



# Cost impact of the transitional care model for hospitalized cognitively impaired older adults

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**Aim:** The goal of this study was to compare postacute care costs of three care management interventions.

**Materials & methods:** A total of 202 hospitalized older adults with cognitive impairment received either Augmented Standard Care, Resource Nurse Care or the Transitional Care Model. The Lin method was used to estimate costs at 30 and 180 days postindex hospital discharge. **Results:** The Transitional Care Model had significantly lower costs than the Augmented Standard Care group at both 30 ( $p < 0.001$ ) and 180 days ( $p = 0.03$ ) and significantly lower costs than Resource Nurse Care at 30 days ( $p = 0.02$ ). **Conclusion:** These findings suggest that the Transitional Care Model can reduce both the amount of other postacute care and the total cost of care compared with alternative services for cognitively impaired older adults. Clinicaltrials.gov: NCT00294307.

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Hospitalized older adults with multiple chronic conditions complicated by cognitive impairment, including Alzheimer's disease and other dementias, as well as multifactorial syndromes (such as delirium), are at risk for poor outcomes including high and costly rates of rehospitalization and use of post-acute services [1–3]. Some conditions such as heart failure can also cause cognitive impairment [4]. This population of older adults with deficits in orientation, recall and executive function, many of whom do not have a diagnosis of dementia, are at risk for poor outcomes during vulnerable health care transitions. The impact of various evidence-based interventions on rehospitalization for cognitively intact frail patients has been extensively studied, such as Care Transitions Intervention [5], Project RED [6,7], or BOOST [8] and the Transitional Care Model [9–11], but much less attention has been paid to impacts on postacute care and cognitively impaired patients. Yet almost all Medicare beneficiaries with a diagnosis of Alzheimer's disease or other dementias have one additional chronic condition and 77% of Medicare beneficiaries with Alzheimer's disease also have three or more additional chronic conditions [12]. This population with cognitive impairment has increased odds of having high use of postacute care and of potentially avoidable hospitalizations for their additional chronic conditions (e.g., diabetes, hypertension) in comparison to those without cognitive impairment [2]. There is, therefore, increased interest in changing the patterns of postacute care use as well as readmissions among the subpopulation of beneficiaries at higher risk because of cognitive impairment. Yet few transitions in care interventions have been specifically designed and tested with this population [13].

The phrase 'postacute care' refers to all services provided immediately following hospitalizations (e.g., home health, skilled nursing facilities, independent rehabilitation facilities or hospice) that are not rendered in physicians' offices or hospital inpatient settings [14]. In a 2013 Institute of Medicine study [15], fully 70% of the variation across hospital referral regions for Medicare beneficiaries was related to varying rates of use and costs for postacute care [16]. Rehospitalization played a relatively minor role in this variation. Using 2016 adjusted costs, the average annual per-person payment for postacute care for Medicare beneficiaries with Alzheimer's and other dementias was 11.5-times greater than older adults without dementia; this is a high risk group [17]. Other research findings

emphasize the role of appropriate postacute care in influencing patient and caregiver satisfaction and improving the quality of patients' lives [18,19]. However, relatively little is known about how to affect patterns of postacute care service use among high-risk cognitively impaired patient groups and what impacts programs targeted to this group will have on total costs of posthospitalization care.

The goal of this study was to determine the effects of the use and cost of postacute care overall and by type of postacute care service, for a population of cognitively impaired older adults hospitalized for a range of medical or surgical health problems who received one of three evidence-based care management interventions. Each of the intervention protocols was specifically designed to improve, to varying extents, posthospitalization health and reduce total postdischarge resource use costs, compared with standard care; each had been demonstrated in prior studies to improve these outcomes when compared with standard care. The protocols designed for older adults with cognitive impairment included Augmented Standard Care (ASC), a lower dose intervention [20], Resource Nurse Care (RNC), a medium dose intervention [21] and, the Transitional Care Model (TCM), a higher dose intervention [9–11]. The first two of these approaches were delivered in the hospital only while the Transitional Care Model also included home based follow-up.

## Methods

### Setting

Three hospitals within one large health system in Southeastern Pennsylvania were randomly assigned to one of three intervention-improvement groups. All sites are part of an academic medical center (Site A: 515 beds; Site B: 317 beds; Site C: 695 beds). All hospitals were located in an urban area, with Sites B and C located approximately one mile apart and Site A being four miles away from Sites B and C. Average 30 day readmission rates available from the Centers for Medicare & Medicaid Services (CMS) at the start of this study (2006) were similar across all study sites; Average – Site A: 21%; Site B: 20%; Site C: 21% – and remained consistent throughout the study period [22]. The health system had the same policies and procedures used by the discharge planning department for referrals to postacute care throughout the study enrollment and follow-up period (2006–2009).

### Sample

Because the interventions were implemented at the system level, the threat of contamination prevented random assignment at the patient level. Hospitalized older adults were eligible to participate if they met the following criteria: age 65 or older, living within 30 miles of hospital, English speaking, with family caregivers willing to co-participate, and had either a pre-existing dementia diagnosis or were assessed as cognitively impaired during hospitalization. Screening for cognitive impairments involved an assessment of orientation and recall using the Six Item Screener (score ranges from 0–6, higher scores indicates fewer deficits), and an executive function clock drawing task [23,24]. Older adults that made two or more errors on the Six Item Screener were eligible to participate (score <4). For patients that made fewer than two errors on the orientation and recall assessment the CLOX 1, clock drawing task (score: 0–15, higher scores indicates fewer deficits), was completed. Older adults that made five or more errors on this task were eligible to participate. Following screening for eligibility and obtaining assent from the older adult and informed consent from the family caregiver, older adults received the intervention protocol assigned to the site where they were hospitalized. This study was reviewed and approved by the academic health center's Institutional Review Board.

### Interventions

Details about each protocol have been published elsewhere [25] and are summarized below by site.

#### *Site A: Augmented standard care*

At Site A, all enrollees were assessed by trained research assistants for cognitive deficits [20]. If no diagnosis of dementia was identified via chart reviews, the patient was screened using a standardized assessment tool comprised of valid and reliable measures assessing orientation, recall and executive function [23,24]. Cognitive assessments were completed within 24 h of hospital admission, and findings of positive assessments were communicated both in writing (via chart notes) and verbally to the care team (i.e., primary nurses, physicians and social workers assigned to enrollees) within one hour of completion.

*Site B: Resource nurse care*

At Site B, registered nurses completed a series of web-based modules designed by the study team and clinical experts in dementia and delirium. The training focused on managing hospitalized cognitively impaired older adults and supporting them and their families in preparation for their transitions back to the community [21]. Ten out of the 69 nurses who completed the training did not demonstrate the expected competency in knowledge related to care management of acutely ill, cognitively impaired older adults (i.e., scored less than 80% on post-test) and, thus, were not included as resource nurses. The remaining 59 nurses received the designation of resource nurse in the hospital and were assigned to the care of enrollees and/or responsible for coaching other nurses assigned to enrollees.

*Site C: Transitional care model*

This hospital to home protocol was implemented by advanced practice registered nurses (master's prepared nurses) [9–11]. In addition to the web-based modules on management of patients with dementia and delirium, these nurses completed modules and clinical experiences unique to this care management strategy over a 1 month training period. The TCM consists of essential core elements including: delivering services from hospital to home; screening at risk older adults; relying on advanced practice registered nurses to implement services; fostering continuity of care by having the same clinician involved across care episodes spanning hospital to home; coordinating services among clinicians and across settings; collaborating with patients, caregivers and health care teams; maintaining relationships with patients and caregivers; engaging patients and caregivers; managing symptoms and other health risks; and, promoting patients' and/or family caregivers' self-management [26]. Following enrollment, the advanced practice registered nurse visited enrollees in the hospital and met with the clinical team at the hospital daily during the hospitalization to work collaboratively develop the care plan and prepare the patient for transition to their next site of care. Advanced practice registered nurses followed patients to their next site of care visiting either in patients' homes, or at skilled nursing facilities (for patients who received short stay care at these sites), and accompanied patients to at least initial follow-up visits with physicians. In-person visits were supplemented by 7 days per week telephone availability. This protocol extended from enrollment in the hospital to an average of two months postindex hospitalization. The TCM had previously been rigorously tested with cognitively intact older adults and showed reductions in resource use and costs [9–11].

**Intervention costs**

The only intervention protocol with additional costs included in the analysis is TCM because elements of the other interventions (ASC and RNC) were included in the TCM in addition to the TCM protocol. The additional cost of the TCM improvement was estimated based on the total amount of time spent on intervention-related efforts (from time reports detailed in the clinical information system). On average the TCM nurses spent 60 min in their initial hospital, skilled nursing facility (SNF) and home visits with patients and their family caregivers; 30 min on follow up hospital, home or SNF visits with patients and their family caregivers; 110 min on visits to the office with the patient and healthcare team and 5–15 min on telephone calls to patients, family caregivers and other healthcare providers. Travel and documentation times were varied and were included in the costs. A regionally representative annual salary for advanced practice registered nurses plus benefits was used to determine an hourly cost for the TCM nurses. The total number of hours devoted to the TCM protocol multiplied by the hourly rate was calculated for each patient. The other two interventions had minimal cost (time and materials) over usual care, and so no additional cost was included for them.

**Postindex hospitalization resource use & costs**

Standardized nationally representative costs were assigned to each hospital and postacute service based on a single year (2011) and aggregated for patients in each intervention group. This method was used to account for any potential changes in reimbursement or regulations over the study period. The primary diagnosis related group code for each patient's rehospitalization was assigned a national average cost for that diagnosis-related group using data from the Nationwide Inpatient Sample, Healthcare Cost and Utilization Project, and the Agency for Healthcare Research and Quality [27]. Costs for a skilled nursing facility stay were calculated based on the number of days at the facility times the per diem Medicare Payment Advisory Commission (MedPAC) average rate for either rural and urban facilities [28]. The same procedure was used to calculate hospice costs. Each home healthcare event was reviewed and any patient with five or more visits by HHC clinicians in a 60 day period was assigned the average episode payment for home healthcare [28]. For patients who received fewer than five visits during a 60-day period,

specific costs by visit type were applied [28]. For patients who did not experience a hospital readmission, the total rehospitalization cost was zero. Costs incurred after 180 days were not included in the study.

Data were collected via patients' or family caregivers' self-report for all postindex hospitalization resource use and verified via medical record reviews. Research assistants conducted in-person interviews with patients and family caregivers at 2-, 6-, 12- and 26-weeks postindex hospital discharge. At each data collection point, questions were asked regarding use of home care, skilled nursing or hospice services, independent rehabilitation or skilled nursing facilities, emergency department visits, rehospitalizations and subsequent use of any postacute services following hospital readmissions. The names of healthcare settings providing services, episode dates, and reasons for service use were also documented. A study team member confirmed the events via record reviews for all resource use within the study site or contacted the external healthcare organization to confirm self-reported information.

### Patient & caregiver characteristics

Demographics were collected for both patients and caregivers enrolled in the study as well as baseline clinical and functional characteristics such as number of hospitalizations in the prior 6 months, reason for index hospitalization, activities of daily living [29,30], cognitive status [31,32], depressive symptoms [33,34], and caregiver time burden [35].

### Propensity score modeling

Due to the inherent design of this study of institution-wide interventions (e.g., the same nursing staff in each setting cared for all patients), random assignment of patients to the intervention arms within sites was not possible. Appropriate statistical methods were therefore used to minimize potential patient selection bias resulting from differences in observable patient characteristics across intervention arms. Specifically, covariate balancing propensity score (CBPS) modeling, a valid statistical method comprised of multiple covariates to control for selection bias arising from observable confounding factors [36], was applied to minimize this problem. This propensity score method models intervention assignment while optimizing the observable covariate balance.

The inverse of this propensity score is then used as the weight in the Kaplan–Meier analysis to create a synthetic sample in which the distribution of measured baseline covariates is independent of intervention assignment. Unweighted and average treatment effect on the population weighted means for each baseline variable within each intervention group was calculated, along with the pre- and postweighting pairwise absolute standardized mean difference (ASMD) on each of the 20 baseline patient and caregiver variables. A value of 0 for a pairwise ASMD represents no difference in means between the two groups for a particular baseline variable, whereas a value of 1 represents one standard deviation difference between the two groups for a particular baseline variable. As a reference, standardized differences of 0.10 and 0.30 are considered small and medium, respectively [37]. To illustrate the reduction in selection bias after propensity score weighting, maximum pairwise ASMD estimates are provided for each covariate before and after weighting (see Table 1).

### Analyses

Since there are censored patients in the data, the Lin method [38] for incomplete follow-up was used to estimate intervention group-specific average total postacute care, as well as rehospitalization costs. This method involves incorporating the Kaplan–Meier survival estimates of the conditional survival probabilities into the computation of average cost per patient. More specifically, the entire period of interest (0–180 days) is divided into time intervals so that censoring occurred only at the beginning of the intervals. Each patient's time in the study was calculated from enrollment to last follow-up date or date of death and used as the patient's censoring time.

The group specific average cost for the use of postacute care (overall and by specific service) is estimated by the sum of the group specific CBPS weighted Kaplan–Meier estimator for the probability of surviving to the start of each interval multiplied by the sample mean of the total costs over the interval conditional on surviving to the start of the interval. The CBPS weights were used in obtaining the Kaplan–Meier estimator to reduce confounding effects.

Bootstrapping method (1000 iterations) was then used to obtain 95% confidence intervals (for each postacute care cost and for differences in postacute care costs) and two-sided p-value (for cost differences only). This method involves randomly selecting with replacement from each intervention group, re-estimating the group specific CBPS weighted Kaplan–Meier survival functions for each bootstrap sample, recomputing the Lin estimates of average costs separately for each group for each type of cost and the combinations of costs, and then recomputing difference in mean costs for each type of cost and the combinations of costs. Costs are presented in US dollars and

**Table 1. Patient and caregiver nonclinical and clinical characteristics at index hospital admission, n = 202.**

| Patient characteristics                                      | Site A: ASC (low) (n = 65) | Site B: RNC (medium) (n = 71) | Site C: TCM (high) (n = 66) | ASMD before weighting | ASMD after weighting |
|--------------------------------------------------------------|----------------------------|-------------------------------|-----------------------------|-----------------------|----------------------|
| Sex – Male – n (%)                                           | 26 (40.0)                  | 24 (33.8)                     | 26 (39.4)                   | 0.22                  | 0.14                 |
| Age, years, M ± SD (range)                                   | 80.8 ± 6.4 (68–98)         | 80.9 ± 6.4 (65–98)            | 79.4 ± 6.6 (68–96)          | 0.07                  | 0.07                 |
| Race – White – n (%)                                         | 33 (50.1)                  | 15 (21.1)                     | 33 (50.0)                   | 0.47                  | 0.30                 |
| Patient lives alone – n (%)                                  | 18 (27.7)                  | 17 (23.9)                     | 18 (27.3)                   | 0.07                  | 0.06                 |
| Patient clinical characteristics                             |                            |                               |                             |                       |                      |
| Diagnosis of dementia – n (%)                                | 14 (21.5)                  | 20 (28.2)                     | 8 (12.1)                    | 0.27                  | 0.16                 |
| Number of co-existing conditions, M ± SD (range)             | 5.0 ± 2.3 (1–11)           | 4.5 ± 2.6 (0–11)              | 5.7 ± 2.5 (1–12)            | 0.20                  | 0.12                 |
| Depressive symptoms present – n (%)                          | 16 (24.6)                  | 16 (22.5)                     | 8 (12.1)                    | 0.26                  | 0.14                 |
| Delirium present – n (%)                                     | 12 (18.5)                  | 21 (29.6)                     | 12 (18.2)                   | 0.27                  | 0.13                 |
| Mini mental state examination (MMSE), M ± SD (range)         | 22.9 ± 4.8 (9–30)          | 20.9 ± 1.2 (4–30)             | 21.7 ± 5.9 (2–30)           | 0.22                  | 0.14                 |
| Basic activities of daily living, M ± SD (range)             | 4.4 ± 1.9 (0–6)            | 4.3 ± 2.1 (0–6)               | 4.4 ± 1.9 (0–6)             | 0.09                  | 0.09                 |
| Instrumental activities of daily living, M ± SD (range)      | 4.8 ± 2.4 (1–8)            | 4.2 ± 2.9 (0–8)               | 5.3 ± 2.6 (0–8)             | 0.22                  | 0.12                 |
| Reasons for index hospitalization – n (%)                    |                            |                               |                             |                       |                      |
| Cardiac/pulmonary                                            | 17 (26.2)                  | 25 (35.2)                     | 35 (53.0)                   | 0.28                  | 0.18                 |
| Orthopedic/mechanical fall                                   | 18 (27.7)                  | 14 (19.7)                     | 4 (6.1)                     | 0.34                  | 0.20                 |
| Neurologic                                                   | 7 (10.8)                   | 10 (14.1)                     | 10 (15.2)                   | –†                    | –†                   |
| Gastrointestinal/genitourinary                               | 12 (18.5)                  | 11 (15.5)                     | 7 (10.6)                    | –†                    | –†                   |
| Endocrine/metabolic                                          | 11 (16.9)                  | 11 (15.5)                     | 10 (15.2)                   | –†                    | –†                   |
| Number of hospitalizations in prior 6-months, M ± SD (range) | 0.8 ± 1.1 (0–5)            | 0.99 ± 1.3 (0–5)              | 1.3 ± 2.4 (0–11)            | 0.22                  | 0.14                 |
| Caregiver variables                                          |                            |                               |                             |                       |                      |
| Sex – Male, n (%)                                            | 14 (19.7)                  | 15 (23.1)                     | 17 (25.8)                   | 0.10                  | 0.06                 |
| Age, years, M ± SD (range)                                   | 60.4 ± 12.8 (34–87)        | 61.0 ± 14.0 (36–93)           | 60.6 ± 12.9 (34–85)         | 0.07                  | 0.07                 |
| Caregiver burden inventory                                   |                            |                               |                             |                       |                      |
| Time subscale, M ± SD (range)                                | 8.0 ± 5.9 (0–20)           | 7.3 ± 6.9 (0–20)              | 7.2 ± 5.5 (0–19)            | 0.03                  | 0.03                 |
| Relationship to patient                                      |                            |                               |                             |                       |                      |
| Spouse                                                       | 20 (30.8)                  | 19 (26.8)                     | 20 (30.3)                   | 0.14                  | 0.11                 |
| Adult child                                                  | 35 (53.8)                  | 35 (49.3)                     | 33 (50.0)                   | 0.05                  | 0.02                 |
| Other relative or friend                                     | 5 (15.4)                   | 17 (23.9)                     | 13 (19.7)                   | 0.10                  | 0.12                 |

ASC: Augmented Standard Care; ASMD: Absolute standardized mean differences; RNC: Resource Nurse Care; M: Mean; SD: Standard deviation; TCM: Transitional Care Model. Percentages may not add to 100 due to rounding. ASMD of 0.10 and 0.30 are considered small and medium, respectively [29].  
† Not included in the propensity score modeling.

comparisons between the higher dose TCM (hospital to home) group and the lower dose ASC and RNC (hospital only) interventions are presented below.

## Results

A total of 202 patients and their family caregivers participated in this study, with 65 in the ASC group (low dose), 71 in the RNC group (medium dose) and 66 in the TCM group (higher dose). [Table 1](#) provides descriptive details about the population; by comparing the before versus after-weighting maximum pairwise ASMD effect size estimates for each covariate, it is evident that the CBPS weighting successfully achieves significant selection bias reduction (see ASMD values in [Table 1](#)). [Tables 2 & 3](#) show a comparison of mean total cost and the mean cost for each postacute care service for each study group, as well as the cost of the TCM intervention at 30 days and 180 days postindex hospital discharge. We present cost comparison results at 30 and 180 days postindex hospitalization (immediate postdischarge impact and longer postacute impact, respectively).

The results indicate that, compared with either of the other two lower dose hospital based interventions, postacute care costs for traditional postacute services (other than TCM) were significantly lower for the TCM group in both time periods. Costs for individual components of postacute services also were lower for the TCM group when compared with the low dose intervention (ASC). See [Tables 2 & 3](#). Once the costs specifically associated with

**Table 2. Propensity score weighted postacute care and rehospitalization cost comparisons of the transitional care model vs other evidence-based interventions at 30 days postindex hospital discharge, n = 202.**

| Service                                                     | Site A; ASC (low); mean standard deviation <sup>†</sup> (95% CI) | Site B; RNC (medium); mean standard deviation <sup>†</sup> (95% CI) | Site C; TCM (high); mean standard deviation <sup>†</sup> (95% CI) | A vs C p-value | B vs C p-value |
|-------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------|----------------|----------------|
| Skilled nursing facility/rehabilitation hospital            | \$1789.93; \$278.25 (\$1211.93–\$2315.78)                        | \$1874.32; \$335.49 (\$1177.45–\$2457.29)                           | \$1123.79; \$214.69 (\$710.25–\$1525.26)                          | 0.068          | 0.088          |
| Home healthcare                                             | \$962.70; \$98.31 (\$770.048–\$1163.98)                          | \$935.27; \$99.02 (\$737.67–\$1127.43)                              | \$536.11; \$86.16 (\$368.43–\$710.52)                             | 0.002          | 0.004          |
| Total postacute care                                        | \$2752.63; \$294.88 (\$2140.52–\$3301.81)                        | \$2809.59; \$350.42 (\$2137.41–\$3461.14)                           | \$1659.97; \$226.82 (\$1210.88–\$2089.81)                         | 0.006          | 0.002          |
| TCM advanced practice nurse <sup>‡</sup>                    | –                                                                | –                                                                   | \$363.73; \$9.75 (\$344.05–\$382.53)                              | –              | –              |
| Total postacute care costs with TCM advanced practice nurse | \$2752.63; \$294.88 (\$2140.52–\$3301.81)                        | \$2809.59; \$350.42 (\$2137.41–\$3461.14)                           | \$2023.70; \$226.98 (\$1578.17–\$2451.95)                         | 0.068          | 0.080          |
| Total all-cause rehospitalizations                          | \$1973.00; \$375.41 (\$1207.84–\$2700.84)                        | \$1269.51; \$297.01 (\$642.29–\$1800.26)                            | \$675.02; \$231.60 (\$197.70–\$1086.61)                           | 0.002          | 0.118          |
| Other healthcare costs: Hospice                             | \$134.94; \$102.33 (\$0–\$237.06)                                | \$91.59; \$70.86 (\$0–\$160.59)                                     | \$0                                                               | <0.001         | <0.001         |
| Total costs                                                 | \$4860.58; \$501.99 (\$3839.51–\$5827.85)                        | \$4170.69; \$519.61 (\$3124.29–\$5125.56)                           | \$2698.72; \$365.05 (\$1978.84–\$3370.72)                         | <0.001         | 0.022          |

<sup>†</sup>TCM advanced practice nurse costs include the time spent on visits, calls, travel and documentation for each patient.

<sup>‡</sup>Calculated from the 1000 bootstrapped samples.

ASC: Augmented Standard Care; RNC: Resource Nurse Care; TCM: Transitional Care Model. Total costs includes total postacute care costs plus TCM costs plus all cause hospitalizations and hospice use.

**Table 3. Propensity score weighted postacute care cost and rehospitalization comparisons of the transitional care model vs other evidence-based interventions at 180 days (6 months) postindex hospital discharge, n = 202.**

| Service                                                     | Site A; ASC (low); mean standard deviation <sup>†</sup> (95% CI) | Site B; RNC (medium); mean standard deviation <sup>†</sup> (95% CI) | Site C; TCM (high); mean standard deviation <sup>†</sup> (95% CI) | A vs C p-value | B vs C p-value |
|-------------------------------------------------------------|------------------------------------------------------------------|---------------------------------------------------------------------|-------------------------------------------------------------------|----------------|----------------|
| Skilled nursing facility/rehabilitation hospital            | \$2316.27; \$418.30 (\$1467.32–\$3059.16)                        | \$3212.15; \$636.80 (\$1856.76–\$4258.27)                           | \$1327.87; \$218.20 (\$914.95–\$1763.53)                          | 0.040          | 0.006          |
| Home healthcare                                             | \$1313.63; \$135.02 (\$1033.04–\$1562.89)                        | \$1393.90; \$131.48 (\$1129.88–\$1641.44)                           | \$932.13; \$140.84 (\$640.78–\$1193.62)                           | 0.074          | 0.010          |
| Total postacute care                                        | \$3629.89; \$427.57 (\$2721.22–\$4397.99)                        | \$4606.05; \$643.17 (\$3294.87–\$5687.31)                           | \$2260.00; \$253.42 (\$1778.78–\$2769.27)                         | 0.008          | <0.001         |
| TCM advanced practice nurse <sup>‡</sup>                    | –                                                                | –                                                                   | \$803.546<br>\$30.36<br>(\$745.07–\$860.08)                       | –              | –              |
| Total postacute care costs with TCM advanced practice nurse | \$3629.89; \$427.57 (\$2721.22–\$4397.99)                        | \$4606.05; \$643.17 (\$3294.87–\$5687.31)                           | \$3063.55; \$263.38 (\$2551.47–\$3583.62)                         | 0.304          | 0.042          |
| Total all-cause hospitalizations                            | \$8096.19; \$1275.75 (\$5552.46–\$10,370.28)                     | \$5316.53; \$667.34 (\$3897.75–\$6511.87)                           | \$4769.04; \$843.82 (\$3002.44–\$6298.60)                         | 0.048          | 0.648          |
| Other healthcare costs: Hospice                             | \$134.944; \$102.33 (\$0–\$237.06)                               | \$127.137; \$72.69 (\$0–\$214.66)                                   | \$0                                                               | <0.001         | <0.001         |
| Total costs                                                 | \$11,861.02; \$1479.08 (\$8898.77–\$14425.38)                    | \$10,049.72; \$1031.17 (\$7866.15–\$11898.51)                       | \$7832.58; \$970.41 (\$5760.72–\$9562.81)                         | 0.028          | 0.124          |

<sup>†</sup>TCM advanced practice nurse costs include the time spent on visits, calls, travel and documentation for each patient.

<sup>‡</sup>Calculated from the 1000 bootstrapped samples.

ASC: Augmented Standard Care; CI: Confidence interval; RNC: Resource Nurse Care; TCM: Transitional Care Model. Total costs include total postacute care costs plus TCM costs plus all cause hospitalizations and hospice use.

providing the additional resources for TCM were included, the total mean postacute care costs were lowest for the TCM group, marginally significantly lower for the TCM group compared with both alternatives at 30 days (TCM vs ASC: \$2024 ± \$227 vs \$2753 ± \$295;  $p = 0.07$ ; TCM vs RNC: \$2034 ± \$227 vs \$2810 ± \$350;  $p = 0.08$ ), and significantly lower for TCM (\$3063 ± \$264) compared with RNC (\$4606 ± \$643) at 180 days ( $p = 0.04$ ).

While the study design was not powered to detect small differences in rehospitalization costs (determined using the same analytical methods described above), findings from the data do also reveal significantly lower inpatient

costs among rehospitalized TCM enrollees compared with enrollees in the Augmented Standard Care group at 30 and 180 days (30 days: TCM \$675 ± \$231 vs ASC \$1973 ± \$102;  $p = 0.002$  and 180 days: TCM \$4769 ± \$844 vs ASC \$8096 ± \$1276;  $p = 0.05$ ); there were no differences in rehospitalization costs between the TCM and Resource Nurse Care groups at either time interval. See [Tables 2 & 3](#).

Finally, when comparing the three intervention groups on all costs after the index hospitalization, we find that the TCM has significantly lower costs than the Augmented Standard Care group at both time intervals (30 days: TCM \$2699 ± \$365 vs ASC \$4861 ± \$502;  $p < 0.001$  and 180 days: TCM \$7833 ± \$970 vs ASC \$11861 ± \$1479;  $p = 0.03$ , respectively), and significantly lower costs than RNC at 30 days (TCM \$2699 ± \$365 vs RNC \$4171 ± \$520;  $p = 0.02$ ) and marginally at 180 days (TCM \$7833 ± \$970 vs RNC \$10050 ± \$1031;  $p = 0.12$ ). That is, in three of four comparisons, TCM was associated with significantly lower subsequent total resource costs.

## Discussion

This study provides robust evidence that the use of nurses with advanced preparation in the care of high risk patients with cognitive impairment and who are positioned to provide continuity of care between hospitals and home can reduce the use and cost of traditional post-acute care. The advanced practice registered nurse contributions are evident in reducing the number of home health visits and, of great importance, in decreasing skilled nursing facility use, the largest single component of post-acute care costs. Data from these three groups of hospitalized older adults with cognitive impairment suggest that the use of the TCM, substituting for traditional home care, may also decrease expensive SNF stay days. While other research suggests that access to services configured for the needs of this population [39,40] and the availability of family caregivers also matter [41–43], this study showed the effectiveness and cost savings at 6 months for the use of the TCM with hospitalized older adults with cognitive impairment and their family caregivers. Not only that, but TCM was also associated with lower costs after the index hospitalization once the reduced rehospitalization costs were taken into account, a reduction more than large enough to cover the specific incremental cost of the TCM intervention. The primary contribution of this research is to show that such care can substantially alter the pattern of patient use of postacute care and reduce its most expensive services.

## Limitations

This analysis needs to be qualified because only sites, not patients, could be randomly assigned to each model. Covariate balancing propensity score weighting successfully minimized the problem of subject selection bias arising from observable patient-specific confounding factors. We note that this approach, however, does not account for unobservable patient and site-specific confounders, and this is a limitation. While all three hospitals had the same policies and procedures for use of post-acute services (referral to home health care or skilled nursing facilities) there were no data available to confirm that prior to the study all three sites made similar referrals for this patient population with cognitive impairment. It is likely that the referral patterns were similar across all three sites but without specific data this is a limitation. One metric of quality, Medicare 30-day rehospitalization rates at each hospital in the study, remained consistent from the start of this study to final data collection [22], however, measures of the intensity of acute care across all three sites were not available. In addition, it is also possible there were differences in the quality of postacute care services, though it is likely that the quality and intensity of care for each type of postacute care service did not change differently across the patient populations from the three sites. Many of the same providers (e.g., skilled nursing facilities, home care agencies) serve all three hospitals in this study.

In addition, the comparison of total estimated costs (postacute plus rehospitalizations) between TCM and Resource Nurse Care may not have been as robust, largely because of inadequate power to detect cost differences associated with relatively uncommon rehospitalizations. However, the key finding that TCM significantly and substantially reduced post-acute care costs, especially those of skilled nursing facility stays, shows that such costs can be affected by the use of specially trained nurses. The result is buttressed by the finding that costs including both rehospitalization and post-acute costs were lower for TCM. These findings open up a rich array of research questions about the specific processes that bring about this outcome as well as challenges in increasing the efficacy or lowering the cost of TCM compared with standard care while preserving TCM's substantial advantage in lowering other costs. Finally, while Medicare payment rates were used from a single year to account for changes in reimbursement and regulations over the study period, this may overstate additional cost in the short run if there are hospital fixed costs; however, all of the sites were large enough to have overcome any increasing returns to scale.

While further replication of these results would be desirable, the current results do suggest that health care systems with high post-acute care costs should explore the use of specially prepared nurses who follow patients from hospital to home as a way of lowering those costs. With post-acute care costs rising to \$60 billion US dollars [44], even with Medicare-accountable care organizations Pioneer and Medicare Shared Savings Programs showing some savings in skilled nursing facility spending [45,46], payment incentives that foster (rather than discourage) efforts to lower post-acute care costs by reimbursing hospitals for effective methods to do so should be considered. Bundled payment or capitation that includes post-acute costs would have similar incentive effects. More generally, management should try to erase the artificial boundaries between inpatient care, formal postacute care and care at home, and instead focus on the total cost and quality of care at all sites.

Older adults with cognitive impairment, in addition to multiple chronic conditions, have high needs at hospital discharge, and are at high risk for rehospitalization as well as high use of costly postacute care services than those without cognitive impairments [17]. This is the first study reporting cost results of an evidence-based transitional care intervention tested with older adults with cognitive impairment that had previously been tested with cognitively intact patients. To date, to the best of our knowledge, these evidence-based transitional care interventions – Care Transitions Intervention [5], Project RED [6,7], or BOOST [8] – have not specifically targeted cognitively impaired older adults. This study shows that, even for this difficult to manage population, the use of evidence-based nursing interventions over a period of time can produce savings on post-acute care service costs and rehospitalizations – relying on advanced practice registered nurses with competencies in the care of high risk patient groups and continuity of care from the hospital to home. Careful discharge instructions in the hospital are not enough. This study adds to the body of evidence that the high cost of post-acute care is not inevitable, and can be altered by nurse-led interventions.

#### Summary points

- The goal of this study was to determine the effects on the use and cost of postacute care overall and by type of postacute care service for a population of hospitalized cognitively impaired older adults who received one of three evidence-based care management interventions implemented in three different hospitals.
- The postacute care costs of three evidence-based interventions of varying intensity (two hospital based and one hospital-to-home), designed to decrease postacute care use and costs for hospitalized cognitively impaired older adults, were compared at 30- and 180-days postindex hospital discharge.
- A total of 202 cognitively impaired, hospitalized older adults and their family caregivers were enrolled and received to one of three intervention protocols based on hospital site: augmented standard care (lower dose,  $n = 65$ ), resource nurse care (medium dose;  $n = 71$ ), or the transitional care model (TCM) (higher dose,  $n = 66$ ).
- Covariate balanced propensity score weighted analyses using the Lin method were used to compare costs at 30- and 180-days postindex hospital discharge.
- The TCM had significantly lower costs than the augmented standard care group at both 30 ( $p < 0.001$ ) and 180 days ( $p = 0.03$ ) and significantly lower costs than resource nurse care at 30 days ( $p = 0.02$ ).
- These findings suggest that the TCM, which includes specialized nurse inputs during both hospitalizations and postdischarge, can reduce both the amount of other postacute care and the total cost of care compared with alternative models of hospital-based transitional services for cognitively impaired older adults.

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#### Ethical conduct of research

The authors state that they have obtained appropriate institutional review board approval or have followed the principles outlined in the Declaration of Helsinki for all human or animal experimental investigations. In addition, for investigations involving human subjects, informed consent has been obtained from the participants involved.

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