

Tongue Carcinoma – 20-Year Comparative Survival and Mortality Analysis by Age, Sex, Race, Stage, Grade, Cohort Entry Time-Period and Disease Duration: A Systematic Review of 31,378 Cases for Diagnosis Years 1975-2017: (SEER*Stat 8.3.6.1)

Anthony F. Milano, MD, MPH, MA, DBIM

Cancer of the tongue is an uncommon cancer site, with only 31,378 cases in the SEER 1975-2017 database, fewer than 1% of all reported cancers. This article updates trends in incidence, prevalence, short and long-term survival and mortality of tongue carcinoma.

Address of Correspondent: PO Box 127, Cummaquid, MA 02637.

Correspondent: Anthony F. Milano, MD.

Key words: Tongue carcinoma, lingual cancer, age and sex stratification, incidence and prevalence trends, short and long-term survival, mortality, SEER Cancer Registry.

Received: May 20, 2020

Accepted: May 30, 2020

Background & Importance.—Cancer of the tongue is infrequent, and although it accounts for 25% (31,378) of all oropharyngeal cancers (126,888) in the National Cancer Institute’s SEER frequency database, 1975-2017,¹ it comprises only 0.64% of all cancers (4,879,410) for the same period, and a total of 24,805 microscopically confirmed malignant cases in the SEER survival database² considered in this article. Tongue cancer is most frequently diagnosed among people ages 55-64 years (28%) and the mean age by sex in males and females was 61 and 64 years, respectively; by race in whites and blacks, 63 and 59 years respectively; mean age at death is 67 years. Lingual cancer is more common in males than females (male-to-female ratio 2.1:1) and by

race, far more common in whites than in blacks (white-to-black ratio 10.6:1). In the United States, there are estimated to be 17,660 new cases in 2020 (1% of all new cancers) and 2830 estimated deaths (0.5% of all cancer deaths).³ While the incidence, frequency and deaths are low in the United States, they are exceptionally important from a clinical and surgical standpoint. The morphological and functional changes require a multidisciplinary approach to treatment including surgical, medical and radiation oncology, speech and physical rehabilitation therapy, and emotional support from family, friends, psychologists or social workers. The base of the tongue is the site of origin of slightly less than 50% of lingual cancers, most of the neoplasms that arise on the anterior two

thirds of the tongue begin on the lateral surfaces. Greater than 96% of these neoplasms are squamous cell (TSCC) characterized by rapid local invasion and early lymph node metastasis and most of the remainder are adenocarcinomas or sarcomas. Risk factors include heavy alcohol use, tobacco use and infection with human papillomavirus (HPV), especially HPV-16.

Objective.—To update trends in incidence, prevalence, short and long-term survival and mortality of tongue carcinoma using the statistical database of SEER*Stat 8.3.6.1⁴ for diagnosis years 1975-2017 employing multiple case selection variables.

Methods.—This study was both a retrospective and prospective population-based cohort study in design using nationally representative data from the National Cancer Institute's (NCI) Surveillance, Epidemiology, and End Results (SEER) program (www.seer.cancer.gov) to evaluate 31,378 cases for diagnosis years 1975-2017 comparing multiple variables of age, sex, race, stage, cohort entry time-period, and disease duration. Frequencies/age-specific incidence rates, median age, extent of spread at diagnosis/stage, survival and mortality were examined. Relative survival statistics were analyzed in two cohorts: 1975-1996 and 1997-2017. Survival statistics were derived from: SEER*Stat 8.3.6.1 Database: Incidence – SEER 9 Regs Research Data, (1975-2017) released April 2020, based on the November 2019 submission. General methods and standard life table methodologies for converting SEER survival data to comparative mortality and explanations of cancer staging and grading procedures are described in previous *Journal of Insurance Medicine* articles^{5,6} and other publications.^{7,8} Excluded were all death certificate only and those alive with no survival time. The percentage of microscopically confirmed malignant behavior cancers for case selections was 100%. Incidence and survival rates were obtained from the most current SEER Cancer Statistics Review (CSR)⁹ publication and prevalence counts are

based on 2017 population estimates from the US Bureau of the Census.

Statistical significance.—Standard errors are shown for survival rates in the SEER survival tables. Actuarial method: Ederer II method is used for cumulative expected survival. Ederer II method calculates the expected survival rates for patients under observation at each point of follow-up so the matched individuals are considered to be at risk until the corresponding cancer patient dies or is censored.¹⁰ Confidence interval: Log (-Log ()) Transformation; the level is 95%. Poisson confidence intervals at the 95% level based on the number of observed deaths are used in this study but not displayed here to conserve space on the mortality tables.

Results.—Incidence rates and trends, absolute & relative frequency distributions, survival & mortality by age, sex, stage of tongue carcinoma in two entrant time-periods as recorded in the SEER Program of the National Cancer Institute for diagnosis years 1975-2017 (SEER*Stat 8.3.6.1) are summarized. Shifts in trends over time are identified, and the findings are correlated with prognosis, including short and long-term observed (actual), expected & relative survival, median observed and relative survival, mortality rates & excess death rates per 1000 people.

Conclusions.—Trends in SEER incidence, prevalence, survival & mortality by age, sex, race, stage, cohort entry time-period, relative frequency & percent distribution, were examined to provide a current epidemiologic and medical-actuarial risk assessment framework for tongue carcinoma in the 1975-2017 time-frame.

Incidence: Table 1 by sex, indicates that tongue cancer AAPC incidence changes from 2013 to 2017 are higher in females than males, 3.4 vs 2.3 per 100,000, respectively. By race, AAPC incidence trends are lower in black males than females, -2.5 vs -1.6 per 100,000, respectively, and lower in blacks than whites.

Limited available data in Table 2 indicates that incidence rates increase with age and vary by sex and race in the United States.

Table 1. Tongue Cancer, Trends in SEER Incidence by Sex and Race: CSR 1975-17, AAPC 2013-17*, CSR Table 20.2

Race	Male	Female	Male & Female
All Races	2.3	3.4	2.1
White	2.9	1.8	-
Black	-2.5	-1.6	-

* AAPC is the Average Annual Percent Change by Race and Sex per 100,000.

Incidence is higher in males than in females, higher in whites than in blacks, and higher in the United States than the average elsewhere in the world.

SEER Case Statistics: The total of 31,378 cases of tongue carcinoma in the 1975-2017 SEER database¹ was distributed by age/sex/race/stage/grade and cohort entry period as shown in Table 3. Tongue carcinoma diagnostic frequency compared by age and sex is illustrated in the Figure 1. Five percent of cases were unstaged, and 23% were of unknown grade. Parenthetically but not displayed are 1020 cases of in-situ carcinoma of the tongue. Regional and distant stages comprised 60% of staged cases. The zenith of diagnostic frequency (see Figure 1) by attained age in men occurred at quinquennial ages 60-64 (16.9%), and declining thereafter. From ages 75 up, 13.7% of male cases were diagnosed; male mean age at diagnosis, 61.4 years. In women the zenith of diagnostic frequency by attained

Table 2. Tongue Cancer, SEER Age-Adjusted Incidence Rates, 2013-2017: CSR 1975-17, CSR Table 20.9

	Total	All Races		White Total	Black Total
		Males	Females		
All ages	3.5	5.3	1.9	3.9	1.9
Under 65	2.1	-	-	-	-
65 & over	13.3	-	-	-	-
WHO** All ages	2.8	-	-	-	-

* Age-Adjusted Incidence Rates per 100,00 by Race, Sex.

** Rates are per 100,000 and are age-adjusted to the world (WHO 2000-2025) standard million.

age also occurred at quinquennial ages 60-64 years, then tended to plateau to ages 75-79 years, declining to 7.3% at 80-84 years, then slightly increased to 7.6% at ages 85+ years; from ages 75 up, 25.0% of female cases were diagnosed (see Figure 1). Female mean age at diagnosis was 63.9 years. There was a 2-to-1 male-to-female ratio by diagnostic frequency and males accounted for 68% of tongue cancers while females accounted for only 32% of cases. In the United States, tongue cancer is a disease of the white race (85%) and 15% or less in black, other and unknown races. Mean ages in whites and blacks are 62.3 years and 58.5 years, respectively.

Cancer Case Characteristics: Men made up 68% of the total cases of cancer of the tongue, and women 32%; there were few patients (8%) under age 45. Cases were excluded from the survival analysis if the diagnosis was made by death certificate or at autopsy. The SEER historic code is used for staging (local, regional or distant) in Tables 5-8. SEER 'Combined Summary Stage 2000 (2004+)' is used in Table 5 to select regional stage patterns of invasion (POI) by direct extension only, lymph nodes involved only, and by both direct extension and lymph node involvement to examine risk outcomes by methods of tumor spread. Tables 5-9 show both durational observed input data and calculated indices of comparative mortality including the mortality ratio (MR), excess death rate (EDR); and for comparative survival, observed and expected survival, P and P', respectively, survival ratio (SR), and observed and relative median survival.

Follow-up (FU): Standard procedures utilized by the SEER registries were so effective that few cases were lost to FU. According to the 1975-2015 Cancer Statistics Review, aggregate FU of cases diagnosed 1975 and followed to 2014 was 98.9% complete for males and 97.9% complete for females.

Results: Table 5 shows results for local cancer of the tongue in the entire 1975-2017 database,

Table 3. SEER: Tongue Cancer Case Statistics, 1975-2017

Age x	M&F No.	Percent %	Male No.	Percent %	Female No.	Percent %
<45	2507	8.0	1592	7.4	915	9.2
45-54	5796	18.5	4252	19.9	1544	15.4
55-64	9651	30.8	7049	33.0	2602	26.0
65-74	7986	25.5	5548	25.9	2438	24.4
75 up	5438	7.3	2939	13.7	2499	25.0
All ages	31378	0.64*	21380	68.1	9998	31.9
Sex-Mean x-Yrs.	62.3		61.4		63.9	
Race	White		Black		Other	Unknown
No. & %	26743	85.2	2529	8.1	1965-6.3%	141-0.4%
Mean X-yrs.	62.3		58.5		62.5	57.0
Cohort Entrants	M&F	%	Male	%	Female	%
Freq. 1975-2017	31378		21380	68.1	9998	31.9
Surv. 1975-2017	24805	(79.1)	17224	69.4	7581	30.6
Stage	Local	Regional	Distant	Reg-Dist	Unstaged	Total S&U
M&F	10822; 40%	12485; 46%	3868; 14%	16353; 60%	1449; 5%	28624
Grade	I	II	III	IV	Unknown	All graded
No. & %	4968; 20%	11892; 49%	7129; 29%	306; 1.3%	7083; 23%	24295; 77%

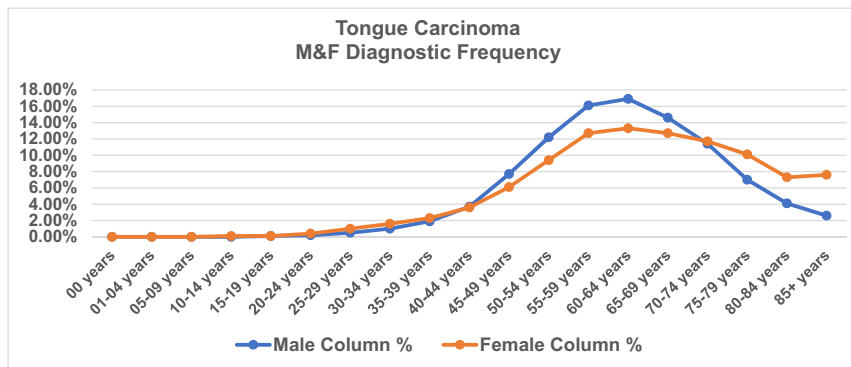
* Represents 0.64% of all malignancies present in the SEER*Stat 8.3.6.1 frequency database () represents 79% of tongue malignancies present in the SEER*Stat 8.3.6.1 frequency database % Unstaged = No. Unstaged ÷ Total Frequency Count for 1973-2014.

** B-O-U = ‘Black’, ‘Other (American Indian/AK Native, Asian/Pacific Islander)’, ‘Unknown’.

by sex and for age groups <65, 65 up, and all ages combined. In comparison with major sites such as breast in women and prostate in men, excess mortality is very high in localized cancer of the tongue in both sexes and age groups. Survival is correspondingly low, with few survivors, less than 10%, after 15 years in patients age 65 and up. Peak mortality occurs at duration 1-2 years, with MR over 450% and EDR about 80 to 92 per 1000 per year, all ages combined, males and females, respectively.

MR decreases and EDR increases with advancing age. MR tends to be higher in women because of their lower expected mortality, but sex differences in EDR appear to be small and irregular. Excess mortality persists to 15-20 years in both men and women, and total 5-year SR is only 74% in men and 77% in women.

Table 6 displays results for regional and distant carcinoma of the tongue. Excess mortality is very high, with 5-year SR of 54% in regional,



Tongue Carcinoma; Diagnostic Frequency by Age and Sex; 1975-2017.

Table 4. Tongue Carcinoma; Regional Stage POI, All Races; 0-5 years Duration

Patterns of Invasion-POI	MR%	EDR/1000	SR%	Median Survival Time-years
Direct tissue invasion-DTIA	674	117	58	Observed=5.6 – Relative=8.2
Nodal involvement-NIA	510	67	74	Observed=12.2 – Relative>20
Both combined	746	106	62	Observed=8.2 – Relative=12.7

and 32% in distant stages, respectively. Maximum mortality occurred in the second year in patients under 65 (MR 1922% and EDR 166 per 1000), and in the first year in patients 65 up (MR 778% and EDR 288 per 1000). When all ages were combined for the regional stage MR and EDR values tended to be higher in females. EDR decreases below 100 per 1000 after 5-year duration. A similar pattern of decreasing excess mortality is seen in the distant stage. Highest values are in the first year, with MR of 1808% and EDR of 365 per 1000 per year (1229 of 3181 patients [39%] died in the 1st duration).

Table 7 results compare subgroups matched by a combination of stage and grade, all ages combined in 2 cohorts, 1975-1996 and 1997-2017. Results are for durations 0-5 and 5-10 years for both sexes in the upper part of the table, and by sex for local stage only in the lower part. At 0-5 years, excess mortality appears to be somewhat lower and SR higher in the localized stage with grades 1&2 in the 1997-2017 cohort, and this is also true for the regional stage. For the more severe grades 3&4, mortality is lower and survival increased in the 1997-2017 cohort than in the earlier cohort as a result of improvements in treatment. Most cancers were graded, and the proportion of cancers graded increased in the more recent cohort. Decrease in mortality and increase in survival as a result of improvements in treatment in the 1997-2017 cohort are modest with carcinoma of the tongue, in contrast to results in some sites such as cancers of the breast and the prostate. Grading at the 3&4 level is associated with a worse 5-year prognosis than grades 1&2 in local cancer of the tongue, but not in regional cancer.

Table 8 summary results for the 1997-2017 cohort are given by race and stage. Excess mortality, both MR and EDR, in all stages, was substantially greater in black-other-unknown races than in the white race. For example, in the 1st duration of local stage cancer, MR was 357% for black-other-unknown patients and 280% for whites; EDR values were 43 and 40 per 1000 per year, respectively.

Table 9 illustrates specific risk results for differing patterns of invasion (POI) in patients with regional stage squamous cell carcinoma of the tongue and details differences in the prognostic impact with direct tissue invasion alone (DTIA), nodal involvement alone (NIA) or a combination of both by race, all ages combined using the SEER *Combined Summary Stage 2000 (2004+)* selection choice. Table 9 shows that in black, other and unknown patients, MR and EDR risk values are approximately twice that for regional stage white patients – both combined tissue extension and nodal invasion – and are associated with much diminished median survival times. However, in the 0-5-year durational interval for all races combined summarized in Table 4, differences in MR, EDR, and relative cumulative survival (SR) are not large. Nevertheless, a pattern of invasion with nodal involvement alone (NIA) compared to direct tissue invasion alone (DTIA), all races combined, 5-year mortality is notably less and survival improved in patients with NIA. Median survival time with NIA is more than twice that with DTIA, and this applies also to both black and white patient-populations listed in Table 9.

Overall, Table 9 prognostic indices by race are comparatively better in the white population.

Table 5. 1975-2017 Entrants, Sex, Age; Local Stage; All Grades Combined. SEER Cancer Data 1975-2017 (SEER*Stat 8.3.6.1): Index Code 51b: TONGUE CARCINOMA

Duration Start-End	No. Alive at Start	Exposure Pt.-Yrs	Number of Deaths			Mortality Ratio (%)	Mean Ann. Mortality Rate/1,000			Cumul. Surv. Rate			Cum. Surv. Ratio (%)
			Observed	Expected	d'		Observed	Expected	Excess (q-q')	Observed	Expected	P'	
t to t+ch t	l	E	d	d'	100d/d'	q	q'	(q-q')	P	P'	100P/P'		
0-1	3,025	3,019.5	155	27.18	570	0.0513	0.0090	42.3	0.9487	0.9910	95.7		
1-2	2,859	2,856.0	269	27.13	991	0.0942	0.0095	84.7	0.8593	0.9816	87.5		
2-5	2,584	6,952.5	391	72.99	536	0.0562	0.0105	45.7	0.7232	0.9509	76.1		
5-10	1,958	8,163.5	332	105.40	315	0.0407	0.0129	27.8	0.5871	0.8905	65.9		
10-15	1,259	5,061.0	235	87.84	268	0.0464	0.0174	29.1	0.4622	0.8150	56.7		
15-20	746	2,876.0	141	67.26	210	0.0490	0.0234	25.6	0.3612	0.7227	50.0		
<i>Median survival time (interval = 12 months): Observed = 13.3439 intervals; Relative = 19.9718 intervals.</i>													
Male, Age 65 up													
0-1	1,771	1,769.0	221	86.33	256	0.1249	0.0488	76.1	0.8751	0.9512	92.0		
1-2	1,546	1,544.0	241	78.13	308	0.1561	0.0506	105.5	0.7385	0.9031	81.8		
2-5	1,301	3,233.5	355	179.44	198	0.1098	0.0555	54.3	0.5239	0.7601	68.9		
5-10	803	2,969.0	303	202.59	150	0.1021	0.0682	33.8	0.3037	0.5305	57.2		
10-15	366	1,254.0	184	113.87	162	0.1467	0.0908	55.9	0.1364	0.3260	41.8		
15-20	132	431.5	66	52.67	125	0.1530	0.1221	30.9	0.0573	0.1659	34.5		
<i>Median survival time (interval = 12 months): Observed = 5.50523 intervals; Relative = 11.8001 intervals.</i>													
Male, All Ages													
0-1	4,796	4,788.5	376	113.49	331	0.0785	0.0237	54.8	0.9215	0.9763	94.4		
1-2	4,405	4,400.0	510	105.16	485	0.1159	0.0239	92.0	0.8147	0.9530	85.5		
2-5	3,885	10,186.0	746	252.86	295	0.0732	0.0248	48.4	0.6501	0.8836	73.6		
5-10	2,761	11,132.5	635	308.23	206	0.0570	0.0277	29.4	0.4842	0.7673	63.1		
10-15	1,625	6,315.0	419	201.02	208	0.0663	0.0318	34.5	0.3435	0.6521	52.7		
15-20	878	3,307.5	207	119.68	173	0.0626	0.0362	26.4	0.2496	0.5414	46.1		
<i>Median survival time (interval = 12 months): Observed = 9.49779 intervals; Relative = 16.6836 intervals.</i>													
Female, Age <65													
0-1	1,802	1,797.0	71	8.45	841	0.0395	0.0047	34.8	0.9605	0.9953	96.5		
1-2	1,721	1,718.0	121	8.59	1,409	0.0704	0.0050	65.4	0.8929	0.9903	90.2		
2-5	1,594	4,253.5	157	23.88	658	0.0369	0.0056	31.3	0.7994	0.9737	82.1		
5-10	1,240	5,258.5	160	39.08	409	0.0304	0.0074	23.0	0.6840	0.9376	73.0		
10-15	833	3,391.0	107	36.05	297	0.0316	0.0106	20.9	0.5808	0.8882	65.4		
15-20	522	2,108.0	51	32.91	155	0.0242	0.0156	8.6	0.5137	0.8198	62.7		
<i>Median survival time (interval = 12 months): Observed = 20.4922 intervals; Relative = 28.2471 intervals.</i>													

Table 5. Continued

Duration Start-End	No. Alive at Start	Exposure Pt.-Yrs	Number of Deaths		Mortality Ratio (%)	Mean Ann. Mortality Rate/1,000		Cumul. Surv. Rate		Cum. Surv. Ratio (%)
			Observed	Expected		Observed	Expected	Observed	Expected	
0-1	1,577	1,570.5	226	71.93	Female, Age 65 up	0.1439	0.0458	0.8561	0.9542	89.7
1-2	1,338	1,336.0	188	59.72		0.1407	0.0447	0.7356	0.9115	80.7
2-5	1,146	2,935.5	269	147.11		0.0916	0.0501	0.5531	0.7806	70.9
5-10	766	2,887.0	289	176.57		0.1001	0.0612	0.3213	0.5664	56.7
10-15	361	1,321.0	154	109.33		0.1166	0.0828	0.1685	0.3643	46.3
15-20	155	532.0	69	59.50		0.1297	0.1119	0.0835	0.1985	42.1
<i>Median survival time (interval = 12 months): Observed = 6.22411 intervals; Relative = 14.0248 intervals.</i>										
0-1	3,379	3,367.5	297	80.48	Female, All Ages	0.0882	0.0239	0.9118	0.9761	93.4
1-2	3,059	3,054.0	309	68.41		0.1012	0.0224	0.8195	0.9542	85.9
2-5	2,740	7,189.0	426	170.71		0.0593	0.0237	0.6843	0.8877	77.1
5-10	2,006	8,145.5	449	215.37		0.0551	0.0264	0.5135	0.7758	66.2
10-15	1,194	4,712.0	261	144.57		0.0554	0.0307	0.3839	0.6631	57.9
15-20	677	2,640.0	120	92.15		0.0455	0.0349	0.3045	0.5547	54.9
<i>Median survival time (interval = 12 months): Observed = 10.554 intervals; Relative = 23.2351 intervals.</i>										

Expected Survival Table: U.S. 1970-2017 by individual year (White, Black, Other [AI/API], Ages 0-99, All races for Other Unspec 1991+ and Unknown).

Table 6. 1975-2017 Entrants, Sex, Age; Regional & Distant Stages; All Grades Combined. SEER Cancer Data 1975-2017 (SEER*Stat 8.3.6.1). Index Code 51b: TONGUE CARCINOMA

Duration Start-End	No. Alive at Start	Exposure Pt.-Yrs	Number of Deaths			Mortality Ratio (%)	Mean Ann. Mortality Rate/1,000			Cumul. Surv. Rate			Cum. Surv. Ratio (%)
			Observed	Expected	d'		Observed	Expected	Excess (q-q')	Observed	Expected	P	
t to t+ch t	l	E	d	Expected	d'	100d/d'	q	Expected	Excess (q-q')	P	P'	100P/P'	
0-1	6,774	6,761.5	1,080	58.83	1,836	Male & Female, Age <65, Regional	0.1597	0.0087	151.0	0.8403	0.9913	84.8	
1-2	5,669	5,660.0	990	51.51	1,922		0.1749	0.0091	165.8	0.6933	0.9823	70.6	
2-5	4,661	11,718.0	831	118.10	704		0.0709	0.0101	60.8	0.5602	0.9527	58.8	
5-10	3,102	11,978.5	540	152.49	354		0.0451	0.0127	32.4	0.4439	0.8927	49.7	
10-15	1,671	6,145.5	314	105.45	298		0.0511	0.0172	33.9	0.3440	0.8175	42.1	
15-20	828	2,934.0	182	70.19	259		0.0620	0.0239	38.1	0.2480	0.7223	34.3	
<i>Median survival time (interval = 12 months): Observed = 7.58807 intervals; Relative = 9.80439 intervals.</i>													
0-1	3,716	3,712.0	1,225	157.39	778	Male & Female, Age 65 up, Regional	0.3300	0.0424	287.6	0.6700	0.9576	70.0	
1-2	2,483	2,481.0	588	98.25	598		0.2370	0.0396	197.4	0.5112	0.9197	55.6	
2-5	1,891	4,468.5	539	187.26	288		0.1206	0.0419	78.7	0.3522	0.8079	43.6	
5-10	1,045	3,473.0	368	184.64	199		0.1060	0.0532	52.8	0.2016	0.6105	33.0	
10-15	385	1,222.0	185	84.90	218		0.1514	0.0695	81.9	0.0882	0.4220	20.9	
15-20	112	348.5	59	33.91	174		0.1693	0.0973	72.0	0.0332	0.2479	13.4	
<i>Median survival time (interval = 12 months): Observed = 2.14227 intervals; Relative = 2.84454 intervals.</i>													
0-1	10,490	10,473.5	2,305	216.80	1,063	Male & Female, All Ages, Regional	0.2201	0.0207	199.4	0.7799	0.9793	79.6	
1-2	8,152	8,141.0	1,578	149.79	1,053		0.1938	0.0184	175.4	0.6288	0.9613	65.4	
2-5	6,552	16,186.5	1,370	305.69	448		0.0846	0.0189	65.8	0.4866	0.9076	53.6	
5-10	4,147	15,451.5	908	337.85	269		0.0588	0.0219	36.9	0.3594	0.8117	44.3	
10-15	2,056	7,367.5	499	189.97	263		0.0677	0.0258	41.9	0.2553	0.7115	35.9	
15-20	940	3,282.5	241	103.75	232		0.0734	0.0316	41.8	0.1730	0.6043	28.6	
<i>Median survival time (interval = 12 months): Observed = 4.56317 intervals; Relative = 6.80041 intervals.</i>													
0-1	7,943	7,931.5	1,628	161.80	1,006	Male, All Ages, Regional	0.2053	0.0204	184.9	0.7947	0.9796	81.1	
1-2	6,292	6,282.5	1,158	116.85	991		0.1843	0.0186	165.7	0.6482	0.9614	67.4	
2-5	5,115	12,581.0	1,030	238.13	433		0.0819	0.0189	62.9	0.5064	0.9076	55.8	
5-10	3,223	11,911.0	674	261.69	258		0.0566	0.0220	34.6	0.3777	0.8113	46.6	
10-15	1,557	5,549.0	343	144.49	237		0.0618	0.0260	35.8	0.2766	0.7100	39.0	
15-20	696	2,390.0	167	78.41	213		0.0699	0.0328	37.1	0.1910	0.5990	31.9	
<i>Median survival time (interval = 12 months): Observed = 5.23143 intervals; Relative = 8.16956 intervals.</i>													

Table 6. Continued

Duration Start-End	No. Alive at Start	Exposure Pt.-Yrs	Number of Deaths		Mortality Ratio (%)	Mean Ann. Mortality Rate/1,000		Cumul. Surv. Rate		Cum. Surv. Ratio (%)	
			Observed	Expected		Observed	Expected	Observed	Expected		
0-1	2,547	2,542.0	677	54.14	1,250	0.2663	0.0213	245.0	0.7337	0.9787	75.0
1-2	1,860	1,858.5	420	32.71	1,284	0.2260	0.0176	208.4	0.5679	0.9615	59.1
2-5	1,437	3,605.5	340	67.08	507	0.0943	0.0186	75.7	0.4252	0.9085	46.8
5-10	924	3,540.5	234	76.19	307	0.0661	0.0215	44.6	0.3035	0.8139	37.3
10-15	499	1,818.5	156	45.54	343	0.0858	0.0250	60.7	0.1963	0.7167	27.4
15-20	244	892.5	74	25.31	292	0.0829	0.0284	54.6	0.1265	0.6198	20.4
<i>Median survival time (interval = 12 months): Observed = 2.95514 intervals; Relative = 3.94269 intervals.</i>											
Male & Female, All Ages, Distant											
0-1	3,181	3,177.0	1,229	67.99	1,808	0.3868	0.0214	365.4	0.6132	0.9786	62.7
1-2	1,944	1,942.0	554	36.90	1,501	0.2853	0.0190	266.3	0.4383	0.9600	45.7
2-5	1,386	3,172.5	432	59.83	722	0.1362	0.0189	117.3	0.2891	0.9066	31.9
5-10	721	2,545.0	175	53.58	327	0.0688	0.0211	47.7	0.2023	0.8141	24.8
10-15	304	991.0	71	22.16	320	0.0716	0.0224	49.3	0.1394	0.7270	19.2
15-20	109	406.0	29	9.14	317	0.0714	0.0225	48.9	0.0976	0.6480	15.1
<i>Median survival time (interval = 12 months): Observed = 1.64692 intervals; Relative = 1.74411 intervals.</i>											

Expected Survival Table: U.S. 1970-2017 by individual year (White, Black, Other [AI/API], Ages 0-99, All races for Other Unspec 1991+ and Unknown).

Table 7. Mortality & Survival by Cohort, Stage, Grade, Sex*, Durations 0-5 & 5-10 Years. SEER Cancer Data 1973-2014 (SEER*Stat 8.3.6.1). Index Code 51b: TONGUE CARCINOMA

Stage	Grade	Period	I	E	Number of Deaths			MR	EDR	Cumul. Surv. Rate		Cum. Surv. Ratio (%)
					Exposure Pt.-Yrs	Observed	Expected			Observed	Expected	
Local	1&2	1975-1996	2,510	10,041.5	1,019	270.86	376	74.5	0.5931	0.8717	68.0	
	1&2	1997-2017	3,213	13,225.5	773	290.27	266	36.5	0.7442	0.8946	83.2	
	3&4	1975-1996	430	1,513.0	230	39.93	576	125.6	0.4652	0.8738	53.2	
	3&4	1997-2017	565	2,141.0	202	38.65	523	76.3	0.6295	0.9132	68.9	
	Unknown	1975-1996	812	3,356.0	295	93.73	315	60.0	0.6367	0.8674	73.4	
	Unknown	1997-2017	645	2,708.0	145	58.18	249	32.1	0.7643	0.8967	85.2	
Regional	1&2	1975-1996	2,021	5,811.5	1,389	137.01	1,014	215.4	0.3117	0.8884	35.1	
	1&2	1997-2017	2,789	9,347.5	1,298	158.31	820	121.9	0.5209	0.9187	56.7	
	3&4	1975-1996	1,089	3,398.0	682	79.14	862	177.4	0.3732	0.8898	41.9	
	3&4	1997-2017	2,318	8,690.5	799	148.45	538	74.9	0.6392	0.9168	69.7	
	Unknown	1975-1996	758	2,153.0	513	52.91	970	213.7	0.3225	0.8838	36.5	
	Unknown	1997-2017	1,515	5,400.5	572	96.20	595	88.1	0.6030	0.9146	65.9	
Distant	G&U	1975-1996	1,102	2,396.5	929	61.53	1,510	362.0	0.1563	0.8806	17.7	
	G&U	1997-2017	2,079	5,895.0	1,286	103.18	1,246	200.6	0.3617	0.9162	39.5	
	Unknown	1975-1996	220	457.0	194	10.59	1,832	401.3	0.1182	0.8979	13.2	
	Unknown	1997-2017	524	1,452.5	314	26.44	1,188	198.0	0.3699	0.9143	40.5	
	Local	1&2	1975-1996	1,482	6,501.0	438	201.73	217	36.3	0.4176	0.7441	56.1
	1&2	1997-2017	1,881	7,052.0	320	168.22	190	21.5	0.5891	0.7926	74.3	
3&4	1975-1996	200	832.0	78	26.32	296	62.1	0.2837	0.7434	38.2		
3&4	1997-2017	283	1,047.0	45	20.67	218	23.2	0.5030	0.8256	60.9		
Regional	Unknown	1975-1996	517	2,269.5	144	70.78	203	32.3	0.4591	0.7402	62.0	
Unknown	1997-2017	404	1,576.5	59	37.06	159	13.9	0.6301	0.7955	79.2		
1&2	1975-1996	627	2,607.0	233	69.54	335	62.7	0.1959	0.7753	25.3		
1&2	1997-2017	1,124	3,921.0	210	76.39	275	34.1	0.3930	0.8319	47.2		
3&4	1975-1996	405	1,767.0	122	43.84	278	44.2	0.2608	0.7844	33.2		
3&4	1997-2017	1,110	3,971.0	161	79.72	202	20.5	0.5202	0.8276	62.9		
Distant	Unknown	1975-1996	243	1,010.0	87	28.20	308	58.2	0.2071	0.7664	27.0	
Unknown	1997-2017	638	2,175.5	95	41.38	230	24.6	0.4832	0.8298	58.2		
G&U	1975-1996	172	688.0	71	17.75	400	77.4	0.0918	0.7721	11.9		
G&U	1997-2017	549	1,857.0	104	35.94	289	36.6	0.2697	0.8300	32.5		
Unknown	1975-1996	26	100.0	12	1.86	645	101.4	0.0636	0.8166	7.8		
Unknown	1997-2017	123	375.5	20	6.93	289	34.8	0.2859	0.8323	34.3		

Table 7. Continued

		No. Alive at Start	Exposure Pt.-Yrs	Number of Deaths		Mortality Ratio	Excess Death Rate	Cumul. Surv. Rate		Cum. Surv. Ratio (%)
				Observed	Expected			Observed	Expected	
Local	1&2	844	3,682.0	255	113.26	225	38.5	0.3966	0.7444	53.3
	1&2	1,834	7,625.5	443	165.26	268	36.4	0.7446	0.8958	83.1
	3&4	258	904.0	142	26.81	530	127.4	0.4496	0.8584	52.4
	3&4	341	1,339.5	116	25.82	449	67.3	0.6471	0.9067	71.4
	G&U	2,250	8,855.5	979	244.78	400	82.9	0.5645	0.8687	65.0
	G&U	2,546	10,519.0	653	227.36	287	40.5	0.7300	0.8960	81.5
Local	1&2	1,022	4,138.0	378	110.31	343	64.7	0.6290	0.8733	72.0
	1&2	1,379	5,600.0	330	125.05	264	36.6	0.7436	0.8930	83.3
	3&4	172	609.0	88	13.16	669	122.9	0.4884	0.8967	54.5
	3&4	224	801.5	86	12.84	670	91.3	0.6034	0.9248	65.2
	G&U	1,502	6,055.0	565	159.72	354	66.9	0.6230	0.8743	71.3
	G&U	1,877	7,555.5	467	159.76	292	40.7	0.7362	0.8986	81.9

* Grade: All Grades=Grades I,II,III,IV Combined; G&U=Graded & Unknown Grade Expected Survival Table: U.S. 1970-2017 by individual year (White, Black, Other [AI/API], Ages 0-99, All races for Other Unspec 1991+ and Unknown).

Table 8. 1997-2017 Entrants, Race, Stage; Both Sexes, All Ages & Grades*Combined. SEER Cancer Data 1975-2017 (SEER*Stat 8.3.6.1). Index Code 51b: TONGUE CARCINOMA

Duration Start-End	No. Alive at Start	Exposure Pt.-Yrs	Number of Deaths			Mortality Ratio (%)	Mean Ann. Mortality Rate/1,000			Cumul. Surv. Rate	Cum. Surv. Ratio (%)
			Observed	Expected	d'		Observed	Expected	Excess		
t to t+ch t	l	E	d	d'	100d/d'	q	q'	(q-q')	P	P'	100P/P'
<p>White, Local Stage</p> <p><i>Median survival time (interval = 12 months): Observed = 12.9947 intervals; Relative is greater than 20 intervals.</i></p>											
0-1	3,731	3,720.0	232	82.96	280	0.0624	0.0223	40.1	0.9376	0.9777	95.9
1-2	3,477	3,473.0	276	75.02	368	0.0795	0.0216	57.9	0.8631	0.9566	90.2
2-5	3,193	8,156.0	445	183.13	243	0.0546	0.0225	32.1	0.7312	0.8935	81.8
0-5	3,731	15,349.0	953	341.11	279	0.0621	0.0222	39.9	0.7312	0.8935	81.8
5-10	2,192	8,249.5	367	198.26	185	0.0445	0.0240	20.5	0.5820	0.7906	73.6
10-15	1,102	3,754.5	202	99.53	203	0.0538	0.0265	27.3	0.4363	0.6904	63.2
15-20	417	1,077.0	44	31.24	141	0.0409	0.0290	11.9	0.3625	0.5941	61.0
<p>White, Regional Stage</p> <p><i>Median survival time (interval = 12 months): Observed = 9.18746 intervals; Relative = 15.3451 intervals.</i></p>											
0-1	5,728	5,716.0	882	104.60	843	0.1543	0.0183	136.0	0.8457	0.9817	86.1
1-2	4,822	4,814.5	647	78.96	819	0.1344	0.0164	118.0	0.7320	0.9656	75.8
2-5	4,160	10,137.5	640	175.54	365	0.0631	0.0173	45.8	0.6058	0.9161	66.1
0-5	5,728	20,668.0	2,169	359.10	604	0.1049	0.0174	87.6	0.6058	0.9161	66.1
5-10	2,589	9,080.0	414	180.77	229	0.0456	0.0199	25.7	0.4794	0.8276	57.9
10-15	1,103	3,501.0	181	78.36	231	0.0517	0.0224	29.3	0.3740	0.7380	50.7
15-20	364	867.5	57	24.05	237	0.0657	0.0277	38.0	0.2629	0.6361	41.3
<p>White, Distant Stage</p> <p><i>Median survival time (interval = 12 months): Observed = 9.18746 intervals; Relative = 15.3451 intervals.</i></p>											
0-1	1,678	1,675.5	524	31.50	1,664	0.3127	0.0188	293.9	0.6873	0.9812	70.0
1-2	1,149	1,147.0	252	19.38	1,300	0.2197	0.0169	202.8	0.5363	0.9646	55.6
2-5	893	2,022.0	238	35.11	678	0.1177	0.0174	100.3	0.3755	0.9152	41.0
0-5	1,678	4,844.5	1,014	85.99	1,179	0.2093	0.0178	191.6	0.3755	0.9152	41.0
5-10	461	1,555.0	80	29.76	269	0.0514	0.0191	32.3	0.2880	0.8301	34.7
10-15	175	470.0	32	8.78	364	0.0681	0.0187	49.4	0.2042	0.7577	27.0
15-20	31	89.5	7	1.40	500	0.0782	0.0156	62.6	0.1296	0.6996	18.5
<p>B-O-U***, Local Stage</p> <p><i>Median survival time (interval = 12 months): Observed = 2.41178 intervals; Relative = 2.67283 intervals.</i></p>											
0-1	692	684.5	41	11.50	357	0.0599	0.0168	43.1	0.9401	0.9832	95.6
1-2	636	633.0	58	10.06	576	0.0916	0.0159	75.7	0.8540	0.9676	88.3
2-5	572	1,408.0	68	24.52	277	0.0483	0.0174	30.9	0.7403	0.9177	80.7
0-5	692	2,725.5	167	46.08	362	0.0613	0.0169	44.4	0.7403	0.9177	80.7

Table 8. Continued

Duration Start-End	No. Alive at Start	Exposure Pt.-Yrs	Number of Deaths		Mortality Ratio (%)	Mean Ann. Mortality Rate/1,000		Cumul. Surv. Rate		Cum. Surv. Ratio (%)
			Observed	Expected		Observed	Expected	Observed	Expected	
5-10	376	1,426.0	57	27.78	205	0.0400	0.0195	0.5978	0.8320	71.8
10-15	183	619.0	23	11.91	193	0.0372	0.0192	0.4930	0.7541	65.4
15-20	70	163.0	4	3.41	117	0.0245	0.0209	0.4377	0.6831	64.1
<i>Median survival time (interval = 12 months): Observed = 14.7267 intervals; Relative is greater than 20 intervals.</i>										
B-O-U, Regional Stage										
0-1	894	891.0	212	14.97	1,416	0.2379	0.0168	0.7621	0.9832	77.5
1-2	676	673.5	158	10.64	1,485	0.2346	0.0158	0.5833	0.9677	60.3
2-5	513	1,206.0	130	18.68	696	0.1078	0.0155	0.4222	0.9235	45.7
0-5	894	2,770.5	500	44.29	1,129	0.1805	0.0160	0.4222	0.9235	45.7
5-10	283	987.5	52	16.43	316	0.0527	0.0166	0.3184	0.8485	37.5
10-15	120	367.0	30	6.84	439	0.0817	0.0186	0.2106	0.7727	27.3
15-20	34	90.0	5	1.36	367	0.0556	0.0152	0.1250	0.7186	17.4
<i>Median survival time (interval = 12 months): Observed = 2.9319 intervals; Relative = 3.52287 intervals.</i>										
B-O-U, Distant Stage										
0-1	401	400.0	157	6.88	2,282	0.3925	0.0172	0.6075	0.9828	61.8
1-2	242	242.0	63	3.63	1,736	0.2603	0.0150	0.4494	0.9681	46.4
2-5	179	408.5	52	6.75	771	0.1273	0.0165	0.3041	0.9204	33.0
0-5	401	1,050.5	272	17.26	1,576	0.2589	0.0164	0.3041	0.9204	33.0
5-10	88	302.0	24	6.15	390	0.0795	0.0204	0.1952	0.8291	23.5
10-15	28	92.0	5	2.23	224	0.0543	0.0243	0.1449	0.7333	19.8
15-20	11	28.5	3	0.55	550	0.1053	0.0192	0.0925	0.6682	13.8
<i>Median survival time (interval = 12 months): Observed = 1.67973 intervals; Relative = 1.76742 intervals.</i>										

All Grades=Known & Unknown

** B-O-U = 'Black', 'Other (American Indian/AK Native, Asian/Pacific Islander)', 'Unknown' Expected Survival Table: U.S. 1970-2017 by individual year (White, Black, Other [AI/API], Ages 0-99, All races for Other Unspec 1991+ and Unknown).

TABLE 9. Mortality & Survival with Differing Patterns of Regional Stage Invasion by Race. SEER Combined Summary Stage 2000 (2004+), All Ages Combined, Duration 0-5 Years. SEER Cancer Data 1975-2017 (SEER*Stat 8.3.6.1). Index Code 51b: TONGUE CARCINOMA

Stage	Grade	Race	I	E	Number of Deaths			Mortality Ratio	Excess Death Rate	Cumul. Surv. Rate		Cum. Surv. Ratio (%)	
					Exposure Pt.-Yrs	Observed	Expected			Observed	Expected		
Regional	All grades K&U	White	443	1,356.5	174	28.91	602	107.0	0.5501	0.8997	61.1		
		<i>Median survival time (interval = 12 months): Observed = 6.26488 intervals; Relative = 9.75475 intervals.</i>											
		B-O-U	83	226.5	44	3.43	1,281	179.1	0.3990	0.9289	43.0		
		<i>Median survival time (interval = 12 months): Observed = 2.82157 intervals; Relative = 3.25357 intervals.</i>											
Regional	All grades K&U	All Races	526	1,583.0	218	32.34	674	117.3	0.5261	0.9037	58.2		
		<i>Median survival time (interval = 12 months): Observed = 5.58939 intervals; Relative = 8.199 intervals.</i>											
		White	2,899	9,228.0	732	152.96	479	62.7	0.6892	0.9191	75.0		
		Regional by lymph node involvement only											
Regional	All grades K&U	<i>Median survival time (interval = 12 months): Observed = 12.7219 intervals; Relative is greater than 20 intervals.</i>											
		B-O-U	362	1,054.0	129	16.00	806	107.2	0.5731	0.9261	61.9		
		<i>Median survival time (interval = 12 months): Observed = 8.54628 intervals; Relative = 10.8025 intervals.</i>											
		All Races	3,261	10,282.0	861	168.79	510	67.3	0.6763	0.9199	73.5		
Regional	All grades K&U	<i>Median survival time (interval = 12 months): Observed = 12.2364 intervals; Relative is greater than 20 intervals.</i>											
		White	1,660	5,132.5	574	84.35	680	95.4	0.5986	0.9205	65.0		
		Regional by both direct extension & lymph node involvement											
		<i>Median survival time (interval = 12 months): Observed = 9.27774 intervals; Relative is greater than 20 intervals.</i>											
Regional	All grades K&U	B-O-U	242	636.5	129	9.97	1,294	187.0	0.3826	0.9236	41.4		
		<i>Median survival time (interval = 12 months): Observed = 2.69415 intervals; Relative = 2.88197 intervals.</i>											
		All Races	1,902	5,769.0	703	94.27	746	105.5	0.5711	0.9208	62.0		
		<i>Median survival time (interval = 12 months): Observed = 8.20206 intervals; Relative = 12.7418 intervals.</i>											

Race = 'White', 'Black', 'Other (American Indian/AK Native, Asian/Pacific Islander)', 'Unknown'.
 Grades=All grades known and unknown.
 Expected Survival Table: U.S. 1970-2017 by individual year (White, Black, Other [AI/API], Ages 0-99, All races for Other Unspec 1991+ and Unknown).

Results for local and distant stages adjusted for cohort entry time-period are proportionally similar to those in the previous tables for all ages, durations 0-5 and 5-10 years.

Comment: Cancer of the tongue is an uncommon cancer site, with only 31,378 cases in the SEER 1975-2017 database, fewer than 1% of all reported cancers. It is characterized by a male predominance, a mean age of 62 years, and a high excess mortality in cases staged as localized. We speculate that staging is more difficult for tongue cancer than for many other sites, because of the highly vascular soft tissue stroma characteristic of the tongue. It is possible that many cancers classified as local have already spread undetected to lymph nodes or adjacent tissues.

Tables 5 and 6 provide detailed results for local and regional cancer by a combination of sex and two age groups, <65 and 65 up, plus all ages combined in a 20-year FU. Highest EDR values are in the second year, about 92 per 1000, all ages in local, and 175 in regional cases, with little sex difference. EDR decreases after 2 years, and excess mortality appears to persist up to 15 years, although there are few survivors after 15 years. EDR values are even higher, over 350 per 1000 in the 1st duration in distant cancer of the tongue. Results in Table 7 do show improvement in the 1997-2017 cohort over results in the matching subgroup of the 1975-1996 cohort (subgroups are for interpolations of stage and grades 1&2, 3&4, unknown grade, or all grades (G&U), at durations 0-5 and 5-10 years, all ages combined). Grading is also less effective in prognosis than it is in many other cancer sites. In Table 8, EDR and MR at 0-5 years duration in black-other-unknown races of patients in all stages appears to be higher, and SR is lower than in white patients. Table 9 illustrates racial differences in tongue carcinoma mortality and survival results by pattern of invasion in the regional stage. However, prognostic indices using the SEER Combined

Summary Stage 2000 are proportionally similar in the most current cohort time-period.

Profound appreciation to my esteemed colleague Dr. Richard B. Singer, MD (deceased) for his friendship, invaluable collaboration and scholarly expertise, encouragement and assistance in the initial (unpublished) iterations of long-term comparative mortality and survival in patients with tongue carcinoma in 2003.

REFERENCES

1. Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER Research Data, 9 Registries, Nov 2019 Sub (1975-2017) - Linked to County Attributes - Time Dependent (1990-2017) Income/Rurality, 1969-2017 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, released April 2020, based on the November 2019 submission.
2. Surveillance, Epidemiology, and End Results (SEER) Program (www.seer.cancer.gov) SEER*Stat Database: Incidence - SEER Research Data, 9 Registries, Nov 2019 Sub (1975-2017) - Linked to County Attributes - Time Dependent (1990-2017) Income/Rurality, 1969-2017 Counties, National Cancer Institute, DCCPS, Surveillance Research Program, released April 2020, based on the November 2019 submission.
3. Howlander N, Noone AM, Krapcho M, et al (eds). SEER Cancer Statistics Review, 1975–2017, National Cancer Institute. Bethesda, MD, https://seer.cancer.gov/csr/1975_2017/, based on November 2019 SEER data submission, posted to the SEER website, April 2020.
4. Surveillance Research Program, National Cancer Institute SEER*Stat software (www.seer.cancer.gov/seerstat): Latest Release: Version 8.3.6.1 – April 29, 2020.
5. Pokorski RJ. *Mortality Methodology and Analysis Seminar Text*. Sponsored by the Association of Life Insurance Medical Directors of America. *J Insur Med*. 1988;20:1-26.
6. Milano AF, Singer RB. The Cancer Mortality Risk Project – Cancer Mortality Risks by Anatomic Site: Part I – Introductory Overview; Carcinoma of the Colon: 20-Year Mortality Follow-up Derived from 1973-2013 (NCI) SEER*Stat Survival Database. *J Insur Med*. 2017;47:65-94.
7. Singer RB, Kita MW, Avery JR, eds. *Medical Risks - 1991 Compend of Mortality and Morbidity*. Westport, Conn: Praeger Publishers; 1994.
8. Brackenridge RDC, Croxson RS, Mackenzie R,

- eds. *Medical Selection of Life Risks*. 5th ed. New York: Palgrave Macmillan; 2006:chaps 3-5.
9. Howlader N, Noone AM, Krapcho M, et al. eds. SEER Cancer Statistics Review, 1975-2017, National Cancer Institute. Bethesda, MD, https://seer.cancer.gov/csr/1975_2017/, based on November 2019 SEER data submission, posted to the SEER website, April 2020.
 10. Cho H, Howlader N, Mariotto AB, Cronin KA. Estimating relative survival for cancer patients from the SEER Program using expected rates based on Ederer I versus Ederer II method. Surveillance Research Program, National Cancer Institute; 2011. Technical Report #2011-01:1-17. Available from: <https://surveillance.cancer.gov/reports/>