Effectiveness of the Rural Transitions Nurse Program for Veterans: A Multicenter Implementation Study

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Abstract

Background

Veterans are often transferred from rural areas to urban VA Medical Centers for care. The transition from hospital to home is vulnerable to post-discharge adverse events.

Objective

To evaluate the effectiveness of the rural Transitions Nurse Program (TNP).

Design, Setting, Participants

National hybrid-effectiveness-implementation study, within site propensity matched cohort in 11 urban VA hospitals. 3,001 Veterans were enrolled in TNP from April 2017 to September 2019, and 6,002 matched controls.

Intervention, Outcomes

The intervention was led by a transitions nurse who assessed discharge readiness, provided post-discharge communication with primary care providers (PCP), and called the Veteran within 72 hours of discharge home to assess needs, and encourage follow-up appointment attendance. Controls received usual care. The primary outcomes were PCP visits within 14-days of discharge and all-cause 30-day readmissions. Secondary outcomes were 30-day emergency department (ED) visits and 30-day mortality. Patients were matched by length of stay, prior hospitalizations and PCP visits, urban/rural status, and 32 Elixhauser comorbidities.

Results

The 3,001Veterans enrolled in TNP were more likely to see their PCP within 14-days of discharge than 6,002 matched controls (Odds Ratio 2.24, 95% CI 2.05-2.45). TNP enrollment was not associated with reduced 30-day ED visits or readmissions but was associated with reduced 30-day mortality (Hazard Ratio 0.33, 95% CI 0.21-0.53). PCP and ED visits did not have a significant mediating effect on outcomes. The observational design, potential selection bias, and unmeasurable confounders limit causal inference.

Conclusions

TNP was associated with increased post-discharge follow-up and a mortality reduction. Further investigation to understand the reduction in mortality is needed.

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INTRODUCTION

Patients who live in rural communities in the United States frequently receive care in urban tertiary hospitals and are uniquely vulnerable during care transitions due to lower rates of follow-up care, greater risk of emergency department (ED) visits,[1] and higher 30-day mortality post-hospitalization.[1-4] Of the almost 9 million Veterans enrolled in the U.S. Department of Veterans Affairs (VA) for care, more than 3 million live in rural communities and receive primary care at local "spoke" sites and acute hospital-level care in urban "hub" centers.[5] Rural Veterans hospitalized at urban "hub" VA Medical Centers (VAMC) are at higher risk for post-discharge adverse events due to geographic and distance barriers (e.g., hundreds of miles between hospital and home)[3], rural primary and specialty care shortages, and communication challenges between urban and rural providers.[1,2,6]

The preventability of post-hospitalization adverse events, including unplanned readmission, is a significant focus both nationally and within VA as approximately 25% of readmissions are potentially preventable.[7,8] Effective transitions of care programs frequently share key components, including: enhanced discharge planning through discharge readiness assessments and medication reconciliation, patient education to promote self-management after discharge, timely discharge follow-up, and enhanced care coordination among team members.[9-14] These programs are frequently led by clinicians, including advanced practice nurses,[15,16,17] nurse case managers,[18] or discharge advocates and clinical pharmacists.[19]

Because the unique challenges of rural Veterans transitioning back home after hospitalization in an urban VAMC had not previously been assessed and addressed,[20,21] our team developed and pilot-tested a rural Transitions Nurse Program (TNP) at one VAMC. Veterans who received the TNP had higher rates of primary care provider (PCP) follow up within 14 days and a 7% absolute reduction in 30-day readmissions ($p=0.06$) compared to a matched VAMC not involved with TNP.[6,22] Due to promising pilot results, a larger-scale program was funded to implement and evaluate the effectiveness of TNP on Veteran outcomes at 11 urban VAMCs serving a geographically diverse population of Veterans. The aim of this paper is to evaluate the effectiveness of the TNP on Veteran outcomes.

STUDY DESIGN

The TNP was designed as a hybrid type 2 effectiveness-implementation study[23] involving 11 sites over two years. Evaluation was guided by the Reach, Effectiveness, Adoption, Implementation, Maintenance (RE-AIM) Framework, with outcomes related to multiple RE-AIM domains reported previously.[24,22,25-30] In this analysis, we describe evaluation of the TNP effectiveness with an observational cohort comparing outcomes for TNP-enrolled Veterans to within-site propensity matched controls (1:2). This approach was selected to address hospital-level confounders. Patient-level randomization was not feasible due to the constraints of the funding mechanism. The manuscript is written in accordance with the Standards for Quality Improvement Reporting and Excellence Guidelines.[31]

METHODS

Setting

VA is the largest integrated health care system in the United States, providing acute care at ~140 hospitals. The 11 urban VAMCs were geographically dispersed across the United States (Appendix Figure 1), were university-affiliated teaching hospitals, and discharged more than 1,000 Veterans annually. All Veterans, including TNP and propensity matched controls, received similar discharge services (e.g., discharge education, medication reconciliation, and follow-up appointment recommendations).

TNP Intervention

Twelve transitions nurses were hired and trained at 11 VA hospitals to complete the TNP.[32] Transitions nurse training included: education on their role in care coordination and transitions, motivational interviewing, and a protocol describing the TNP intervention within a toolkit. After completion of online training, transitions nurses worked with standardized patients and completed simulated skills practice and assessment.

Enrollment in TNP was conducted by each transitions nurse based on site priorities and program eligibility criteria (Appendix Table 1). Veterans were eligible for TNP if they met all the following criteria: admitted to an inpatient setting (excluding psychiatry), assigned a VA PCP, resident of a rural community or resided in an urban setting and had multiple high-risk conditions (i.e., high VA Care Assessment Needs Score [CAN]) that increased their risk of readmission, and were discharging home. Veterans were also enrolled if they met eligibility criteria and were referred by an inpatient medical team member (versus being identified by a transitions nurse). Veterans were not eligible for TNP if they were: transferred from another facility to the VA, receiving non-VA primary care discharged with hospice or palliative care, or discharged to a skilled nursing or rehabilitation facility.

The TNP intervention included four core components that were not routine care coordination activities during the study timeframe: (1) identify eligible Veterans and provide bedside counseling and assessment of discharge readiness, (2) schedule PCP appointments within 14 days of discharge, and communicate with inpatient and outpatient care teams, (3) ensure health information transfer to all VA and non-VA care teams, and, (4) call the Veteran within 72 hours of discharge to review progress and the plan of care.[22] Transition nurse documentation in a TNP database was used to assess fidelity to and completion of each component. The transitions nurse was the designated point of contact for Veterans and their caregivers until the first PCP appointment and/or 14-days post-discharge.[22] Due to the time-intensive nature of the TNP, enrollment goals for each site were set at ~30 Veterans a month.

Study Cohort Creation

For the non-TNP (i.e., matched) cohort, inclusion and exclusion criteria aligned with those used for TNP enrollees. Although the focus of TNP was high-risk Veterans from rural communities who were discharged home, many urban-residing Veterans were enrolled due to inpatient medical team requests or due to similar high-risk medical or social issues as rural Veterans (e.g., comorbidities, lack of support) that increased readmission risk.

Data sources

VA clinical data were obtained from the VA Corporate Data Warehouse, including VA "fee-basis" data in which VA paid for care in the community. Rurality data were obtained using residential addresses matched to Rural-Urban Commuting Area geographical categories from the VA's Planning and Systems Support Group. Death data were obtained from the VA Vital Status File (complete through December 2020). We obtained Medicare Provider Analysis and Review and Master Beneficiary Summary Files for TNP and non-TNP enrolled Veterans to identify health care utilization and mortality outside VA. We did not obtain data from commercial insurers or Medicaid regarding PCP visits or readmissions.

Outcomes

The primary outcomes of interest were PCP visits within 14 days of discharge (process outcome) and all-cause 30-day readmissions (utilization outcome). Secondary outcomes included ED visits and mortality within 30 days after discharge.

Matching and Confounding Variables

We chose variables to match based on propensity to receive the TNP intervention and based on known risk factors for 30-day readmissions (Table 1).[33,34] Given the large control group, nearest neighbor matching was used in a 1:2 fashion to increase statistical power while controlling the risk of introducing bias into the sample. All available covariates were assessed for achieving covariate balance, including the CAN score, which calculates the severity of illness and predicts hospitalization and death in Veterans and includes patient level demographics, and data regarding pharmacy visits and laboratory results.[35] Matching was assessed using standardized mean differences (SMD), restricting to common support, with a threshold of $\leq$0.10 indicating minimal residual differences.

Statistical Analysis

To create the control cohort, we matched each TNP Veteran with two unenrolled Veterans who had an inpatient discharge during the same timeframe (e.g., date of hospital discharge) that TNP was enrolling Veterans at each site. Since patient selection, program implementation, and population characteristics were expected to vary between VAMCs, we matched within each TNP site to address hospital-level confounding. Single imputation and multivariate imputation with chained equations were implemented on race and ethnicity (both were missing in <5% of the population) and rurality (missing in <1%) variables. The propensity scores were used to create the matched cohort and were not included in the subsequent outcome model analyses.

Bivariate analyses were completed using t-tests or Pearson Chi-square tests to compare continuous or categorical variables between groups, respectively. PCP visits within 14 days and ED visits within 30 days were modeled using logistic regression and treated as a binary outcome; odds ratios (OR) were calculated to show effects of TNP enrollment on PCP visits. Readmission at 30 days and mortality were modeled using cox proportional hazards models and treated as time to event outcomes; hazard ratios (HR) were calculated to show effects for time to event outcomes. Assumption of proportionality in the time to event models was assessed and was acceptable. P-values were obtained with bootstrapping. Death was considered a censoring event.

Additional post-hoc sensitivity analyses included use of an interaction term in each model to examine if TNP had a different effect on clinical outcomes for rural compared to urban Veterans. Mediation tests were conducted to determine the indirect effect of TNP on utilization and survival outcomes (i.e., readmissions, ED visits, and mortality) through increasing PCP visits within 14 days.[36] E-values were calculated for the mortality outcome to determine the minimum strength of association that an unmeasured confounder would need to have on both the outcome and intervention to explain a specific treatment-outcome association.[37] P-values were two tailed. Significance was set at 0.05. Analyses were conducted using SAS® v9.2 (Cary, NC), and R v3.5.

RESULTS

Cohort Characteristics Before and After Matching

Between April 1, 2017, and September 30, 2019, the available cohort of patients included 3,080 TNP Veterans and 58,245 eligible controls for matching (Appendix Table 2). Reflective of a Veteran population, only 4% of the cohort (n = 342) were female, with a mean age of 68.5 years. About 8% were non-white and 3% were Hispanic. The mean CAN score at admission was 81 (range 0-99). Rural Veterans were more common in the TNP group compared to controls (68% vs 63%: SMD 0.12). For the index admission, 57% of the total cohort were admitted to the hospital for short stays (< 120 hours). Only 8% of the total cohort were admitted to a surgical service. In terms of health care utilization, 34% of the cohort had a hospital admission in the previous year and 95% had visited a primary care provider in the previous year.

In total, 3,001 TNP Veterans were matched to 6,002 non-enrolled Veterans at a 1:2 ratio from 11 VA hospitals. 79 TNP Veterans were dropped from the analysis for there were no match within the control population. Differences between the TNP and non-TNP enrolled cohort were reduced after the match (Table 1), with all SMDs <0.10 with the exception of rurality (SMD = 0.12), diabetes with (SMD = 0.12) and without complications (SMD = 0.11), and obesity (SMD = 0.11).

Bivariate Analysis of Outcomes

As outlined in Table 2, 54% of the TNP cohort attended a PCP visit within 14 days, compared to 34% of controls (p<0.01). The average time to PCP follow-up was 7 days for both groups. There were no statistically significant differences for readmissions or ED visits. There were few deaths within 30 days of discharge in the cohort, however there were significantly fewer in TNP Veterans compared to controls (0.8% vs. 2.3%, p<0.01). In total, 53 patients were readmitted at or prior to death. Of these, 8 (6.6%) were enrolled in TNP and 45 (85%) were controls. The mediating effect of readmission on death was non-significant (p = 0.8).

Modeling of Outcomes

In the regression models, the TNP group had a higher odds of PCP follow up within 14 days with an odds ratio (OR) of 2.24 (95% CI 2.05-2.45). Readmissions and ED visits were not significantly different between groups at 7 or 30 days (Appendix Figure 2). Death within 30 days was markedly lower in the TNP

group with a hazard ratio (HR) of 0.33 (95% CI 0.21-0.53) (Table 3). The Kaplan-Meier curve for mortality separated the most within the first 7 days post-hospitalization (Figure 1).

Post-Hoc Sensitivity Analyses

PCP visits within 14 days were similar in both rural and urban subgroups enrolled in TNP (interaction p=0.32) (Table 3). However, a higher HR for readmission was identified in rural compared to urban TNP enrollees (HR 1.16 versus 0.81, respectively, interaction p=0.01). A similar association was observed for ED visits in rural versus urban TNP enrollees (OR 1.19 and 0.90, respectively, interaction p=0.02). There was a reduced HR for 30-day mortality in TNP enrollees in both urban and rural areas, without evidence of effect modification by rurality (interaction p=0.26).

No significant mediation effect for PCP visits on any outcome was noted (i.e., readmission: $p = 0.85$, ED visits: $p = 0.85$, death: $p = 0.97$). Finally, an E-value for the 30-day mortality outcome was 5.4 (SD, 3.1) indicating a very strong unmeasured confounder would be needed to push the 30-day mortality finding out of significance. Similarly, the E-value was calculated for 30-day mortality in the rural and urban TNP enrollees as 6.6 (SD, 2.9) and 3.8 (SD, 1.4), respectively.

DISCUSSION

In this multi-site implementation study across 11 VA hospitals, enrollment in the TNP intervention was associated with an increase in PCP visits within 14 days of discharge, but no decrease in 30-day readmissions or ED visits. However, TNP was associated with significantly decreased 30-day mortality, with the largest changes in the first week following hospital discharge.

TNP was designed to incorporate four key components that had been effective in prior transitional care studies,[9] with a unique focus on VAMC to rural home transitions for Veterans. The design and implementation of TNP was theoretically guided [26,28] and included rigorous pre-implementation assessment [25,27] to adapt the intervention to local contexts. Fidelity to the four-step TNP intervention was high (>96%), which explains the

finding that Veterans enrolled in TNP were more likely to have PCP visits within 14 days.[32] The TNP pilot identified a trend toward fewer unplanned 30-day readmissions that was not detected in this study. We attribute this to the higher baseline readmission rate in the pilot population pre-intervention (18% TNP and 15% controls) compared to this study (12% TNP and 11% controls) and the novelty of a structured nurse-driven care coordination program at that time.[6] Since the initial design of TNP, structured care coordination interventions are increasingly offered to high-risk patients.[38]

In addition, our findings are consistent with prior studies in which the relationship between timely outpatient follow-up and acute care outcomes including readmissions has been variable. While some studies have found no difference or an increase in readmissions with timely outpatient follow-up, other studies have found reductions in readmissions with timely outpatient follow-up, [39-41] particularly for high-risk patient groups.[38,42,43]

The substantially reduced 30-day mortality rate in Veterans who received the TNP intervention was notable and unexpected. Given the non-randomized design, unmeasured or unmeasurable confounding may play a role. We attempted to understand the mortality finding with mediation analyses. We hypothesized that timely post-discharge follow-up may have identified medical issues, which in turn could have prompted referrals to the ED or hospital while avoiding death. However, the mediation analyses did not identify a significant mediating effect of 14-day PCP follow-up on 30-day readmissions, ED visits, or mortality. The Kaplan-Meier survival curve for mortality differed most in the first 7 days post-discharge. Some patients were readmitted prior to death, however the difference in those readmitted before death between TNP and controls was non-significant. The early separation in curves could suggest the pre-discharge interactions were impactful, but it appears unlikely that the separation in curves was the result of earlier readmissions in the TNP group given the non-significant differences in readmissions prior to death.

The SMD scores between TNP enrollees and controls overall suggest that the matching was effective with the variables available, with only rurality, diabetes, and obesity just above the SMD threshold. However, important factors that are associated with readmissions, ED visits, and mortality outcomes, such as physical and

cognitive function, caregiver support, and structural factors important to care such as transportation, housing, and food security were not measured. It is possible that Veterans enrolled in TNP had more community or social support than controls or had different levels of physical and/or cognitive function that contributed to decreased mortality after discharge. We found that a confounder with an E value >5 would be needed to affect the mortality outcome so that it was no longer significantly different between groups. Therefore, while unmeasured confounders may still be present, the strength of the confounder would need to be substantial to eliminate the mortality reduction for the TNP versus control group.

In turn, this may suggest that the additional care transitions support met a key need for Veterans after hospital discharge to home. For example, the pre-discharge interactions with Veterans to assess discharge readiness may have identified important information about social supports that influenced the inpatient team's discharge plan. Further, TNP may uniquely address the geographic and systematic fragmentation for Veterans transitioning from urban VAMCs to their rural communities. This is consistent with prior studies that identified higher readmissions and ED visits in older adults who reside in rural (versus urban) communities following hospital discharge.[1,4,44] A recent analysis of Medicare beneficiaries discharged to home found that in rural compared to urban counties, adjusted readmission and mortality rates were 0.4% higher at 30 days.[4]

Additional studies have emerged that suggest areas for expansion of this program. For example, a recent multi-method study within 10 VAMCs found that centers that used a greater number of 20 unique care transitions processes (e.g., patient education, discharge checklists, social/community support provision) had lower readmission rates.[45] As a result, additional components of transitional care, such as assessment for social and community support needs like housing and food delivery, could broaden TNP eligibility and improve readmissions and ED visits.

Given the non-randomized study design, the reduced mortality finding should be interpreted with caution as enrollment selection bias and residual confounding may be affecting results. To better understand this finding, we did conduct propensity matching and sensitivity analyses. In addition, because this was a pragmatic quality improvement study in VA, the participating sites had flexibility to adjust enrollment criteria to local VA

priorities. This resulted in a heterogeneous sample of TNP enrollees. To mitigate some of this heterogeneity, the propensity matching was performed within hospitals.

We found that in Veterans transitioning from urban tertiary VA hospitals back to their rural communities, TNP was associated with increased post-discharge follow-up, unchanged readmissions or ED visits, and a substantial mortality reduction. This suggests the program components were effective in ensuring timely post-hospitalization follow-up and a reduction in mortality for Veterans.

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Table 1. Post-matching Characteristics of TNP and Non-TNP Enrolled Veterans

Characteristic	Control (n=6,002)	TNP (n=3,001)	Total Cohort (n=9,003)	SMD*
VA Medical Centers *n (%)*				<0.001
Site 1	666 (11.1)	333 (11.1)	999 (11.1)	
Site 2	76 (1.3)	38 (1.3)	114 (1.3)	
Site 3	886 (14.8)	443 (14.8)	1329 (14.8)	
Site 4	502 (8.4)	251 (8.4)	753 (8.4)	
Site 5	700 (11.7)	350 (11.7)	1050 (11.7)	
Site 6	626 (10.4)	313 (10.4)	939 (10.4)	
Site 7	512 (8.5)	256 (8.5)	768 (8.5)	
Site 8	288 (4.8)	144 (4.8)	432 (4.8)	
Site 9	532 (8.9)	266 (8.9)	798 (8.9)	
Site 10	332 (5.5)	166 (5.5)	498 (5.5)	
Site 11	882 (14.7)	441 (14.7)	1323 (14.7)	
Gender = Female, *n (%)*	238 (4.0)	104 (3.5)	342 (3.8)	0.03
Race = Non-white, *n (%)*	511 (8.5)	225 (7.5)	736 (8.2)	0.04
Ethnicity = Hispanic, *n (%)*	200 (3.3)	89 (3.0)	289 (3.2)	0.02
Mean age at admission (SD), *y*	68.36 (11.10)	68.80 (10.50)	68.51 (10.91)	0.04
Mean Care Assessment Need Score at time of admission, (SD)	81.79 (19.8)	81.31 (19.2)	81.63 (19.63)	0.03
+ Urban-Rural-Highly Rural, *n (%)*				0.12
Urban	2082 (34.7)	871 (29.0)	2953 (32.8)	
Rural	3780 (63.0)	2047 (68.2)	5827 (64.7)	
Highly rural	140 (2.3)	83 (2.8)	223 (2.5)	
Observed Length of Stay, *n (%)*				0.05
Long stay (>120 hours)	1672 (27.9)	898 (29.9)	2570 (28.5)	
Short stay (<120 hours)	3467 (57.8)	1668 (55.6)	5135 (57.0)	
Observation (<1-48 hours)	863 (14.4)	435 (14.5	1298 (14.4)	
Inpatient Service = Surgery, n (%)	475 (7.9)	235 (7.8)	710 (7.9)	0.00
Mean hours index length of stay (SD)	103.00 (128.59)	106.44 (106.80)	104.15 (121.76)	0.03
Any hospitalization year prior to admission, *n (%)*	2002 (33.4)	1080 (36.0)	3082 (34.2)	0.06
Number of primary care visits in prior year, *n (%)*				0.07
0	370 (6.2)	150 (5.0)	520 (5.8)	
1-2	2033 (33.9)	993 (33.1)	3026 (33.6)	
3-4	1883 (31.4)	936 (31.2)	2819 (31.3)	
5-8	1370 (22.8)	711 (23.7)	2081 (23.1)	
9+	346 (5.8)	211 (7.0)	557 (6.2)	
# Elixhauser Categories, *n (%)*				
Complicated hypertension	4670 (77.8)	2430 (81.0)	7100 (78.9)	0.08
Congestive heart failure	1872 (31.2)	1062 (35.4)	2934 (32.6)	0.09

Valvular disease	699 (11.6)	411 (13.7)	1110 (12.3)	0.06
Pulmonary circulation disease	185 (3.1)	130 (4.3)	315 (3.5)	0.07
Peripheral vascular disease	900 (15.0)	550 (18.3)	1450 (16.1)	0.09
Paralysis	170 (2.8)	84 (2.8)	254 (2.8)	0.01
Other neurological disorders	764 (12.7)	393 (13.1)	1157 (12.9)	0.01
Chronic pulmonary disease	2138 (35.6)	1127 (37.6)	3265 (36.3)	0.04
Diabetes without chronic complications	1791 (29.8)	1056 (35.2)	2847 (31.6)	0.11
Diabetes with chronic complications	1832 (30.5)	1079 (36.0)	2911 (32.3)	0.12
Hypothyroidism	844 (14.1)	447 (14.9)	1291 (14.3)	0.02
Renal failure	1448 (24.1)	804 (26.8)	2252 (25.0)	0.06
Liver disease	649 (10.8)	362 (12.1)	1011 (11.2)	0.04
Peptic ulcer disease - bleeding	95 (1.6)	54 (1.8)	149 (1.7)	0.02
AIDS	20 (0.3)	9 (0.3)	29 (0.3)	0.01
Lymphoma	126 (2.1)	76 (2.5)	202 (2.2)	0.03
Metastatic cancer	185 (3.1)	118 (3.9)	303 (3.4)	0.04
Solid tumor without metastasis	573 (9.5)	368 (12.3)	941 (10.5)	0.09
Rheumatoid arthritis/collagen	164 (2.7)	101 (3.4)	265 (2.9)	0.04
Coagulopathy	429 (7.1)	235 (7.8)	664 (7.4)	0.03
Obesity	1329 (22.1)	811 (27.0)	2140 (23.8)	0.11
Weight Loss	552 (9.2)	302 (10.1)	854 (9.5)	0.03
Fluid and electrolyte disorders	1884 (31.4)	1045 (34.8)	2929 (32.5)	0.07
Chronic blood loss anemia	113 (1.9)	69 (2.3)	182 (2.0)	0.03
Deficiency anemias	1592 (26.5)	912 (30.4)	2504 (27.8)	0.09
Alcohol abuse	655 (10.9)	352 (11.7)	1007 (11.2)	0.03
Drug abuse	282 (4.7)	140 (4.7)	422 (4.7)	0.01
Psychoses	419 (7.0)	235 (7.8)	654 (7.3)	0.03
Depression	1525 (25.4)	799 (26.6)	2324 (25.8)	0.03
Myocardial infarction	173 (2.9)	122 (4.1)	295 (3.3)	0.07

Key: * Standardized mean differences between sample means/pooled standard deviation. Values >0.1 are considered not ideally balanced. + Urban-Rural-Highly Rural zip code classification defined by the VA's Planning and Systems Support Group. # Elixhauser categories defined by Healthcare Cost and Utilization Project Elixhauser comorbidity software (FY17v of ICD-10 codes).

Table 2: Bivariate Analyses: Outcomes of TNP and Controls

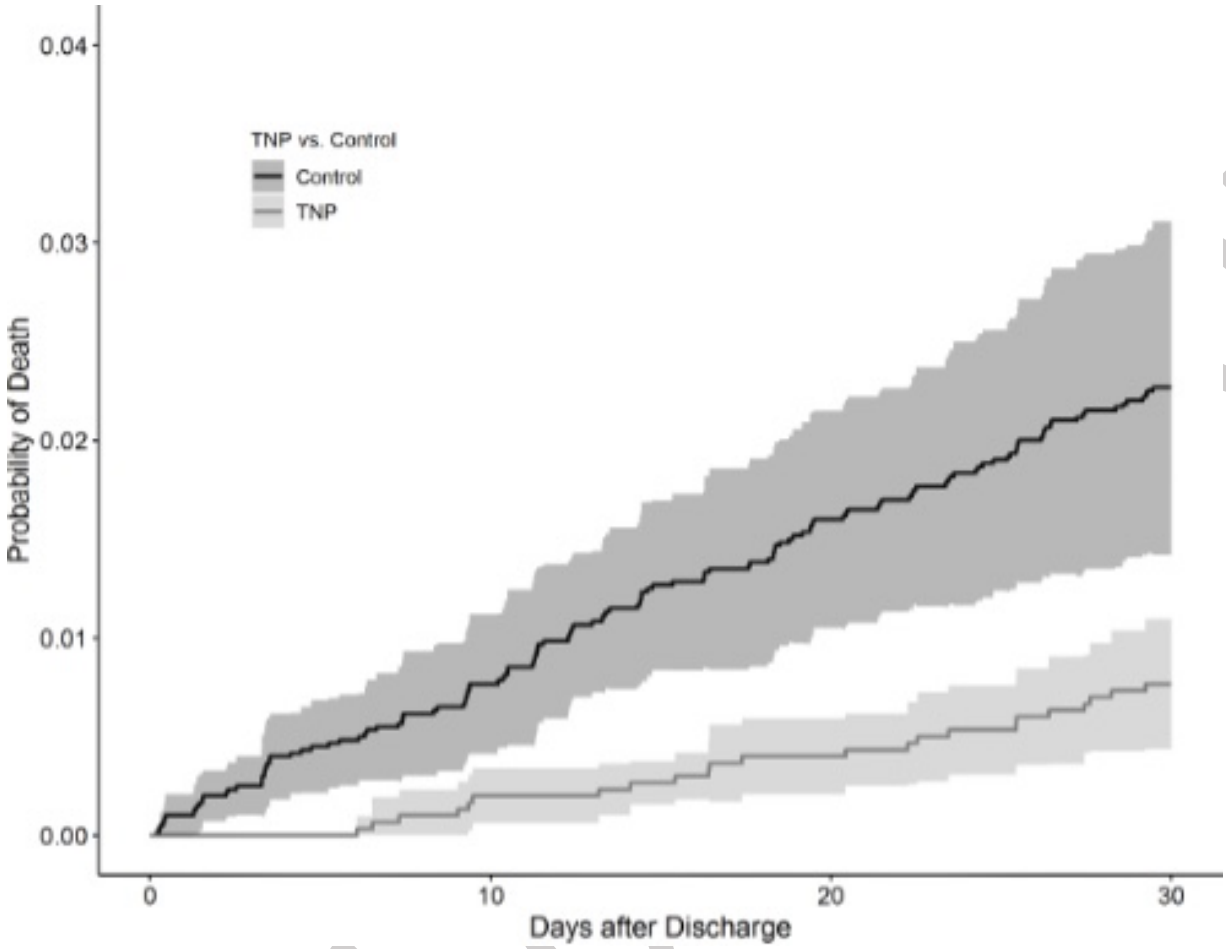
Outcomes	***Control*** **(n=6,002)** **N (%)**	***TNP*** **(n=3,001)** **N (%)**	***P. value***
Primary care visit within 14 days	2065 (34.4)	1622 (54.0)	<0.001
Rural Subgroup	1374 (35.1)	1179 (55.4)	<0.001
Urban Subgroup	691 (33.2)	443 (50.9)	
Readmissions within 30 days	697 (11.6)	363 (12.1)	0.503
Rural Subgroup	422 (10.8)	267 (12.5)	0.022
Urban Subgroup	275 (13.2)	96 (11.0)	
Emergency department visit within 30 days	1313 (21.9)	698 (23.3)	0.145
Rural Subgroup	802 (20.5)	500 (23.5)	0.001
Urban Subgroup	511 (24.5)	198 (22.7)	
Death within 30 days	136 (2.3)	23 (0.8)	<0.001
Rural Subgroup	78 (2.0)	12 (0.6)	<0.001
Urban Subgroup	58 (2.8)	11 (1.3)	

Table 3: Regression Model Analyses: Outcomes of TNP versus Controls

Regression Models	***Method***	***Estimate [95% CI]***	***P. value***
Primary care visit within 14 days	Odds Ratio	2.24 [2.05-2.45]	<0.001
Rural Subgroup		2.30 [2.06-2.55]	<0.001
Urban Subgroup		2.08 [1.77-2.44]	<0.001
Readmissions within 30 days	Hazard Ratio	1.03 [0.91-1.17]	0.60
Rural Subgroup		1.16 [1.00-1.36]	0.046
Urban Subgroup		0.81 [0.64-1.02]	0.080
Emergency department visit within 30 days	Odds Ratio	1.08 [0.98-1.20]	0.14
Rural Subgroup		1.19 [1.05-1.35]	0.005
Urban Subgroup		0.90 [0.74-1.08]	0.300
Death within 30 days	Hazard Ratio	0.33 [0.21-0.53]	<0.001
Rural Subgroup		0.28 [0.15-0.57]	<0.001
Urban Subgroup		0.44 [0.23-0.93]	0.005

Key: CI = confidence interval.

Figure 1. Propensity Matched, Kaplan-Meier Survival Curve: TNP and Non-TNP Enrolled Veteran Death within 30 Days after Discharge. TNP deaths (n = 23) compared to matched veteran deaths (n = 23) 30 days after discharge were markedly lower with a hazard ratio of 0.33 (95% CI 0.21- 0.53). Assumption of non-informative censoring was met.



Appendix Table 1: TNP Eligibility Criteria

All criteria must be met:

1. Admitted to inpatient medicine
2. Admitted to another specialty (Surgery, Rehab, etc.) with clear discharge follow up needs or as requested by the Attending physician or Senior Resident
3. Assigned to a VA primary care provider (PCP)
    a. If veteran not currently assigned to a VA PCP – transitions nurse will match them to a VA PCP
4. Veteran residency is within an urban/rural/highly rural setting
5. Veterans from outside of TNP hospital catchment area (domestic or international veteran) as requested by VA Traveling Veteran Program Coordinator
6. Veteran has multiple high-risk conditions (i.e., high VA Care Assessment Needs Score [CAN]) that increases their risk of readmission
7. Discharged home

Non-Eligible Patients

1. Veteran transferred from another hospital to VA facility with TNP program
2. Admitted to inpatient psychiatry
3. Does not use the VA for primary care/ (use another health care system)
4. Transferred to a non-VA hospital at end of hospital stay
5. Discharged from the VA to a non-VA hospital
6. Discharged to a skilled nursing, rehabilitation facility, or home-based primary care
7. Discharged with hospice or palliative care services, community nursing home care, hospital in home, medical foster home, psychosocial, residential, telephone or state rehabilitation treatment
8. No working telephones
9. Chronic heart failure admission receiving care coordination services through other group
10. Deceased at time of discharge

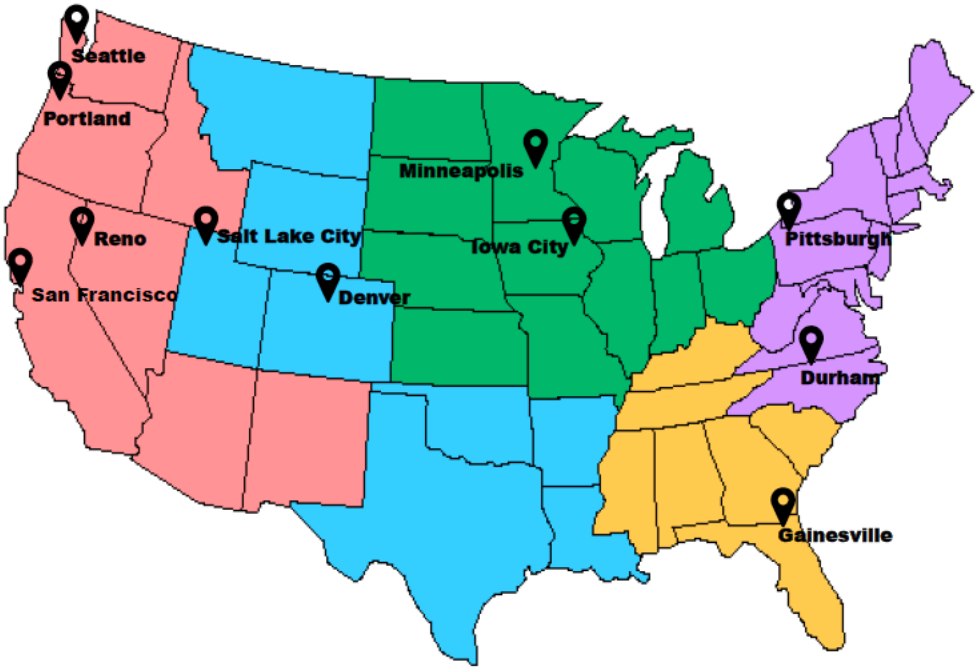
Appendix Table 2. Pre-matching Characteristics of TNP and Non-TNP Enrolled Veterans

Characteristic	Control (n=58,245)	TNP (n=3,080)	Total Cohort (n = 61,325)	SMD*
VA Medical Centers *n (%)*				0.37
Site 1	6487 (11.1)	333 (10.8)	6820 (11.1)	
Site 2	2533 (4.3)	39 (1.3)	2572 (4.2)	
Site 3	7852 (13.5)	454 (14.7)	8306 (13.5)	
Site 4	5984 (10.3)	260 (8.4)	6244 (10.2)	
Site 5	3176 (5.5)	358 (11.6)	3534 (5.8)	
Site 6	9428 (16.2)	314 (10.2)	9742 (15.9)	
Site 7	5559 (9.5)	267 (8.7)	5826 (9.5)	
Site 8	2510 (4.3)	148 (4.8)	2658 (4.3)	
Site 9	5244 (9.0)	286 (9.3)	5530 (9.0)	
Site 10	3630 (6.2)	174 (5.6)	3804 (6.2)	
Site 11	5842 (10.0)	447 (14.5)	6289 (10.3)	
Gender = Female, n (%)	3906 (6.7)	104 (3.4)	4010 (6.5)	0.15
Race = Non-white, n (%)	8672 (14.9)	231 (7.5)	8903 (14.5)	0.24
Ethnicity = Hispanic, n (%)	2142 (3.7)	90 (2.9)	2232 (3.6)	0.04
Mean age at admission (SD), y	66.39 (12.71)	68.82 (10.46)	66.51 (12.62)	0.21
Mean Care Assessment Need Score at time of admission, (SD)	76.25 (21.49)	81.57 (19.20)	76.52 (21.41)	0.26
+ Urban-Rural-Highly Rural, n (%)				0.83
Urban	38910 (66.8)	878 (28.5)	39788 (64.9)	
Rural	18752 (32.2)	2114 (68.6)	20866 (34.0)	
Highly rural	583 (1.0)	88 (2.9)	671 (1.1)	
Observed Length of Stay, n (%)				0.39
Long stay (>120 hours)	9876 (17.0)	955 (31.0)	10831 (17.7)	
Short stay (<120 hours)	33739 (57.9)	1686 (54.7)	35425 (57.8)	
Observation (<1-48 hours)	14630 (25.1)	439 (14.3)	15069 (24.6)	
Inpatient Service = Surgery, n (%)	20844 (35.8)	243 (7.9)	21087 (34.4)	
Mean hours index length of stay (SD)	79.92 (164.25)	108.82 (109.10)	81.37 (162.05)	0.21
Any hospitalization year prior to admission, n (%)	11690 (20.1)	1130 (36.7)	12820 (20.9)	0.38
Number of primary care visits in prior year, n (%)				0.25
0	4544 (7.8)	153 (5.0)	4697 (7.7)	
1-2	22877 (39.3)	1007 (32.7)	23884 (38.9)	
3-4	18037 (31.0)	952 (30.9)	18989 (31.0)	
5-8	10470 (18.0)	739 (24.0)	11209 (18.3)	
9+	2317 (4.0)	229 (7.4)	2546 (4.2)	
# Elixhauser Categories, *n (%)*				
Complicated hypertension	30527 (52.4)	2505 (81.3)	33032 (53.9)	0.65
Congestive heart failure	7419 (12.7)	1118 (36.3)	8537 (13.9)	0.57
Valvular disease	2797 (4.8)	445 (14.4)	3242 (5.3)	0.33
Pulmonary circulation disease	487 (0.8)	152 (4.9)	639 (1.0)	0.25
Peripheral vascular disease	4224 (7.3)	587 (19.1)	4811 (7.8)	0.36

Paralysis	1189 (2.0)	87 (2.8)	1276 (2.1)	0.05
Other neurological disorders	4374 (7.5)	413 (13.4)	4787 (7.8)	0.19
Chronic pulmonary disease	10774 (18.5)	1175 (38.1)	11949 (19.5)	0.45
Diabetes without chronic complications	9511 (16.3)	1110 (36.0)	10621 (17.3)	0.46
Diabetes with chronic complications	8193 (14.1)	1133 (36.8)	9326 (15.2)	0.54
Hypothyroidism	4713 (8.1)	462 (15.0)	5175 (8.4)	0.23
Renal failure	7847 (13.5)	842 (27.3)	8689 (14.2)	0.35
Liver disease	3575 (6.1)	376 (12.2)	3951 (6.4)	0.21
Peptic ulcer disease - bleeding	542 (0.9)	56 (1.8)	598 (1.0)	0.08
AIDS	285 (0.5)	9 (0.3)	294 (0.5)	0.03
Lymphoma	470 (0.8)	83 (2.7)	553 (0.9)	0.14
Metastatic cancer	984 (1.7)	122 (4.0)	1106 (1.8)	0.14
Solid tumor without metastasis	2083 (3.6)	390 (12.7)	2473 (4.0)	0.34
Rheumatoid arthritis/collagen	1037 (1.8)	107 (3.5)	1144 (1.9)	0.11
Coagulopathy	2370 (4.1)	247 (8.0)	2617 (4.3)	0.17
Obesity	6324 (10.9)	857 (27.8)	7181 (11.7)	0.44
Weight Loss	2275 (3.9)	317 (10.3)	2592 (4.2)	0.25
Fluid and electrolyte disorders	9522 (16.3)	1099 (35.7)	10621 (17.3)	0.45
Chronic blood loss anemia	436 (0.7)	84 (2.7)	520 (0.8)	0.15
Deficiency anemias	6924 (11.9)	969 (31.5)	7893 (12.9)	0.49
Alcohol abuse	3919 (6.7)	363 (11.8)	4282 (7.0)	0.18
Drug abuse	2028 (3.5)	144 (4.7)	2172 (3.5)	0.06
Psychoses	2477 (4.3)	246 (8.0)	2723 (4.4)	0.16
Depression	8557 (14.7)	831 (27.0)	9388 (15.3)	0.31
Myocardial infarction	565 (1.0)	135 (4.4)	700 (1.1)	0.21

Key: * Standardized mean differences between sample means/pooled standard deviation. Values >0.1 are considered not ideally balanced. + Urban-Rural-Highly Rural zip code classification defined by the VA's Planning and Systems Support Group. # Elixhauser categories defined by Healthcare Cost and Utilization Project Elixhauser comorbidity software (FY17v of ICD-10 codes).

Appendix Figure 1: Map of TNP Sites



Appendix Figure 2. Propensity Matched, Kaplan-Meier Survival Curve: TNP and Non-TNP Enrolled Veteran Readmissions within 30 Days after Discharge. TNP readmissions (n = 363; 12%) compared to matched veteran readmissions (n = 697; 12%) 30 days after discharge were no different with a hazard ratio of 1.03 (95% CI 0.91- 1.17; p. = 0.60). Assumption of non-informative censoring was met.