Reduced survival among patients using dual system care

Title: Reduced Overall and Event-Free Survival Among Colon Cancer Patients Using Dual System Care

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ABSTRACT

BACKGROUND:

Many veterans have dual Veterans Administration (VA) and Medicare healthcare coverage. We compared 3-year overall and cancer event-free survival (OS; EFS) among patients with non-metastatic colon cancer who obtained substantial portions of their care in both systems and those whose care was obtained predominantly in the VA or in the Medicare fee-for-service system.

METHODS:

We conducted a retrospective observational cohort study of patients older than 65 years with stages I-III colon cancer diagnosed 1999-2001 in VA and non-VA facilities. Dual use of VA and non-VA colon cancer care was categorized as predominantly VA use, dual use, or predominantly non-VA use. Extended Cox regression models evaluated associations between survival and dual use.

RESULTS:

VA and non-VA users (all stages) had reduced hazard of dying compared to dual users (for example, for stage I, VA HR 0.40, CI_{95} 0.28–0.56; non-VA HR 0.54, CI_{95} 0.38–0.78). For EFS, stage I findings were similar (VA HR 0.47, CI_{95} 0.35–0.62; non-VA HR 0.64, CI_{95} 0.47–0.86). Stage II and III VA users, but not non-VA users, had improved EFS (Stage II: VA HR 0.74, CI_{95} 0.56–0.97; non-VA HR 0.92 CI_{95} 0.69–1.22. Stage III: VA HR 0.73, CI_{95} 0.56–0.94; non-VA HR 0.81 CI_{95} 0.62–1.06).

CONCLUSIONS:

Improved survival among VA and non-VA compared to dual users raises questions about coordination of care and unmet needs.

IMPACT

Additional study is needed to understand why these differences exist, why patients use both systems and how systems may be improved to yield better outcomes in this population.
INTRODUCTION/BACKGROUND

Most U.S. military veterans over age 65 who use VA healthcare services are also enrolled in the Medicare program. The majority of those use both VA and Medicare benefits (1,2). A growing body of research has documented various aspects of dual VA-Medicare use including patient populations more likely to seek care in both systems, the types of services sought by patients using both systems, and geographic patterns of dual use (1,3-9). However, relatively little is known about the comparative health outcomes of veterans who receive their care predominantly or entirely in one system—VA or the private sector—and those who receive substantial portions of their care in both systems (10-14).

For cancer patients, the potential consequences of dual care may be particularly hazardous. The challenges that cancer patients and their families face in navigating a complex healthcare system to access timely and appropriate care are well recognized (15-17). There are multiple barriers to coordination of care across settings and few automated systems established for doing so. Particularly for older patients with complex chronic care needs, this lack of coordination could result in delays in care, gaps in care, and duplication of services.

Whether dually-covered patients who obtain their cancer care in both the VA and the private sector have different outcomes than those who remain predominantly in one system is not known. In this study, we compared 3-year survival among patients with non-metastatic colon cancer who obtained substantial portions of their care in both systems and those whose care was obtained predominantly in the VA or in the private sector. We examined overall survival and colon cancer event-free survival separately for each cancer stage, I to III.

METHODS

Study Design and Population

This study employed a retrospective observational cohort design. The study sample comprised veterans with stages I-III colon cancer identified from VA and National Cancer Institute Surveillance,
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Epidemiology, and End Results (SEER) Program registry records (18). VA Central Cancer Registry (VACCR) cases were reported from VA facilities nationwide while SEER-reported cases resided in one of eight registry coverage areas with whom we had data sharing agreements (California, Metropolitan Detroit, Georgia, Hawaii, Iowa, Louisiana, New Jersey, and Western Washington). Patients diagnosed with colon cancer between July 1, 1999 and December 31, 2001 at 66 years of age or older who were both Medicare-enrolled and eligible for VA care, and who lived at least 30 days after diagnosis, were eligible for inclusion. We excluded cases for whom we had no or incomplete healthcare utilization data (principally owing to Medicare HMO enrollment, Part B Medicare coverage only, or non-Medicare primary payer coverage). We also excluded patients with Stage I cancer who received chemotherapy and Stage II and III cancer patients who did not undergo a colectomy since those patients were likely to have differed from their counterparts in unobservable characteristics that may have had a bearing on survival.

Data Sources and Construction of Variables

We used data from the VA, SEER program registries, the Centers for Medicare and Medicaid Services (19), and the 2000 U.S. Census to ascertain cancer clinical characteristics, healthcare services, comorbidities, demographic information and dates of death. The VACCR receives registered case reports from certified cancer registrars at VA medical centers, which adhere to standards of the Commission on Cancer (20). The regional SEER registries are responsible for complete case ascertainment for patients residing in their coverage areas. They adhere to rigorous SEER standards and all received North American Association of Central Cancer Registries silver or gold certification for 1999-2001 incidence data (20-22). The VACCR and SEER data provided information on cancer date of diagnosis, anatomic site, staging elements and AJCC-5 stage (23), and marital status.

We obtained information on chemo- and radiotherapy administration, healthcare utilization, and comorbidities from national VA databases, which comprise extracts from the VA’s electronic health
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record system, and Medicare claims (24-26). The combination of registry, medical records, and claims
data provides valid and more complete ascertainment of cancer treatment over any one source alone
(27-30). We obtained demographics (age, gender, and race) from the Medicare Vital Status File (19,31).

The study endpoint for OS was death from any cause. For EFS, the endpoint was a colon event
signaling cancer progression or death from any cause. We observed patients for 36 months; those who
survived without a colon event were censored. We ascertained vital status from the VHA Vital Status
File which is a central source for veterans’ date of death information from VA, Medicare, and Social
Security Administration databases (32). Absence of a death date was accepted as evidence of survival to
the 3-year endpoint.

To identify colon events, we began by defining a colon surveillance period. We defined the
beginning of the colon surveillance period differently depending on initial treatment, that is, none;
colectomy alone; or colectomy plus chemo- or radiotherapy. (Codes used to identify colon cancer
treatment are provided in the data supplement). For patients who received no initial treatment or
colectomy alone, the surveillance period began 12 months from the diagnosis date. For patients who
had chemo- or radiotherapy in addition to a colectomy, the surveillance period began at the later of two
time points: 12 months from the diagnosis date or 4 months after the discontinuation of therapy.
Chemo- and radiotherapy discontinuation dates were defined as the date of service on the last
healthcare record with a relevant code after which there were no records with those codes for at least
30 (for chemotherapy) or 14 (for radiotherapy) days. We defined a colon event as any of the following,
when it occurred during the colon surveillance period: initiation of chemotherapy or radiotherapy; a
secondary malignant neoplasm diagnosis; and a lung, liver, or colon resection. We identified these
events in VA pharmacy and encounter records and in Medicare claims using ICD-9 diagnosis, ICD-9
(HCPCS), revenue center, and diagnostic-related group (DRG) codes (see data supplement) (33). The
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earliest of either the date of service on a healthcare record that satisfied an event definition or a date of
death was taken as the failure event.

Our independent variable of primary interest was dual use of cancer care. The following
services were considered colon cancer care: a colectomy; chemotherapy; and an acute inpatient stay or
outpatient evaluation-and-management visit for which a diagnosis code for colon cancer was entered.
We constructed a time-varying measure of percentage of all colon cancer care received in VA from the
date of diagnosis to a colon event, death or 36 months. We calculated the cumulative percentage of
care received in the VA on each day of the follow-up period. We then created a 3-level categorical
variable: 86-100% VA use (predominantly VA user), 15-85% VA use (dual user), and 0-14% VA use
(predominantly non-VA user). Each patient was assigned to a category based on the cumulative
proportion of VA use on the date of an event (colon event or death) or, if none, the end of the
observation period (36 months). The proportion of patients’ colon cancer care received in VA averaged
98.9% among predominantly VA users, 50.6% among dual users, and 1.3% among predominantly non-
VA users.

Covariates included tumor grade; number of lymph nodes examined; colectomy (stage I) and
chemotherapy (stage II and III) received as part of initial treatment plan (defined for colectomy as
occurring in the data 1 month prior to or not later than 6 months after the diagnosis date, and for
chemotherapy as initiated not later than 9 months after the diagnosis date); comorbidities; distance to
nearest VA outpatient facility; geographic region; and demographic characteristics. Specific data
sources and codes used to ascertain cancer treatment and comorbidities are shown in the data
supplement. To establish each case’s baseline health status and patterns of healthcare utilization, we
ascertained comorbidities during the 6 months prior to diagnosis. We calculated a modified Deyo-
Charlson comorbidity score with Romano and Klabunde adaptations and constructed four categories: 0
(no comorbidities), 1, 2-3, and 4-or-higher (34-37).
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To account for the many ways in which treatment approaches and preferences differ across geographic regions (38,39), we identified the U.S. Census Division in which each patient resided at the time of diagnosis but, due to sparse numbers, collapsed the Pacific and Mountain Divisions and Middle Atlantic and New England Divisions to the West and Northeast Census Regions, respectively. Patient demographic characteristics included age at diagnosis, gender, race (40,41), ethnicity, marital status, and a census-based measure of educational attainment (census tract proportion with a high school diploma or more education among adults age 65 and older in the patient’s gender group) as a proxy for socioeconomic resources.

**Statistical Analysis**

Analyses were conducted separately for each cancer stage. Frequency distributions of patient characteristics were computed for each dual use category and the association of each characteristic with dual use was evaluated using Chi-square or Fisher’s exact tests for categorical variables and T-tests for continuous variables. We plotted Kaplan-Meier survival curves and used log rank tests to compare the survival distributions of the dual use groups over the 3-year follow-up period. We used separate extended Cox models to evaluate associations between days to event (OS and EFS) and dual use. Models controlled for all covariates described above. We evaluated the sensitivity of our estimates of the impact of dual use on survival to a different specification of our dual use measure. Specifically, rather than assigning dual use category based on the cumulative percentage of VA use on the final day of observation (i.e., date of death, colon event, or 36 months) as we did initially, we based the assignment on the cumulative percentage of VA use as of 30 days prior to the final observation day. In doing so, we reduced the potential influence of reverse causation, that is, declining health leading to dual use (for example, a dying VA user who in the last month of life needed hospice care close to home and therefore sought that care through Medicare). Proportional hazards assumptions were evaluated using log-log survival curves, observed Kaplan-Meier survival curves versus predicted Cox survival...
curves, Goodness-of-Fit tests (Cox-Snell residuals, Schoenfeld Residuals), and time-dependent variables (42). We judged statistical significance at the p<0.05 level and report hazard ratios and 95% confidence intervals. All tests were two-sided. Statistical analyses were conducted using Stata® MP software version 12.1. Our protocol was approved by the Hines VA Hospital Institutional Review Board and granted a waiver of informed consent.

RESULTS

We identified 3,014 cancer patients meeting study inclusion criteria, 1,855 from VACCR records and 1,472 in SEER registry records (313 patients had records in both sources).

Cohort Characteristics

Stage I (n=1,028), II (n=1,129), and III (n=857) sample characteristics broken down by dual use category are shown in Table 1. Among stage I patients, the dual and predominantly VA user groups had similar age distributions but dual users were older than predominantly non-VA users (≥76 years: Dual 45.0% vs. VA 44.3% and Dual 45.0% vs. non-VA 61.0%). Dual users were substantially less likely than VA users but twice as likely as non-VA users to be African American (14.1% vs. 20.6% and 14.1% vs. 7.0%). Dual users were slightly less likely than VA and more likely than non-VA users to have had five or fewer regional lymph nodes examined (52.1% vs. 55.5% and 52.1% vs. 46.3%). More dual users than either VA or non-VA users had coexisting chronic conditions (comorbidity score ≥1: 48.8% vs. 41.7% and 48.8% vs. 44.3%). Stage I dual use groups did not differ in tumor grade, proportion who underwent colectomy, or distance to VA outpatient center.

Among Stage II patients, dual users were older; 61.5% were 76 years or older compared to 46.5% (VA) and 55.2% (non-VA). African Americans comprised larger percentages of the dual (14.4%) and VA (16.7%) than non-VA users (10.9%). Fewer dual and VA users than non-VA users had a grade III or IV tumor (Dual 12.6%; VA 11.4%; non-VA 18.1%). Dual users were much less likely than either VA or non-VA users to have received chemotherapy (7.5% vs. 18.9% and 7.5% vs. 30.9%). There were no
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differences in number of lymph nodes examined, comorbidity score, or distance to VA across dual use categories for stage II patients.

Among stage III patients, dual users were substantially older than predominantly VA but not predominantly non-VA users (>75 years: 58.3% vs. 38.7% and 58.3% vs. 56.9%). Substantially fewer dual users than either VA or non-VA users received chemotherapy services (40.0% vs. 70.2% and 40.0% vs. 57.5%). Dual users’ comorbidity burden was similar to that of non-VA users (comorbidity score 0 or 1: 73.3% vs. 74.2%) but lower than that of VA users (comorbidity score 0 or 1: 73.3% vs. 82.4%). There were no differences across dual use categories in proportion African American, tumor grade, number of nodes examined, or distance to VA outpatient center.

For all stages, some of the differences in characteristics, though statistically significant, were small and of questionable clinical importance. Notably, across all stages, distance to VA outpatient center was not associated with dual use category; dual users tended to live in areas with higher percentages of high-school graduates compared to VA users but lower percentages compared to non-VA users; and predominantly non-VA patients were concentrated in the West region of the U.S.

**Overall Survival**

Table 2 presents numbers of deaths per 100 person-years of follow-up. Dual users experienced more deaths than both VA and non-VA users in stages II and III but not I. VA users experienced fewest deaths in all stages. Figure 1 shows Kaplan-Meier curves for overall survival, comparing survival distributions across user groups within each stage. The survival distributions were statistically different for stages I and III (p=0.032 and p=0.003, respectively), for stage I showing lower survival in the dual compared to the VA group but higher compared to the non-VA group and for stage III showing lowest survival among the dual group across nearly the entire distribution.

Hazard ratios (HR) estimated from extended Cox models controlling for age, comorbidity score, marital status, race, area percentage of high school graduates, distance to VA outpatient center,
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colecotomy (stage I), chemotherapy (stage II, III), tumor grade, number of regional lymph nodes
examined, and geographic region are shown in Table 3. Among stage I, II, and III patients,
predominantly VA and predominantly non-VA users had better overall survival. For example, compared
to dual users with stage I cancer, predominantly VA users had 60% and predominantly non-VA users had
46% reduced hazard of dying from any cause (VA HR 0.40, CI95 0.28–0.56; non-VA HR 0.54, CI95 0.38–
0.78). Other hazard ratios ranged from 0.59 for stage II and III VA users (stage II: CI95 0.43–0.80; stage III:
CI95 0.44–0.78) to 0.70 for stage II non-VA users (CI95 0.52–0.93).

When we ascertained patients’ dual use status at 30 days prior to death and did not allow it to
change after that, the results were very similar (Table 4). While we found that the magnitude of the HRs
were somewhat closer to 1.0 and in some models lost statistical significance, the direction of the effects
was unchanged. For example, among stage III patients, HRs were 0.71 (CI95 0.53–0.96) for VA and 0.80
(CI95 0.59–1.09) for non-VA users compared to 0.59 and 0.69, respectively, when dual use was allowed
to vary up to the time of death.

Event-Free Survival

Table 2 presents numbers of events per 100 person-years of follow-up. Again, in all three stage
groups, VA users experienced the fewest deaths. Stage III dual users had substantially higher event
rates than their VA and non-VA counterparts (46 compared to 35 and 38 per 100 person-years,
respectively). Figure 2 shows Kaplan-Meier curves for event-free survival. Survival distributions differed
across dual use groups only in stage I patients (p=0.008). In stage I, survival in the dual group was
between that of VA (highest) and non-VA (lowest) users across the entire follow-up period.

Among stage I patients, both predominantly VA and predominantly non-VA users had better EFS
(Table 3). Compared to dual users, VA users had 53% and non-VA users had 36% reduced hazard of a
progression event (VA HR 0.47, CI95 0.35–0.62; non-VA HR 0.64, CI95 0.47–0.86). Among stage II patients,
VA users had a reduced hazard of a progression event (HR 0.74, CI95 0.56–0.97) but there was no
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difference in risk of a progression event among non-VA users compared to dual users (non-VA HR 0.92 CI$_{95}$ 0.69–1.22). Similarly, among stage III patients, VA users had a 27% reduced hazard of a progression event (HR 0.73, CI$_{95}$ 0.56–0.94) while the non-VA HR of 0.81 (CI$_{95}$ 0.62–1.06) did not reach statistical significance.

When we ascertained patients’ dual use status at 30 days prior to an event and did not allow it to change after that, results were similar (Table 4). As we found for OS, HRs obtained with the revised dual use measure were somewhat attenuated. For example, HRs among stage I patients were 0.55 (CI$_{95}$ 0.41–0.74) for VA users and 0.69 (CI$_{95}$ 0.50–0.94) for non-VA users, compared to 0.47 and 0.64, respectively, when dual use was allowed to vary up to the time of the event. In stage III patients, while HRs continued to suggest a greater hazard of progression among dual users, confidence intervals for both VA and non-VA crossed 1.0. The same was true for stage II VA users. As before, the hazard of an event among stage II non-VA users was not different from that among dual users.

DISCUSSION

In this cohort of veterans with non-metastatic colon cancer who were dually eligible for VA and Medicare benefits, we found associations between receiving substantial portions of a patient’s cancer care in two systems—both VA and private sector non-VA—rather than one, and reduced OS and EFS. Relative differences were largest and most consistent for care received predominantly in the VA. Regardless of stage and accounting for multiple demographic and clinical factors, patients who received their cancer care predominantly in the VA had substantially better OS and EFS than dual users. Patients who received predominantly non-VA cancer care had better OS than dual users regardless of stage and, among stage I patients, improved EFS as well. None of our analyses suggested that dual system use was associated with a survival advantage. Our sensitivity analyses show that while unobserved declining health status among dual users may have contributed to their outcomes, this cannot be the only explanation for poorer survival in that group.
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What might account for poorer survival among those receiving substantial care in two systems or, conversely, improved outcomes among cancer patients receiving care in a single system? Some dual users may have failed to receive timely or appropriate diagnosis and treatment as a result of fragmented care. We note that stage II and III dual users were substantially less likely than VA and non-VA users to receive chemotherapy. Perhaps for that reason, dual users also had fewer total provider visits for colon cancer care, leading us to wonder whether these patients were lost to follow-up. Stage I dual users, in contrast, had more provider visits for cancer care than their single-system counterparts and yet they, too, had poorer survival.

Regardless of whether dual users received more care, the effectiveness of that care in prolonging survival seems to have been diminished. Previous research suggests that care fragmentation has deleterious effects on health, including increased emergency department (ED) visits among patients with diabetes and greater probability of hospitalization for ambulatory care sensitive conditions in a VA population, and conversely, that greater continuity is associated with lower probability of hospitalization, fewer ED visits, and higher patient satisfaction (43-48). Fragmentation of care associated with dual use may influence outcomes through reduced continuity and associated coordination of care. Cancer care in particular is complex, multi-faceted, and often prolonged. Coordination of the spectrum of care needed by cancer patients is a challenge for providers, patients, and families (17,49). Even within one system like the VA which has an electronic health record system, imperfect communication between multiple providers and between providers and patients, and imperfect systems for accomplishing administrative tasks involved in coordinating care can present barriers to timely care and optimal treatment (50). When care is sought across unrelated networks of providers, those problems are surely magnified.

To our knowledge, ours is the first study to examine impacts of dual healthcare system use in colon cancer. Recently, Landrum and colleagues (51) used VA and SEER-Medicare data to compare
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survival of older veterans with colon cancer in VA care to men in a general population sample using fee-
for-service (FFS) Medicare. They found better all-cause and cancer-specific survival rates in VA, partly
explained by more favorable stage at diagnosis. The authors did not examine dual use or account for
varying proportions of VA patients’ care in versus outside the VA. Because of those and other
differences in the studies, direct comparisons of study results are not possible though our findings of
better survival among predominantly VA users are not inconsistent with the results of that study.

Our study has limitations, particularly those related to the use of administrative data. It is
possible, for example, that our finding of poorer survival among dual users is a result of the effect of
unmeasured factors in our analysis. In that case, the seeming association between dual use and survival
could have been confounded by unmeasured health status, preferences for treatment, quality of non-
colon cancer care, or other factors. We accounted for comorbidities at baseline and the magnitude of
the comorbidity HRs diminished as stage progressed (not shown), consistent with the expectation that
underlying health is less influential in determining survival in patients with stage III cancer, for example,
than those with stage I cancer and offering reassurance that our comorbidity measure captured
important aspects of health. Nonetheless, our ability to ascertain and control for other potentially
determinative conditions—frailty, for example—or changes in non-cancer related health status after
diagnosis was limited.

Measurement error in our colon progression event outcome, if substantial and unequally
distributed between VA and Medicare data sources, could bias results. For example, an ICD-9 code for
“Secondary malignant neoplasm” accounted for a higher percentage of progression events in VA records
than in Medicare claims. Differences in ICD-9 coding practices, if they existed, could have contributed to
the fewer and smaller survival differences we found between predominantly non-VA and dual users
than between predominantly VA and dual users. Additionally, some events signaling cancer progression
are more measurable in administrative data than others, regardless of the source. Chemotherapy, for
example, is readily ascertained while a positive biopsy result is not (28,30,33). If patients receiving care outside the VA are more likely to receive treatment services that are measurable (e.g., chemotherapy among stage II patients), predominantly VA users could appear to have lower rates of progression than patients who use both systems. We note, however, that these potential limitations in outcome measurement would not have impacted our OS analysis in which we used a single data source for death ascertainment and found larger and more consistent deleterious effects associated with dual use. Thus, we conclude that findings of greater propensity toward death and progression among dual users are unlikely to be attributable to measurement error alone. Finally, because we did not have information on cause of death, we are unable to draw conclusions regarding the association of dual use with cancer death per se.

Our findings signal potential problems among patients with colon cancer who use both VA and Medicare FFS healthcare. Providing inducements to patients for single system care and mechanisms to facilitate improved care coordination across systems may be two potential avenues to achieve improved outcomes. To be successful, interventions targeting dual use will need to address the removal of barriers to single system care that may confront patients, alignment of financial incentives on the private sector side, and advancement of the electronic health record and health information exchange (2,50).

While this study has revealed some important differences in outcomes according to dual versus single system use, further study using prospectively collected data is needed. Future research should confirm these results and learn more about why the differences exist, why patients use both systems, what problems occur as a result, and how dual users who have Medicare managed care coverage fare. Together with a better understanding of barriers to better provider communication and coordination, this information will lead to potential implementable solutions and better patient outcomes in colon cancer care.
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Reference List


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Figure 1. Overall survival Kaplan-Meier curves for predominantly VA users (-----), dual users (----), and predominantly non-VA users (-----). A, stage I; B, stage II; C, stage III. X-axis, analysis time (months); Y-axis, survival probability. Note: Kaplan-Meier estimates are unadjusted.
Figure 2. Event-free survival Kaplan-Meier curves for predominantly VA users (-----), dual users (---), and predominantly non-VA users (----). A, stage I. B, stage II. C, stage III. X-axis, analysis time (months); Y-axis, survival probability. Note: Kaplan-Meier estimates are unadjusted.
Table 1. Patient Characteristics

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<td>Mean Percent (Std.)</td>
<td>Mean Percent (Std.)</td>
</tr>
<tr>
<td>Tumor Grade</td>
<td>0.06</td>
<td>0.04</td>
<td>0.32</td>
</tr>
<tr>
<td></td>
<td>Grade I</td>
<td>17.6</td>
<td>14.6</td>
</tr>
<tr>
<td></td>
<td>Grade II</td>
<td>59.1</td>
<td>61.0</td>
</tr>
<tr>
<td></td>
<td>Grade III</td>
<td>4.4</td>
<td>3.8</td>
</tr>
<tr>
<td></td>
<td>Grade IV</td>
<td>0.2</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>Unknown</td>
<td>18.8</td>
<td>20.2</td>
</tr>
<tr>
<td>Regional Lymph Nodes Examined</td>
<td>0.01</td>
<td>0.25</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>0 - 5</td>
<td>22.7</td>
<td>23.0</td>
</tr>
<tr>
<td></td>
<td>6 - 11</td>
<td>20.6</td>
<td>19.7</td>
</tr>
<tr>
<td></td>
<td>12 - 90</td>
<td>1.1</td>
<td>5.2</td>
</tr>
<tr>
<td>Colectomy</td>
<td>0.46</td>
<td>&lt;.01</td>
<td>&lt;.01</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Comorbidity Score\(^b\)

<table>
<thead>
<tr>
<th></th>
<th>0</th>
<th>1</th>
<th>2 or 3</th>
<th>4 or higher</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>58.3</td>
<td>22.9</td>
<td>15.5</td>
<td>3.2</td>
</tr>
<tr>
<td>1</td>
<td>51.2</td>
<td>27.2</td>
<td>18.3</td>
<td>3.3</td>
</tr>
<tr>
<td>2 or 3</td>
<td>55.7</td>
<td>18.1</td>
<td>19.2</td>
<td>7.0</td>
</tr>
<tr>
<td>4 or higher</td>
<td>48.2</td>
<td>26.4</td>
<td>22.1</td>
<td>4.3</td>
</tr>
</tbody>
</table>

### Distance to VA Outpatient Center (miles)

<table>
<thead>
<tr>
<th></th>
<th>0.03</th>
<th>0.22</th>
<th>0.03</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean (Std.)</td>
<td>13.4 (14.3)</td>
<td>14.1 (16.4)</td>
<td>14.8 (15.6)</td>
</tr>
<tr>
<td>Bottom Tertile</td>
<td>2.3 (1.2)</td>
<td>2.4 (1.1)</td>
<td>2.6 (1.1)</td>
</tr>
<tr>
<td>Middle Tertile</td>
<td>8.3 (2.8)</td>
<td>7.9 (2.3)</td>
<td>8.6 (2.7)</td>
</tr>
<tr>
<td>Top Tertile</td>
<td>29.7 (14.1)</td>
<td>32.3 (16.3)</td>
<td>32.5 (14.8)</td>
</tr>
</tbody>
</table>

### U.S. Census Division / Region

<table>
<thead>
<tr>
<th></th>
<th>&lt;.01</th>
<th>&lt;.01</th>
<th>&lt;.01</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northeast</td>
<td>18.8</td>
<td>24.4</td>
<td>20.9</td>
</tr>
<tr>
<td>East North Central</td>
<td>11.6</td>
<td>11.7</td>
<td>8.4</td>
</tr>
<tr>
<td>West North Central</td>
<td>9.7</td>
<td>10.8</td>
<td>11.8</td>
</tr>
<tr>
<td>South Atlantic</td>
<td>23.5</td>
<td>18.3</td>
<td>13.9</td>
</tr>
<tr>
<td>East South Central</td>
<td>10.4</td>
<td>7.0</td>
<td>0.7</td>
</tr>
<tr>
<td>West South Central</td>
<td>14.0</td>
<td>8.0</td>
<td>9.8</td>
</tr>
<tr>
<td>West</td>
<td>12.1</td>
<td>19.7</td>
<td>34.5</td>
</tr>
</tbody>
</table>

\(^a\) P-values from chi-square tests or Fisher’s Exact tests (Gender, Marital Status, Tumor Grade, Regional Lymph Nodes, Comorbidity Score)

\(^b\) We constructed a modified Deyo-Charlson Score with Romano adaptations.
Table 2. Number of Events per 100 Person-Years of Follow-up

<table>
<thead>
<tr>
<th></th>
<th>Stage I</th>
<th>Stage II</th>
<th>Stage III</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Deaths</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VA</td>
<td>7.7</td>
<td>11.7</td>
<td>19.0</td>
</tr>
<tr>
<td>Dual</td>
<td>10.2</td>
<td>14.9</td>
<td>30.9</td>
</tr>
<tr>
<td>Non-VA</td>
<td>11.2</td>
<td>13.0</td>
<td>22.6</td>
</tr>
<tr>
<td><strong>Colon Events</strong>&lt;sup&gt;a&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VA</td>
<td>12.0</td>
<td>19.2</td>
<td>34.9</td>
</tr>
<tr>
<td>Dual</td>
<td>15.7</td>
<td>19.6</td>
<td>46.1</td>
</tr>
<tr>
<td>Non-VA</td>
<td>17.3</td>
<td>23.9</td>
<td>38.3</td>
</tr>
</tbody>
</table>

<sup>a</sup> Events include deaths
Table 3. Estimated Hazard Ratios Comparing Healthcare System User Groups<sup>a</sup>

<table>
<thead>
<tr>
<th>Healthcare System Use</th>
<th>Overall Survival</th>
<th>Event-Free Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage I</td>
<td>Stage II</td>
</tr>
<tr>
<td></td>
<td>(N=1,028)</td>
<td>(N=1,129)</td>
</tr>
<tr>
<td>Predominantly VA</td>
<td>0.40 (0.28–0.56)</td>
<td>0.59 (0.43–0.80)</td>
</tr>
<tr>
<td>Dual User</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Predominantly Non-VA</td>
<td>0.54 (0.38–0.78)</td>
<td>0.69 (0.50–0.94)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Healthcare System Use</th>
<th>Overall Survival</th>
<th>Event-Free Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage I</td>
<td>Stage II</td>
</tr>
<tr>
<td></td>
<td>(352 events)</td>
<td>(524 events)</td>
</tr>
<tr>
<td>Predominantly VA</td>
<td>0.47 (0.35–0.62)</td>
<td>0.74 (0.56–0.97)</td>
</tr>
<tr>
<td>Dual User</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Predominantly Non-VA</td>
<td>0.64 (0.47–0.86)</td>
<td>0.92 (0.69–1.22)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Hazard ratios were obtained from Extended Cox survival models adjusted for age, race, comorbidity score, marital status, area high school graduation rate, tumor grade, number of regional lymph nodes examined, colectomy (stage I), chemotherapy (stage II, III), distance to VA outpatient center, and geographic region.

Table 4. Estimated Hazard Ratios Comparing Healthcare System User Groups: Revised Dual Use Measure<sup>a</sup>

<table>
<thead>
<tr>
<th>Healthcare System Use</th>
<th>Overall Survival</th>
<th>Event-Free Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage I</td>
<td>Stage II</td>
</tr>
<tr>
<td></td>
<td>(N=1,028)</td>
<td>(N=1,129)</td>
</tr>
<tr>
<td>Predominantly VA</td>
<td>0.50 (0.35–0.71)</td>
<td>0.72 (0.52–0.99)</td>
</tr>
<tr>
<td>Dual User</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Predominantly Non-VA</td>
<td>0.63 (0.43–0.91)</td>
<td>0.79 (0.57–1.11)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Healthcare System Use</th>
<th>Overall Survival</th>
<th>Event-Free Survival</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Stage I</td>
<td>Stage II</td>
</tr>
<tr>
<td></td>
<td>(352 events)</td>
<td>(524 events)</td>
</tr>
<tr>
<td>Predominantly VA</td>
<td>0.55 (0.41–0.74)</td>
<td>0.91 (0.68–1.23)</td>
</tr>
<tr>
<td>Dual User</td>
<td>Ref</td>
<td>Ref</td>
</tr>
<tr>
<td>Predominantly Non-VA</td>
<td>0.69 (0.50–0.94)</td>
<td>1.12 (0.83–1.51)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Hazard ratios were obtained from Extended Cox survival models adjusted for age, race, comorbidity score, marital status, area high school graduation rate, tumor grade, number of regional lymph nodes examined, colectomy (stage I), chemotherapy (stage II, III), distance to VA outpatient center, and geographic region. Dual use status was held static at its value 30 days prior to the event.
Reduced Overall and Event-Free Survival Among Colon Cancer Patients Using Dual System Care

Elizabeth Tarlov, Todd A. Lee, Thomas Weichle, et al.

Cancer Epidemiol Biomarkers Prev  Published OnlineFirst October 11, 2012.

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Author Manuscript

Author manuscripts have been peer reviewed and accepted for publication but have not yet been edited.