

Surveillance Research Program, NCI, Technical Report #2011-01

Estimating relative survival for cancer patients from the SEER Program using expected rates based on Ederer I versus Ederer II method

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INTRODUCTION

Relative survival (Ederer, Axtell and Cutler 1961) was developed to provide an objective measure of survival probability from cancer controlling for differences in mortality for causes other than cancer. For most cancer registries, cause of death information obtained from death certificate is either unavailable or unreliable due to misclassification errors. Therefore, instead of calculating the probability of surviving cancer in the usual way, considering deaths from other causes as censoring events, the concept of relative survival was developed by comparing the observed survival probability of a group of cancer patients with the survival of a “similar” cancer-free group. Relative survival is defined as the ratio of the observed survival (all cause survival) of a cohort of cancer patients to the expected survival of a comparable set of cancer free individuals. Since a cohort of cancer-free individuals is difficult to obtain, expected life tables representing survival of the general population are used instead. The underlying assumption is that the cancer deaths are a negligible proportion of all deaths (Ederer, et al. 1961).

Expected survival can be calculated using different methods which vary with respect to the definition of the matching group. The three most common methods are: Ederer I (Ederer, et al. 1961), Ederer II (Ederer and Heise 1959) and Hakulinen (Hakulinen 1982). In the previous versions of SEER*Stat (<http://www.seer.cancer.gov/seerstat/>), relative survival could be calculated using Ederer I and Hakulinen methods, and Ederer I was the default for calculations in the SEER*stat as well as the Cancer Statistics Review. In Ederer I and Hakulinen methods, individuals are matched to each patient and considered being at risk for the entire follow-up. Hakulinen adjusts for potential follow-up times but relative survivals from these two methods are

very similar. Recent researches on relative survival have resuscitated the initial method to estimate relative survival, Ederer II. Although none of the three methods can be considered a gold standard, Ederer II method has been shown to be in better alignment with the concept of net cancer survival (http://www.irpps.cnr.it/it/system/files/Esteve_0.pdf). Also, it has been long known (Hakulinen 1977) that relative survival calculated using Ederer I and Hakulinen tend to increase in the long term reflecting a better health condition of the long-term cancer survivors than that of the general population. In order to control for increasing relative survival, SEER*Stat has provided an option that constrains survival ratio not to increase. Since matched individuals are considered to be at risk only until the corresponding cancer patient dies or censored in the Ederer II method, the increase in relative survival is less.

The objective of this report is to briefly review the three methods for calculating expected survival in relative survival. We investigate their differences and impact on the relative survival using the SEER registry data. We focus our illustration on the comparison between Ederer I and Ederer II methods as we change our default calculation of the expected survival from Ederer I to Ederer II in the SEER*Stat version 7.0 (Surveillance Research Program 2011) as well as the SEER Cancer Statistics Review (CSR) (Howlander, et al. 2011) as of April 2011.

DEFINITIONS AND METHODS

Relative survival is defined as the ratio of the **observed survival** rate in a group of patients, during a specified interval (follow-up period), to the **expected survival** rate in a population (Ederer, et al. 1961). For the population-based cancer statistics, relative survival is a standard method to estimate cancer survival in the absence of other causes of death. This relative survival provides a measure of excess mortality experienced by cancer patients without requiring cause of death information and the formulation is based on the assumption of independent competing cause of death.

Observed survival is the probability of surviving from all causes of death for a group of cancer patients under study and it can be estimated using the life-table method.

Expected survival is the survival probability of a population similar to the patient group but free of the specific disease under study (Ederer, et al. 1961), and it can be estimated in a number of ways using the national life table for individuals from general population matched by age, sex, race and calendar year of the cancer patients under the study. The three most common ways are

called: Ederer I (Ederer, et al. 1961), Ederer II (Ederer, et al. 1959) and Hakulinen (Hakulinen 1982) method. The three methods differ regarding how long the matched individuals are considered to be at risk for calculation of the expected survival (Dickman, Coviello and Hills).

- Ederer I method calculates the expected survival rates assuming each patient would be a member of the general population from diagnosis to entire follow-up so the matched individuals are considered to be at risk indefinitely.
- 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
- Hakulinen method takes potential follow-up times of the patients into account and produces the expected survival rates where the follow up times have been censored when the patients cannot be followed any longer. Thus, a matched individual is assumed to be no longer at risk if the corresponding cancer patient is censored however, the matched individual is assumed to be at risk until the end of the follow-up if the corresponding cancer patient dies.

For mathematical details, see appendix. The standard error of the relative survival can be estimated as the standard error of observed survival divided by the expected survival rate (Ederer, et al. 1961). The standard error of the observed survival is estimated by the Greenwood's formula (Greenwood 1926).

In practice, especially if the analysis is stratified by age or when estimating short-term relative survival, the three methods do not make much difference and provide similar relative survival estimates. However, in some particular situations, as for example, for cancers sites diagnosed over a wide range of ages (e.g. thyroid) long term relative survival for all ages combined may vary depending on the method used to estimate expected survival (Hakulinen and Dyba 2007). In these cases, Ederer I and Hakulinen methods provide similar and increasing relative survival, while the relative survival calculated by Ederer II is lower than those calculated by Ederer I and Hakulinen.

Expected survival calculations in SEER*Stat

In the 2011 April release of SEER*Stat version 7.0, the Ederer II method is being added to the previous methods, Ederer I, Hakulinen Exact (Hakulinen 1982) and Hakulinen Simplified

(Hakulinen and Abeywickrama 1985), and becomes the default for the calculation of relative survival in the CSR (1975-2008). In the previous versions, Ederer I was the default. Note that relative survival can be calculated by any of the four methods by selecting the appropriate method in the Statistics Tab of the survival session.

ILLUSTRATIVE EXAMPLES

We provide an example in which the estimates vary. We also show that in most typical calculations of relative survival the expected method used has negligible effect on relative survival estimates.

Comparisons of Ederer I, Ederer II and Hakulinen relative survival estimates using SEER data

We investigate the difference between the three methods using data from the SEER registries. The results are as follows:

Table 1 shows relative survival estimates with corresponding expected rates calculated by the three methods (Hakulinen, Ederer I, and Ederer II) stratified by follow-up time and gender for all thyroid-cancer diagnosed patients from the nine registries of the SEER Program. Overall, there is very little difference in relative survival estimates regardless of which method is being used for calculating expected rates. However, as the follow-up time becomes longer, some differences start to show (Figure 1). For example, thirty-year relative survival rates for male thyroid cancer patients were 95.34, 102.15, and 88.32 by Hakulinen, Ederer I, and Ederer II, respectively. As has been pointed out before, with Ederer I approach we have a survival rate that is not only slightly overestimated, but is also over 100; which is completely unrealistic with survival measures. This occurs when the observed survival for the cohort decreases more slowly than the expected survival for that same age, race, sex, and year group and is more common for Ederer I and Hakulinen expected survival methods. In particular, when follow-up time is more than 10 years Ederer II gives slightly higher expected rates compared to Hakulinen or Ederer I methods; Thirty-year expected survival estimates for female thyroid cancer patients were 69.85 with Ederer II versus 65.58 with Ederer I (or 66.79 with Hakulinen). However, we have further explored our results for age-specific survival rates; there are very little differences in relative survival estimates (Table 2).

Since the CSR report routinely updates the most recent five-year relative survival rates as a measure of survival improvement among cancer patients in the United States, we compared five-year relative survival rates for over 100+ cancer sites. We have essentially found no statistically significant difference regardless of whichever method is being used to calculate expected rates (Table 3). Note that relative survival statistics for CSR are generated using the default edit settings on the “Output Tab” in SEER*STAT where the options to adjust relative survival that is increasing or greater than 1.0 are checked off. As a result, we do not see anomalies such as those in Table 1 in the CSR report.

DISCUSSION

Relative survival is a measure of the excess mortality experienced by cancer patients in comparison with a similar group of people in the general population. Relative survival is a useful measure for reporting trends and for comparing between different populations because it eliminates the effect of other cause mortality. There have been several recent developments in relative survival analysis which include discussion of the different methods to estimate expected survival (Esteve, Benhamou, Croasdale and Raymond 1990, Perme, Henderson and Stare 2008), regression models that control for different covariates (Nelson, Lambert, Squire and Jones 2007, Lambert, Dickman, Nelson and Royston 2010) and cause-specific survival (Howlader, et al. 2010). Hakulinen and Dyba (2007) provide an overview of methods and issues of relative survival. However, those discussions are not a scope of this report.

There is a growing consensus among cancer registry communities, especially in Europe that the Ederer II is a more preferable compared to the Ederer I or the Hakulinen. Eurocare will use the Ederer II method in their calculation (De Angelis personal communication). As such, the purpose of this report is to notify that Ederer II method has been implemented in SEER*Stat and is being used as a default in relative survival calculation of Cancer Statistics Review in 2011. Importantly, although the default method to calculate expected survival has been changed from Ederer I to Ederer II, relative survival estimates, using any of the methods available are very similar for most of the calculations.

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APPENDIX - Mathematical details

We show formulas to estimate observed, expected and relative survival. For definitions and notations, we follow methodological notes no. 24 (Axtell 1969) with some modifications.

Observed survival

Let

L_j = number of cases alive at the beginning of interval j ,

D_j = number of cases dying during interval j ,

U_j = number of cases lost to follow up during interval j , where the definition of “lost to follow-up” is “alive with follow-up date prior to some prescribed date”,

W_j = number of cases withdrawn alive during interval j , where the definition of “withdrawn alive” is “alive with follow-up date later than or equal to some specified date”.

Then total number of cases alive at the start of follow up is L_1 and $L_j = L_{j-1} - D_{j-1} - U_{j-1} - W_{j-1}$, where $j > 1$.

$L_j^* = L_j - \frac{1}{2}(U_j + W_j)$ for actuarial method and $L_j^* = L_j$ for Kaplan-Meier method.

The observed survival probability at interval j is defined by

$$P_j^o = 1 - \frac{D_j}{L_j^*}$$

The cumulative observed survival probability for surviving interval x can be obtained as

$$CP_x^o = \prod_{j=1}^x P_j^o$$

Expected survival

Let \tilde{P}_{ij} be the expected probability of individual i for surviving interval j then the expected

survival probability for interval j is $P_j^E = \frac{1}{L_j} \sum_{i=1}^{L_j} \tilde{P}_{ij}$.

For the relative survival calculation, individual i is selected as a person in the general population similar to the i th patients with respect to age, sex, race and calendar year. For example, expected probabilities for individual i can be obtained as follows:

| Interval | Race | Sex | Age | Calendar year | \tilde{P}_{ij} |
|----------|------|-----|-------|---------------|------------------|
| 1 | r | s | g | y | \tilde{P}_{i1} |
| 2 | r | s | g+1 | y+1 | \tilde{P}_{i2} |
| 3 | r | s | g+2 | y+2 | \tilde{P}_{i3} |
| ⋮ | ⋮ | ⋮ | ⋮ | ⋮ | ⋮ |
| x | r | s | g+x-1 | y+x-1 | \tilde{P}_{ix} |

Where r is race, s is sex, g is age at entry into life table, y is calendar year of entry into life table and x is interval of follow-up for individual i . $\tilde{P}_{i1}, \tilde{P}_{i2}, \dots, \tilde{P}_{ix}$ can be obtained from a national life table.

Ederer I method

The cumulative expected survival probability of surviving interval x is given by

$$CP_x^E = \frac{1}{L_1} \sum_{i=1}^{L_1} \left(\prod_{j=1}^x \tilde{P}_{ij} \right)$$

For all individuals matched to the patient cohort at the start of follow-up, expected probabilities of surviving intervals 1, 2, ..., x for each of the individuals are calculated and averaged.

Ederer II method

The cumulative expected survival probability of surviving interval x is given by

$$CP_x^E = \prod_{j=1}^x \left(\frac{1}{L_j} \sum_{i=1}^{L_j} \tilde{P}_{ij} \right)$$

For all individuals matched to the patient cohort at the beginning the interval j , average of expected probabilities of surviving interval j is calculated for $j = 1, \dots, x$ and multiplied.

Hakulinen method

See Hakulinen (1982), Hakulinen and Abeywickrama (1985).

Relative survival

The relative survival probability at interval \mathbf{J} is given by

$$\mathbf{R}_j = \frac{\mathbf{P}_j^O}{\mathbf{P}_j^E}$$

and cumulative relative survival probability of surviving interval \mathbf{x} is given by

$$\mathbf{CR}_x = \frac{\mathbf{CP}_x^O}{\mathbf{CP}_x^E}$$

The standard errors of observed survival based on Greenwood's formula (Greenwood 1926) is given by

$$\mathbf{SE}(\mathbf{P}_j^O) = \mathbf{P}_j^O \sqrt{\frac{\mathbf{D}_j}{\mathbf{L}_j^*(\mathbf{L}_j^* - \mathbf{D}_j)}} \quad , \quad \mathbf{SE}(\mathbf{CP}_x^O) = \mathbf{CP}_x^O \sqrt{\sum_{j=1}^x \frac{\mathbf{D}_j}{\mathbf{L}_j^*(\mathbf{L}_j^* - \mathbf{D}_j)}} \quad .$$

The standard errors of relative survival can be obtained as follows (Ederer, et al. 1961):

$$\mathbf{SE}(\mathbf{R}_j) = \mathbf{R}_j \sqrt{\frac{\mathbf{D}_j}{\mathbf{L}_j^*(\mathbf{L}_j^* - \mathbf{D}_j)}} \quad , \quad \mathbf{SE}(\mathbf{CR}_x) = \mathbf{CR}_x \sqrt{\sum_{j=1}^x \frac{\mathbf{D}_j}{\mathbf{L}_j^*(\mathbf{L}_j^* - \mathbf{D}_j)}} \quad .$$

Figure 1. Comparison of relative survival using Ederer I, Ederer II, and Hakulinen methods for expected survival for female patients diagnosed with thyroid cancer at all ages in the SEER-9 areas.

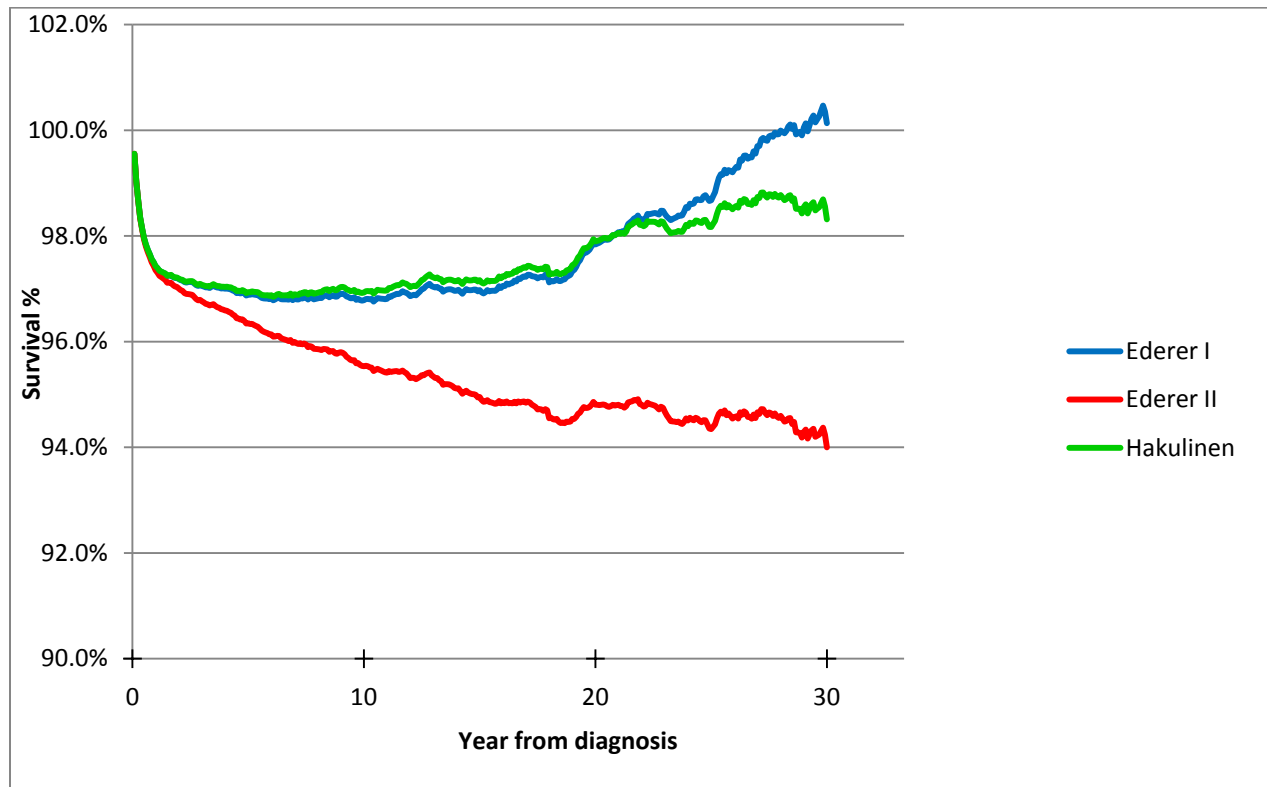


Table 1: Relative Survival Estimates (%) Presented with Expected Rates (%) Calculated by Hakulinen, Ederer I, and Ederer II, respectively for All Thyroid Cancer Patients Diagnosed between 1975-2007 in SEER-9 Registries.

| Follow-up Time (Years) | Male Relative Survival | | | Male Expected Rates | | | Female Relative Survival | | | Female Expected Rates | | |
|---------------------------|---------------------------|--------|-------|------------------------|-------|-------|-----------------------------|--------|-------|--------------------------|-------|-------|
| | Hak | EI | EII | Hak | EI | EII | Hak | EI | EII | Hak | EI | EII |
| 5 | 93.15 | 93.10 | 92.29 | 92.96 | 93.00 | 93.81 | 96.94 | 96.89 | 96.35 | 96.12 | 96.17 | 96.71 |
| 10 | 92.03 | 92.01 | 90.05 | 85.31 | 85.32 | 87.18 | 96.93 | 96.79 | 95.54 | 91.53 | 91.67 | 92.87 |
| 15 | 91.57 | 91.79 | 88.13 | 77.18 | 77.00 | 80.19 | 97.16 | 96.98 | 94.95 | 86.25 | 86.42 | 88.26 |
| 20 | 93.89 | 95.01 | 88.98 | 68.89 | 68.09 | 72.69 | 97.90 | 97.84 | 94.81 | 80.30 | 80.35 | 82.92 |
| 30 | 95.34 | 102.15 | 88.32 | 52.69 | 49.18 | 56.88 | 98.31 | 100.13 | 94.00 | 66.79 | 65.58 | 69.85 |

Hak= Hakulinen

EI=Ederer I

EII=Ederer II

Table 2: Relative Survival Estimates (%) Presented with Expected Rates (%) Calculated by Ederer I, and Ederer II, respectively for Thyroid Cancer Patients Diagnosed between 1975-2007 in SEER-9 Registries. The results are stratified by Age at Diagnosis and follow-up time in Years.

Ages 0-44

| Follow-up Time (Years) | Relative Survival | | Expected Rates | |
|------------------------|-------------------|-----------|----------------|-----------|
| | Ederer I | Ederer II | Ederer I | Ederer II |
| 5 | 99.34 | 99.34 | 99.34 | 99.34 |
| 10 | 99.01 | 98.98 | 98.41 | 98.43 |
| 15 | 98.68 | 98.61 | 97.08 | 97.15 |
| 20 | 98.52 | 98.34 | 95.14 | 95.31 |
| 30 | 98.40 | 97.60 | 88.28 | 89.01 |

Ages 45-59

| Follow-up Time (Years) | Relative Survival | | Expected Rates | |
|------------------------|-------------------|-----------|----------------|-----------|
| | Ederer I | Ederer II | Ederer I | Ederer II |
| 5 | 96.92 | 96.94 | 97.25 | 97.23 |
| 10 | 95.63 | 95.82 | 93.37 | 93.19 |
| 15 | 94.07 | 94.66 | 87.95 | 87.40 |
| 20 | 94.26 | 95.52 | 80.32 | 79.27 |
| 30 | 92.73 | 95.57 | 55.65 | 54.00 |

Ages 60-74

| Follow-up Time (Years) | Relative Survival | | Expected Rates | |
|------------------------|-------------------|-----------|----------------|-----------|
| | Ederer I | Ederer II | Ederer I | Ederer II |
| 5 | 88.45 | 88.51 | 90.18 | 90.11 |
| 10 | 84.50 | 84.99 | 77.34 | 76.90 |
| 15 | 81.23 | 82.32 | 61.11 | 60.30 |
| 20 | 81.67 | 83.20 | 42.56 | 41.78 |
| 30 | 70.92 | 76.36 | 11.30 | 10.50 |

Ages 75+

| Follow-up Time (Years) | Relative Survival | | Expected Rates | |
|------------------------|-------------------|-----------|----------------|-----------|
| | Ederer I | Ederer II | Ederer I | Ederer II |
| 5 | 71.92 | 70.04 | 66.66 | 68.45 |
| 10 | 67.11 | 64.22 | 37.81 | 39.51 |
| 15 | 59.39 | 57.61 | 16.93 | 17.46 |
| 20 | 60.33 | 62.43 | 5.47% | 5.29 |
| 30* | | | | |

*Estimates were unstable due to small sample size to present in the table

Table 3: Comparison of 5-Year Relative Survival Rates using Expected Rates based on Ederer I vs. Ederer II Approaches. Survival Rates were compared for 100+ Cancer Sites in SEER Registries*.

| SEER Cancer Sites | 5-year Survival Rates | | | 95% Confidence Intervals | | | |
|-------------------------------|-----------------------|-----------|------------------------------|--------------------------|----------------------|-----------------------|-----------------------|
| | Ederer I | Ederer II | Absolute Difference I vs. II | Ederer I Lower limit | Ederer I Upper limit | Ederer II Lower limit | Ederer II Upper limit |
| All Sites | 66.35% | 65.16% | 1.19% | 66.27% | 66.44% | 65.08% | 65.24% |
| Oral Cavity and Pharynx | 61.41% | 60.55% | 0.86% | 60.86% | 61.94% | 60.01% | 61.08% |
| Lip | 90.73% | 90.60% | 0.13% | 88.73% | 92.39% | 88.61% | 92.25% |
| Tongue | 59.85% | 59.08% | 0.77% | 58.82% | 60.87% | 58.06% | 60.09% |
| Salivary Gland | 74.10% | 71.92% | 2.18% | 72.47% | 75.65% | 70.34% | 73.43% |
| Floor of Mouth | 51.74% | 50.88% | 0.87% | 49.54% | 53.90% | 48.71% | 53.00% |
| Gum and Other Mouth | 59.97% | 58.64% | 1.32% | 58.42% | 61.48% | 57.13% | 60.12% |
| Nasopharynx | 58.73% | 57.74% | 1.00% | 56.77% | 60.63% | 55.81% | 59.61% |
| Tonsil | 67.53% | 66.85% | 0.67% | 66.23% | 68.79% | 65.57% | 68.10% |
| Oropharynx | 39.71% | 38.74% | 0.97% | 36.72% | 42.69% | 35.82% | 41.65% |
| Hypopharynx | 29.87% | 29.40% | 0.48% | 27.94% | 31.83% | 27.50% | 31.32% |
| Other Oral Cavity and Pharynx | 35.74% | 34.34% | 1.41% | 32.10% | 39.40% | 30.84% | 37.86% |
| Digestive System | 45.28% | 44.44% | 0.84% | 45.09% | 45.47% | 44.25% | 44.63% |
| Esophagus | 17.27% | 16.75% | 0.52% | 16.65% | 17.90% | 16.15% | 17.37% |
| Stomach | 26.46% | 25.61% | 0.85% | 25.91% | 27.01% | 25.08% | 26.14% |
| Small Intestine | 63.31% | 61.57% | 1.75% | 61.91% | 64.68% | 60.20% | 62.90% |
| Colon and Rectum | 65.19% | 64.25% | 0.95% | 64.92% | 65.46% | 63.98% | 64.51% |
| Colon excluding Rectum | 64.56% | 63.67% | 0.88% | 64.23% | 64.88% | 63.35% | 63.99% |
| Cecum | 62.03% | 61.59% | 0.44% | 61.32% | 62.74% | 60.88% | 62.29% |
| Appendix | 65.32% | 64.76% | 0.56% | 63.04% | 67.49% | 62.51% | 66.92% |
| Ascending Colon | 67.79% | 67.40% | 0.40% | 66.97% | 68.60% | 66.58% | 68.20% |
| Hepatic Flexure | 64.20% | 63.70% | 0.51% | 62.73% | 65.64% | 62.23% | 65.12% |
| Transverse Colon | 65.13% | 64.60% | 0.53% | 63.97% | 66.25% | 63.45% | 65.71% |
| Splenic Flexure | 63.14% | 62.39% | 0.75% | 61.40% | 64.83% | 60.67% | 64.06% |
| Descending Colon | 66.52% | 65.55% | 0.97% | 65.19% | 67.82% | 64.24% | 66.83% |

| SEER Cancer Sites | 5-year Survival Rates | | | 95% Confidence Intervals | | | |
|---|-----------------------|-----------|------------------------------|--------------------------|----------------------|-----------------------|-----------------------|
| | Ederer I | Ederer II | Absolute Difference I vs. II | Ederer I Lower limit | Ederer I Upper limit | Ederer II Lower limit | Ederer II Upper limit |
| Sigmoid Colon | 69.88% | 69.13% | 0.75% | 69.31% | 70.44% | 68.57% | 69.68% |
| Large Intestine, NOS | 28.20% | 26.01% | 2.19% | 26.98% | 29.43% | 24.89% | 27.15% |
| Rectum and Rectosigmoid Junction | 66.65% | 65.68% | 0.97% | 66.17% | 67.13% | 65.20% | 66.15% |
| Rectosigmoid Junction | 65.81% | 65.05% | 0.76% | 64.91% | 66.70% | 64.16% | 65.93% |
| Rectum | 67.00% | 65.93% | 1.07% | 66.43% | 67.56% | 65.37% | 66.49% |
| Anus, Anal Canal and Anorectum | 66.49% | 65.69% | 0.79% | 65.05% | 67.88% | 64.28% | 67.07% |
| Liver and Intrahepatic Bile Duct | 14.38% | 13.75% | 0.63% | 13.91% | 14.86% | 13.30% | 14.20% |
| Liver | 15.16% | 14.54% | 0.61% | 14.66% | 15.67% | 14.07% | 15.03% |
| Intrahepatic Bile Duct | 6.09% | 5.69% | 0.40% | 5.04% | 7.27% | 4.71% | 6.79% |
| Gallbladder | 16.50% | 15.95% | 0.55% | 15.30% | 17.74% | 14.78% | 17.15% |
| Other Biliary | 17.16% | 15.96% | 1.20% | 16.14% | 18.22% | 15.01% | 16.94% |
| Pancreas | 5.77% | 5.36% | 0.41% | 5.52% | 6.02% | 5.13% | 5.60% |
| Retroperitoneum | 52.22% | 50.82% | 1.39% | 49.51% | 54.85% | 48.20% | 53.39% |
| Peritoneum, Omentum and Mesentery | 30.06% | 29.34% | 0.73% | 28.00% | 32.15% | 27.33% | 31.37% |
| Other Digestive Organs | 11.05% | 10.10% | 0.95% | 9.50% | 12.74% | 8.68% | 11.64% |
| Respiratory System | 19.33% | 18.64% | 0.69% | 19.16% | 19.50% | 18.48% | 18.81% |
| Nose, Nasal Cavity and Middle Ear | 56.56% | 55.48% | 1.08% | 54.37% | 58.69% | 53.33% | 57.57% |
| Larynx | 61.56% | 61.25% | 0.31% | 60.62% | 62.49% | 60.31% | 62.18% |
| Lung and Bronchus | 16.05% | 15.47% | 0.58% | 15.88% | 16.22% | 15.31% | 15.63% |
| Pleura | 27.30% | 24.73% | 2.57% | 19.20% | 36.00% | 17.45% | 32.69% |
| Trachea, Mediastinum and Other Respiratory Organs | 49.23% | 47.59% | 1.64% | 45.60% | 52.74% | 44.09% | 51.00% |
| Bones and Joints | 68.05% | 66.99% | 1.05% | 66.49% | 69.55% | 65.46% | 68.48% |
| Soft Tissue including Heart | 67.04% | 66.07% | 0.96% | 66.09% | 67.96% | 65.15% | 66.98% |
| Skin excluding Basal and Squamous | 91.24% | 90.75% | 0.49% | 90.93% | 91.54% | 90.44% | 91.05% |
| Melanoma of the Skin | 91.53% | 91.15% | 0.38% | 91.21% | 91.83% | 90.84% | 91.45% |
| Other Non-Epithelial Skin | 87.74% | 86.19% | 1.55% | 86.38% | 88.98% | 84.86% | 87.41% |
| Breast | 89.13% | 89.06% | 0.07% | 88.97% | 89.29% | 88.89% | 89.22% |

| SEER Cancer Sites | 5-year Survival Rates | | | 95% Confidence Intervals | | | |
|-------------------------------------|-----------------------|-----------|------------------------------|--------------------------|----------------------|-----------------------|-----------------------|
| | Ederer I | Ederer II | Absolute Difference I vs. II | Ederer I Lower limit | Ederer I Upper limit | Ederer II Lower limit | Ederer II Upper limit |
| Female Genital System | 69.62% | 68.33% | 1.29% | 69.31% | 69.93% | 68.03% | 68.64% |
| Cervix Uteri | 70.28% | 69.42% | 0.86% | 69.60% | 70.94% | 68.75% | 70.07% |
| Corpus and Uterus, NOS | 82.66% | 82.03% | 0.63% | 82.25% | 83.06% | 81.62% | 82.43% |
| Corpus Uteri | 83.78% | 83.26% | 0.52% | 83.37% | 84.18% | 82.85% | 83.66% |
| Uterus, NOS | 28.89% | 26.81% | 2.08% | 26.08% | 31.75% | 24.21% | 29.47% |
| Ovary | 45.87% | 43.87% | 2.00% | 45.24% | 46.50% | 43.26% | 44.47% |
| Vagina | 51.96% | 49.94% | 2.02% | 48.76% | 55.06% | 46.85% | 52.95% |
| Vulva | 75.42% | 73.36% | 2.06% | 73.73% | 77.02% | 71.72% | 74.92% |
| Other Female Genital Organs | 63.97% | 61.88% | 2.08% | 61.15% | 66.64% | 59.17% | 64.48% |
| Male Genital System | 98.89% | 99.01% | -0.12% | 98.73% | 99.04% | 98.84% | 99.16% |
| Prostate | 99.23% | 99.33% | -0.10% | 99.05% | 99.38% | 99.14% | 99.48% |
| Testis | 95.36% | 95.32% | 0.05% | 94.95% | 95.74% | 94.90% | 95.70% |
| Penis | 66.62% | 66.02% | 0.61% | 63.34% | 69.69% | 62.76% | 69.06% |
| Other Male Genital Organs | 87.69% | 87.84% | -0.15% | 81.91% | 91.72% | 82.03% | 91.87% |
| Urinary System | 74.84% | 73.87% | 0.97% | 74.52% | 75.16% | 73.55% | 74.19% |
| Urinary Bladder | 79.37% | 78.15% | 1.22% | 78.93% | 79.80% | 77.72% | 78.57% |
| Kidney and Renal Pelvis | 69.72% | 68.54% | 1.18% | 69.24% | 70.21% | 68.06% | 69.02% |
| Ureter | 53.00% | 51.72% | 1.28% | 49.71% | 56.17% | 48.52% | 54.82% |
| Other Urinary Organs | 56.49% | 53.81% | 2.68% | 52.06% | 60.68% | 49.61% | 57.82% |
| Eye and Orbit | 83.69% | 83.48% | 0.21% | 81.94% | 85.29% | 81.74% | 85.07% |
| Brain and Other Nervous System | 35.48% | 33.37% | 2.11% | 34.90% | 36.05% | 32.82% | 33.91% |
| Brain | 32.19% | 30.12% | 2.07% | 31.60% | 32.77% | 29.57% | 30.67% |
| Cranial Nerves Other Nervous System | 80.33% | 79.14% | 1.19% | 78.21% | 82.26% | 77.07% | 81.06% |
| Endocrine System | 95.06% | 94.62% | 0.44% | 94.77% | 95.34% | 94.33% | 94.90% |
| Thyroid | 97.44% | 97.05% | 0.40% | 97.17% | 97.68% | 96.78% | 97.29% |
| Other Endocrine including Thymus | 62.99% | 62.38% | 0.62% | 61.11% | 64.81% | 60.51% | 64.18% |
| Lymphoma | 70.58% | 68.79% | 1.79% | 70.22% | 70.93% | 68.44% | 69.13% |

| SEER Cancer Sites | 5-year Survival Rates | | | 95% Confidence Intervals | | | |
|----------------------------------|-----------------------|-----------|------------------------------|--------------------------|----------------------|-----------------------|-----------------------|
| | Ederer I | Ederer II | Absolute Difference I vs. II | Ederer I Lower limit | Ederer I Upper limit | Ederer II Lower limit | Ederer II Upper limit |
| Hodgkin Lymphoma | 85.05% | 83.84% | 1.21% | 84.35% | 85.73% | 83.15% | 84.50% |
| Hodgkin - Nodal | 85.11% | 83.93% | 1.18% | 84.40% | 85.79% | 83.23% | 84.60% |
| Hodgkin - Extranodal | 82.32% | 80.78% | 1.54% | 77.62% | 86.13% | 75.78% | 84.86% |
| Non-Hodgkin Lymphoma | 67.92% | 66.25% | 1.67% | 67.52% | 68.31% | 65.86% | 66.64% |
| NHL - Nodal | 65.76% | 63.95% | 1.81% | 65.27% | 66.24% | 63.48% | 64.42% |
| NHL - Extranodal | 72.59% | 71.24% | 1.34% | 71.89% | 73.27% | 70.56% | 71.91% |
| Myeloma | 39.65% | 38.12% | 1.53% | 38.88% | 40.41% | 37.39% | 38.85% |
| Leukemia | 55.09% | 52.93% | 2.16% | 54.59% | 55.59% | 52.45% | 53.41% |
| Lymphocytic Leukemia | 74.84% | 73.85% | 0.99% | 74.14% | 75.51% | 73.16% | 74.52% |
| Acute Lymphocytic Leukemia | 65.59% | 64.39% | 1.20% | 64.51% | 66.65% | 63.33% | 65.43% |
| Chronic Lymphocytic Leukemia | 79.29% | 77.56% | 1.73% | 78.34% | 80.21% | 76.63% | 78.46% |
| Other Lymphocytic Leukemia | 82.55% | 80.45% | 2.10% | 80.06% | 84.75% | 78.05% | 82.62% |
| Myeloid and Monocytic Leukemia | 34.52% | 31.75% | 2.77% | 33.84% | 35.21% | 31.12% | 32.38% |
| Acute Myeloid Leukemia | 24.29% | 21.70% | 2.59% | 23.53% | 25.06% | 21.02% | 22.38% |
| Acute Monocytic Leukemia | 25.42% | 23.13% | 2.29% | 22.83% | 28.09% | 20.78% | 25.57% |
| Chronic Myeloid Leukemia | 58.33% | 55.25% | 3.08% | 56.89% | 59.74% | 53.89% | 56.59% |
| Other Myeloid/Monocytic Leukemia | 32.99% | 31.23% | 1.76% | 29.03% | 36.99% | 27.49% | 35.04% |
| Other Leukemia | 27.45% | 24.20% | 3.25% | 25.45% | 29.48% | 22.45% | 26.00% |
| Other Acute Leukemia | 16.89% | 13.85% | 3.04% | 14.55% | 19.38% | 11.94% | 15.90% |
| Aleukemic, Subleukemic and NOS | 36.35% | 33.18% | 3.17% | 33.31% | 39.38% | 30.42% | 35.96% |
| Mesothelioma | 8.00% | 7.43% | 0.57% | 7.04% | 9.04% | 6.54% | 8.40% |
| Kaposi Sarcoma | 63.85% | 64.95% | -1.11% | 61.97% | 65.66% | 63.04% | 66.79% |
| Miscellaneous | 17.18% | 15.76% | 1.42% | 16.76% | 17.61% | 15.38% | 16.15% |

*Based on the SEER 17 areas. California excluding SF/SJM/LA, Kentucky, Louisiana, and New Jersey contribute cases for diagnosis years 2000-2007. The remaining 13 SEER Areas contribute cases for the entire period 1999-2007. Based on follow-up of patients into 2008.