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Analysis of Risk Factors for Death from Melanoma and Genitourinary Diseases in Male Patients with Cutaneous Melanoma: A Cohort Propensity Score Matching Study

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Objective: To analyze the influencing factors of male cutaneous melanoma (CM) patients dying from genitourinary diseases (GUD).

Methods: We searched the surveillance, epidemiology, and end results (SEER) database and extracted data on male CM patients according to the inclusion and exclusion criteria, including male patients whose cause of death was CM (cohort A) or GUD (cohort B). Comparisons between the two cohorts were performed before and after propensity score matching (PSM). An interaction analysis between age and year of diagnosis was also conducted. Cox regression analysis were performed to find the risk factors for death from GUD.

Results: Seven thousand seventy-eight CM patients were included, including 6415 (90.6%) in cohort A and 663 (9.4%) in cohort B. Compared with cohort A, cohort B patients were older (median age 74 ys. vs 65 ys.) and were more under the localized stage and had longer survival time no matter before or after PSM (all $p<0.001$). The stage was an inhibitory factor for cohort B ($p <0.001$). After PSM, only age and year of diagnosis were found to be cohort B's promoting factors ($p<0.001$). The interaction analysis showed that older patients diagnosed in later years (2009–2020) had a higher risk of dying from GUD compared to those diagnosed earlier ($p<0.05$). Patients with a later year of diagnosis (2009–2020) had a lower median survival time than patients with an earlier year of diagnosis (2000–2008) ($p<0.001$). When the patient's year of diagnosis was earlier (2000–2008), older patients (>75 ys.) had a higher risk of dying from GUD than younger patients (≤75 ys.) ($p<0.001$).

Conclusion: We first reported a significant interaction between age and year of diagnosis in male CM patients dying from GUD, highlighting the increased risk in older patients diagnosed more recently. We may pay attention to the possibility of dying from genitourinary diseases for CM patients.

Keywords: cutaneous melanoma, genitourinary diseases, non-cancer mortality, genitourinary cancer, cohort study

Introduction

Cutaneous melanoma (CM), the third most common skin cancer, is a malignant melanocytic tumor associated with poor survival and extremely high mortality.[1,2] The annual incidence of CM in Europe ranges from 3.5/100,000 in Mediterranean countries to 12–35/100,000 in Nordic countries.[1] Mortality and morbidity rates increased in Eastern European countries compared with Western European countries.[3] Although any age can be affected, studies have found that melanoma incidence peaks at age 65, posing a severe threat to the survival of older adults.[1] CM is also one of the cancers with the fastest incidence rate in China; its net annual incidence rates for men and women were 3.523% and 3.779%, respectively.[4] With the global aging process, more and more older adults may suffer from CM.[5]

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CM is a fatal cancer; thus, such patients' leading cause of death is CM, especially patients with advanced CM, and people may ignore that CM may die from other systemic diseases.[1,6] Genitourinary diseases (GUD) in CM patients are often overlooked, which may negatively impact the comprehensive management of these patients. In our clinical experience, a number of CM patients face complications related to renal or bladder neoplastic diseases, or renal functional disorders, which pose challenges in managing CM and may directly or indirectly affect the survival of these patients. In addition, there is a rare but clinically aggressive form of primary melanoma of the genitourinary tract that has been documented in the past decades.[7] While this form of melanoma is not common, its existence further emphasizes the importance of investigating the connection between CM and GUD, particularly in understanding its impact on patient outcomes. There were very few studies on the specific causes of death of CM patients, especially on deaths from other systemic diseases; for example, studies on CM patients dying from GUD have not been reported.[1,2,8] This study would analyze the influencing factors of male CM patients dying from GUD, including age, CM stage, CM treatment such as surgery, radiotherapy, and systemic therapy, and provide the basis for urogenital health during the management of CM patients.

Methods

In August 2023, we searched the surveillance, epidemiology, and end results (SEER) database (https://seer.cancer.gov/) for data on CM. Data extraction was performed according to the following inclusion criteria: (a) the primary cancer was CM; (b) the year of diagnosis from 2000 to 2020; (c) survival time was one month and above; (d) age from 18 to 84 years old; (e) the cause of death was CM (cohort A) or GUD (cohort B); (f) male patient. GUD included diseases of kidney parenchyma, kidney renal pelvis, penis, prostate, testis, ureter, urethra, urinary bladder, other urinary and other male genital tissues and organs. The exclusion criteria were[1] to exclude patients whose survival time was less than one month or whose CM was confirmed by autopsy and (b) to exclude patients who died from other causes.

The data was analyzed using SPSS 27.0 for Windows (IBM Inc, New York, USA). The measurement data included age (years old, ys). and survival time (months, mo). Cohort A and B were compared using two independent samples of non-parametric tests (Mann–Whitney Test). Other measurement data was classified in the following way. The ordered categorical variables include home location (divided into big city or small city), median household income (income) (divided into $75,000 and above or less than $75,000 according to the median), year of diagnosis (divided into 2000 to 2008, and 2009 to 2020), and CM stage (divided into localized and advanced, the later one including regional and distant). The comparisons between two cohorts of ordered categorical variables used the Wilcoxon rank sum test in non-parametric tests. Unordered categorical variables include race (divided into white and others), marriage (divided into married and single), cancer-directed surgery (CDS) (divided into surgery performed and surgery not performed), radiation therapy (divided into radiation therapy performed, and radiation not performed or unknown), systemic therapy (divided into systemic therapy performed, and not performed or unknown). Unordered categorical variables were analyzed using the Chi-square test, including Pearson Chi-Square or Fisher's Exact Test. Propensity score matching (PSM) matched cohorts A and B at a ratio of 1:1. According to the utterly random model, the matching volume was 0.0002; the matching items included age, home location, income, year of diagnosis, race, and marriage. The R studio (RStudio Team 2022) software performed Kaplan- Meier analysis and plotting.[9] Univariate and Multivariable Cox regression analyses were also performed to discover risk factors for death from GUD. $p<0.05$ was considered statistically significant.

Results

Comparisons of the Two Cohorts Before PSM

A total of 7078 patients with primary CM were included, of whom 6415 (90.6%) died of CM (cohort A) and 663 (9.4%) died of GUD (cohort B). Compared with cohort A (Table 1), cohort B patients had an older age at the onset of CM (median age 74 ys. Vs 65ys., $p<0.001$) and a higher proportion of white race (98.9% vs 97.4%, $p=0.012$), more proportion of earlier year of diagnosis (2000–2008 vs 2009–2020 was 58.4% vs 51.3%, $p<0.001$), more proportion of localized stage (87.3% vs 41.7%, $p<0.001$), and higher proportion of CDS (95.5% vs 79.6%, $p<0.001$), lower proportion of radiotherapy (2.3% vs.16.5%,

Table 1 Comparisons of the Two Cohorts Before Propensity Score Matching

	Cohort A n=6415 (%)		Cohort B n=663 (%)		P value
Age (ys.) median (range)	**65 (18–84)**		**74 (29–84)**		**<0.001***
Race					0.012**
White	6246	97.4	656	98.9	
Others	169	2.6	7	1.1	
Home location					0.813***
Big city	3404	53.1	355	53.5	
Small city	3011	46.9	308	46.5	
Marriage					<0.001**
Married	3962	61.8	377	56.9	
Single	1799	28.0	112	16.9	
Missing value	654	10.2	174	26.2	
Income					0.445***
≥$75,000	2886	45.0	288	43.4	
<$75,000	3529	55.0	375	56.6	
Years of diagnosis					<0.001***
2000–2008	3291	51.3	387	58.4	
2009–2020	3124	48.7	276	41.6	
Stage					<0.001***
Localized	2672	41.7	579	87.3	
Advanced	3208	50.0	57	8.6	
Missing value	535	8.3	27	4.1	
CDS					<0.001**
Yes	5107	79.6	633	95.5	
No	1285	20.0	28	4.2	
Missing value	23	0.4	2	0.3	
Radiation therapy					<0.001**
Yes	1058	16.5	15	2.3	
No or unknown	5357	83.5	648	97.7	
Systemic therapy					<0.001**
Yes	794	12.4	7	1.1	
No	3107	48.4	350	52.8	
Missing value	2514	39.2	306	46.2	
Survival time (mo.)	26(1−244)		63 (1–242)		<0.001*

Note: * Mann–Whitney Test; **Chi-square test; ***Wilcoxon rank sum test. Cohort A =male cutaneous melanoma patients died from cutaneous melanoma; cohort B =male cutaneous melanoma patients died from genitourinary diseases.

Abbreviation: CDS, cancer-directed surgery.

p<0.001), lower proportion of systemic therapy (1.1% vs.12.4%, p<0.001), and longer survival time (63 mo. vs 26 mo., p<0.001).

Comparisons of the Two Cohorts After PSM

Through PSM, we matched age, home location, income, year of diagnosis, race, and marriage in the two cohorts (Table 2) (all p>0.05). Then, comparing with cohort A, we found that cohort B patients still had a higher proportion of CM localized stage (85.6% vs 50.5%), a higher proportion of CDS (95.8% vs 84.3%), and a lower proportion of radiotherapy (2.9% vs 13.6%), a lower proportion of systemic therapy (1.5% vs 8.6%), and longer survival time (58 mo. vs 27 mo). (all p<0.001).

Table 2 Comparisons of the Two Cohorts After Propensity Score Matching

	Cohort A n=479 (%)		Cohort B n=479 (%)		P value
Age (ys.) median (range)	**75 (37–84)**		**75 (29–84)**		**0.925***
Race					1.000**
White	477	99.6	476	99.4	
Others	2	0.4	3	0.6	
Home location					0.650***
Big city	257	53.7	264	55.1	
Small city	222	46.3	215	44.9	
Marriage					0.323**
Married	359	74.9	372	77.7	
Single	120	25.1	107	22.3	
Income					0.649***
≥$75,000	207	43.2	214	44.7	
<$75,000	272	56.8	265	55.3	
Years of diagnosis					0.844***
2000–2008	286	59.7	283	59.1	
2009–2020	193	40.3	196	40.9	
Stage					<0.001***
Localized	242	50.5	410	85.6	
Advanced	211	44.1	52	10.9	
Missing value	26	5.4	17	3.5	
CDS					<0.001**
Yes	404	84.3	459	95.8	
No	75	15.7	20	4.2	
Radiation therapy					<0.001**
Yes	65	13.6	14	2.9	
No or unknown	414	86.4	465	97.1	
Systemic therapy					<0.001**
Yes	41	8.6	7	1.5	
No	206	43.0	255	53.2	
Missing value	232	48.4	217	45.3	
Survival time (mo.)	27(1−194)		58(1−242)		<0.001*

Notes: * Mann–Whitney Test; **Chi-square test; ***Wilcoxon rank sum test. Cohort A =male cutaneous melanoma patients died from cutaneous melanoma; cohort B =male cutaneous melanoma patients died from genitourinary diseases.
Abbreviation: CDS, cancer-directed surgery.

Univariate and Multivariable Cox Regression Analysis

This part of the study was conducted with the occurrence of cohort B as the event. Before doing this regression analysis, it was found that there was no intersection between age and year of diagnosis (Tolerance 0.991, Variance inflation factor 1.009 before PSM; Tolerance 0.998, Variance inflation factor 1.002 after PSM). Before PSM (Table 3), regardless of univariate or multivariable analysis, it was found that compared to cohort A, age, year of diagnosis, and systematic therapy were found to be promoting factors for cohort B (all $p<0.05$), indicating that the older the age, later year of diagnosis (later vs earlier = 2009–2020 vs 2000–2008), or CM patients who did not accept systemic therapy, lending to more patients died from GUD. CM stage was an inhibitory factor for cohort B ($p <0.001$), suggesting that the later the CM stage, the fewer patients died from GUD.

After PSM (Table 4), it was found that regardless of univariate or multivariable analysis, compared with cohort A, only age and year of diagnosis were found to be the promoting factors of cohort B (both $p<0.001$), once again suggesting that CM more patients died from GUD in those who were older or whose year of diagnosis was later.

Table 3 Univariate and Multivariable Cox Regression Analysis Before Propensity Score Matching

	Univariate analysis						Multivariate analysis					
	B	Wald	P value	Exp(B)	95% CI for EXP(B)		B	Wald	P value	Exp(B)	95% CI for EXP(B)	
					Lower	Upper					Lower	Upper
Age	0.078	315.923	<0.001	1.081	1.072	1.091	0.066	76.724	<0.001	1.068	1.052	1.084
Race	−0.385	1.025	0.311	0.680	0.323	1.434	–	–	–	–	–	–
Home location	−0.054	0.481	0.488	0.947	0.813	1.104	–	–	–	–	–	–
Marriage	−0.222	4.176	0.041	0.801	0.647	0.991	−0.036	0.052	0.820	0.965	0.710	1.311
Income	−0.145	3.362	0.067	0.865	0.741	1.010	–	–	–	–	–	–
Years of diagnosis	0.920	104.817	<0.001	2.508	2.103	2.991	0.472	0.052	0.003	1.603	1.178	2.182
Stage	−1.194	71.758	<0.001	0.303	0.230	0.399	−1.051	24.148	<0.001	0.350	0.230	0.532
CDS	−0.226	1.340	0.247	0.797	0.544	1.170	–	–	–	–	–	–
Radiation therapy	0.616	5.485	0.019	1.851	1.106	3.100	−0.236	0.472	0.492	0.790	0.403	1.549
Systemic therapy	1.816	22.566	<0.001	6.150	2.907	13.011	0.939	4.133	0.042	2.557	1.034	6.321

Abbreviation: CDS, cancer-directed surgery.

Table 4 Univariate and Multivariable Cox Regression Analysis After Propensity Score Matching

	Univariate analysis						Multivariate analysis					
	B	Wald	P value	Exp(B)	95% CI for EXP(B)		B	Wald	P value	Exp(B)	95% CI for EXP(B)	
					Lower	Upper					Lower	Upper
Age	0.033	32.911	<0.001	1.033	1.022	1.045	0.027	23.283	<0.001	1.028	1.016	1.039
Race	0.299	0.266	0.606	1.349	0.433	4.202	–	–	–	–	–	–
Home location	−0.067	0.527	0.468	0.935	0.780	1.121	–	–	–	–	–	–
Marriage	−0.046	0.173	0.677	0.955	0.768	1.187	–	–	–	–	–	–
Income	−0.097	1.096	0.295	0.908	0.758	1.088	–	–	–	–	–	–
Years of diagnosis	0.865	71.615	<0.001	2.375	1.944	2.902	0.794	59.851	<0.001	2.212	1.809	2.705
Stage	−0.263	3.149	0.076	0.768	0.574	1.028	–	–	–	–	–	–
CDS	0.240	1.088	0.297	1.271	0.810	1.993	–	–	–	–	–	–
Radiation therapy	−0.003	1.480*10−4	0.990	0.997	0.584	1.700	–	–	–	–	–	–
Systemic therapy	0.446	1.344	0.246	1.563	0.735	3.323	–	–	–	–	–	–

Abbreviation: CDS, cancer-directed surgery.

Survival Analysis Stratified by Age and Year of Diagnosis

After PSM, the patients were divided into two categories based on the median age of 75 ys.: ≤75 ys. and >75 ys. Survival curves were made according to age stratification (Figure 1) to find the impact of the year of diagnosis on cohort B. It was found that regardless of age ≤75 ys. or >75 ys., compared with patients with an earlier year of diagnosis (2000–2008), patients with a later year of diagnosis (2009–2020) had a lower median survival rate (both p< 0.001), indicating that the later the year of diagnosis, the more patients were likely to die from GUD.

Then, we made a survival curve stratified by year of diagnosis (Figure 2) to find the impact of age on cohort B. It was found that when the CM year of diagnosis was earlier (2000–2008), older patients (age>75 ys.) had a higher median survival rate dying from GUD than younger patients (age ≤75 ys). (p<0.001). When the CM year of diagnosis was later (2009–2020), there was no significant difference in the median survival rate of death from GUD among older patients (>75 ys.) or younger (≤75 ys.) (p>0.05).

Interaction between age and year of diagnosis.

To explore whether there was an interaction effect between age and year of diagnosis on the risk of dying from GUD, we performed an interaction test after PSM. The interaction term between age and year of diagnosis was included in the multivariable Cox regression analysis. The interaction test showed a significant interaction effect, with p value =0.003 (hazard ratio [HR], 0.58 [95% CI, 0.40–0.81]), indicating that the effect of age on the risk of death from GUD differs depending on the year of diagnosis. Specifically, older patients diagnosed in the later years (2009–2020) showed a higher risk of dying from GUD compared to those diagnosed in earlier years (2000–2008). This suggests that the relationship

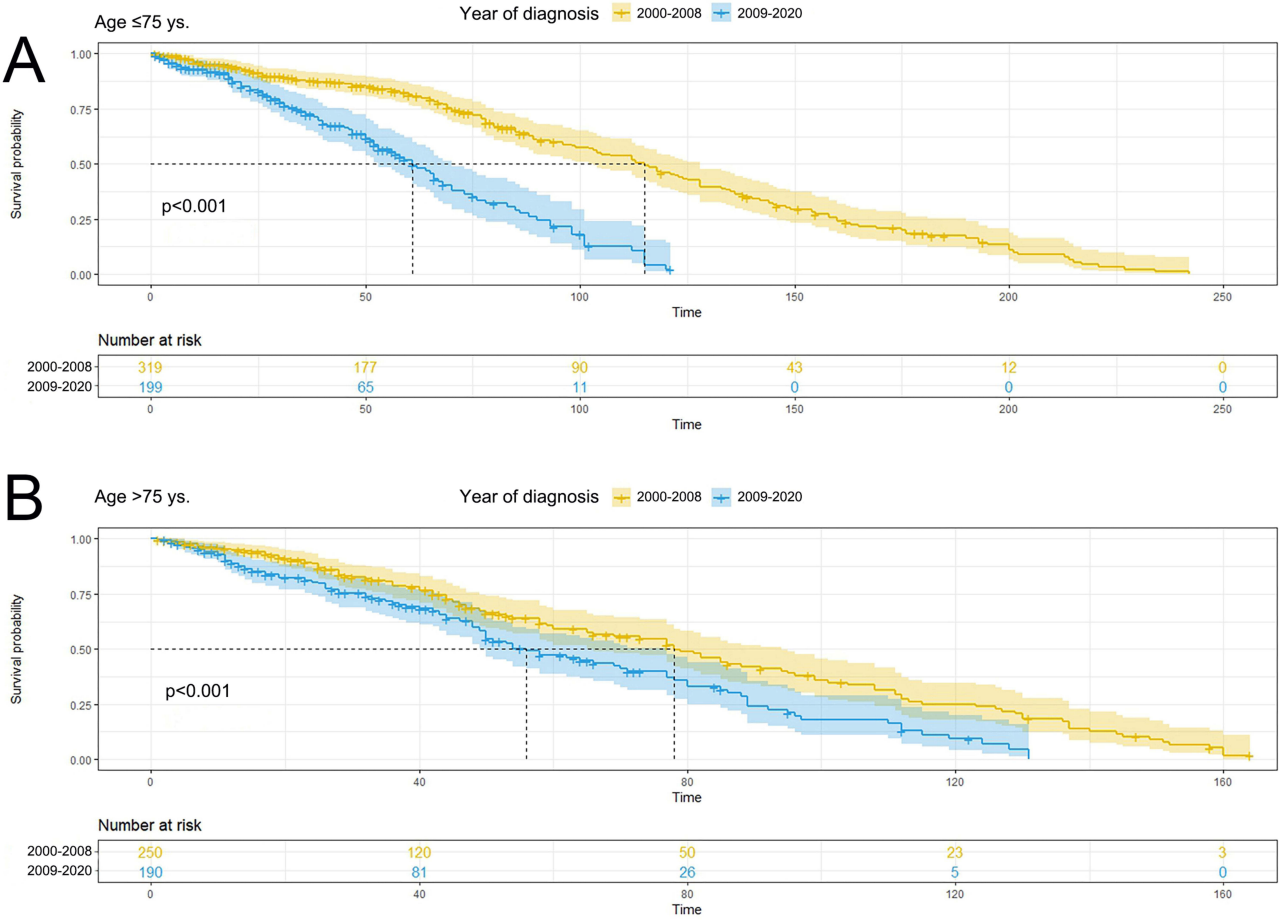

Figure 1 Survival analysis stratified by age. Regardless of age ≤75 ys. (**A**) or >75 ys. (**B**), compared with patients with an earlier year of diagnosis (2000–2008), patients with a later year of diagnosis (2009–2020) had a lower median survival rate (both p< 0.001).

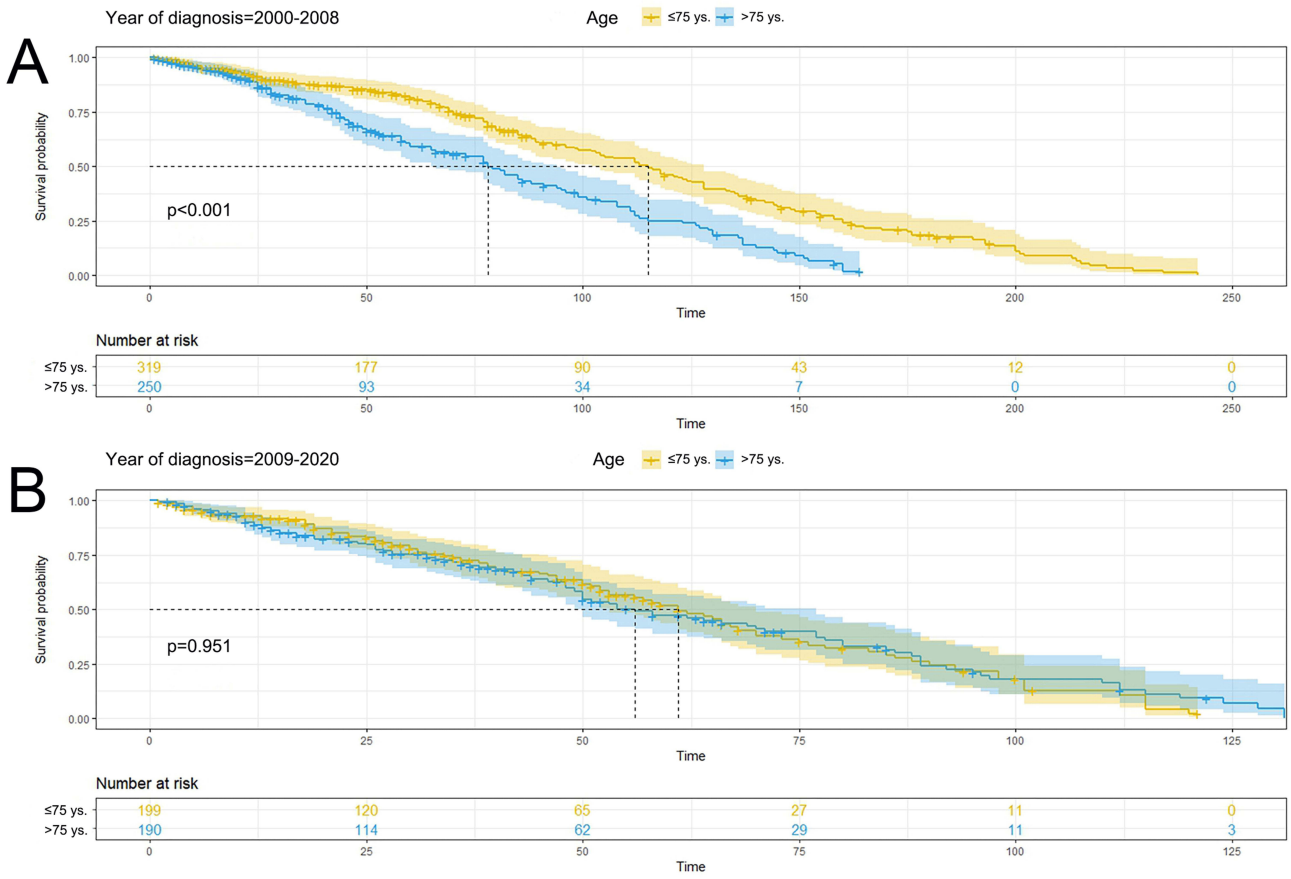

Figure 2 Survival analysis stratified by year of diagnosis. CM patients with earlier year of diagnosis (2000–2008), older patients (age>75 ys.) had a higher median survival rate dying from GUD than younger patients (age ≤75 ys.) (**A**) (p<0.001). CM patients with a later year of diagnosis (2009–2020), no significant difference was found in the median survival rate of death from GUD between older patients (>75 ys.) or younger (≤75 ys.) (**B**) (p>0.05).

between age and GUD-related mortality in CM patients may have been influenced by changes in treatment practices and comorbidities over time.

Discussion

We reported for the first time the influencing factors of CM patients dying from GUD. In this study, we found that age, year of diagnosis, CM stage, and a significant interaction between age and year of diagnosis were key factors associated with death from GUD. Specifically, older patients diagnosed in the later period (2009–2020) had a higher likelihood of dying from GUD compared to those diagnosed earlier (2000–2008). Our analysis also showed that patients with early-stage CM were more likely to die from GUD compared to those with advanced-stage disease. After PSM, age and year of diagnosis remained independent factors, while the impact of CM stage and related treatments on death from GUD became less significant. The significant interaction between age and year of diagnosis suggests that the relationship between these factors has evolved over time, particularly affecting older patients diagnosed more recently.

Before this study, we also retrieved and analyzed the male CM patients (n=18697) registered on the SEER database between 2000 and 2020. As of the time of data acquisition (September 10, 2023), the CM-specific mortality was only 34.3% (n=7311), 65.7% (n=11386) patients died from other causes, among which the most common death cause was diseases of heart (about 15.10%); and the death from GUD reached 3.5% (unpublished data).[10] Although the proportion of patients who died from GUD seemed small, it should not be ignored due to the continued increase in the incidence of CM and the aging trend. Cancer-specific mortality was one of the essential causes in cancer patients. In contrast, deaths caused by non-cancer-specific causes such as heart disease, chronic kidney disease, and urogenital cancers such as prostate and bladder cancer were also worthy of attention.[11–14] One potential explanation for GUD-related deaths in CM

patients might be comorbidities between CM and GUD. Studies suggest androgen could be a shared risk factor for both melanoma and prostate cancer.[15] A population-based assessment from Lithuania found that men with melanoma had a higher risk of developing prostate cancer.[16] Although studies have found that excessive sun exposure increases the risk of CM, vitamin D from sunlight reduces the risk of genitourinary cancers, including prostate, bladder, and kidney cancer.[17] However, increasing environmental pollution, such as consuming drinking water contaminated with arsenic, increases the risk of many cancers, including skin and bladder cancer.[18] Drinking alcohol was positively associated with the risk of melanoma and prostate cancer.[19] The specific impact of newly diagnosed prostate cancer or combined bladder cancer on survival rate after CM deserved further study. Our research provided specific value for alerting of death from GUD during the management of CM.

In the context of other melanoma subtypes, such as mucosal melanoma, which is a rarer and more aggressive form, it is essential to consider how these findings may apply. Mucosal melanoma, which can occur in the genitourinary tract, often presents with worse prognoses and outcomes compared to cutaneous melanoma due to its later detection and more aggressive nature.[7] Although this study focused on cutaneous melanoma, the findings on GUD-related mortality may also have implications for patients with mucosal melanoma, particularly in terms of the management of comorbid genitourinary conditions. Future studies should address the differences in outcomes between cutaneous melanoma and other subtypes, such as mucosal melanoma, in the context of GUD-related mortality.

CM treatment may have a particular relationship with GUD and cause-related death. Treatment of CM depends on its stage, and for early localized CM, wide local excision[8] or radiotherapy[20] are effective treatments to achieve radical cure. Long-term survival may be possible for CM patients with radically cured;[1] patients who survive CM long-term may develop other urogenital cancers, potentially increasing the number of GUD-related deaths.[16] Especially with the aging process, the diagnosis of CM in elderly patients is gradually increasing;[1,5] age was a risk factor for CM dying from GUD. A study found the 5-year survival rate of cancers including CM had increased in recent years, but age was a significant negative factor affecting their survival rates; the mortality rate of patients over 80 years old was significantly lower than that of patients with CM under 80 years old.[16] There was a significant link between older age and increased rates of cancers and chronic kidney disease.[21,22] We found that patients with CM who died from GUD generally had an earlier CM stage. We further found that the independent influencing factors of death from GUD were age and year of diagnosis, suggesting that old age was a significant risk factor for CM patients who tended to die from GUD. The death of elderly CM patients from GUD might be mainly related to comorbid genitourinary cancers and chronic kidney disease.

In addition, systemic therapy was a required adjuvant or palliative treatment for patients with localized stage, metastatic, or progressive CM,[6] including interferon alfa,[23] anti-cytotoxic T lymphocyte-associated antigen 4,[24] anti-PD-1[24] and targeted therapies.[25] These treatments might induce acute renal impairment or aggravate chronic kidney disease, increasing the risk of death from GUD.[26–28] However, one finding that requires further discussion is why patients diagnosed in the later years (2009–2020) did worse compared to those diagnosed earlier (2000–2008), despite the introduction of novel therapies such as immunotherapy and targeted therapy after 2011.[29] These treatments have significantly improved melanoma outcomes, as data showing a dramatic decrease in melanoma mortality in the last decade.[30] Therefore, the increased deaths from GUD in later-diagnosed patients may seem contradictory. We speculate that this result could be related to factors such as an increase in comorbidities like chronic kidney disease or other genitourinary cancers in the aging population,[31] or potentially the side effects of modern cancer treatments, including immunotherapy and targeted therapy, which could contribute to GUD-related deaths.[32,33] This apparent contradiction warrants further investigation.

The significant interaction between age and year of diagnosis adds complexity to this observation. Older patients diagnosed in the later years were at a particularly higher risk, suggesting that evolving treatments and increasing age-related comorbidities could both contribute to the rising GUD-related mortality in these patients. This underscores the need for careful management of comorbidities in CM patients, especially those undergoing systemic therapies.

Further research is necessary to explore the role of modern treatments and comorbidities in the rising GUD-related mortality in older CM patients diagnosed in later years. Understanding these relationships can help improve comprehensive care for CM patients, particularly as the population continues to age.

This study had several limitations. First, this was a retrospective study and analysis based on data registered in North America. Our included population represents a small subset of American CM patients. The racial classification was mainly white, so that the study results might have limited reference value for other racial people. Prospective multi-center, multi-ethnic studies are needed to determine the proportion of CM patients dying from GUD and the influencing factors. In addition, we focused on analyzing the influencing factors of CM dying from GUD. Generally speaking, the proportion of CM patients dying from GUD seemed to be a small probability event. However, due to the continued process of population aging, elderly patients with CM were worthy of attention. The situation of elderly patients combined with chronic kidney disease, prostate cancer, and other GUDs on the comprehensive treatment of CM and their impacts on patient survival could not be ignored. Furthermore, it may not be entirely appropriate to group all genitourinary diseases (GUD) together as either tumor or non-tumor, or benign or malignant diseases, given the wide variation in prognosis across different GUDs. For instance, prostate cancer, which only occurs in male patients, generally has a better prognosis than many other genitourinary cancers. This variability in prognosis may complicate the interpretation of our findings and should be considered in future studies that aim to differentiate between various types of GUD and their specific impacts on CM patient outcomes. One particularly puzzling finding was that patients diagnosed with CM in later years (2009–2020) had worse outcomes in terms of dying from GUD compared to those diagnosed earlier (2000–2008), despite the introduction of immunotherapy and targeted therapies after 2011, which are known to improve melanoma-specific survival. This seemingly contradictory result could be related to an increase in comorbid conditions such as chronic kidney disease and other genitourinary cancers in the aging population, or potentially adverse effects of these newer treatments that may contribute to GUD-related mortality. This aspect deserves further investigation in future studies. Additionally, we did not investigate whether some GUD cases, particularly chronic or acute inflammatory diseases, were related to melanoma treatments such as immunotherapy, targeted therapy, or chemotherapy. These treatments could potentially contribute to the development of GUD, which is an area that warrants further exploration in future research. Our study did not include important melanoma pathological factors such as Breslow depth, ulceration, node status, and distant metastasis, which could provide a more precise comparison between patients who died of CM versus those who died of GUD. This lack of detailed tumor burden data might have impacted the study's ability to thoroughly account for the severity of melanoma in the analysis. Finally, we did not conduct analysis and research on the specific causes of GUD (such as genitourinary cancers and chronic kidney disease), mainly because the sample size was small and a positive result by stratified analysis was difficult to achieve. Still, our research results might help remind medical service providers to pay attention to the potential risk of death from GUD in CM patients.

Conclusion

We report the influencing factors of death from GUD in CM patients for the first time. Our study alerts us to the possibility of dying from genitourinary diseases, especially for elderly and later-diagnosed CM patients. However, the impact of the CM stage and its related treatments on death from GUD was not as significant as expected. Prospective multi-center, multi-ethnic studies are needed to determine the proportion of CM patients dying from GUD and the influencing factors.

Data Sharing Statement

The data can be accessed in the surveillance, epidemiology, and end results (SEER) database.

Ethics Statement

The patient data was sourced from the United States Department of Health and Human Services. The dataset is publicly accessible and fully anonymized following approval. Consequently, this study did not require individual participant consent and was granted exemption from ethical review by the Ethics Committee of Fujian Provincial Hospital.

Author Contributions

All authors made a significant contribution to the work reported, including the conception, study design, execution, acquisition of data, analysis and interpretation; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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