



The impact of insurance status on the survival outcomes of patients with renal cell carcinoma

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Background: The impact of insurance status on renal cell carcinoma (RCC) patient survival is unclear. In this study, we investigated the effects of insurance status on the survival outcomes of RCC patients in the United States of America.

Methods: Data of patients diagnosed with RCC between 2007 and 2014 were obtained from the Surveillance, Epidemiology and End Results (SEER) database, a large national database including statistics on cancer patients. The Kaplan-Meier method and Cox regression analysis were used to determine the influence of insurance status on cancer-specific survival (CSS).

Results: A total of 30,951 eligible RCC patients were identified. Of these patients, 25,493 (82.37%) were insured, 3,959 (12.79%) had any Medicaid coverage, and 1,499 (4.84%) were uninsured. Kaplan-Meier analysis revealed that insurance status was associated with better CSS ($P < 0.001$). The 5-year CSS rates of patients with insurance, any Medicaid, and no insurance were 88.3%, 82.6%, and 82.7%, respectively. Multivariate Cox regression analysis showed that patients with any Medicaid had poorer CSS than insured patients [hazard ratio (HR), 1.222; 95% confidence interval (CI), 1.100–1.357]. Stratified analysis revealed that at localized tumor stage and at regional tumor stage or among white patients, any Medicaid insurance was an independent predictor of an unfavorable survival outcome.

Conclusions: Among the RCC patients in this study, individuals with insurance experienced improved CSS while individuals with any Medicaid tended to suffer worse survival outcomes.

Keywords: Adult; cancer-specific survival (CSS); renal cell carcinoma (RCC); Surveillance, Epidemiology and End Results database (SEER database); insurance status

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Introduction

Renal cell carcinoma (RCC) is the most common form of kidney cancer among adults. The global incidence and mortality rates of RCC have been increasing by 2–3% every decade (1). The 5-year survival rate in patients with advanced RCC is extremely low, ranging from 5–10%, because of recurrence and distant metastasis (2). Over

the past decades, although medical treatment for RCC has great progress which transitioned from a surgical resection approach, to targeted therapy incorporates both surgical and systemic therapies, and now combining novel immunotherapy agents (3). However, despite these recent advances, RCC patients can still expect a dire prognosis

A study reported that nearly 30% of all survivors of

cancer reported cancer-related financial problems (4). Recently, a considerable literature has grown up around the health insurance as indicative of the financial capacity which has been shown to be associated with treatment and survival gap in various diseases, including cancer (5). Several studies have demonstrated that uninsured cancer patients present with more advanced disease, thus experiencing worse survival outcomes (6-8). In addition, a study on patients with gallbladder cancer revealed the insurance status of patients as an independent prognostic factor (9). Data from 2004 to 2012 National Health Interview Survey in United States shown that approximately 17% among population under 65 years old live without insurance (10,11). For RCC, treatment patterns with a large shift and associated costs with marked increased in metastatic renal cell carcinoma (mRCC) patients with private insurance from 2004 to 2011 (12). It has been reported that insurance status may be an important factor for survival outcomes in RCC (13); however, the relationship between insurance status and prognosis in RCC has yet to be fully explored.

Therefore, in this study, we explored the impact of insurance status on the survival outcomes of RCC patients using data from the Surveillance, Epidemiology and End Results (SEER) cancer registry database. We hypothesized that insurance status was associated with better CCS compared with those without insurance among the RCC patients. We present the following article in accordance with the STROBE reporting checklist (available at <http://dx.doi.org/10.21037/tau-20-1045>).

Methods

Data source

This study retrospectively analyzed the open-access SEER database, run by the US National Cancer Institute, collects and reports patient demographic and cancer incidence and survival data from 18 population-based cancer registries. The dataset analyzed in this study was documentation version April 2017, which collects patients diagnosed 1973–2014 and covers about 30% of the US population. Using the reference number ‘11039-Nov2017’, we obtained and extracted all primary data from the SEER database using SEER*Stat Version 8.3.2. Because the data extracted from this database were anonymized and de-identified before being published, our study did not require informed consent. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The details of the study were reviewed and approved by the ethics

committee of The Fourth Affiliated Hospital (Harbin, China).

Study population

Our study included individuals who had tumors with a primary site of ‘kidney and renal pelvis’ [code C64.9 and C65.9, according to the International Classification of Diseases for Oncology 3rd Edition (ICD-O-3)]. Patients with common histologic subtypes (clear cell, papillary, and chromophobe renal carcinoma) were included. Histologic confirmation of RCC was determined according to the ICD-O-3, based on the following codes: clear cell (8310, 8320, 8316), papillary (8050, 8260, 8342), and chromophobe (8270, 8290, 8317). Because the database only began to report insurance status in 2007, patients who were diagnosed before 2007 were excluded from the analysis. All of the included patients were diagnosed between 2007 and 2014. Any patients meeting the following criteria were excluded: (I) unknown insurance status; (II) a previous primary tumor; (III) aged <18 or >65 years at diagnosis; or (IV) an autopsy or death certificate was the only reporting source.

A total of 30,951 eligible RCC patients were included. Patient demographic characteristics and clinical variables included: age at diagnosis, gender, race, histotype, grade, tumor size, SEER stage, TNM (tumor, node, and metastasis) stage, and surgical therapy. Race was classified as white, black, or other (American Indian/Alaska Native, Asian/Pacific Islander). TNM stage was assessed according to the 6th edition of the American Joint Committee on Cancer staging system. Treatment strategies were classified as binary values; namely, surgical therapy (i.e., surgery and/or radiotherapy), or no treatment (due to lack of relevant information on chemotherapy or systemic therapy). We extracted median household income data using the country attributes ACS-2010-2014 datasets. Education level represents the percentage of adult individuals with at least a bachelor’s degree. Marital status was classified into four groups including (married, single, separated/divorced, or widowed). Insurance status was classified as insured, any form of Medicaid, or uninsured.

Statistical analysis

Cancer-specific survival (CSS) was the endpoint of this study. In terms of cause-specific survival, deaths attributed to RCC were considered as events, while deaths from

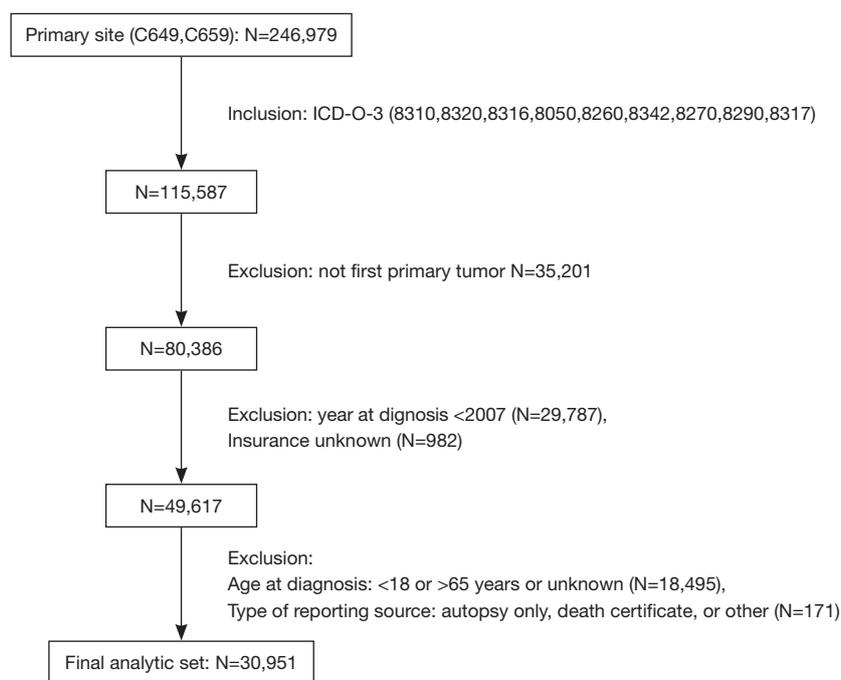


Figure 1 Flow diagram of patient selection in the current study.

other causes or survival were treated as censored events. To provide descriptive statistics for continuous variables, the patients were divided into categories based on the variable: age was divided into two categories according to the median, median household income and education levels were converted into categorical variables according to the interquartile range (IQR). The baseline characteristics of patients stratified by their insurance status were analyzed with χ^2 tests. The Kaplan-Meier method and the log-rank test were employed to compare each factor of CSS. Hazard ratios (HR) and 95% confidence intervals (CIs) were estimated using univariate and multivariate Cox regression models. Stratified analysis to examine the impact of insurance status on the outcomes of RCC patients was performed according to SEER stage and racial group. SPSS Version 21.0 software (SPSS Inc., Chicago, IL, USA) was used to carry out all statistical analyses. All tests were two-sided, and the significance level was set at $P < 0.05$.

Results

Patient baseline characteristics

A total of 246,979 individuals with kidney cancer were included in the SEER registries. After the exclusion criteria had been applied, there were 30,951 RCC patients deemed

eligible for inclusion. *Figure 1* shows the flow chart for patient selection in this study. Of these patients, 25,493 (82.37%) were insured, 3,959 (12.79%) had any form of Medicaid, and 1,499 (4.84%) were uninsured. The clinicopathological characteristics and demographics of patients with different insurance statuses are summarized in *Table 1*. Among the included RCC patients, 20,128 (65.0%) were male and 24,976 (80.7%) were white, which reflects the higher risk of RCC in white males. The enrolled individuals had a median age of 55 years old. Interestingly, every subgroup was significantly different (all $P < 0.001$). Individuals in the uninsured group were more likely to have poorly-differentiated/undifferentiated tumors as well as larger tumor size (>7 cm) compared to the insured group. The uninsured group also tended to be at a later stage of cancer at the time of diagnosis and were less likely to receive surgical therapy.

Insurance status and RCC

The overall median survival was 34 months, and the 5-year CSS was 87.4%. Moreover, the insured patients (88.3%) had the highest 5-year RCC CSS rate (compared with 82.7% and 82.6% for the uninsured patients and any Medicaid patients, respectively). The CSS curves were

Table 1 Variations in insurance coverage in the enrolled population

Parameters	Total (N=30,951)	Insured (N=25,493)	Any medical (N=3,959)	Uninsured (N=1,499)	P
Gender					<0.001
Female	10,823 (35.0)	8,607 (33.8)	1,674 (42.3)	542 (36.2)	
Male	20,128 (65.0)	16,886 (66.2)	2,285 (57.7)	957 (63.8)	
Age					<0.001
<55 y	16,151 (52.2)	12,892 (50.6)	2,348 (59.3)	911 (60.8)	
≥55 y	14,800 (47.8)	12,601 (49.4)	1,611 (40.7)	588 (39.2)	
Race					<0.001
White	24,976 (80.7)	20,848 (81.8)	2,940 (74.3)	1,188 (79.3)	
Black	3,581 (11.6)	2,686 (10.5)	657 (16.6)	238 (15.9)	
Other*	2,091 (6.8)	1,695 (6.6)	331 (8.4)	65 (4.3)	
Unknown	303 (1.0)	264 (1.0)	31 (0.8)	8 (0.5)	
Histotype					<0.001
Clear cell	24,157 (78.0)	19,726 (77.4)	3,216 (81.2)	1215 (81.1)	
Papillary	4,371 (14.1)	3,654 (14.3)	518 (13.1)	199 (13.3)	
Chromophobe	2,423 (7.8)	2,113 (8.3)	225 (5.7)	85 (5.7)	
Grade					<0.001
Well/moderate	17,423 (56.3)	14,771 (56.8)	2,167 (54.7)	785 (52.4)	
Poor/undifferentiated	9,038 (29.2)	7,470 (29.3)	1,104 (27.9)	464 (31.0)	
Unknown	4,490 (14.5)	3,552 (13.9)	688 (17.4)	250 (16.7)	
Tumor size					<0.001
≤7 cm	23,065 (75.4)	19,241 (76.2)	2,838 (73.0)	986 (67.6)	
>7 cm	7,521 (24.6)	5,999 (23.8)	1,049 (27.0)	473 (32.4)	
SEER stage					<0.001
Localized	2,844 (9.2)	2,156 (8.5)	492 (12.4)	196 (13.1)	
Regional	23,652 (76.4)	19,723 (77.4)	2,885 (72.9)	1,044 (69.6)	
Distant	4,328 (14.0)	3,524 (13.8)	554 (14.0)	250 (16.7)	
Unknown	127 (0.4)	90 (0.4)	28 (0.7)	9 (0.6)	
TNM stage					<0.001
I/II	23,291 (75.3)	19,446 (76.3)	2,823 (71.3)	1,022 (68.2)	
III/IV	7,066 (22.8)	5,591 (21.9)	1,032 (26.1)	443 (29.6)	
Unknown	594 (1.9)	456 (1.8)	104 (2.6)	34 (2.3)	
Marital status					<0.001
Married	19,195 (62.0)	17,200 (67.5)	1,368 (34.6)	627(41.8)	
Single	6,094 (19.7)	4,033 (15.8)	1,529 (38.6)	532(35.5)	
Separated/divorced	3,454 (11.2)	2,460 (9.6)	737 (18.6)	257(17.1)	

Table 1 (continued)

Table 1 (continued)

Parameters	Total (N=30,951)	Insured (N=25,493)	Any medical (N=3,959)	Uninsured (N=1,499)	P
Widowed	760 (2.5)	566 (2.2)	155 (3.9)	39 (2.6)	
Unknown	1,448 (4.7)	1,234 (4.8)	170 (4.3)	44 (2.9)	
Median household income					<0.001
Quartile 1 (US\$<4,903)	7,484 (24.2)	5,718 (22.4)	1,251 (31.6)	515 (34.4)	
Quartile 2 (US\$4,903–5,620)	5,234 (16.9)	4,354 (17.1)	639 (16.1)	241 (16.1)	
Quartile 3 (US\$5,620–6,747)	10,223 (33.0)	8,316 (32.6)	1,383 (34.9)	524 (35.0)	
Quartile 4 (≥US\$ 6,747)	8,008 (25.9)	7,103 (27.9)	686 (17.3)	219 (14.6)	
Education level					<0.001
Quartile 1 (<21.25)	7,736 (25.0)	5,953 (23.4)	1,298 (32.8)	485 (32.4)	
Quartile 2 (21.25–30.27)	6,507 (21.0)	5,452 (21.4)	759 (19.2)	296 (19.7)	
Quartile 3 (30.27–35.785)	8,939 (28.9)	7,276 (28.5)	1,229 (31.0)	434 (29.0)	
Quartile 4 (>35.78)	7,767 (25.1)	6,810 (26.7)	673 (17.0)	284 (18.9)	
Surgery therapy					<0.001
No	1,427 (4.6)	960 (3.8)	344 (8.7)	123 (8.2)	
Yes	29,516 (95.4)	24,527 (96.2)	3,614 (91.3)	1,375 (91.8)	

*, other includes American Indian/Alaska native, Asian/Pacific Islander, and unknown. SEER, Surveillance, Epidemiology, and End Results.

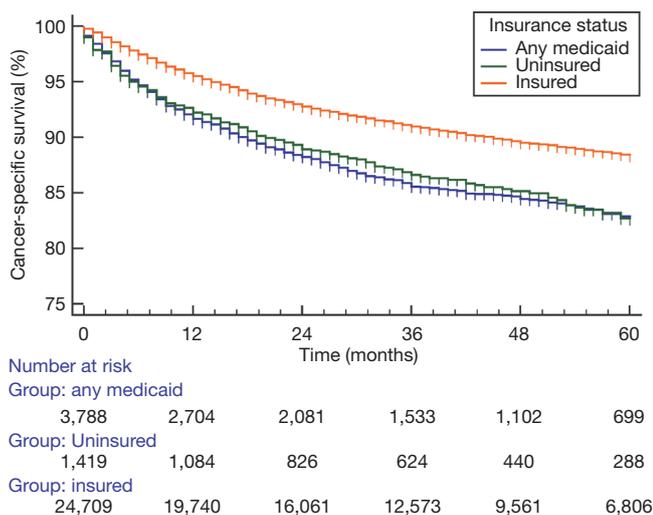


Figure 2 Survival curves for renal cell carcinoma patients according to insurance status. $\chi^2=125.901$, $P=0.001$.

analyzed according to insurance status using the Kaplan-Meier method and the log-rank test, which showed significant differences ($P=0.001$) (Figure 2). Univariate analysis revealed that all variables had significant differences

between the groups ($P<0.05$; Table 2). Compared with insured patients, the any Medicaid and uninsured groups had poorer CSS (HR, 1.651; 95% CI, 1.498–1.820) and (HR, 1.557; 95% CI, 1.339–1.809) respectively.

Multivariate analysis was performed to analyze the effect of independent factors on patients' survival (Table 3). After adjustments for age and gender, the results showed that patients with any Medicaid and uninsured had poorer CSS than insured patients (HR, 1.781; 95% CI, 1.615–1.965 and HR, 1.651; 95% CI, 1.420–1.919, respectively). Adjustments were also made for age, gender, race, histological type, grade, tumor size, Seer stage, TNM, marital status, median household income, education level, and surgical therapy. The results showed that patients with any Medicaid still had poorer CSS than insured patients, (HR, 1.222; 95% CI, 1.100–1.357); however, uninsured patients did not experience worse outcomes (HR, 1.000; 95% CI, 0.851–1.174).

Subgroup analysis of insurance status of RCC patients based on SEER stage

Stratified analysis was performed to explore the impact

Table 2 Kaplan-Meier analysis and univariate analysis for renal cell carcinoma cause-specific survival in SEER database

Variable	5-year CCS (%)	Kaplan-Meier analysis		Univariate analysis	
		Log rank χ^2 test	P	HR (95% CI)	P
Gender		75.749	<0.001		<0.001
Female	90.3			1	
Male	85.9			1.434 (1.322–1.555)	<0.001
Age		133.055	<0.001		<0.001
<55 y	89.7			1	
≥55y	84.8			1.542 (1.432–1.659)	<0.001
Race		13.772	0.003		<0.003
White	87.2			1	
Black	88.4			0.982 (0.874–1.012)	0.754
Other*	87.1			1.031 (0.892–1.191)	0.679
Unknown	97.1			0.223 (0.100–0.497)	<0.001
Histological type		149.781	<0.001		<0.001
Clear cell	86.0			1	
Papillary	89.7			0.749 (0.669–0.838)	<0.001
Chromophobe	96.7			0.231 (0.179–0.297)	<0.001
Grade		1,531.812	<0.001		<0.001
Well/moderate	95.6			1	
Poor/undifferentiated	76.8			5.946 (5.396–6.551)	<0.001
Unknown	75.9			7.030 (6.308–7.834)	<0.001
Tumor size		2,513.870	<0.001		<0.001
≤7 cm	95.0			1	
>7 cm	66.3			7.882 (7.271–8.545)	<0.001
Seer stage		6,871.885	<0.001		<0.001
Localized	97.0			1	
Regional	78.3			7.862 (6.986–8.847)	<0.001
Distant	20.3			60.347 (54.495–66.828)	<0.001
Unknown	82.8			6.629 (3.966–11.082)	<0.001
TNM stage		3,778.803	<0.001		<0.001
I/II	97.0			1	
III/IV	55.3			21.500 (19.481–23.730)	<0.001
Unknown	89.3			4.005 (2.976–5.389)	<0.001
Marital status		35.18	<0.001		<0.001
Married	85.5			1	
Single	84.6			1.130 (1.029–1.241)	0.011

Table 2 (continued)

Table 2 (continued)

Variable	5-year CCS (%)	Kaplan-Meier analysis		Univariate analysis	
		Log rank χ^2 test	P	HR (95% CI)	P
Separated/divorced	83.5			1.249 (1.118–1.395)	<0.001
Widowed	82.2			1.391 (1.130–1.711)	0.002
Unknown	87.7			0.776 (0.632–0.952)	0.015
Median household income		13.922	<0.001		0.003
Quartile 1 (US\$<4,903)	86.6			1	
Quartile 2 (US\$4,903–5,620)	87.1			0.946 (0.845–1.059)	0.333
Quartile 3 (US\$5,620–6,747)	87.5			0.914 (0.831–1.006)	0.065
Quartile 4 (\geq US\$6,747)	88.2			0.824 (0.744–0.914)	<0.001
Education level		17.534	0.001		0.001
Quartile 1 (<21.25)	86.1			1	
Quartile 2 (21.25–30.27)	87.9			0.859 (0.773–0.955)	0.005
Quartile 3 (30.27–35.78)	87.7			0.871 (0.791–0.960)	0.005
Quartile 4 (>35.78)				0.813 (0.734–0.901)	<0.001
Surgery therapy		4,791.203	<0.001		<0.001
No	23.2			1	
Yes	90.3			0.055 (0.051–0.060)	<0.001
Insurance status		123.053	<0.001		<0.001
Insured	88.3			1	
Any Medicaid	82.6			1.651 (1.498–1.820)	<0.001
Uninsured	82.7			1.557 (1.339–1.809)	<0.001

*, other includes American Indian/Alaska native, Asian/Pacific Islander. SEER, Surveillance, Epidemiology, and End Results; CCS, cancer cause-specific survival; HR, hazard ratio; CI, confidence interval.

Table 3 Relationship between insurance status and renal cell carcinoma cause-specific survival

Insurance status	Crude model		Model I		Model II	
	β (95% CI)	P value	β (95% CI)	P value	β (95% CI)	P value
Insured	Reference	–	Reference	–	Reference	–
Any Medicaid	1.651 (1.498–1.820)	<0.001	1.781 (1.615–1.965)	<0.001	1.222 (1.100–1.357)	<0.001
Uninsured	1.557 (1.339–1.809)	<0.001	1.651 (1.420–1.919)	<0.001	1.000 (0.851–1.174)	0.998

Model I adjusted for age and gender. Model II adjusted for age, gender, race, histological type, grade, tumor size, Seer stage, TNM stage, marital status, median household income, education level, surgery therapy. CI, confidence interval.

of insurance status on RCC CSS at each SEER stage (Table 4 and Figure 3A,B,C). Kaplan-Meier analysis showed significant differences ($P<0.05$) between the three insurance status subgroups at each SEER stage. According

to the results of the univariate analysis, patients with any Medicaid had worse survival outcomes than insured patients at each stage (localized stage: HR, 1.839, 95% CI, 1.451–2.330, $P<0.001$; regional stage: HR, 1.422, 95%

Table 4 Univariate and multivariate analysis of insurance status on renal cell carcinoma cause-specific survival based on different SEER stages

Insurance status	Univariate analysis		Multivariate analysis	
	HR (95% CI)	P	HR (95% CI)	P
Localized				
Insured	1		1	
Any Medicaid	1.839 (1.451–2.330)	<0.001	1.714 (1.329–2.212)	<0.001
Uninsured	1.372 (0.908–2.073)	0.133	1.168 (0.768–1.777)	0.468
Regional				
Insured	1		1	
Any Medicaid	1.422 (1.143–1.770)	0.002	1.374 (1.090–1.733)	0.007
Uninsured	1.202 (0.874–1.653)	0.257	0.966 (0.691–1.349)	0.838
Distant				
Insured	1		1	
Any Medicaid	1.248 (1.104–1.412)	<0.001	1.046 (0.853–1.283)	0.664
Uninsured	1.163 (0.963–1.405)	0.116	1.088 (0.955–1.239)	0.205

Multivariate analysis adjusted for age, gender, race, histological type, grade, tumor size, TNM stage, marital status, median household income, education level, surgery therapy. HR, hazard ratio; CI, confidence interval.

CI, 1.143–1.770, $P=0.002$; distant stage: HR, 1.248, 95% CI, 1.104–1.412, $P<0.001$). However, univariate analysis did not identify significant differences between insured and uninsured individuals at each SEER stage (localized stage: $P=0.133$; regional stage: $P=0.257$; distant stage: $P=0.116$). Multivariate Cox regression analyses for each SEER stage were then performed to explore the impact of insurance status on RCC CSS. The results confirmed that the Medicaid patients in the localized and regional stage subgroups had the worst survival outcomes (localized stage, HR, 1.714, 95% CI, 1.329–2.212; regional stage, HR, 1.374, 95% CI, 1.090–1.733).

Subgroup analysis of insurance status on RCC according to racial group

The relationship between insurance status and CSS survival was further explored according to patients' race (see *Table 5* and *Figure 3D,E,F*). Kaplan-Meier analysis showed significant differences ($P<0.05$) between the three insurance status subgroups in each racial group. As shown in *Figure 3*, insured individuals in all subgroups had the highest 5-year CSS compared to uninsured individuals and those on any form of Medicaid. Univariate analysis also revealed that insured patients had better outcomes (for white patients,

any Medicaid: HR, 1.627, 95% CI, 1.454–1.820; uninsured: HR 1.566, 95% CI, 1.326–1.849; for black patients any Medicaid: HR, 1.855, 95% CI, 1.448–2.377; uninsured, HR 1.556, 95% CI, 1.042–2.323). Multivariate analysis confirmed that patients with Medicaid experienced poorer survival outcomes (for white individuals: HR, 1.205, 95% CI, 1.067–1.360; for black individuals: HR, 1.328, 95% CI, 1.010–1.748).

Discussion

Previous studies have demonstrated that tumor grade, histology, T stage and N stage are independent predictors of survival in RCC (14,15). Numerous molecular markers such as E-cadherin, C-reactive protein (CRP), PTEN (phosphatase and tensin homolog) (cell cycle), Ki67 (for proliferation), p53, carbonic anhydrase IX (CaIX), hypoxia-inducible factor (HIF), and osteopontin (OPN) have also been investigated to determine their impact on the survival outcomes of RCC patients (16). However, none of these markers have improved the predictive accuracy of the current prognostic systems, and they have not been recommended for use in routine clinical practice (17). In recent years, several studies have highlighted the relevance of sociodemographic factors to the survival of patients

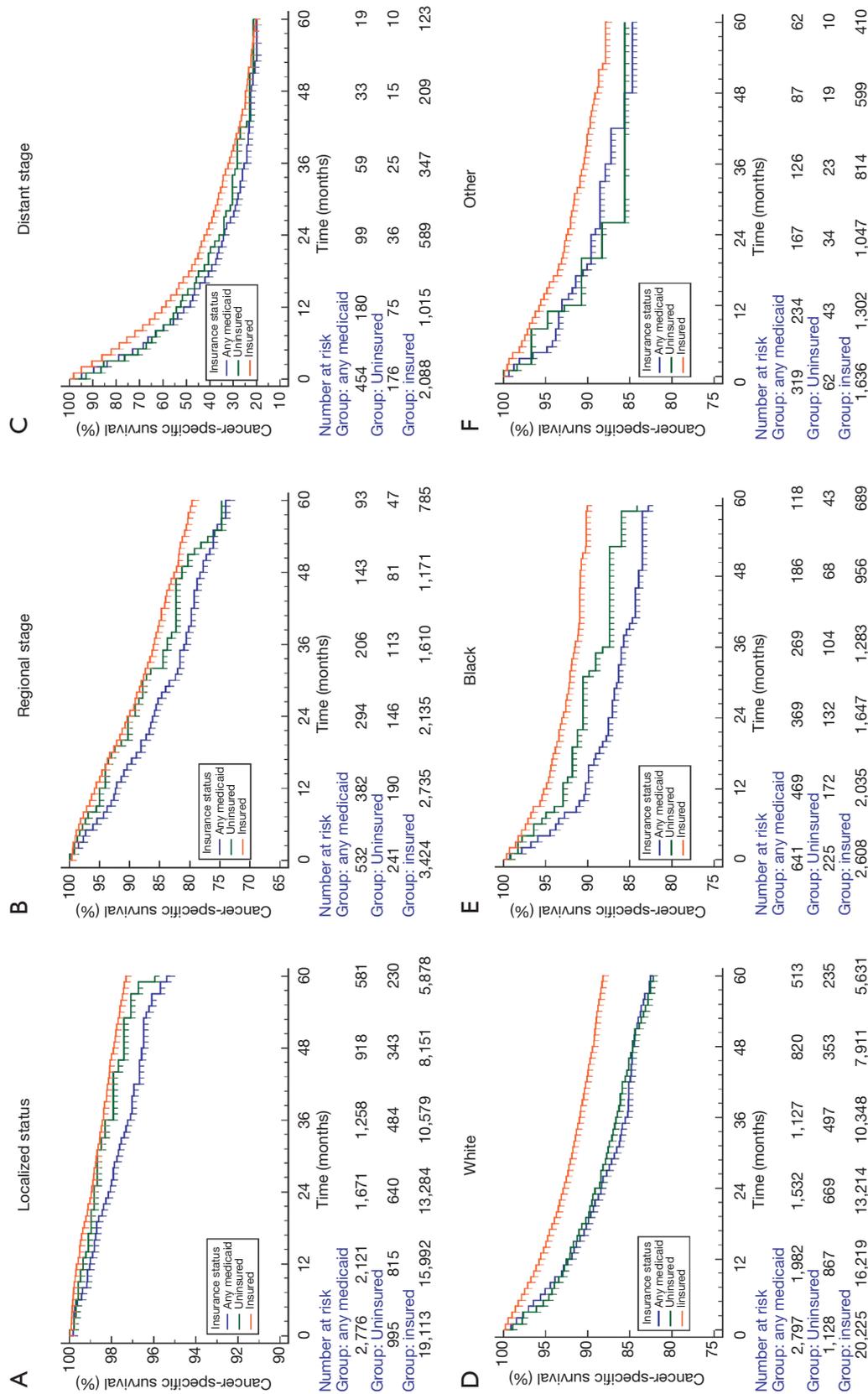


Figure 3 Survival curves for renal cell carcinoma patients according to insurance status in each subgroups. (A) SEER localized stage: $\chi^2 = 27.206$ ($P < 0.001$); (B) SEER regional stage: $\chi^2 = 10.739$ ($P = 0.005$); (C) SEER distant stage: $\chi^2 = 14.387$ ($P = 0.001$); (D) White: $\chi^2 = 93.168$ ($P < 0.001$); (E) Black: $\chi^2 = 26.370$ ($P < 0.001$); (F) Other (American Indian/Alaska native, Asian/Pacific Islander): $\chi^2 = 5.934$ ($P = 0.051$).

Table 5 Univariate and multivariate analysis of insurance status on renal cell carcinoma cause-specific survival based on different ethnicities

Insurance status	Univariate analysis		Multivariate analysis	
	HR (95% CI)	P	HR (95% CI)	P
White				
Insured	1		1	
Any medicaid	1.627 (1.454–1.820)	<0.001	1.205 (1.067–1.360)	0.003
Uninsured	1.566 (1.326–1.849)	<0.001	1.049 (0.877–1.255)	0.602
Black				
Insured	1		1	
Any medicaid	1.855 (1.448–2.377)	<0.001	1.328 (1.010–1.748)	0.042
Uninsured	1.556 (1.042–2.323)	0.031	1.172 (0.763–1.802)	0.468
Other				
Insured	1		1	
Any medicaid	1.513 (1.068–2.143)	0.020	1.214 (0.834–1.769)	0.315
Uninsured	1.392 (0.652–2.969)	0.392	0.931 (0.428–2.028)	0.857

Multivariate analysis adjusted for age, gender, histological type, grade, tumor size, Seer stage, TNM stage, marital status, median household income, education level, surgery therapy. HR, hazard ratio; CI, confidence interval.

with various cancers, including genitourinary malignancies (18–20). One previous study revealed marital status to be an important prognostic factor and showed that marriage can improve survival outcomes for patients with RCC (21). In this study, we explored the relationship between the insurance status and survival outcomes of patients with kidney cancer.

Firstly, we result demonstrated sex, age, race, marital status, SEER stage, TNM stage, tumor histology, and income all showed significance differences according to insurance status ($P < 0.001$ for all). In our study, patients with insurance were more likely to have high incomes and education levels. They were also more likely to be male, older, and white. These findings are consistent with those of previous studies based on information from the SEER database (9). Additionally, insured patients experienced better CSS outcomes compared to patients with any form of Medicaid. Even after adjusting for sex, age, race, tumor grade, tumor pathological grade, tumor size, histological type, SEER stage, and surgical therapy, insured patients (88.3%) still had a better 5-year CSS than patients with any form of Medicaid (82.6%). In our stratified analysis of the different SEER stages and racial groups, we found that within the SEER localized stage and the white racial group, having any form of Medicaid insurance was an independent

predictor of an unfavorable survival outcome. However, due to insufficient information, we cannot investigate the potential risk factors, such as genetic characteristics, surgical procedures and hospitalizations, and comorbidities, further. Differences in social characteristics, as well as cultural, biological, psychological, and environmental factors, between the individuals included in our study may have resulted in heterogeneity and impacted the results. Further large-scale studies are necessary to explore the mechanisms underlying the relationship between insurance status and survival outcomes.

The survival benefit for insured RCC patients may result from multiple factors. Firstly, insurance status can be considered as an indirect index of the socioeconomic status of the patient, usually indicating that the patient has financial and social support sufficient for acquiring a better level of home and hospital care. Secondly, insured patients have greater access to cancer screening, which can decrease the prevalence and increase the early detection rate in female-specific cancers, such as breast and cervical cancer, which can also prolong the lifetime of the patients (22). Finally, insured patients tend to have a lifestyle that includes fewer cancer risk factors, such as excessive alcohol consumption and smoking (23), which thereby decreases the incidence of cancers of the digestive, respiratory and

genitourinary systems. Insurance status has already been proved to be an important factor in obtaining cancer information and screening tests (24). Patients with Medicaid or no insurance have been shown to experience significantly poorer survival outcomes for several malignancies such as melanoma, pancreatic exocrine carcinoma, and certain leukemias (25-27). The explanation offered for this is that uninsured and Medicaid patients are less likely to receive appropriate cancer screening and timely access to medical care (28-31). Moreover, patients without insurance or on Medicaid often have low incomes, and are less likely to be employed or self-employed, less likely to marry or have a stable lifestyle, and more likely to be recent immigrants (32). In our study, patients on any form of Medicaid had poorer survival rates than patients with insurance. However, according to multivariate analysis, there was no significant difference between uninsured and insured patients ($P=0.162$).

There are several limitations of our study. Firstly, because of the study's retrospective nature, it was not possible to avoid statistical bias which could potentially impact the accuracy of the results. Secondly, the SEER data does not provide information regarding adjuvant therapy, which may have significantly impacted the survival period of patients with RCC. Thirdly, detailed information on patient insurance, such as the duration of insurance, are not available from the SEER database. Finally, this conclusion should be cautiously extrapolated to Chinese population, due to the two countries exhibit difference the supply of medical services and be in different economic development (33). These limitations may have led to some inaccuracy; however, the large sample size overrides some of these biases to demonstrate the underlying general trend.

Conclusions

In this study, we investigated the effects of insurance status on survival outcomes among RCC patients. Compared to uninsured patients and those on any form of Medicaid, insured patients had the highest 5-year RCC CSS. Stratified analysis revealed that for those within the localized tumor stage group or the white racial group, having any form of Medicaid insurance independently predicted an unfavorable survival outcome. Insured RCC patients experienced survival benefits, whilst those on Medicaid suffered poor survival outcomes. Future investigations are needed to validate these findings and explore the underlying mechanisms of poor CSS in Medicaid patients.

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Footnote

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Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at <http://dx.doi.org/10.21037/tau-20-1045>). The authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Because the data extracted from this database were anonymized and de-identified before being published, our study did not require informed consent. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The details of the study were reviewed and approved by the ethics committee of The Fourth Affiliated Hospital (Harbin, China).

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