered outcomes in the economic setting of cost reduction defines value creation.

Table 5
Annual Medicare Payments per Patient by Site of Care for PCHP Group vs. Control Group

Site of Care	PCHP Group		Control Group	
	Before Enrollment	After Enrollment	Year 1	Year 2
Hospital, inpatient	\$15,847.64	\$4384.22	\$9935.46	\$18,128.19
Hospital, outpatient	\$1730.65	\$849.36	\$1529.38	\$1406.07
Hospital ED	\$1714.91	\$963.16	\$1728.13	\$1551.71
Clinic, outpatient	\$2312.00	\$1430.81	\$2310.91	\$2017.32

PCHP = palliative care homebound program; ED = emergency department.

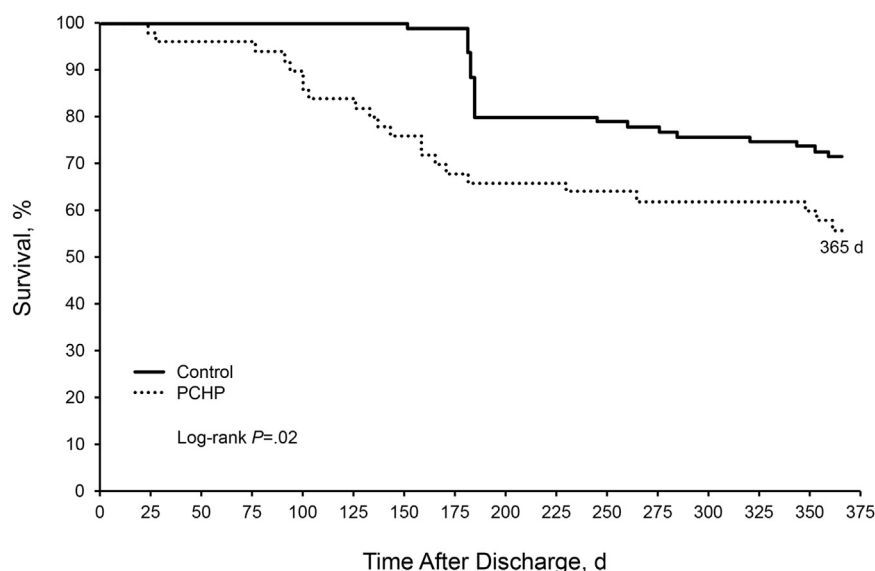


Fig. 1. Time to event for one-year survival between PCHP group and control group. PCHP indicates palliative care homebound program. Data report 22 events for 50 PCHP patients and 27 events for 95 controls. Comparison of Kaplan-Meier estimate mean (95% CI) survival for PCHP patients vs. controls at 92 days are 92.0% (84.8%–99.8%) vs. 100.0% (100.0%–100.0%); 190 days, 66.0% (54.1%–80.5%) vs. 80.0% (72.3%–88.5%); and 365 days, 56.0% (43.8%–71.6%) vs. 71.6% (63.1%–81.2%).

We provide the comparative outcomes for cases and controls that were DNR/DNI at the time of entry in our study. The patients in the program demonstrate significant cost reduction in the year after enrollment, and the controls demonstrate cost increase in the year after enrollment, both at the same increment as the full study. The adjusted DID analysis on all patients including DNR/DNI status also reflected a consistent impact of the PCHP program while DNR status was not significant ($P > 0.05$). This supports the contention that cost savings is a function of the program intervention and not resuscitation or intubation status.

This study used Medicare reimbursement based on national schedules from 2014, which is a readily identifiable construct for health care systems that begin to look at alternative payment models such as Independence at Home²⁴ or similar CMS bundling initiatives, as well as potential secondary insurance shared-risk contracting. A particular health system cost savings is likely much greater than the estimated Medicare reimbursement savings, depending on the health system's internal ratio of cost of care to Medicare reimbursement for this high-risk population that requires frequent inpatient care from a medical service.

Limitations

Our study had limitations. Of 54 PCHP participants and 108 matched control patients meeting study criteria, 17 were excluded from this analysis, resulting in 50 PCHP participants and 95 controls. This relatively small number of exclusions is not likely to have significant effect on the results. Furthermore, our program has strict criteria for

comorbidity, code status (DNR/DNI), and mortality index that may make generalizing to different palliative homebound programs difficult. Patients enroll in the program with a focus on quality of life. They may view prolonged hospitalization with intensive care and its associated functional decline; time away from home; and the associated family burden as less desirable in the medical setting of advanced illness, with limited effective, life-extending treatment options. These goals are in keeping with the PCHP philosophy 1) to provide effective life-extending therapy that includes hospitalization at the patient's discretion and 2) to avoid low-value care that is not in keeping with the patient's stated goals of care.

For this study, we used national Medicare reimbursement rates applied to our internal service data. This application enabled us to include all eligible patients and provide relevant estimates; yet, we still likely underestimated the total internal expenditures. By basing our costs on our services, we did not capture potential cost differences of an outpatient pharmacy or a skilled nursing home or other home health care costs. Since our program provided palliative care in the patient's home, these omitted services (e.g., outpatient pharmacy) would likely increase the difference between groups when added to the data. In addition, this study involved an inception cohort, and thus program savings may be underestimated. Apart from logistical start-up issues, a lack of both weekend home visit coverage and a dedicated after-hours call triage system available 24 hours a day and seven days a week is likely an important contributor to missed opportunities to reduce preventable hospitalizations and ED visits.

Conclusion

The present study showed that the Mayo Clinic Palliative Care Homebound Program reduced annual Medicare expenditures by a mean (95% CI) of \$18,251 (\$11,268–\$25,234) per patient in rounded numbers compared with propensity score–matched controls. The finding supports the role of home-based palliative medicine in high-value care for high-risk older adults with advanced medical illness and functional decline. The results add to the increasing and reliable evidence that these programs should be considered an integral component in future models of care to support the aging population.

Disclosures and Acknowledgments

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Dr. Thorsteinsdottir received an extramural grant from Satellite Healthcare.

References

1. Aldridge M, Kelley A. Appendix E: epidemiology of serious illness and high utilization of health care. In: Committee on Approaching Death: Addressing Key End of Life Issues, Institute of Medicine, ed. *Dying in America: Improving Quality and Honoring Individual Preferences Near the End of Life*. Washington (DC): National Academies Press (US), 2015:487–532.
2. Meier DE, Back AL, Berman A, et al. A national strategy for palliative care. *Health Aff (Millwood)* 2017;36:1265–1273.
3. Aldridge MD, Kelley AS. The myth regarding the high cost of end-of-life care. *Am J Public Health* 2015;105:2411–2415.
4. Meier DE, Back AL, Berman A, Block SD, Corrigan JM, Morrison RS. A national strategy for palliative care. *Health Aff* 2017;36:1265–1273.
5. Figueroa JF, Joynt Maddox KE, Beaulieu N, Wild RC, Jha AK. Concentration of potentially preventable spending among high-cost Medicare subpopulations: an observational study. *Ann Intern Med* 2017;167:706–713.
6. Zhang B, Wright AA, Huskamp HA, et al. Health care costs in the last week of life: associations with end-of-life conversations. *Arch Intern Med* 2009;169:480–488.
7. Teno JM, Fisher ES, Hamel MB, Coppola K, Dawson NV. Medical care inconsistent with patients' treatment goals: association with 1-year Medicare resource use and survival. *J Am Geriatr Soc* 2002;50:496–500.
8. Pritchard RS, Fisher ES, Teno JM, et al. Influence of patient preferences and local health system characteristics on the place of death. SUPPORT Investigators. Study to Understand Prognoses and Preferences for Risks and Outcomes of Treatment. *J Am Geriatr Soc* 1998;46:1242–1250.
9. Ornstein K, Wajnberg A, Kaye-Kauderer H, et al. Reduction in Symptoms for homebound patients receiving home based palliative care. *J Palliat Med* 2013;16:1048–1054.
10. Brumley R, Enguidanos S, Jamison P, et al. Increased satisfaction with care and lower costs: results of a randomized trial of in-home palliative care. *J Am Geriatr Soc* 2007;55:993–1000.
11. Brumley RD, Enguidanos S, Cherin DA. Effectiveness of a home-based palliative care program for end-of-life. *J Palliat Med* 2003;6:715–724.
12. Lustbader D, Mudra M, Romano C, et al. The impact of a home-based palliative care program in an accountable care organization. *J Palliat Med* 2017;20:23–28.
13. Chen CY, Thorsteinsdottir B, Cha SS, et al. Health care outcomes and advance care planning in older adults who receive home-based palliative care: a pilot cohort study. *J Palliat Med* 2015;18:38–44.
14. Covinsky KE, Eng C, Lui LY, Sands LP, Yaffe K. The last 2 years of life: functional trajectories of frail older people. *J Am Geriatr Soc* 2003;51:492–498.
15. Gomes B, Calanzani N, Curiale V, McCrone P, Higginson IJ. Effectiveness and cost-effectiveness of home palliative care services for adults with advanced illness and their caregivers. *Cochrane Database Syst Rev* 2013;CD007760.
16. Takahashi PY, Naessens JM, Peterson SM, et al. Short term and Long term effectiveness of a post-hospital care transitions program in an older, medically complex population. *HealthC (Amst)* 2016;4:30–35.
17. Crane SJ, Tung EE, Hanson CJ, et al. Use of an electronic administrative database to identify older community dwelling adults at high-risk for hospitalization or emergency department visits: the elders risk assessment index. *BMC Health Serv Res* 2010;10:338.
18. Lee SJ, Lindquist K, Segal MR, Covinsky KE. Development and validation of a prognostic index for 4-year mortality in older adults. *JAMA* 2006;295:801–808.
19. Carey EC, Walter LC, Lindquist K, Covinsky KE. Development and validation of a functional morbidity index to predict mortality in community-dwelling elders. *J Gen Intern Med* 2004;19:1027–1033.
20. Kerr CW, Donohue KA, Tangeman JC, et al. Cost savings and enhanced hospice enrollment with a home-based palliative care program implemented as a hospice-private payer partnership. *J Palliat Med* 2014;17:1328–1335.
21. Brian Cassel J, Kerr KM, McClish DK, et al. Effect of a home-based palliative care program on healthcare Use and costs. *J Am Geriatr Soc* 2016;64:2288–2295.
22. Kelley AS, Covinsky KE, Gorges RJ, et al. Identifying older adults with serious illness: a critical step toward improving the value of health care. *Health Serv Res* 2017;52:113–131.
23. Porter ME. What is value in health care? *N Engl J Med* 2010;363:2477–2481.
24. Services CfMM. Independence at Home Demonstration. 2017. Available from: <https://innovation.cms.gov/initiatives/independence-at-home/>. Accessed February 23, 2018.