# Supplemental Online Content

Guterman EL, Kiekhofer RE, Wood AJ, et al. Care Ecosystem collaborative model and health care costs in Medicare beneficiaries with dementia: a secondary analysis of a randomized clinical trial. *JAMA Intern Med.* Published online September 18, 2023. doi:10.1001/jamainternmed.2023.4764

**eMethods.**

**eFigure 1.** Distribution of Total Cost of Care Among Patients With 24-Month continuous Medicare Fee-for-Service (FFS) Coverage

**eFigure 2.** Mean Monthly Total Cost of Care Among Patients With 24-Month Continuous Medicare FFS Coverage

**eTable 1.** Proportion of Participants With Missing Medicare Reimbursement Data, Stratified by Completeness of Fee-for-Service (FFS) Coverage

**eTable 2.** Comparison of Baseline Characteristics Between Patients With Complete 24-Month Continuous Medicare FFS and Patients With Incomplete 24-Month Medicare FFS by Intervention Group

**eTable 3.** Total Cost of Care in the 12-Months Preceding and 12-Months During Enrollment Among Patients With 24-Month Continuous Medicare FFS Coverage

**eTable 4.** Heterogeneity of the Effect of the Care Ecosystem on Total Cost of Care From 1-6 Months and 7-12 Months After Trial Enrollment

**eTable 5.** Effect of the Care Ecosystem on Total Cost of Care From 7 to 12 Months After Enrollment With Outliers Trimmed at 97.5th to 99.5th Percentile

**eTable 6.** Effect of the Care Ecosystem on Total Cost of Care From 7 to 12 Months After Enrollment With Winsorization at 97.5th to 99.5th Percentile

**eTable 7.** Effect of the Care Ecosystem on Total Cost of Care From 7 to 12 Months After Enrollment Modeled Among Enrollees With 24-Month Continuous Medicare FFS Coverage Using a Hurdle Model

**eTable 8.** Community Resources and Other Topic Areas That Care Team Navigators Discussed With Caregivers

This supplemental material has been provided by the authors to give readers additional information about their work.

**eMethods**

**Intervention description**

The intervention entailed assignment to an unlicensed dementia care guide called a Care Team Navigator (CTN), who received training about dementia and who met with the dyad regularly (typically monthly) by phone or video. CTNs provided personalized information, support, and resources. During monthly calls, CTNs listened and asked questions as guided by standardized protocols to screen for safety hazards, medical issues, and psychosocial risks that required attention from a member of the Care Ecosystem dementia specialist team (nurse, social worker, or pharmacist) or another treating provider. These were addressed during weekly team meetings or individual meetings between the provider and caregiver. CTNs helped caregivers access community services, selected informational resources for them (eTable 8), and guided the caregivers to implement non-pharmacologic strategies to improve problematic behavioral and psychological symptoms of dementia.

**Claims files**

Claims files were obtained from the Medicare Inpatient, Outpatient, Carrier, Durable Medical Equipment, Skill Nursing Facility, Home Health Agency, and Hospice files. Part D payments were not included to limit increased variability in total cost of care related to high-priced brand-name specialty drugs, and because the Care Ecosystem intervention was hypothesized to have an effect on low-priced and over-the-counter as opposed to high-priced drugs.[1,2] Care Ecosystem participation was not a service reimbursable by Medicare thus total cost of care did not include the cost of participation among those randomized to receive the Care Ecosystem intervention.

**Patient level variable details**

Rural-Urban Community Area was coded as metropolitan: 1-3, or non-metropolitan, including small town or rural: 4+.[3] Charlson Comorbidity Index was derived from encounter-related ICD-10 codes associated with any encounter during the 12 month baseline period.[4,5] Medicare program enrollment included a monthly indicator of whether the patient had coverage under a Medicare fee-for-service (FFS) or Medicare Advantage (MA) plan.

**References**

1. Policy Recommendations for Public Health Plans to Stem the Escalating Costs of Prescription Drugs: A Position Paper From the American College of Physicians. https://www.acpjournals.org/doi/epdf/10.7326/M19-0013 doi:10.7326/M19-0013.

2. Recommendations for Lowering Prescription Drug Spending in Public Programs. https://www.acpjournals.org/doi/epdf/10.7326/M19-2895 doi:10.7326/M19-2895.

3. US Department of Agriculture Economic Research Service. 2010 Rural-urban commuting area (RUCA) codes. Last accessed July 15, 2023. https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes/documentation/

4. Charlson, M. E., Pompei, P., Ales, K. L. & MacKenzie, C. R. A new method of classifying prognostic comorbidity in longitudinal studies: Development and validation. *J. Chronic Dis.* **40**, 373–383 (1987).

5. Charlson, M. E. *et al.* The Charlson comorbidity index is adapted to predict costs of chronic disease in primary care patients. *J. Clin. Epidemiol.* **61**, 1234–1240 (2008).

**eFigure 1. Distribution of total cost of care among patients with 24-month continuous Medicare Fee-For-Service (FFS) coverage**
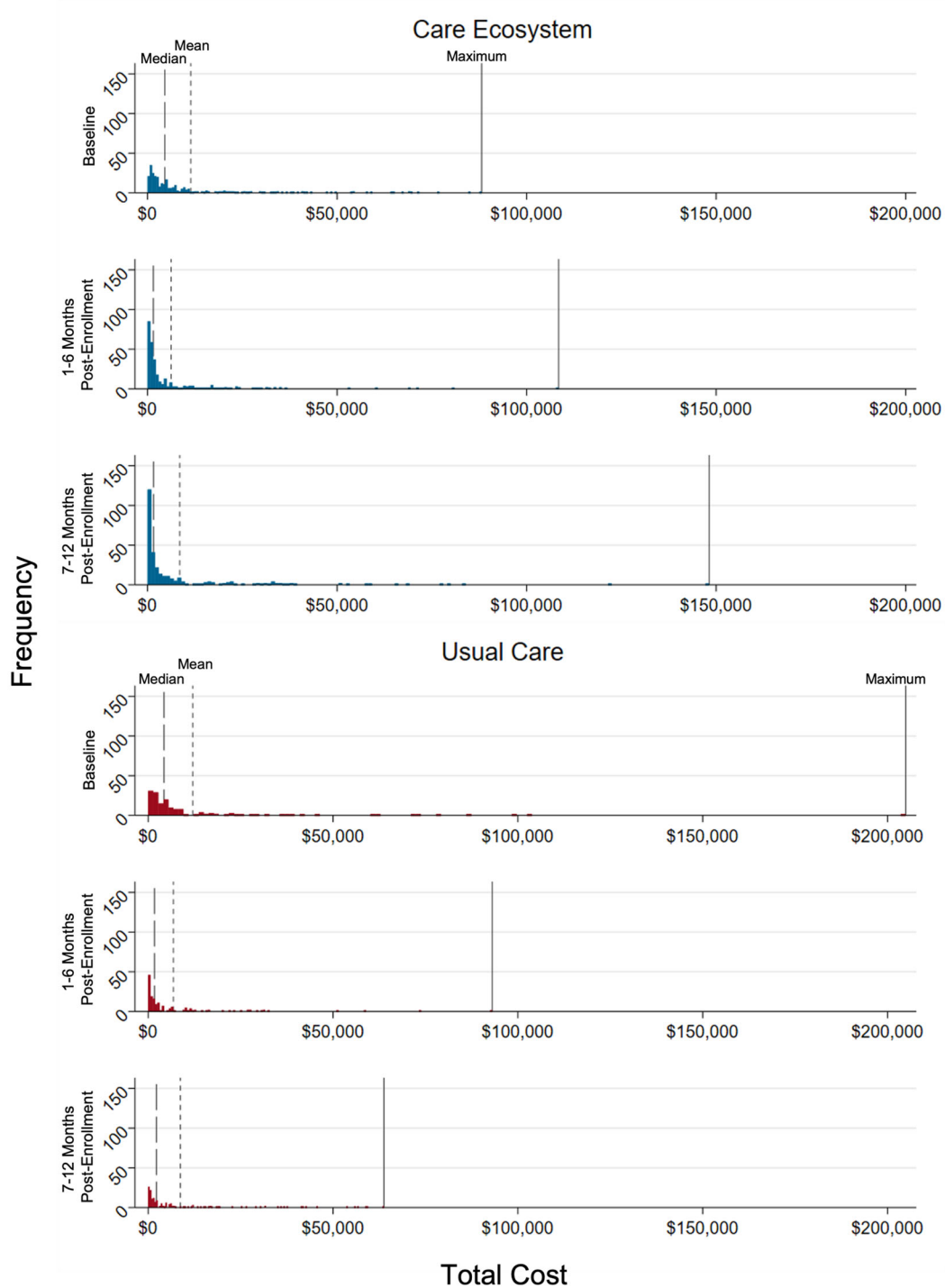


eFigure 1 Legend: Total cost of care is presented separately for the intervention (blue) and usual care (red) arms by the three time periods: baseline (12 months preceding enrollment), 1-6 months post-enrollment, and 7-12 months post-enrollment. Dashed lines indicate median total cost of care, dotted lines indicate mean, and solid lines indicate maximum during the specified periods.

**eFigure 2. Mean monthly total cost of care among patients with 24-month continuous Medicare FFS coverage**
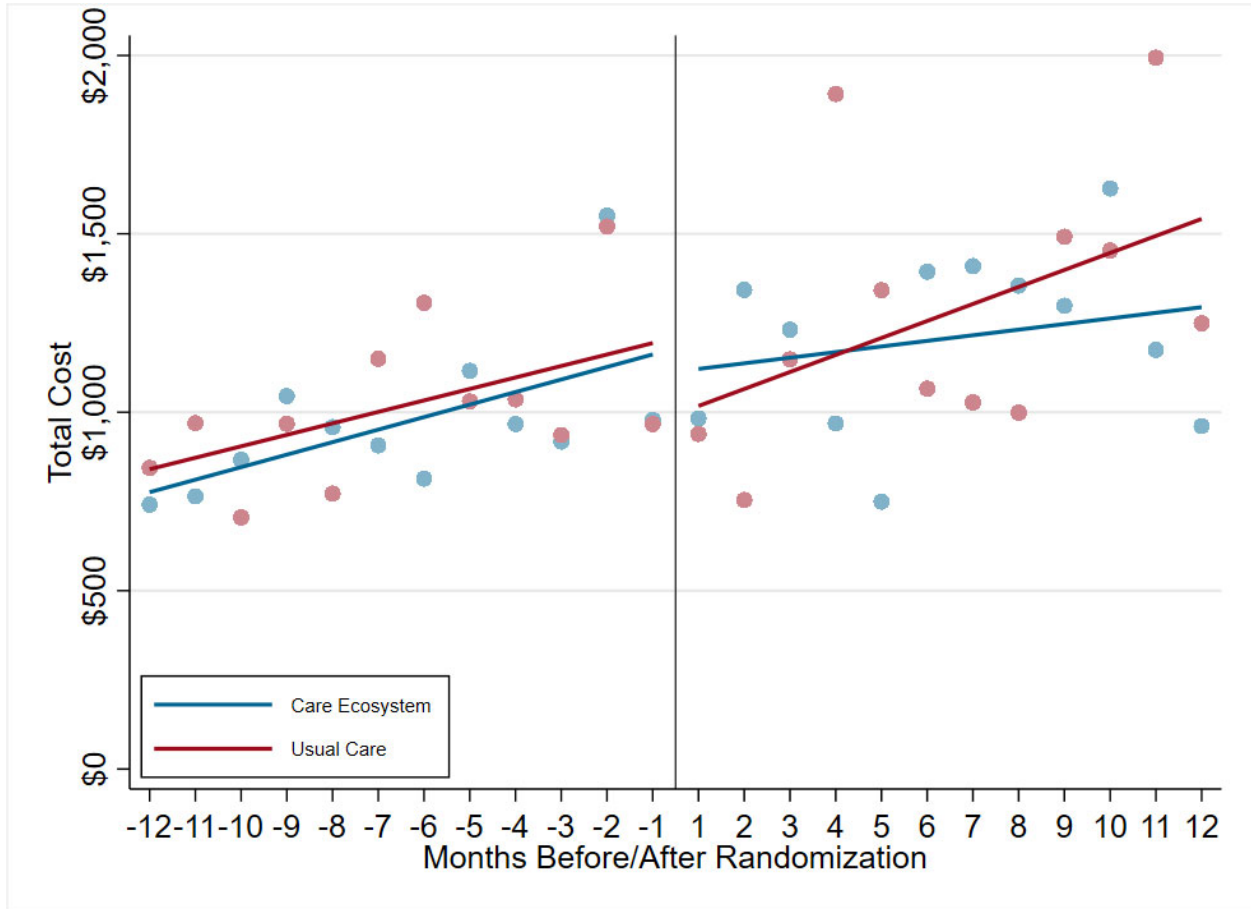


eFigure 2 Legend. Dots represent mean monthly total cost of care in the intervention (blue) and usual care (red) arm. Lines are fitted for each trial arm for the 12 months preceding and 12 months during trial enrollment.

**eTable 1. Proportion of participants with missing Medicare reimbursement data, stratified by completeness of Fee-for-service (FFS) coverage**

| | Complete FFS [b] | Incomplete FFS | |
| --- | --- | --- | --- |
| | | Any MA | Other [a] |
| | N = 460 | N = 183 | N = 140 |
| Missing cost data in 12 months preceding trial enrollment | 2 (0.4%) | 115 (62.8%) | 48 (34.3%) |
| Missing cost data in the 12 months during trial enrollment | 1 (0.2%) | 102 (55.7%) | 47 (33.6%) |

[a] Other reasons for incomplete FFS coverage include death or lapse in FFS coverage during 24 month period or linkage failure due to non-Medicare insurance coverage (Medicaid, commercial, VA, etc.), early death, or failure of probabilistic linkage (N = 44).

[b] There were 3 participants with complete FFS coverage who did not have any claims during the year before enrollment (2) and the year after enrollment (1). These costs were set to 0 for the main analysis.

**eTable 2. Comparison of baseline characteristics between patients with complete 24-month continuous Medicare FFS and patients with incomplete 24-month Medicare FFS by intervention group**

| | Care Ecosystem | | | Usual Care | | |
|---|---|---|---|---|---|---|
| | Complete FFS | Incomplete FFS | p-value[a] | Complete FFS | Incomplete FFS | p-value[a] |
| | **303** | **209** | | **157** | **111** | |
| **Patient characteristics** | | | | | | |
| Any Medicare Advantage | 0 (0) | 120 (57.4) | | 0 (0) | 63 (56.8) | |
| Age, median (IQR) | 78.0 (73.0, 84.0) | 78.0 (71.0, 85.0) | 0.59 | 78.0 (72.0, 84.0) | 78.0 (66.0, 85.0) | 0.64 |
| Female sex, N (%) | 171 (56.4%) | 128 (61.2%) | 0.28 | 85 (54.1%) | 55 (49.5%) | 0.46 |
| Race, N (%) | | | 0.02 | | | 0.78 |
| Asian | 19 (6.6%) | 15 (8.0%) | | 8 (5.3%) | 7 (7.1%) | |
| Black | 8 (2.8%) | 15 (8.0%) | | 6 (4.0%) | 4 (4.0%) | |
| White | 259 (89.9%) | 154 (82.4%) | | 135 (90.0%) | 88 (88.9%) | |
| Other | 2 (0.7%) | 3 (1.6%) | | 1 (0.7%) | 0 (0.0%) | |
| Hispanic, N (%) | 21 (6.9%) | 33 (16.0%) | 0.001 | 10 (6.4%) | 19 (17.1%) | 0.005 |
| Charlson comorbidity index, N (%) | | | 0.97 | | | 0.50 |
| 0 | 47 (15.6%) | 16 (16.5%) | | 22 (14.2%) | 10 (21.3%) | |
| 1 | 111 (36.9%) | 36 (37.1%) | | 55 (35.5%) | 16 (34.0%) | |
| $\geq 2$ | 143 (47.5%) | 45 (46.4%) | | 78 (50.3%) | 21 (44.7%) | |
| Patient dementia severity – QDRS baseline, median (IQR) | 10.5 (6.0, 15.5) | 12.5 (8.0, 18.0) | <0.001 | 10.5 (7.0, 15.6) | 11.5 (8.0, 19.0) | 0.16 |
| ADI, median (IQR) | 3.0 (1.0, 6.0) | 3.0 (2.0, 5.0) | 0.53 | 3.0 (1.0, 5.0) | 3.0 (1.0, 5.0) | 0.91 |
| Metropolitan, N (%) | 257 (84.8%) | 193 (92.3%) | 0.01 | 129 (82.2%) | 100 (90.1%) | 0.07 |
| **Caregiver characteristics** | | | | | | |

| | | | | | | |
|---|---|---|---|---|---|---|
| Caregiver age, median (IQR) | 68.0 (59.0, 75.0) | 64.0 (55.0, 71.0) | <0.001 | 65.0 (56.5, 73.0) | 64.5 (56.5, 71.0) | 0.87 |
| Caregiver female sex, N (%) | 204 (67.3%) | 153 (73.2%) | 0.15 | 110 (70.1%) | 86 (77.5%) | 0.18 |
| Caregiver relationship, N (%) | | | 0.003 | | | 0.96 |
| Spouse | 183 (60.4%) | 98 (46.9%) | | 88 (56.1%) | 64 (57.7%) | |
| Child | 100 (33.0%) | 83 (39.7%) | | 58 (36.9%) | 39 (35.1%) | |
| Other | 20 (6.6%) | 28 (13.4%) | | 11 (7.0%) | 8 (7.2%) | |
| Caregiver depression, N (%) | | | 0.45 | | | 0.54 |
| None | 184 (60.7%) | 120 (57.4%) | | 95 (60.5%) | 63 (56.8%) | |
| Mild to severe | 119 (39.3%) | 89 (42.6%) | | 62 (39.5%) | 48 (43.2%) | |
| High caregiver burden, N (%) | 167 (55.1%) | 120 (57.4%) | 0.61 | 85 (54.1%) | 71 (64.0%) | 0.11 |

[a]For categorical data, complete vs. incomplete FFS groups are compared using Pearson's chi-squared. Wilcoxon rank-sum is used where median and IQR is reported. Comparison of race is white vs. not white.

**eTable 3. Total cost of care in the 12-months preceding and 12-months during enrollment among patients with 24-month continuous Medicare FFS coverage**

| | 12-months preceding enrollment | | 12-months during enrollment | |
|---|---|---|---|---|
| | **Care Eco** | **Usual Care** | **Care Eco** | **Usual Care** |
| N | **303** | **157** | **303** | **157** |
| **Total cost of care, $** | | | | |
| Median | 4,579 | 4,284 | 4,507 | 5,764 |
| Mean | 11,401 | 12,038 | 14,721 | 15,528 |
| 25th %ile | 1,660 | 1,847 | 1,622 | 1,696 |
| 75th %ile | 12,739 | 8,477 | 16,928 | 17,599 |
| Maximum | 88,142 | 204,899 | 185,913 | 94,695 |
| Adjusted median[a] | 4,540 | 3,542 | 4,362 | 4,223 |
| Adjusted mean[a] | 10,785 | 6,390 | 12,254 | 9,781 |
| Adjusted maximum[a] | 69,251 | 42,298 | 86,329 | 68,269 |

[a] Adjusted median, mean, and maximum of total cost of care reflects removal of individuals with DFBETA value above $2/\sqrt{N}$.

**eTable 4. Heterogeneity of the effect of the Care Ecosystem on total cost of care from 1-6 months and 7-12 months after trial enrollment**

| Subgroup | N | Trial Period 1-6 Months | | | Trial Period 7-12 Months | | | Overall | |
|---|---|---|---|---|---|---|---|---|---|
| | | Effect[a] | 95% CI | p[b] | Effect | 95% CI | p[c] | Mean monthly cost reduction[d] | p[e] |
| Enrollees with 24-month FFS coverage | 428 | -3290.16 | -6149.41, -430.91 | 0.02 | -3026.71 | -5899.07, -154.34 | 0.04 | $526 | NA |
| Enrollees with 24-month FFS coverage or FFS coverage until time of death | 484 | -2806.92 | -5613.35, -0.49 | 0.05 | -3302.66 | -6156.80, -448.51 | 0.02 | $509 | NA |
| All enrolled Medicare beneficiaries[f] | 589 | -2536.71 | -5013.91, -59.50 | 0.05 | -3016.63 | -5495.35, -537.90 | 0.02 | $463 | NA |
| Patient dementia severity | | | | | | | | | |
|     None to mild | 257 | -2673.35 | -6440.52, 1093.82 | 0.64 | -1708.02 | -5484.33, 2068.30 | 0.30 | $365 | 0.59 |
|     Moderate to severe | 171 | -4063.24 | -8496.85, 370.37 | | -4773.70 | -9218.08, -329.33 | | $736 | |
| ED Encounters during baseline[g] | | | | | | | | | |
|     0 | 244 | -1806.36 | -5437.20, 1824.48 | 0.30 | -527.86 | -4246.86, 3191.14 | 0.07 | $195 | 0.18 |
|     1 or more | 184 | -4777.15 | -9064.73, -489.57 | | -5944.31 | -10335.99, -1552.63 | | $893 | |
| Caregiver Burden | | | | | | | | | |
|     Not high | 193 | -3275.21 | -7539.31, 988.90 | 0.99 | -2763.95 | -7045.95, 1518.05 | 0.87 | $503 | 0.98 |
|     High | 235 | -3304.16 | -7172.34, 564.02 | | -3246.11 | -7130.52, 638.30 | | $546 | |
| Caregiver Depression | | | | | | | | | |
|     None | 258 | -2684.32 | -6393.38, 1024.74 | 0.62 | -658.32 | -4386.23, 3069.58 | 0.05 | $279 | 0.12 |
|     Mild to severe | 170 | -4164.05 | -8645.02, 316.92 | | -6555.72 | -11059.46, -2051.98 | | $893 | |

[a]Interaction analyses were performed after excluding patients who exceeded the DFBETA cutoff value of 0.09

[b]p-value specifies the interaction effect of the characteristic (e.g. dementia severity) at 0-6 months after the patient was enrolled in the Care Ecosystem trial

[c] p-value specifies the interaction effect of the characteristic (e.g. dementia severity) at 7-12 months after the patient was enrolled in the Care Ecosystem trial

[d]Mean reduction in total costs on a monthly basis calculated by adding the effect of the intervention at 1-6 Months and 7-12 Months then dividing by 12

[e]p-value specifies the effect of the three-way interaction (e.g. dementia severity across all time periods)

[f]Participants in the Care Ecosystem trial with Medicare FFS or Medicare Advantage coverage who have non-missing costs in the 12 months preceding and 12 months during trial enrollment

[f]Number of ED encounters in the 12 months preceding trial enrollment

**eTable 5. Effect of the Care Ecosystem on total cost of care from 7 to 12 months after enrollment with outliers trimmed at 97.5th to 99.5th percentile**

| Trimming threshold | N | Coefficient | Lower CI | Upper CI | P-value |
|---|---|---|---|---|---|
| >97.5 percentile | 428 | -3620.63 | -6349.24 | -892.02 | 0.009 |
| >98.0 percentile | 434 | -3907.13 | -6761.55 | -1052.71 | 0.007 |
| >98.5 percentile | 443 | -3752.55 | -6814.04 | -691.05 | 0.016 |
| >99.0 percentile | 448 | -3289.62 | -6526.10 | -53.14 | 0.046 |
| >99.5 percentile | 454 | -2408.66 | -5902.89 | 1085.57 | 0.177 |

**eTable 6. Effect of the Care Ecosystem on total cost of care from 7 to 12 months after enrollment with winsorization at 97.5th to 99.5th percentile**

| Winsorization threshold | N | Coefficient | Lower CI | Upper CI | P-value |
|---|---|---|---|---|---|
| >97.5 percentile | 460 | -3422.15 | -6153.57 | -690.72 | 0.014 |
| >98.0 percentile | 460 | -3724.22 | -6608.79 | -839.65 | 0.011 |
| >98.5 percentile | 460 | -3617.34 | -6716.80 | -517.89 | 0.022 |
| >99.0 percentile | 460 | -3222.27 | -6477.24 | 32.71 | 0.052 |
| >99.5 percentile | 460 | -2399.62 | -5887.64 | 1088.40 | 0.178 |

**eTable 7. Effect of the Care Ecosystem on total cost of care from 7 to 12 months after enrollment modeled among enrollees with 24-month continuous Medicare FFS coverage using a hurdle model[a]**

|  | Estimate | **Lower CI** | **Upper CI** | **P-value** |
|---|---|---|---|---|
| Stage 1 | Odds Ratio = 0.29 | 0.01 | 5.54 | 0.40 |
| Stage 2 | Coefficient = -0.25 | -0.62 | 0.12 | 0.18 |
|  | Marginal predicted mean 12-month effect ($) = -1378.28 | -4565.24 | 1808.67 | 0.40 |

[a] Performed as a mixed effects logistic regression model of any cost versus no cost followed by removing observations with zero costs (N = 27) and performing mixed effect linear regression model with log link function and gamma distribution to model total cost of care among enrollees with 24-month continuous Medicare FFS coverage, including outliers with a DFBETA value > $2/\sqrt{N}$

**eTable 8. Community resources and other topic areas that Care Team Navigators discussed with caregivers**

| Community Resources | |
|---|---|
| | Support groups |
| | Counseling |
| | Educational workshops |
| | Public benefits |
| | Respite grants |
| | Legal services |
| | Home safety services |
| | Exercise |
| | Activity or day programs |
| | In-home services |
| | Residential care services |
| **Other Topic Areas** | |
| | Communication |
| | Disease Information |
| | Behavior Symptoms & Delirium |
| | Caregiver Well-being |
| | Safety (driving, falls, wandering, weight loss, choking) |
| | Medications |
| | Daily Care (activities, nutrition, bathing/grooming, incontinence) |
| | Advance Care Planning |
| | End of Life Care |
| | Respite Care Options |
| | Caregiving Supplies & Technology |
| | Care Transitions (hospitalization, placement) |