The full version of this article may be viewed online at jop.ascopubs.org

Access to Care in Vermont: Factors Linked With Time to Chemotherapy for Women With Breast Cancer—A Retrospective Cohort Study

Ali Johnson, MBA, CTR, Leanne Shulman, MS, Jennifer Kachajian, MPH, MA, Brian L. Sprague, PhD, Farrah Khan, MD, Ted James, MD, MS, David Cranmer, Peter Young, GISP, MA, and Ruth Heimann, MD, PhD

Vermont Department of Health; University of Vermont Medical Center; University of Vermont Cancer Center, Burlington; and Vermonters Taking Action Against Cancer, Williston, VT

Corresponding author: Ali Johnson, MBA, CTR, Vermont Department of Health, 108 Cherry St, Burlington, VT 05401; e-mail: alison.johnson@vermont.gov.

Disclosures provided by the authors are available with this article at jop.ascopubs.org.

QUESTION ASKED: What factors are associated with delays in the time from initial diagnosis to first systemic therapy among women with breast cancer in Vermont?

SUMMARY ANSWER: Longer drive time from home to clinic, more invasive surgery, and breast reconstruction are all associated with delays in chemotherapy initiation. Patients age younger than 65 years whose primary payer was Medicare had significantly longer average time to systemic therapy compared with those with private or military insurance.

WHAT WE DID: We used Vermont Cancer Registry data and multivariable linear regression to evaluate associations between time from initial diagnosis to first systemic therapy and patient, tumor, treatment, and geographic variables for 702 female Vermont residents with stage I to III breast cancer between 2006 and 2010 who received adjuvant chemotherapy.

WHAT WE FOUND: Most patients with stage I to III breast cancer are receiving adjuvant chemotherapy within the recommended timeframe; however, improvements are needed for certain subgroups. Novel approaches for women with long drive times need to be developed and evaluated in the community (Fig).

BIAS, CONFOUNDING FACTOR(S), DRAWBACKS: The study was dependent on the accurate reporting of data from hospitals to the Vermont Cancer Registry regarding receipt of chemotherapy. The study included a geographic area with nearly half of the study population living in rural towns. Results may not be generalizable to urban settings, other cancer types, or other treatments received for breast cancer (eg, radiotherapy).

REAL-LIFE IMPLICATIONS: Recent studies using large population databases describe the impact of therapy delays (time to surgery and/or chemotherapy) on survival. Therefore, it is critical to improve our understanding of what factors may influence the timing of breast cancer treatment. Variation in time to chemotherapy by hospital, even after adjusting for patient, tumor, and treatment factors, suggests opportunities for process improvement. There is an opportunity for interventions that could reduce drive time for patients. Improved outreach and coordination and novel approaches, including mobile chemotherapy units, increased use of patient navigators, establishment of more guest housing near medical oncology practices, and recruitment of more volunteers to drive patients to medical appointments, need to be developed and evaluated in the community. JOP

See the figure on the following page.

DOI: 10.1200/JOP.2016.013409; published online ahead of print at jop.ascopubs.org on August 30, 2016.

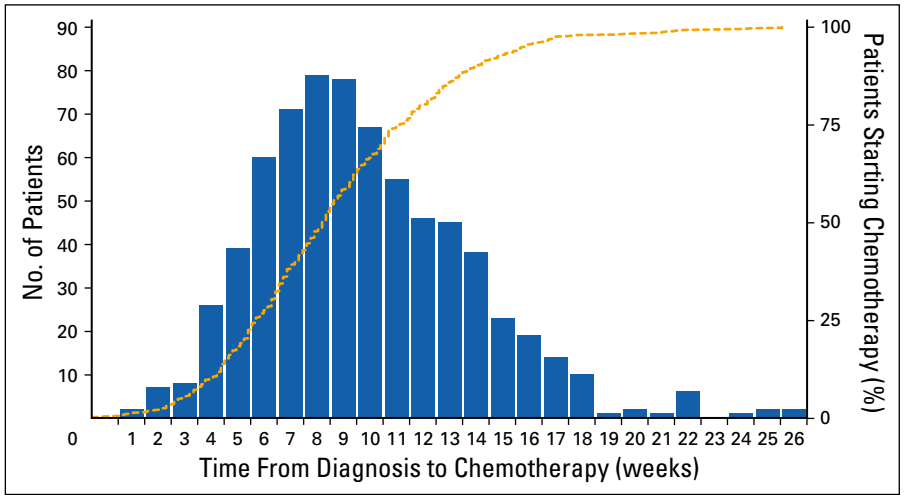

FIG. Time from breast cancer diagnosis to initiation of chemotherapy. Histogram bars refer to number of patients, as indicated on left *y*-axis. Dashed line indicates cumulative percentage of patients who received chemotherapy, as indicated by right *y*-axis.

Access to Care in Vermont: Factors Linked With Time to Chemotherapy for Women With Breast Cancer—A Retrospective Cohort Study

Ali Johnson, MBA, CTR, Leanne Shulman, MS, Jennifer Kachajian, MPH, MA, Brian L. Sprague, PhD, Farrah Khan, MD, Ted James, MD, MS, David Cranmer, Peter Young, GISP, MA, and Ruth Heimann, MD, PhD

Vermont Department of Health; University of Vermont Medical Center; University of Vermont Cancer Center, Burlington; and Vermonters Taking Action Against Cancer, Williston, VT

Abstract

Purpose

In the rural United States, there are multiple potential barriers to the timely initiation of chemotherapy. The goal of this study was to identify factors associated with delays in the time from initial diagnosis to first systemic therapy (TTC) among women with breast cancer in Vermont.

Methods

Using data from the Vermont Cancer Registry, we explored TTC for 702 female Vermont residents diagnosed with stage I to III breast cancer between 2006 and 2010 who received adjuvant chemotherapy. Multivariable linear regression was used to evaluate the associations between TTC and patient, tumor, treatment, and geographic variables.

Results

Mean TTC was 10.2 weeks. Longer drive time ($P < .001$), more invasive surgery ($P = .01$), and breast reconstruction ($P < .001$) were each associated with longer TTC. Each additional 15 minutes of drive time was associated with a 0.34-week (95% CI, 0.22 to 0.46 weeks) increase in TTC. Participants age younger than 65 years whose primary payer was Medicare (n = 27) had significantly longer average TTC, by 2.37 weeks ($P = .001$), compared with those with private or military insurance. There was also substantial variation in TTC across hospitals ($P < .001$).

Conclusion

Most female patients with stage I to III breast cancer in Vermont are receiving adjuvant chemotherapy within the National Comprehensive Cancer Network–recommended timeframe; however, improvements remain needed for certain subgroups. Novel approaches for women with long drive times need to be developed and evaluated in the community. Variation in TTC by hospital, even after adjusting for patient, tumor, and treatment factors, also suggests opportunities for process improvement.

ASSOCIATED CONTENT

Appendix DOI: 10.1200/JOP.2016.013409

DOI: 10.1200/JOP.2016.013409; *published online ahead of print at jop.ascopubs.org on August 30, 2016.*

INTRODUCTION

Adjuvant chemotherapy for breast cancer is a key component in the management of patients at risk for systemic recurrence and conveys a significant survival advantage in appropriately selected groups.[1] However, the timing of administration of adjuvant chemotherapy is not uniform.[2] Several

reports have demonstrated that the timeliness of adjuvant chemotherapy for breast cancer has an impact on survival.[3-8] Timeliness of appropriate care is one of the six aims for improvement promoted by the Institute of Medicine.[9] The American Society of Clinical Oncology and National Comprehensive Cancer Network (NCCN) quality measures recommend starting adjuvant chemotherapy within 120 days of diagnosis for women age younger than 70 years with stage II or III hormone receptor–negative breast cancer.[10] However, a recent study suggested that in certain high-risk breast cancers, chemotherapy should not be delayed more than 60 days after surgery.[11]

Prior studies have demonstrated rural versus urban disparities in the timely initiation of chemotherapy; these must be addressed to enhance outcomes and quality of care.[12-15] The availability and quality of cancer care in rural settings may be influenced by structural barriers (eg, treatment facility hours of operation, appointment wait times, and access to transportation), physician factors, and patient factors (eg, health literacy and perceptions about the health care system).[16]

Vermont is a predominantly rural state, with a goal of increasing adherence to NCCN treatment standards,[17] including timeliness of care.[18] In 2012, 89% of eligible women treated at Commission on Cancer–accredited centers in Vermont considered or received adjuvant chemotherapy within 4 months of breast cancer diagnosis.[19] A task force was convened to evaluate which factors influence time to chemotherapy (TTC) in Vermont.

The goal of this study was to determine the distribution of TTC among Vermont women diagnosed with breast cancer at all facilities in Vermont and identify the possible barriers that may contribute to delay in TTC, where TTC is defined as time from initial diagnosis to first systemic therapy. We hypothesized that timeliness of chemotherapy administration would vary based on geographic barriers to access, such as drive time to the treatment facility.

METHODS

Data Source

The Vermont Cancer Registry (VCR) is the statewide population-based cancer surveillance system in Vermont. The registry collects information about all cancers (except nonmelanoma skin cancers and carcinoma in situ of the cervix) and all benign brain tumors diagnosed in Vermont. The VCR has a public health exemption to collect these data under the Health Insurance Portability and Accountability Act, and state law provides the VCR with the authority to conduct and publish studies of cancer using these data.[20]

Cohort Selection

The criteria for inclusion in the study were: female Vermont residents with stage I to III breast cancer who were diagnosed between 2006 and 2010, received chemotherapy, underwent surgery before starting systemic therapy, and either received no radiotherapy or received radiotherapy after systemic therapy. Patients missing data on one or more variables necessary to determine study inclusion were excluded. One patient was excluded because of an extreme TTC, 32.8 weeks, which was more than 6 weeks past the second to longest TTC (26.5 weeks). This left a final sample size for analysis of 702 participants.

Variable Definitions

Type of surgery to the primary site, which was performed as part of the first course of treatment, was coded according to the version of the Commission on Cancer Facility Oncology Registry Data Standards manual applicable to the diagnosis year. Each surgical code specified whether the surgical intervention was followed by breast reconstruction.

Tumor stage was defined as the derived American Joint Committee on Cancer (AJCC) –6 stage group (for 2006 to 2009 diagnoses) or derived AJCC-7 stage group (for 2010 diagnoses) and was coded according to Collaborative Stage Data Collection System (version 02.04). The Collaborative Stage Data Collection System was designed by an AJCC joint task force to provide a single uniform set of codes and rules for coding stage information to meet the needs of all participating standard setters.[21] A computer algorithm provided the derivation of T, N, M, and stage on the basis of the sixth and seventh editions of the *AJCC Cancer Staging Manual*.

Primary payer was defined as the insurance plan at the time of initial diagnosis and/or treatment. Primary payer was grouped into five categories: insurance but no further information regarding type, any type of Medicare coverage, Medicaid coverage, private or TRICARE insurance, and no insurance or unknown insurance status.

Hospital was defined as the facility reporting the patient case to the VCR. In the event that chemotherapy was administered outside the hospital setting, the facility responsible for reporting the treatment to the state was described as a hospital. Hospital was assigned in the following order of priority: first, if there was one reporting hospital, that hospital

was used; second, if there was more than one reporting hospital, and only one facility reported surgery, the hospital reporting surgery was used; and third, if there was more than one reporting hospital, and more than one facility reported surgery, the largest facility (determined by the average annual caseload of all cancers reported) was used. For records with an unspecified out-of-state facility (n = 24), the largest reporting facility of that state was used. Hospitals with fewer than 20 participants were combined into one group.

County was determined based on residence at time of diagnosis. Two counties had few participants; they were divided based on hospital service areas and assigned to an adjacent county, which included the majority of the same hospital service area.

Each patient's geocoded town of residence was assigned through a spatial join of their geocoded location (*x* and *y* coordinates) and Vermont towns. Rural versus urban residence was determined by a spatial join between the town of residence and towns with significant overlapping with Census 2010 urbanized areas of 50,000 or more people or urban clusters of at least 2,500 but fewer than 50,000 people (Appendix Fig A1, online only).[22]

An origin–destination cost matrix analysis (ESRI ArcGIS 10.2.1 Network Analyst; http://www.esri.com/software/arcgis/extensions/networkanalyst) was used to measure drive time, where the origins were the patients' geocoded residences and destinations were the managing facilities. For each patient, the model calculated drive time as both distance and travel time to all destinations, using Vermont road networks, resulting in a drive time for each patient to each possible hospital. A drive time to the hospital, determined as described, was assigned to each patient. Ninety-six percent of patient cases (n = 674) were geocoded to an address with number and street; the remaining patient cases were geocoded to a town centroid. Only 0.4% of records (n = 3) were excluded from the drive time analysis because the hospital was out of state and could not be located.

TTC was calculated by subtracting the date of first systemic therapy from the date of initial diagnosis. During the study period, the North American Association of Central Cancer Registries required cancer registries to record the date of initiation for systemic therapy; the data exchange standards did not separate chemotherapy from hormonal agents or other systemic therapies.[23] Because chemotherapy preceded hormonal therapy in the standard of care, it was assumed that the date of first systemic therapy was the date of adjuvant chemotherapy initiation. The date of diagnosis recorded in the VCR is the date of initial diagnosis by a recognized medical practitioner for the tumor being reported, whether clinically or microscopically confirmed.[23]

Statistical Analyses

All statistical analyses were performed using SAS software (version 9.3; SAS Institute, Cary, NC). An alpha of 0.05 was used to determine statistical significance for all results.

The distribution of TTC was illustrated using Kaplan-Meier failure curves. The log-rank test was used to assess univariable differences in TTC Kaplan-Meier failure curves according to independent variables. Linear regression was used to further evaluate the association between each independent variable and TTC, with both age and drive time analyzed as continuous variables. In addition to univariable analyses, two multivariable linear regression models were constructed. The first, hospital adjusted, controlled for the effect of managing facility; the second, multivariable adjusted, controlled for the effects of tumor, patient, and treatment factors. Each variable related to geographic location (hospital, county of residence, urban *v* rural geography, and drive time) was added separately to the multivariable-adjusted model. These four geographic variables had some colinearity and, as such, were not added to the multivariable model together. To evaluate the effect of type of insurance, an additional analysis was conducted that was restricted to participants age younger than 65 years at the time of diagnosis.

RESULTS

The demographic, tumor, and treatment characteristics of participants are listed in Table 1. A majority of the participants were between the ages of 40 and 64 years; only 14% were age 65 years or older. Fifty-six percent of participants (n = 396) had private or military health insurance; only 4% (n = 25) had no insurance or an unknown insurance status. A majority of the women underwent breast-conserving surgery (64%; n = 452), and 10% (n = 72) underwent breast-reconstruction surgery. The distribution of rural to urban residents was quite even (47% *v* 53%). A significant proportion of the study population (25%; n = 177) had a drive time of 1 hour or more from their home to the hospital managing their care.

Among the 702 participants, mean TTC was 10.2 weeks (standard deviation, 3.99), and median TTC was 9.7 weeks (Fig 1). Treatment factors were strongly associated with TTC in multivariable linear regression analyses (Table 2). More

Table 1. Demographic and Clinical Characteristics of Participants Included in Analysis

Characteristic	No.	%*
Age, years		
< 40	49	7
40-49	218	31
50-64	334	48
65-74	86	12
≥ 75	15	2
Primary payer		
No insurance or unknown	25	4
Insurance NOS	120	17
Medicaid	43	6
Medicare	118	17
Private, TRICARE, or VA	396	56
Urban or rural residence		
Missing	1	< 1
Rural	328	47
Urban	373	53
Drive time, minutes		
< 15	204	29
15-29	126	18
30-44	95	14
45-59	97	14
≥ 60	177	25
Unknown	3	< 1
Tumor stage		
I	249	35
II	341	49
III	112	16
Surgery		
Radical mastectomy, mastectomy NOS, or modified radical mastectomy	73	10
Total mastectomy	177	25
Partial mastectomy	452	64
Reconstruction†		
Yes	72	10
No	630	90

Abbreviations: NOS, not otherwise specified; VA, Veterans Affairs.
*May not sum to 100% because of rounding.
†Among those who underwent surgery.

invasive surgical intervention, such as total or other mastectomy, was associated with longer TTC (0.64 weeks, $P = .106$; 1.56 weeks, $P = .003$; overall $P = .009$), as was reconstructive surgery (2.22 weeks, $P < .001$). Increased age was nearly significantly associated with increased average TTC, when adjusting for patient, tumor, and treatment factors ($P = .055$).

Hospital and county of residence were both significant predictors of TTC (both $P < .001$), even after adjusting for patient, tumor, and treatment factors (results for individual facilities and counties not shown). The specification of a patient's residence as urban or rural was not significantly associated with TTC, although there was a nonsignificant decrease of an average of 0.54 weeks in TTC among those patients who lived in urban areas ($P = .068$). Increasing drive time was significantly associated with an increase in TTC; an additional 15 minutes of drive time was associated with a 0.34-week increase in TTC.

Laterality and year of diagnosis were not significant in univariable or hospital-adjusted analyses and were not considered further (data not shown). Primary payer (type of insurance) was significant in univariable analyses but not significant after adjusting for hospital (data not shown). This was likely because of systematic differences between hospitals in the level of detail provided to the VCR regarding patient insurance and the fact that the primary payer for a majority of patients age 65 years or older was Medicare.

Appendix Table A1 (online only) lists the results of a multivariable model, with adjustment for patient, tumor, and treatment factors, as well as hospital, which was restricted to participants age younger than 65 years (n = 601) to remove all those who had Medicare because of age. Patients whose primary payer was Medicare (for a reason other than age; n = 27) had significantly longer average TTC, by 2.37 weeks, compared with those participants who had private or TRICARE insurance ($P = .001$).

DISCUSSION

The mean TTC in our study for Vermont (10.2 weeks) was similar to the TTC reported for the NCCN institutions (12.0 weeks),[23] which are generally large urban institutions. Considering the logistic challenges patients with cancer face in a small rural state with more limited resources, this finding is reassuring.

As hypothesized, geographic variables were significantly associated with longer TTC. Other factors associated with longer TTC were hospital, more extensive surgery, and breast reconstruction. It is not unexpected that northeastern and southeastern counties had longer TTCs, given that these areas have more rural roads and are farther away from large highways. Notably, there were no differences in TTC as a function of patient age or year of diagnosis. A delay in TTC was also found for a small number of study participants age

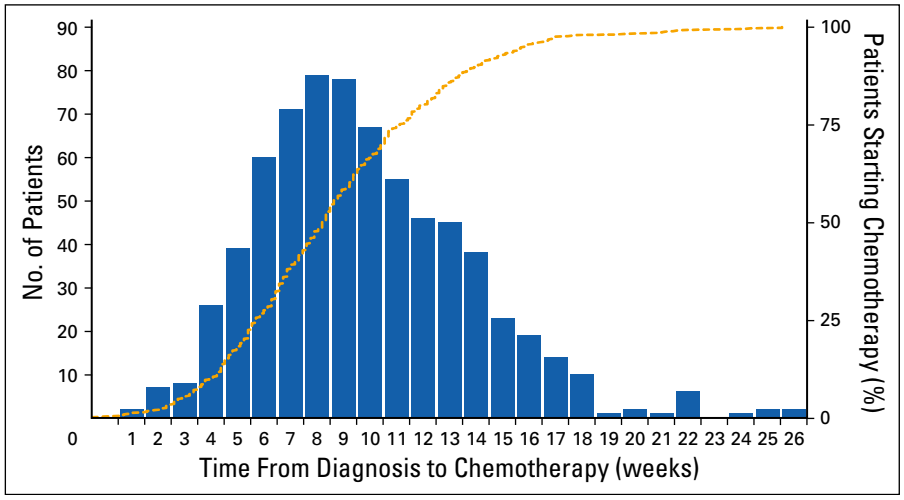

FIG 1. Time from breast cancer diagnosis to initiation of chemotherapy. Histogram bars refer to number of patients, as indicated on left *y*-axis. Dashed line indicates cumulative percentage of patients who received chemotherapy, as indicated by right *y*-axis.

younger than 65 years whose primary payer was Medicare. There is a need to further investigate access to care among patients with breast cancer who are covered by Medicare for reasons other than age.

The findings of more invasive surgery and breast reconstruction being associated with longer TTC were consistent with previous research by Vandergrift et al,[2] who found that most observed variation in TTC among patients in the NCCN Outcomes Database was related to use of appropriate therapeutic interventions. This is expected, given that patients with more extensive surgery may require longer recovery periods. The fact that hospital was a significant predictor of TTC, even after adjusting for patient, tumor, and treatment factors, offers opportunities for process improvement, particularly relating to hospitals with patients who have longer drive times on average.

There are several limitations to our research. The study is dependent on the accurate reporting of data from hospitals to the VCR regarding receipt of chemotherapy. We conducted an exploratory analysis to investigate whether hospitals underreported chemotherapy, because facilities may have prioritized reporting of incidence and stage over treatment data as a result of the statutory requirements for timely reporting.[20] We followed back all potentially eligible patient cases of breast cancer from one small community hospital that were not included in the analysis because the patient case record indicated no chemotherapy treatment. In all cases, we found that provider and patient decision making resulted in no chemotherapy treatment. This provides reassurance that under-reporting of chemotherapy treatment was not frequent. Furthermore, a Delaware study recently supported the validity of central cancer registry data to evaluate timeliness of breast cancer treatment, providing the ability to benchmark breast cancer treatment timelines to national recommendations.[24] The use of population-based data to evaluate access to breast cancer care is an inclusive approach because women are included regardless of residence or treating hospital.

There are recognized limitations with origin (patient residence) and destination (hospital) in the drive time analysis. A small number of patients (n = 24; 3%) received their care at an out-of-state hospital about which we did not have enough detail to determine a specific facility. In those instances, the patients were attributed to the largest reporting facility for that state. In the case where a hospital had a satellite medical oncology practice, it was impossible to tell the geographic location where chemotherapy was administered using the reporting hospital code. When two or more hospitals were involved in a patient's care, and both facilities reported surgery, we assigned the largest facility the role of hospital. This affected 24% (n = 168) of patient cases (data not shown). It is possible that the assignment rule could have resulted in longer drive time estimates for some unknown portion of these 24%.

A change in residence after diagnosis or use of short-term housing near the hospital during treatment would not have been recorded by the VCR. A small number of patients'

Table 2. Linear Regression Results for Models of TTC As Function of Various Patient, Tumor, Treatment, and Geographic Variables

	Unadjusted			Hospital Adjusted			Multivariable Adjusted*		
Variable	Estimated ΔTTC (weeks)	95% CI	*P*	Estimated ΔTTC (weeks)	95% CI	*P*	Estimated ΔTTC (weeks)	95% CI	*P*
Stage			.115			.052			.155
I	Referent			Referent			Referent		
II	−0.32	−0.97 to 0.34	.341	−0.63	−1.24 to −0.03	.041	−0.60	−1.24 to 0.04	.067
III	0.58	−0.31 to 1.47	.202	0.13	−0.70 to 0.95	.760	−0.13	−1.05 to 0.79	.784
Surgery			< .001			.002			.009
Partial mastectomy	Referent			Referent			Referent		
Total mastectomy	1.39	0.71 to 2.08	< .001	1.06	0.42 to1.71	.001	0.64	−0.14 to 1.42	.106
Other mastectomy or unspecified mastectomy	1.84	0.86 to 2.81	< .001	0.94	−0.01 to 1.89	.052	1.56	0.53 to 2.59	.003
Reconstruction			< .001			< .001			< .001
No	Referent			Referent			Referent		
Yes	2.38	1.42 to 3.34	< .001	1.66	0.75 to 2.57	< .001	2.22	1.13 to 3.31	< .001
10-year increase in age	0.02	−0.01 to 0.05	.124	0.16	−0.12 to 0.43	.260	0.30	−0.01 to 0.60	.055
Hospital			< .001						< .001
County			< .001			.100			< .001
Rural or urban (n = 701)†			.061			.802			.068
Rural	Referent			Referent			Referent		
Urban	−0.57	−1.16 to 0.03	.061	0.07	−0.49 to 0.64	.80	−0.54	−1.12 to 0.04	.068
Drive time (n = 699)†			< .001			.207			< .001
15-minute increase	0.37	0.25 to 0.49	< .001	0.09	−0.05 to 0.24	.207	0.34	0.22 to 0.46	< .001

NOTE. Results are presented as overall variable significance and individual estimates of change in TTC, measured in weeks, when comparing specific level of variable with referent level, along with associated 95% CIs and *P* values.

Abbreviation: TTC, time to chemotherapy.

*Multivariable model adjusted for tumor subsite, tumor histology, tumor stage, type of surgery, use of breast reconstruction surgery, and patient age at time of diagnosis.

†All 702 participants were included, except when model contained drive time, which could not be determined for three participants, or rural versus urban geography variable, which was missing for one participant (also missing drive time).

residences (n = 28; 6%) were geocoded to a town centroid. For all of these patient cases, it is possible that the calculated drive time was longer or shorter than the actual drive time. Only 0.4% of records (n = 3) were excluded from the drive time analysis because the hospital was out of state and could not be located. We would not expect these challenges to explain our observation that TTC differed by drive time; rather, we would expect any such misclassification of drive time to attenuate the observed results.

The rural versus urban classification system used in this study is helpful for dissemination of results among community stakeholders, but it is a less accurate residential classification than drive time when considering factors for delays in adjuvant chemotherapy. The urban category could include rural study participants because residents of rural areas of towns would be designated urban if any part of the town contained a Census 2010 urban cluster.

Our study included a geographic area with nearly half of the study population living in rural towns. It is unclear how generalizable these results would be to more urban areas. Our results should be generalizable to women undergoing chemotherapy for breast cancer in rural settings; results may not be generalizable to urban settings, other cancer types, or other treatments received for breast cancer (eg, radiotherapy).

Most female Vermont patients with stage I to III breast cancer are receiving adjuvant chemotherapy within the NCCN-recommended timeframe. However, there are some demographic, hospital, and treatment factors related to reduced timeliness in breast cancer treatment. Recent studies using large population databases have described the impact

of therapy delays (time to surgery and/or chemotherapy) on survival.[12,25] Therefore, it is critical to improve our understanding of what factors may be influencing the timing of breast cancer treatment.

Now that those factors have been identified, there is an opportunity to research interventions that could reduce drive time for patients. The delay in TTC with increasing drive time suggests this area is in need of targeted interventions. For example, could patients going to larger hospitals for surgery access chemotherapy at nearby hospitals? Could transportation assistance programs be developed for these patients? Could surgeons recommend that patients seek chemotherapy at local hospitals? Referral patterns and hospital affiliations would have to be considered in designing such interventions. Improved outreach and coordination, such as with Vermonters Taking Action Against Cancer, and novel approaches, including mobile chemotherapy units, increased use of patient navigators, establishment of more guest housing near medical oncology practices, and recruitment of more volunteers to drive patients to medical appointments, need to be developed and evaluated in the community. JOP

Acknowledgment

Supported in part by Cooperative Agreement No. U58/DP003911 from the Centers for Disease Control and Prevention (A.J.) and Grant No. U54 CA163303 from the National Institutes of Health (B.L.S.). These findings are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the National Institutes of Health.

Authors' Disclosures of Potential Conflicts of Interest

Disclosures provided by the authors are available with this article at jop.ascopubs.org.

Author Contributions

Conception and design: Ali Johnson, Jennifer Kachajian, Farrah Khan, Ted James, David Cranmer, Ruth Heimann
Financial support: Ali Johnson, Brian L. Sprague
Administrative support: Ali Johnson, David Cranmer
Collection and assembly of data: Ali Johnson, Jennifer Kachajian
Data analysis and interpretation: Ali Johnson, Leanne Shulman, Jennifer Kachajian, Brian L. Sprague, Peter Young
Manuscript writing: All authors
Final approval of manuscript: All authors
Accountable for all aspects of the work: All authors

Corresponding author: Ali Johnson, MBA, CTR, Vermont Department of Health, 108 Cherry St, Burlington, VT 05401; e-mail: alison.johnson@vermont.gov.

References

1. Early Breast Cancer Trialists' Collaborative Group (EBCTCG): Effects of chemotherapy and hormonal therapy for early breast cancer on recurrence and 15-year survival: An overview of the randomised trials. Lancet 365:1687-1717, 2005

2. Vandergrift JL, Niland JC, Theriault RL, et al: Time to adjuvant chemotherapy for breast cancer in National Comprehensive Cancer Network institutions. J Natl Cancer Inst 105:104-112, 2013

3. Lohrisch C, Paltiel C, Gelmon K, et al: Impact on survival of time from definitive surgery to initiation of adjuvant chemotherapy for early-stage breast cancer. J Clin Oncol 24:4888-4894, 2006

4. Colleoni M, Bonetti M, Coates AS, et al: Early start of adjuvant chemotherapy may improve treatment outcome for premenopausal breast cancer patients with tumors not expressing estrogen receptors. J Clin Oncol 18:584-590, 2000

5. Hershman DL, Greenlee H, Awad D, et al: Randomized controlled trial of a clinic-based survivorship intervention following adjuvant therapy in breast cancer survivors. Breast Cancer Res Treat 138:795-806, 2013

6. Downing A, Twelves C, Forman D, et al: Time to begin adjuvant chemotherapy and survival in breast cancer patients: A retrospective observational study using latent class analysis. Breast J 20:29-36, 2014

7. Nurgalieva ZZ, Franzini L, Morgan RO, et al: Impact of timing of adjuvant chemotherapy initiation and completion after surgery on racial disparities in survival among women with breast cancer. Med Oncol 30:419, 2013

8. McLaughlin JM, Anderson RT, Ferketich AK, et al: Effect on survival of longer intervals between confirmed diagnosis and treatment initiation among low-income women with breast cancer. J Clin Oncol 30:4493-4500, 2012

9. Committee on Quality Health Care in America; Institute of Medicine: Crossing the Quality Chasm: A New Health System for the 21st Century. Washington, DC, National Academy of Sciences, 2001

10. Desch CE, McNiff KK, Schneider EC, et al: American Society of Clinical Oncology/National Comprehensive Cancer Network quality measures. J Clin Oncol 26:3631-3637, 2008

11. Gagliato Dde M, Gonzalez-Angulo AM, Lei X, et al: Clinical impact of delaying initiation of adjuvant chemotherapy in patients with breast cancer. J Clin Oncol 32:735-744, 2014

12. Chavez-MacGregor M, Clarke CA, Lichtensztajn DY, et al: Delayed initiation of adjuvant chemotherapy among patients with breast cancer. JAMA Oncol 2:322-329, 2016

13. Johnson A, Rees JR, Schwenn M, et al: Oncology care in rural northern New England. J Oncol Pract 6:81-89, 2010

14. Hershman DL, Wang X, McBride R, et al: Delay of adjuvant chemotherapy initiation following breast cancer surgery among elderly women. Breast Cancer Res Treat 99:313-321, 2006

15. Johnson AM, Hines RB, Johnson JA III, et al: Treatment and survival disparities in lung cancer: The effect of social environment and place of residence. Lung Cancer 83:401-407, 2014

16. American Cancer Society: Cancer Treatment and Survivorship Facts & Figures 2014-2015. Atlanta, GA, American Cancer Society, 2014

17. National Comprehensive Cancer Network: NCCN clinical practice guidelines in oncology: Breast cancer (version 3.2014). https://www.nccn.org/professionals/physician_gls/f_guidelines.asp

18. Vermont Department of Health, Vermonters Taking Action Against Cancer: Vermont Cancer Plan: A Framework for Action. Burlington, VT, Vermont Department of Health, 2014

19. Vermont Department of Health, Vermonters Taking Action Against Cancer: Vermont State Cancer Plan: Status Report. http://www.healthvermont.gov/pubs/cancerpubs/documents/vtcancerstatusreport.pdf

20. Vermont Cancer Registry Law: Vermont Statutes Annotated: Title 18, §§ 151-157

21. American Joint Committee on Cancer: Collaborative Stage Data Collection System. https://cancerstaging.org/cstage/Pages/default.aspx

22. Federal Register: Urban area criteria for the 2010 Census, Vol. 76, No. 164, 2011

23. Thornton M (ed): North American Association of Central Cancer Registries: Standards for Cancer Registries, Volume II—Data Standards and Data Dictionary, Version 14. Springfield, IL, North American Association of Central Cancer Registries, 2013.

24. Belinkske SO, Shannnon M, Henry L, et al: Feasibility of using central registry data to assess timeliness of breast cancer care in Delaware. J Registry Manag 40:151-158, 2013

25. Bleicher RJ, Ruth K, Sigurdson ER, et al: Time to surgery and breast cancer survival in the United States. JAMA Oncol 2:330-339, 2016

AUTHORS' DISCLOSURES OF POTENTIAL CONFLICTS OF INTEREST

Access to Care in Vermont: Factors Linked With Time to Chemotherapy for Women With Breast Cancer—A Retrospective Cohort Study

The following represents disclosure information provided by authors of this manuscript. All relationships are considered compensated. Relationships are self-held unless noted. I = Immediate Family Member, Inst = My Institution. Relationships may not relate to the subject matter of this manuscript. For more information about ASCO's conflict of interest policy, please refer to www.asco.org/rwc or jop.ascopubs.org/site/misc/ifc.xhtml.

Ali Johnson
No relationship to disclose

Leanne Shulman
No relationship to disclose

Jennifer Kachajian
No relationship to disclose

Brian L. Sprague
No relationship to disclose

Farrah Khan
No relationship to disclose

Ted James
Consulting or Advisory Role: Perimeter
Patents, Royalties, Other Intellectual Property: Provisional patent for breast ultrasound training product

David Cranmer
No relationship to disclose

Peter Young
No relationship to disclose

Ruth Heimann
No relationship to disclose

Appendix

Table A1. Results From Model Restricted to Patients Age < 65 Years (n = 601), Adjusted for Patient, Tumor, and Treatment Factors and Hospital

	Multivariable and Hospital Adjusted		
Variable	**Estimated ΔTTC (weeks)**	**95% CI**	***P***
Age, years			.066
Add 10 years	0.36	−0.02 to 0.74	.066
Hospital			< .001
Payer			.008
Private or TRICARE insurance (n = 391)	Referent		
Unknown or no insurance (n = 24)	1.13	−0.38 to 2.64	.143
Insurance NOS (n = 116)	−0.04	−0.88 to 0.80	.924
Medicaid (n = 43)	−0.45	−1.60 to 0.70	.440
Medicare (n = 27)	2.37	0.97 to 3.78	.001

NOTE. Results are presented for three variables: age, hospital (overall significance only), and primary payer. Results are presented as overall variable significance and individual estimates of ΔTTC when comparing specific level of variable with referent level, along with associated 95% CIs and *P* values.

Abbreviations: NOS, not otherwise specified; TTC, time to chemotherapy.

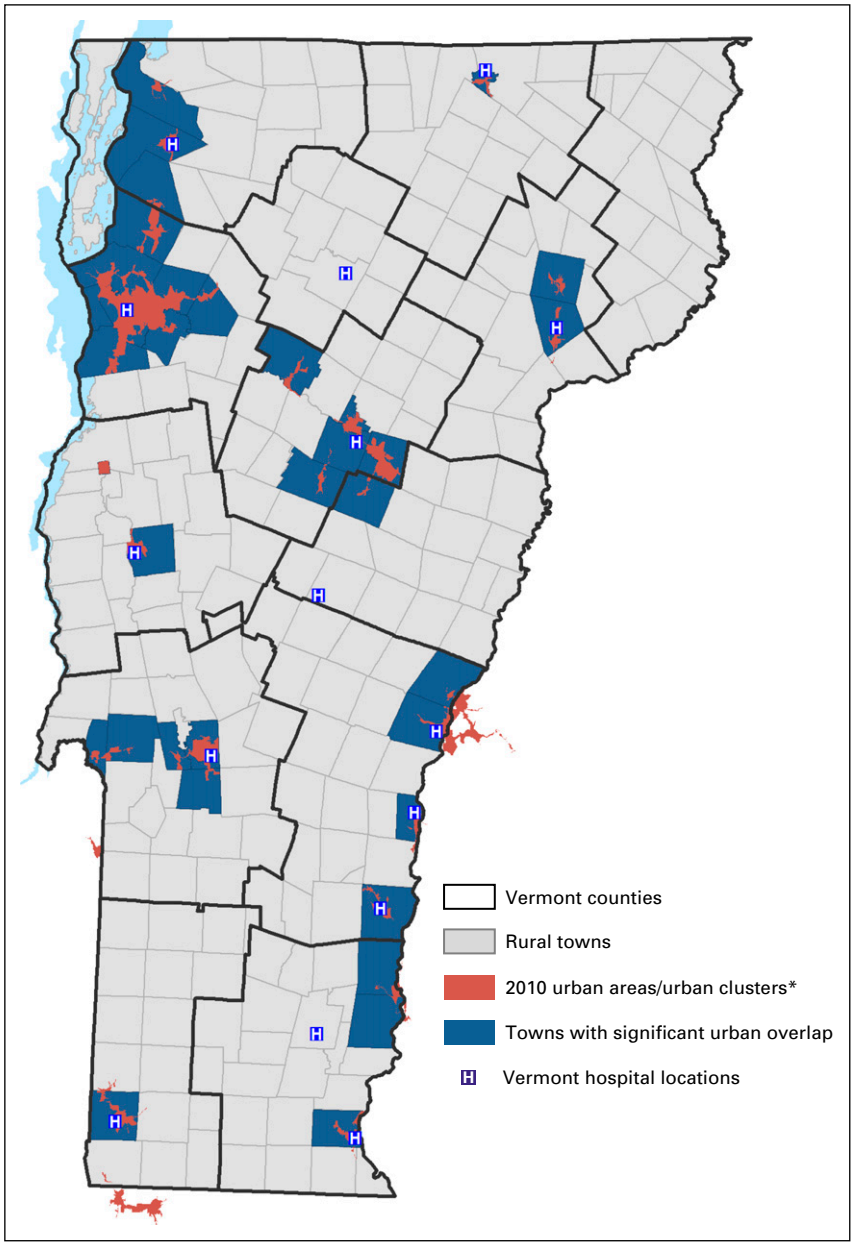

FIG A1. Urban and rural areas in Vermont according to Vermont 2010 Census. (*) Census Bureau identifies two types of urban areas: urbanized areas (≥ 50,000 people) and urban clusters (≥ 2,500 to < 50,000 people). Rural encompasses all populations, housing, and territories not included within urban areas.