



Survival Query System

Working Group

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Motivation for Development of the System

- Limitations of information on survival currently provided by SEER
- Better utilization of patient follow-up data collected by SEER
 - National resource
- Types of questions asked by patients
 - Input from Cancer Information Service
- Provide more useful information to clinicians and patients

Development Process



- Focus on one cancer initially in order to identify issues associated with development of the System
 - Colon cancer
- Make a set of initial decisions
 - Interface
 - Output
- Get feedback on technical, interface, and usability issues
 - Advocacy Workshop
- Make revisions

Data and Methods used to Estimate Chance of Dying from Cancer

- Diagnosis years 1990-2001 included with follow-up through Dec. 2002
- SEER 13 Registries – (LA starts in 1992)
- Period Method with 3 diagnosis year chunks to get up to date estimates
- Chance of surviving up to 10 years post diagnosis
 - Conditional results also available (e.g. given you are alive 2 years post dx, what is your chance of surviving 5 more years)

10-Year All Cause Survival

All Sites Combined, both Sexes

Interval (i.e. conditional) survival probabilities by year of follow-up (t) and year of diagnosis (y)

Cohort

Multiple - Cohort

Period with 3 year chunks

Year of Diagnosis

Year of Follow-Up

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
1-year	73.1%	74.6%	75.1%	74.6%	74.5%	74.6%	75.0%	75.7%	75.9%	76.6%	76.9%	77.4%
2-year	85.7%	86.3%	87.2%	87.4%	87.2%	87.5%	88.1%	88.2%	88.5%	88.7%	88.9%	
3-year	90.3%	90.6%	91.2%	91.2%	91.5%	91.7%	91.9%	92.0%	92.2%	92.3%		
4-year	92.1%	92.4%	92.7%	92.8%	92.8%	93.1%	93.3%	93.4%	93.5%			
5-year	93.2%	93.1%	93.3%	93.5%	93.8%	94.0%	94.0%	94.0%				
6-year	93.4%	93.5%	93.8%	94.1%	94.1%	94.3%	94.4%					
7-year	93.5%	93.8%	93.8%	94.0%	94.3%	94.5%						
8-year	93.9%	93.8%	94.0%	94.2%	94.5%							
9-year	94.0%	94.1%	94.3%	94.1%								
10-year	94.0%	94.1%	94.0%									

Period with one year chunk: 41.7%

37.9 %
39.3 %
41.0 %

Dimensions of Survival

	Net (Absence of other causes)	Crude (Presence of other causes)
Cause of death	Cause-specific survival	Crude probability of death using cause of death information
Expected survival	Relative survival	Crude probability of death using expected survival

Methods of Calculating Net Survival

- Relative Survival

Uses *expected survival* for a cohort from the US population matched to the cancer cohort to estimate the probability of surviving other causes until time t , $P(T_o > t)$

Assuming independence of T_o and T_c

$$P(T_c > t) = P(T_c > t \text{ and } T_o > t) / P(T_o > t)$$

This is estimated as:

(overall survival)/(expected survival)

Purposes of a Net Survival Measure

- Provide a cancer progress measure that is not affected by changes in other-causes mortality
- Compares the cancer experience of various populations in a way that removes the effect of other-causes mortality
- Measure of “biological cure” by identifying when the net survival curve levels off, i.e. an individual is no longer at risk of dying from the cancer

Crude Probability of Death (Presence of Other Causes)

Crude probability of death is a measure of the mortality patterns actually experienced in a cohort of cancer patients

$$P(\text{dying of cancer before time } t) = P(T_c < t \text{ and } T_c < T_o)$$

Why Crude Probability of Death Instead of Crude Survival?

At any point in time, t , the population can be classified into categories

Net Measures:

$$P(\text{died of cancer at or before } t) + P(\text{survived past time } t) = 1$$

Crude Measure:

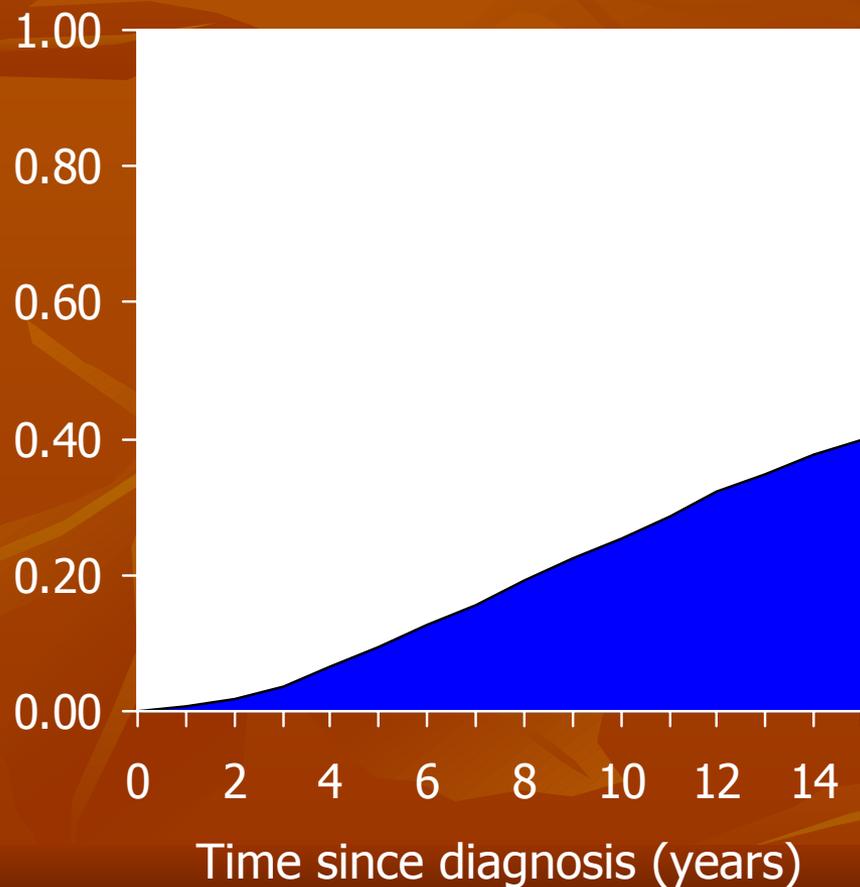
$$P(\text{died of cancer at or before } t) + \\ P(\text{died of other causes at or before time } t) + \\ P(\text{survived past time } t) = 1$$

Purposes of a Crude Mortality Measure

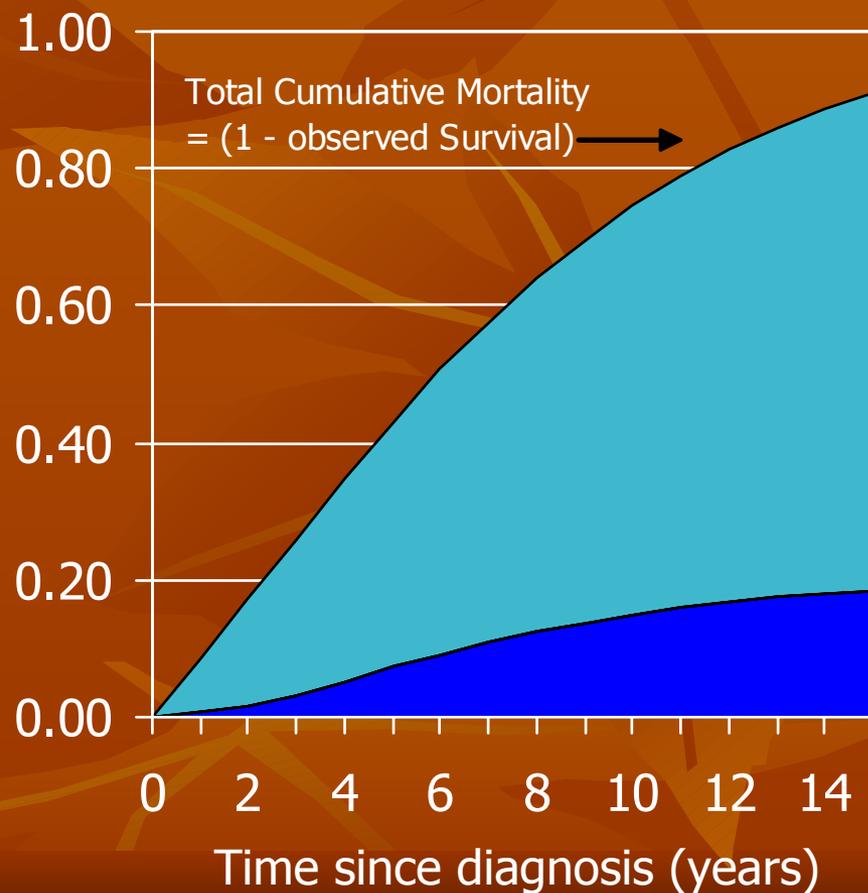
- Represent mortality patterns actually experienced by a cohort of cancer patients
- Investigate the probability of actually dying from cancer (personal cure)
- Evaluate treatment alternatives taking into account personal co-morbidities

Cumulative Probability of Death in Men Age 70+ Diagnosed with Localized Prostate Cancer, 1973 - 1994

■ (1 - relative survival)



■ Crude probability of death, other
■ Crude probability of death, cancer



Components of the System

- Death from cancer -- in the absence of other cause mortality
- Death from causes other than the cancer -- in the absence of death from cancer
- Combined using methods in Cronin and Feuer (Stat. in Med., 2000) under an assumption of conditional independence
 - The chance of living with or dying from cancer and other causes are independent conditional on the selected strata
 - e.g. the chance of dying of lung cancer and other causes are not independent, but they are approx. independent if we condition on smoking history

Comorbidity

- Level of comorbidity assessed in system by asking if patient was hospitalized and/or seen as outpatient for 16 conditions prior to the diagnosis of cancer
- Modified Charlson Comorbidity Index derived from SEER-Medicare linked data to ensure index reflects relative importance of conditions affecting other cause mortality for cancer patients
 - Utilizes claims files for cancer patients during the year before diagnosis
 - Based on ideas from earlier work of Klabunde
- Derived index used to classify 5% sample of non-cancer patients as healthy/moderately healthy/poor health based on one year of claims
- Other cause mortality lifetables derived by age, race, sex, comorbidity status using 5% sample for those age 66+
- General US lifetables by age, race, sex used for those under age 66

Chance of Dying of Other Causes

- Ages <66

- Based on general population life tables, conditioned on:
 - Age
 - Race (Black, White, Other)
 - Sex

- Ages 66+

- Based on level of comorbidity (Healthy, Moderately Healthy, Poor Health) life tables, conditioned on:
 - Age (single years, up to age 90 at diagnosis)
 - Race (Black, White, Other)
 - Sex

System Inputs

- AJCC Stage, 6th ed. – including substages (e.g. IIIa)
- Sex
- Age (<75, 75 and over) – cancer mortality
- Patient age – other cause mortality
- Race (Black, White, Other)
- Subsite of colon (Proximal, Distal, Rectal)

Order for Collapsing Strata Due to Small Numbers

- Sex
- Age
- Age and sex
- Subsite (proximal and distal only)
- Subsite and sex
- **Collapse if:**
 - **Number in any 3 diagnosis year cohorts is <100 at baseline**
 - **Standard error of the cumulative probability of death from cancer at 10 years is >0.05**
 - **95% confidence interval is approx. \pm 10 percentage points**
- **Never collapse on stage**

Defining Health Status

Cancer Survival Query System For Clinicians

Prototype Version 1.0-Alpha

Colorectal Cancer

Selecting Health Status

Prior to cancer diagnosis, was patient diagnosed with or treated for any of the following conditions:

Outpatient = Diagnosed or treated as an outpatient in a hospital or physician's office

Inpatient = Diagnosed or treated as an inpatient in a hospital

- | | | | | |
|-------------------------------------|-----------|-------------------------------------|------------|--|
| <input checked="" type="checkbox"/> | Inpatient | <input type="checkbox"/> | Outpatient | Chronic Obstructive Pulmonary Disease |
| <input type="checkbox"/> | Inpatient | <input type="checkbox"/> | Outpatient | Renal Disease (includes chronic glomerulonephritis, nephritis, nephropathy, |
| <input type="checkbox"/> | Inpatient | <input type="checkbox"/> | Outpatient | Rheumatologic Disease (includes lupus erythematosus, systemic sclerosis, |
| <input type="checkbox"/> | Inpatient | <input type="checkbox"/> | Outpatient | Ulcer Disease (gastric, duodenal, peptic, and gastrojejunal ulcers) |
| <input type="checkbox"/> | Inpatient | <input type="checkbox"/> | Outpatient | Mild Liver Disease (cirrhosis with or without mention of alcohol, biliary cirrh |
| <input type="checkbox"/> | Inpatient | <input type="checkbox"/> | Outpatient | Moderate-severe Liver Disease (hepatic coma, portal hypertension, other se |
| <input type="checkbox"/> | Inpatient | <input checked="" type="checkbox"/> | Outpatient | Diabetes |
| <input type="checkbox"/> | Inpatient | <input type="checkbox"/> | Outpatient | Diabetes With Sequelae (renal, ophthalmic, or neurological manifestations) |

Selected Health Status

Poor Health

OK

Cancel

Help

Summary of Selected Profile

Cancer Survival Query System For Clinicians

Prototype Version 1.0 - Not for release - intended for test and demonstration purposes only.

Colorectal Cancer

Selected Profile:

Cancer Characteristics:

Sub-site=Proximal (Cecum, Ascending Colon, Hepatic Flexure, Transverse Colon, Splenic Flexure)

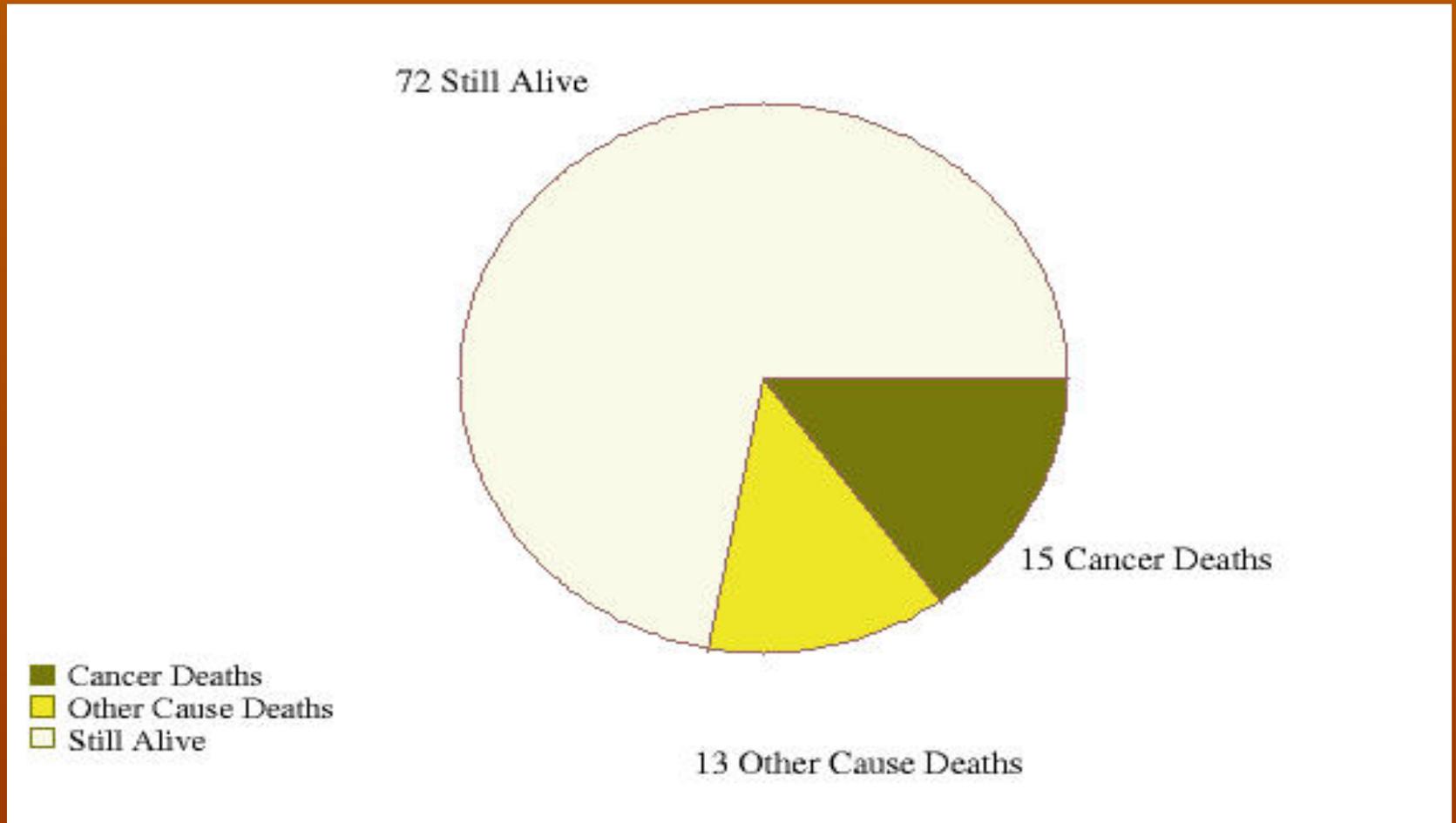
AJCC Stage (6th edition)=Stage IIIB, Race=White, Sex=Male

Age Group at Diagnosis=75 and Over, Conditioned On Being Alive=At Diagnosis

Characteristics Used to Determine Death from Causes Other than Cancer:

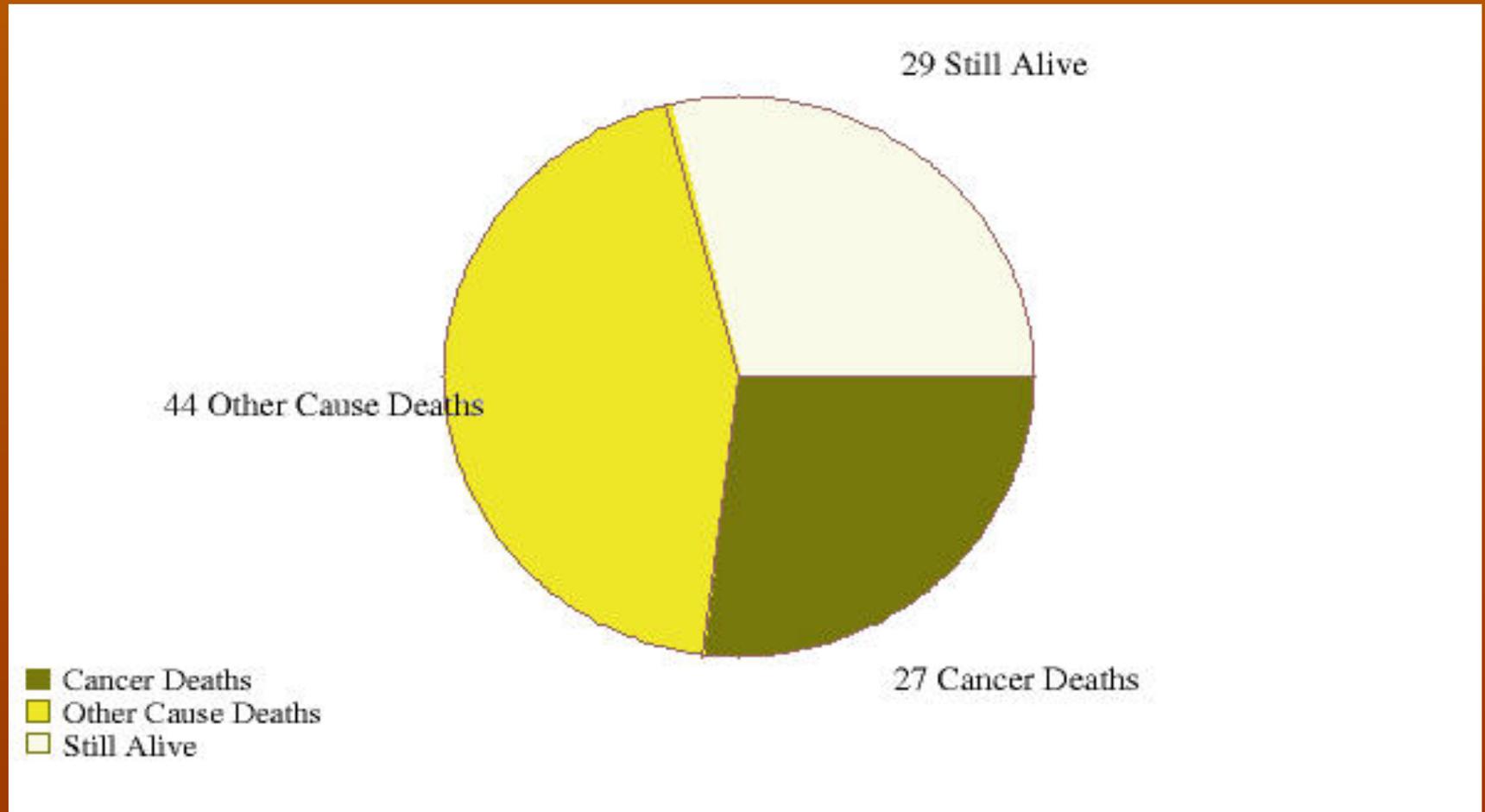
Race=White, Sex=Male, Age at Diagnosis=75 years old, Health Status=Poor Health

Results of 100 people with similar cancer, demographic, and general health characteristics as the selected profile, by 1 year from diagnosis:



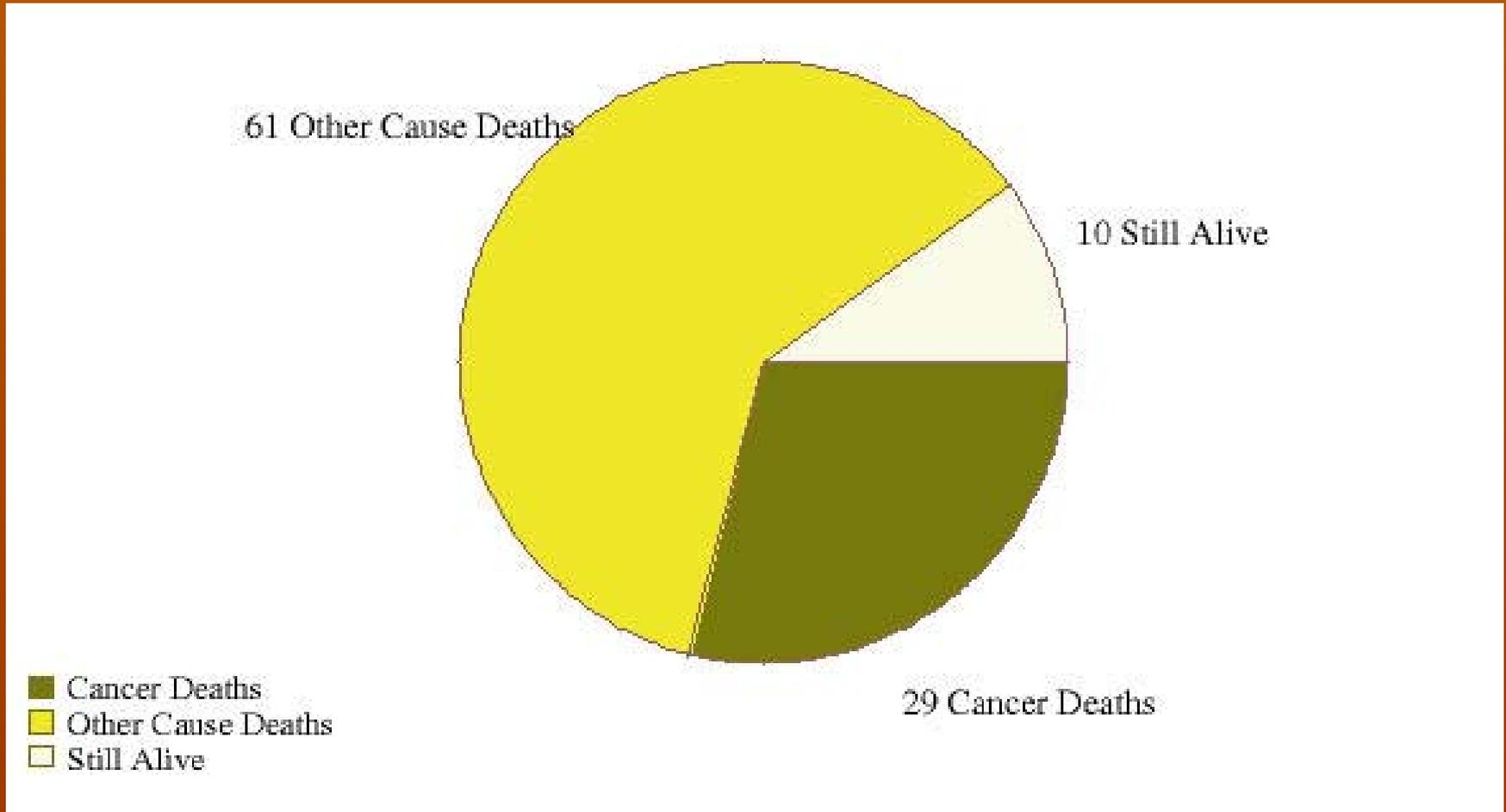
These results represent averages within each profile. Actual results for any specific individual could vary based on other factors not characterized and random variability.

Results of 100 people with similar cancer, demographic, and general health characteristics as the selected profile, by 5 years from diagnosis:



These results represent averages within each profile. Actual results for any specific individual could vary based on other factors not characterized and random variability.

Results of 100 people with similar cancer, demographic, and general health characteristics as the selected profile, by 10 years from diagnosis:



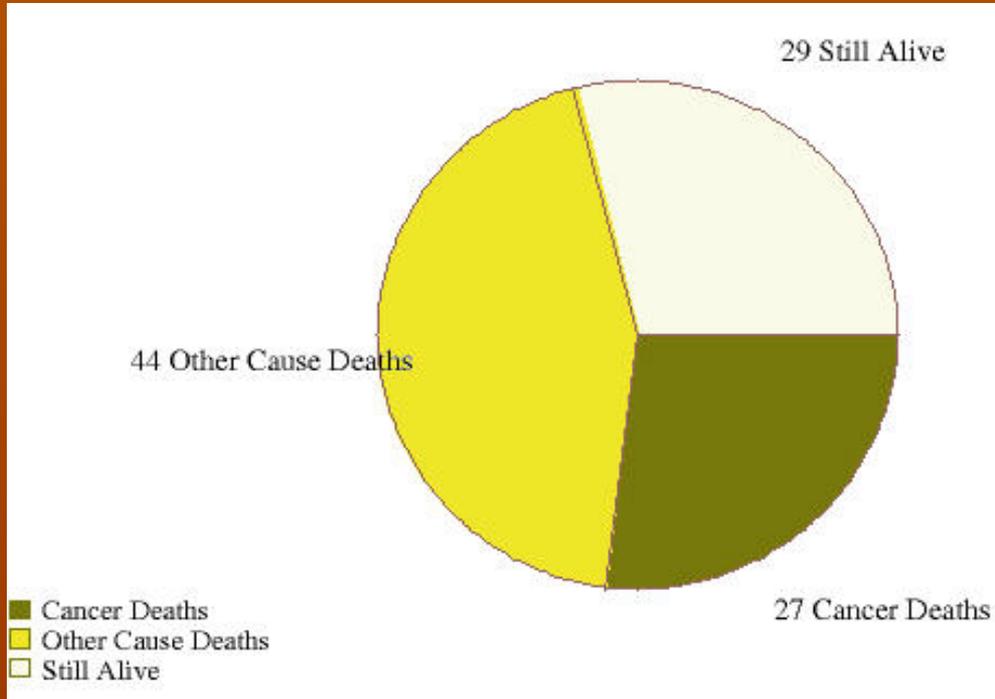
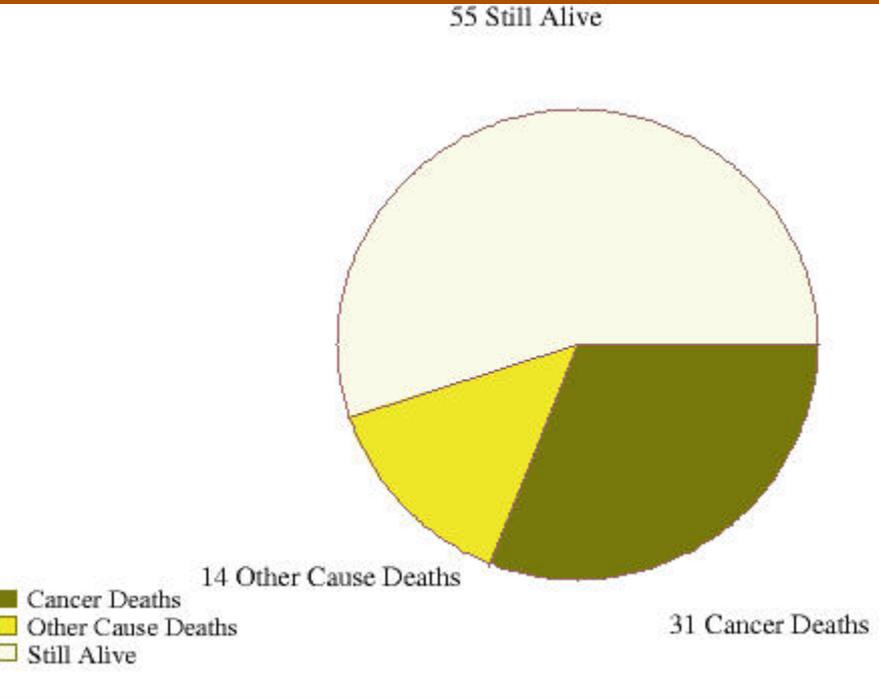
These results represent averages within each profile. Actual results for any specific individual could vary based on other factors not characterized and random variability.

Results of 100 people with similar cancer, demographic, and general health characteristics as the selected profile, by 5 year from diagnosis:

Comparison by Health Status

Good Health

Poor Health



These results represent averages within each profile. Actual results for any specific individual could vary based on other factors not characterized and random variability.

Ideas to Explore - Technical

- Model cancer survival rather than using strata
- Use cause-specific (instead of relative) approach to estimate net probability of death from cancer
- Continuous comorbidity rather than three categories
- Include comorbidity in the chance of dying of cancer
- Develop comorbidity weights for specific cancers rather than all cancer combined
- Develop alternative to Charlson Score using self-reported health status and/or activities of daily living from national surveys
 - Develop lifetables based on mortality follow-up in NHIS and CPS (i.e. NLMS)
 - May not be as objective, but nationally representative, and available for all ages
 - Not available for cancer patients (except in relatively small NLMS-SEER link)

Ideas to Explore - Usability

- What is the best way to describe the results
- Would clinicians feel comfortable showing this to patients?
- Should access to non-clinicians be limited?
- In what context would this system be used – e.g. cancer center, internist, nurse
- How do physicians/patients react to the fact that this information may not be perfectly matched to their situation
 - Profiles are averages and could leave out relevant information necessary to describe their exact situation
- Develop clinical expert panel for advice