Published in final edited form as:

Cancer. 2020 July 01; 126(13): 3053–3060. doi:10.1002/cncr.32884.

Survival among Glioma Patients in the U.S. Military Health System: A Comparison with Patients in the Surveillance, Epidemiology, and End Results (SEER) Program

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Abstract

Background: Glioma is the most common malignant brain cancer. Accessibility to health care is an important factor affecting cancer outcome in the U.S. general population. The U.S. Military Health System (MHS) provides universal health care to its beneficiaries. It is unknown whether the universal health care has translated into improved survival outcomes among MHS beneficiaries with glioma. We compared overall survival of glioma patients in the MHS with that of the general population.

Methods: The MHS cases were identified from the Department of Defense's Automated Central Tumor Registry (ACTUR). Glioma cases from the general population were identified from the

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Author Contributions: Conception and Design: Lin, Zhu, Shriver; Methodology and Investigation: Lin, Zhu; Data Analysis and Interpretation: Lin, Bytnar, Theeler, McGlynn, Shriver, Zhu; Writing and Review: Lin, Bytnar, Theeler, McGlynn, Shriver, Zhu; Study Supervision: Lin, Zhu, Shriver

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Conflict of Interest Disclosure: None

National Cancer Institute's Surveillance, Epidemiology, and End Results (SEER) program. SEER cases were matched 2:1 to ACTUR cases by age, sex, race, histology and diagnosis year. All cases had histologically confirmed glioma diagnosed between January 1, 1987 and December 31, 2013. Kaplan-Meier analysis was conducted to compare survival among the ACTUR and SEER cases. Multivariable Cox proportional hazards models were used to estimate hazard ratios (HRs) and 95% confidence intervals (CIs).

Results: The study included 2,231 glioma cases from ACTUR and 4,462 cases from SEER. ACTUR cases exhibited significantly better overall survival than SEER cases (HR = 0.74, 95% CI = 0.67–0.83). The survival advantage of the ACTUR patients was observed in most subgroups stratified by age, gender, race, diagnosis year, and histology. For glioblastoma, the survival advantage was observed in both the pre- and post-temozolomide periods.

Conclusions: Universal MHS health care may have translated into improved survival outcomes in glioma. Future studies are warranted to identify factors contributing to the improved survival.

Precis:

Glioma patients in a universal care system had significant better survival than similar patients from the U.S. general population.

Keywords

Glioma; Survival; Universal Health Care; Military Health System

Introduction

Glioma is the most common type of malignant brain cancer in the United States, constituting approximately 81% of primary malignant brain tumors.¹ Glioma are comprised of a broad group of brain tumors of glial origin. Glioblastoma is the most common primary brain cancer in adults and has a poor prognosis with a median survival time of only fourteen months.¹

In the U.S. general population, access to health care, as reflected by health insurance, has an impact on survival among cancer patients.^{2–5} Lack or limited access to health care could affect the utilization of health care services, receipt of treatments, and quality of care delivered, which could lead to reduced survival, as shown in the U.S. general population.^{2, 6–9} In studies of brain cancer, studies have shown that patients without health insurance or with Medicaid had shorter survival than patients with other insurance coverage.^{10–12}

While the mortality from malignant brain tumors is not a major component of cancer mortality in the U.S. general population, brain cancer ranks the third most common cause of cancer death in the U.S. active duty military, following colon cancer and leukemia.¹³ The military health system (MHS) provides universal health care to 9.5 million beneficiaries, including active duty service members, National Guard and Reserve members, retirees, and their family members.¹⁴ The beneficiaries receive medical care free of charge or with minimal out-of-pocket cost.¹⁴ However, it is unknown whether the universal health

care access has translated into improved outcome among glioma patients in the MHS. In this study, we compared overall survival of glioma cases in the MHS with that of the general population. In addition, the standard-of-care changed for glioblastoma in 2005, when radiation therapy plus temozolomide chemotherapy replaced radiation therapy alone.¹⁵ The change has been correlated with improved survival in general population and other populations with glioblastoma was noted.^{16–18} For this reason, we also compared overall survival of glioblastoma between MHS and the general population for the time period before 2005, as well as 2005 and after.

Materials and Methods

Data sources

The data source for MHS beneficiaries was the Automated Central Tumor Registry (ACTUR) of the Department of Defense (DoD) and the data for the general population were from the Surveillance, Epidemiology, and End Results (SEER) program of the National Cancer Institute (NCI). ACTUR records and tracks cancer patients who are diagnosed and/or receive cancer treatment at military treatment facilities (MTFs). ACTUR complies with the uniform data standards set by the North American Association of Central Cancer Registries (NAACCR).¹⁹ Data are collected on demographics, tumor characteristics, cancer treatment, follow up, vital status and other information. The use of de-identified ACTUR data was approved by the institutional review board of Walter Reed National Military Medical Center.

The SEER program is a U.S. cancer registry program that collects population-based data from the areas covered by the SEER cancer registries. In this study, we used data from the SEER-18 registries (Atlanta, Connecticut, Detroit, Hawaii, Iowa, New Mexico, San Francisco-Oakland, Seattle-Puget Sound, Utah, Los Angeles, San Jose-Monterey, Rural Georgia, the Alaska Native, Greater California, Greater Georgia, Kentucky, Louisiana, and New Jersey), which represents 28% of the U.S. general population.²⁰ Data are collected on demographics, tumor characteristics, first cancer treatment, follow up, vital status, and other information. The SEER data are de-identified for public use.

Study Populations

Adult cases (ages 18 or older) diagnosed with histologically confirmed primary glioma between January 1, 1987 and December 31, 2013 were identified from the ACTUR and SEER databases. Glioma was defined with the cancer site codes (C71.0 to C71.9) and morphology codes (9440, 9441, 9442, 9381, 9401, 9421, 9400, 9410, 9411, 9420, 9424, 9382, 9450, 9451, 9460, 9391, 9392, 9393, 9380, 9423, 9430) of the International Classification of Diseases for Oncology, third edition (ICD-O-3).²¹ Cases with diagnosis from death certificate only or autopsy were excluded. Cases with multiple primary tumors were excluded to minimize effects of other cancers on the study outcomes. To reduce potential confounding effects of demographic variables and histology on survival, the ACTUR and SEER patients were matched on age (within 5 years), sex (male and female), race (white, black, Asian/Pacific islander, other), histology (glioblastoma, non-glioblastoma astrocytoma, oligodendroglioma tumor, ependymoma, and other gliomas)^{22, 23} and diagnosis year (1987–

1989, 1990–1994, 1995–1999, 2000–2004, 2005–2009, 2010–2013) with a matching ratio of 1:2. Cases with missing values for matching variables were excluded.

Study Variables

Variables extracted from both ACTUR and SEER included demographics, cancer diagnosis, tumor features, surgery, follow up, and vital status. Since brain tumors do not typically spread outside of the brain, there are no standard staging systems for adult brain tumors.²⁴ According to tumor clinical features and behaviors, brain tumors were graded into “well differentiated (grade I)”, “moderately differentiated (grade II)”, “poorly differentiated (grade III)”, “un-differentiated (grade IV)” using ICD-O-3 standard.²⁵ Histology was grouped into glioblastoma, non-glioblastoma astrocytoma, oligodendroglioma tumor, ependymoma, and other gliomas.²² Tumor location was defined as following groups: supratentorial (ICD-O-3 71.0–71.4), infratentorial (ICD-O-3 C71.6, 71.7), or other (ICD-O-3 71.5, 71.8, 71.9) if the site was unspecified or had overlapping regions.²⁶ Site-specific surgery codes were used to define surgery types and then grouped into “cancer-directed surgery received”, “no cancer-directed surgery” or “unknown or missing” according to SEER guidelines.²⁷ Receipt of radiation therapy was grouped into “yes”, “no”, and “unknown or missing”. All-cause mortality was used as the study outcome since data on cause of death were not complete in ACTUR.

Statistical Analysis

We first compared the distributions of demographic and tumor characteristics among ACTUR and SEER patients using the Chi-Square test. Kaplan-Meier curves with log rank test were used to compare overall survival between ACTUR and SEER cases. Multivariable Cox proportional hazards model for matched data was then used to estimate hazard ratios (HR) and 95% confidence intervals (CI) overall survival among ACTUR cases compared to SEER cases. The proportional hazards assumption was checked by plotting the log-log survival curves.²⁸ Follow-up time was calculated from diagnosis to death during five-year period. If death was not observed during the period, follow-up time was censored at the end of the fifth year. Patients who were not dead through the end of the study without a full five-year follow-up time were censored on the study ending date (i.e. December 31, 2013). To control for potential confounding from non-matching variables, multivariable Cox regression models were used to adjust for tumor grade (grade I, grade II, grade III, grade IV, or unknown), tumor location (supratentorial, infratentorial, or other), ethnicity (Hispanic, non-Hispanic, unknown), cancer-directed surgery (yes, no, or unknown) and age as a continuous variable. The analysis was further stratified by age, sex, race, diagnosis year, tumor histology, surgery or radiation. Considering potential p value inflation due to testing multiple hypotheses in this analysis, we implemented the false discovery rate (FDR) correction for multiple comparisons and reported FDR-corrected p values.²⁹

Finally, multivariable Cox regression models were used to compare survival of ACTUR cases with SEER case with glioblastoma in the temozolomide era (i.e. 2005–2013) and the pre-temozolomide era (1987–2003). Data from year 2004 was not used in this analysis because 2004 was a transition year between the two eras.¹⁸

All statistical analyses were conducted using SAS software version 9.4.0 (SAS Institute, Inc.). All reported p-values were two sided with a significance level of $p < 0.05$.

Results

A total number of 2,231 cases were identified from ACTUR and 4,462 cases from SEER. Demographic and tumor characteristics of cases were shown in Table 1. The ACTUR and SEER cases had the same distributions of the matching variables (age group, sex, race, year of diagnosis and histology group). ACTUR cases were more likely to have well differentiated tumors (5.92% vs. 3.45%) and poorly differentiated tumors than the SEER cases (8.56% vs. 7.31%), but less likely to have moderately differentiated tumors (10.31% vs. 11.27%) ($p < 0.001$) (Table 1). ACTUR cases had a higher percentage of supratentorial tumors (74.59% vs. 70.89%), a lower percentage of infratentorial tumors (6.54% vs. 7.53%) and tumors of other locations (18.87% vs. 21.58%) ($p < 0.001$). In regard to surgery treatment, the ACTUR cases were less likely than the SEER cases to receive cancer-directed surgery (72.84% vs. 77.21%), but more likely to have missing information on surgery (3.72% vs. 0.96) ($p < 0.001$).

The median survival times were 20 months (95% CI=19 to 21 months) and 23 months (95% CI=21 to 25 months) for the SEER and ACTUR patients, respectively. The Kaplan-Meier survival curves showed slightly better overall survival for ACTUR than SEER, but the difference was not statistically significant (Log Rank $p = 0.08$) (Figure 1). In multivariable Cox regression models, ACTUR cases exhibited significantly better overall survival than SEER cases (HR = 0.74, 95% CI=0.67 to 0.83) (Table 2). When the model was stratified by demographics, diagnosis year group and histology (Table 2), the significant survival advantage of the ACTUR cases was present among subgroups of cases aged 18–39 years (HR=0.77, 95% CI=0.63 to 0.95), 40–54 years (HR=0.69, 95% CI=0.56 to 0.85), 55–69 years (HR=0.73, 95% CI=0.60 to 0.88), men (HR=0.73, 95% CI=0.64 to 0.83), women (HR=0.75, 95% CI=0.62 to 0.91), whites (HR=0.82, 95% CI=0.75 to 0.90), blacks (HR=0.49, 95% CI=0.33 to 0.73) and those diagnosed during 1990–1994 (HR=0.63, 95% CI=0.44 to 0.91), 2000–2004 (HR=0.71, 95% CI=0.58 to 0.87), and 2005–2009 (HR=0.63, 95% CI=0.50 to 0.80). When stratified by age ≥ 65 vs. < 65 , the Medicare eligible age, the HRs for those ≥ 65 and < 65 were 0.83 (95% CI=0.66–1.04) and 0.71 (95% CI=0.63–0.80), respectively. In stratified analysis by tumor histology, significantly better survival was present in glioblastomas (HR=0.77, 95% CI=0.67 to 0.89) and non-glioblastoma astrocytomas (HR=0.69, 95% CI=0.56 to 0.85). Significantly better survival of ACTUR cases than SEER cases was observed regardless of surgery receipt with a HR of 0.77 (95% CI=0.68 to 0.88) and 0.61 (95% CI=0.42 to 0.89) for patients with and without surgery, respectively. When stratified by radiation, the better survival was observed only among patients who did not receive radiation (HR=0.74, 95% CI=0.65–0.85).

Table 3 shows the comparisons of patients with glioblastoma for pre- temozolomide and temozolomide eras, respectively. Better survival of ACTUR glioblastoma cases than SEER cases was observed during both periods (HR=0.79, 95% CI=0.64 to 0.96 for 1987–2003, the pre- temozolomide era, and HR=0.82, 95% CI=0.66 to 1.01 for 2005–2013 period,

the temozolomide era, respectively), although the HR for the temozolomide era was only borderline significant (Table 3).

Discussion

In this study, we found that glioma cases in the MHS had better overall survival than those in the general population. Our results suggest that the MHS's universal health care may improve glioma survival outcome.

We previously reported better overall survival of non-small cell lung cancer patients in MHS than in the SEER population.³⁰ In a study of invasive breast cancer, Ru et al. (2017) found that MHS beneficiaries treated at a U.S. military medical center had higher breast cancer specific survival than did the SEER patients.³¹ The improved survival of MHS beneficiaries with different cancers may support the benefit of universal health care for cancer patients. In this study of glioma, we observed a nearly 25% reduced all-cause mortality for the MHS cases compared to that of the SEER cases. This adds additional evidence, suggesting that the improved survival may not be cancer-site specific.

In the MHS, beneficiaries receive medical care free of charge or with minimal out-of-pocket cost and thus financial barriers to care are minimized. Studies of the U.S. general population regarding influence of health care access (or health insurance status) on the survival of cancer patients have found that patients without health insurance or those with Medicaid had worse survival than patients with insurance, especially those with private insurance.^{2-4, 8, 32, 33} In studies of brain cancer, a SEER-based study of 13,665 adult patients with glioblastoma reported that uninsured patients and patients with Medicaid had significantly worse glioblastoma-specific survival than patients with other insurance plans.¹⁰ A recent study based on the National Cancer Database (NCDB) reported better overall survival for patients with private insurance and other insurance than for uninsured patients with glioblastoma.¹¹

To the best of our knowledge, our study is the first study comparing survival of glioma patients in the MHS and the U.S. general populations. As one of the largest health care providers in the U.S., the MHS provides health care for 9.5 million beneficiaries.¹⁴ Regarding cancer care, the recent TRICARE (DoD's health insurance program) report to congress showed better utilization of screening services for several cancers among beneficiaries compared to national bench marks.¹⁴ Early detection of low-grade glioma is essential to improve survival because low-grade glioma progresses rapidly to the non-"de-novo" high-grade glioma and death.³⁴

In stratified analysis, the better survival for the MHS cases was observed in a majority of subgroups by demographics and tumor histology. In particular, better survival was significant for patients with glioblastoma and non-glioblastoma astrocytoma, the two most common types of glioma. The improved survival for glioblastoma, an aggressive tumor with poor prognosis, suggests that the survival advantage of the MHS cases was still evident for aggressive tumors. The better survival was not observed in other histological types likely due to either small numbers or low death rates of these rare types of glioma. In stratified

analysis by race, although the CIs of HRs overlapped, it is noteworthy that the lowest reduced mortality was observed for blacks (i.e. a nearly 50% reduction in mortality). This suggests that blacks, who have less access to care than whites in the general population,^{35, 36} may benefit more than whites from the universal health care provided by the MHS. It is also noteworthy that in the stratified analysis by surgery, the survival advantage of ACTUR over SEER was present regardless of whether patients received surgery or not. This suggests that the receipt of surgery might not modify the survival differences between the two populations. It is unknown why the survival advantage did not show among those who received radiation therapy. However, the role of radiation treatment on the survival difference should be better evaluated in the context of treatment combinations and modalities. The lack of association in this stratum may also be related to confounding factors that are not included in the study.

The mechanisms for the improved survival in the MHS may be related to multiple factors along the continuum of cancer care. In studies of the general population, the worse survival of uninsured patients and Medicaid patients with glioma was correlated with lower likelihood to receive recommended treatment modality,^{10–12, 37–39} higher odds of delayed treatment,³⁸ and lack of primary care physicians.¹² To our knowledge, there have been no studies of glioma that compare treatment receipt, health care delivery, quality of care or other factors between MHS and the general population. Further research on differences between the two populations on these factors is warranted to reveal possible mechanisms. As noted previously, the better survival of ACTUR over SEER was observed among cases with surgery and those without surgery, and that the better survival was present after adjusting for surgery in the models, indicating that surgery alone may not play an appreciable role in the survival difference observed. However, given the complexity of treatment modalities for glioma, a heterogeneous group of diseases, the potential role of treatment adherence in the survival difference cannot be fully evaluated without an in-depth analysis of specific surgery types and other therapies.

We observed a similar survival advantage of ACTUR cases over SEER cases among glioblastoma patients during the temozolomide era and the pre- temozolomide period. The similar results suggest that the differences in overall survival between the two populations remained despite the change in standard care from radiation therapy alone to radiation therapy plus temozolomide.

Our study has the strength of having large numbers of cases of glioma, a relative rare cancer, from the DoD and SEER cancer registries. We also applied a matching procedure in the study design to rigorously control for confounding effects of prognostic factors on survival. However, due to the limitation of cancer registry data, confounding effects from other factors not available in the cancer registry data cannot be excluded. In addition, since all-cause mortality rather than cancer-specific death was used as the outcome, the potential effects from causes other than glioma on the survival difference cannot be excluded. Finally, there is a concern of potential overlap between cases from MHS and SEER. However, if there is overlap, the overlap would only dilute the survival difference between the two populations and the true hazard ratios would be lower than what are observed in this study. Thus, our current estimates of HRs are rather conservative.

In conclusion, we found better survival of glioma patients in the MHS than the U.S. general population. Universal care in the MHS may have translated into improved survival outcome of glioma. Future studies are warranted to identify health care and delivery factors that may contribute to the improved survival outcome in the MHS.

Acknowledgement:

The authors thank Joint Pathology Center and SEER program for using the cancer registry data.

Funding:

This project was supported by Murtha Cancer Center Research Program via Uniformed Services University of the Health Sciences under the auspices of the Henry. M. Jackson Foundation for the Advancement of Military medicine.

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Figure 1.
Kaplan-Meier survival curve for ACTUR and SEER patients with glioma diagnosed during 1987–2013

Table 1.

Characteristics of glioma cases diagnosed during 1987–2013 from ACTUR and SEER registries

	ACTUR (N=2,231)		SEER (N4,462)		p-value
	N	%	N	%	
Age group					1.00
18–39	940	42.13	1880	42.13	
40–54	492	22.05	984	22.05	
55–64	424	19.00	848	19.00	
65 or older	375	16.81	750	16.81	
Sex					1.00
Male	1554	69.65	3108	69.65	
Female	677	30.35	1354	30.35	
Race					1.00
White	2025	90.77	4050	90.77	
Black	140	6.28	280	6.28	
Asian or Pacific Islander	54	2.42	108	2.42	
Other	12	0.54	24	0.54	
Year of diagnosis					1.00
1987–1989	240	10.76	480	10.76	
1990–1994	530	23.76	1060	23.76	
1995–1999	402	18.02	804	18.02	
2000–2004	378	16.94	756	16.94	
2005–2009	377	16.90	754	16.90	
2010–2013	304	13.63	608	13.63	
Histology group					1.00
Glioblastoma	965	43.25	1930	43.25	
Non-glioblastoma astrocytomas	782	35.05	1564	35.05	
Oligodendroglial tumors	317	14.21	634	14.21	
Ependymoma	47	2.11	94	2.11	
Other gliomas	120	5.38	240	5.38	
Tumor grade					<0.001
Well differentiated, grade 1	132	5.92	154	3.45	
Moderately differentiated, grade 2	230	10.31	503	11.27	
Poorly differentiated, grade 3	191	8.56	326	7.31	
Undifferentiated, grade 4	779	34.92	1564	35.05	
Unknown	899	40.30	1915	42.92	
Tumor location					0.006
Supratentorial	1664	74.59	3163	70.89	
Infratentorial	146	6.54	336	7.53	
Other locations	421	18.87	963	21.58	
Cancer-directed surgery					<0.001
No	523	23.44	974	21.83	

	ACTUR (N=2,231)		SEER (N4,462)		p-value
	N	%	N	%	
Yes	1625	72.84	3445	77.21	
Unknown or Missing	83	3.72	43	0.96	
Radiation					<0.001
No	659	29.54	1336	29.94	
Yes	1464	65.62	3012	67.50	
Unknown or Missing	108	4.84	114	2.55	

Table 2.

Overall and stratified hazard ratios of all-cause mortality comparing ACTUR with SEER among glioma cases diagnosed between 1987 and 2013

Variables	Numbers		Adjusted HR (95% CI)*	p-value#
	All cases	Deaths		
Overall				
SEER	4462	2775	1.00 (ref.)	
ACTUR	2231	1365	0.74 (0.67–0.83)	<0.001
By age groups				
18–39				
SEER	1880	649	1.00 (ref.)	
ACTUR	940	299	0.77 (0.63–0.95)	0.022
40–54				
SEER	984	671	1.00 (ref.)	
ACTUR	492	338	0.69 (0.56–0.85)	0.001
55–69				
SEER	1116	993	1.00 (ref.)	
ACTUR	558	499	0.73 (0.60–0.88)	0.002
70 or older				
SEER	482	462	1.00 (ref.)	
ACTUR	241	229	0.80 (0.60–1.05)	0.168
By sex				
Male				
SEER	3108	1953	1.00 (ref.)	
ACTUR	1554	956	0.73 (0.64–0.83)	<0.001
Female				
SEER	1354	822	1.00 (ref.)	
ACTUR	677	409	0.75 (0.62–0.91)	0.007
By race				
White				
SEER	4050	2515	1.00 (ref.)	
ACTUR	2025	1245	0.82 (0.75–0.90)	<0.001
Black				
SEER	280	175	1.00 (ref.)	
ACTUR	140	78	0.49 (0.33–0.73)	0.001
Asian or Pacific Islander				
SEER	108	75	1.00 (ref.)	
ACTUR	54	36	0.51 (0.22–1.16)	0.168
By year of diagnosis				
1987–1989				
SEER	480	324	1.00 (ref.)	
ACTUR	240	150	0.60 (0.30–1.19)	0.195

Variables	Numbers		Adjusted HR (95% CI)*	p-value [#]
	All cases	Deaths		
1990–1994				
SEER	1060	719	1.00 (ref.)	
ACTUR	530	361	0.63 (0.44–0.91)	0.022
1995–1999				
SEER	804	525	1.00 (ref.)	
ACTUR	402	270	0.93 (0.75–1.17)	0.655
2000–2004				
SEER	756	504	1.00 (ref.)	
ACTUR	378	230	0.71 (0.58–0.87)	0.003
2005–2009				
SEER	754	457	1.00 (ref.)	
ACTUR	377	207	0.63 (0.50–0.80)	<0.001
2010–2013				
SEER	608	246	1.00 (ref.)	
ACTUR	304	147	0.85 (0.63–1.15)	0.361
By histology				
Glioblastoma				
SEER	1930	1734	1.00 (ref.)	
ACTUR	965	888	0.77 (0.67–0.89)	0.001
Non-glioblastoma astrocytomas				
SEER	1564	758	1.00 (ref.)	
ACTUR	782	344	0.69 (0.56–0.85)	0.001
Oligodendroglial tumors				
SEER	634	166	1.00 (ref.)	
ACTUR	317	72	0.79 (0.53–1.18)	0.320
Ependymoma				
SEER	94	19	1.00 (ref.)	
ACTUR	47	11	0.95 (0.19–4.76)	0.951
Other gliomas				
SEER	240	98	1.00 (ref.)	
ACTUR	120	50	1.04 (0.60–1.79)	0.929
By Surgery				
Yes	3445	2006	1.00 (ref.)	
SEER	1625	921	0.75 (0.66–0.86)	<0.001
ACTUR				
No				
SEER	974	736	1.00 (ref.)	
ACTUR	523	377	0.57 (0.39–0.83)	0.007
Unknown				
SEER	43	33	1.00 (ref.)	
ACTUR	83	67	1.31 (0.39–4.42)	0.712

Variables	Numbers		Adjusted HR (95% CI) [*]	p-value [#]
	All cases	Deaths		
By Radiation				
Yes				
SEER	3012	2081	1.00 (ref.)	
ACTUR	1464	980	0.92 (0.65–1.30)	0.712
No				
SEER	1336	617	1.00 (ref.)	
ACTUR	659	311	0.74 (0.65–0.85)	<0.001
Unknown				
SEER	114	77	1.00 (ref.)	
ACTUR	108	74	0.73 (0.48–1.11)	0.195

^{*} All HRs were estimated from multivariable Cox proportional hazard model for matched data. In the overall analysis, HR was further adjusted for age (as continuous variable), Hispanic origin, tumor grade, tumor location, surgery and radiation. In stratified analysis, all variables adjusted in the overall analysis were adjusted except the stratified variable itself.

[#] All p values were corrected for multiple comparisons.

HR=Hazard ratio; CI=Confidence Interval

Table 3.

Hazard ratios of all-cause mortality comparing ACTUR with SEER among glioblastoma cases stratified by diagnosis year period

Variables	Numbers		Adjusted HR (95% CI)*	p-value
	All cases	Deaths		
Year 1987–2003				
SEER	1227	1172	1.00 (ref.)	
ACTUR	617	588	0.79 (0.64–0.96)	0.019
Year 2005–2013				
SEER	634	497	1.00 (ref.)	
ACTUR	317	273	0.82 (0.66–1.01)	0.065

* Adjusted for age (as continuous variable), sex, race, Hispanic origin, year of diagnosis, tumor grade, tumor location, surgery and radiation

HR=Hazard ratio; CI=Confidence Interval