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JOHNS HOPKINS  
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## *Measures of Prognosis*

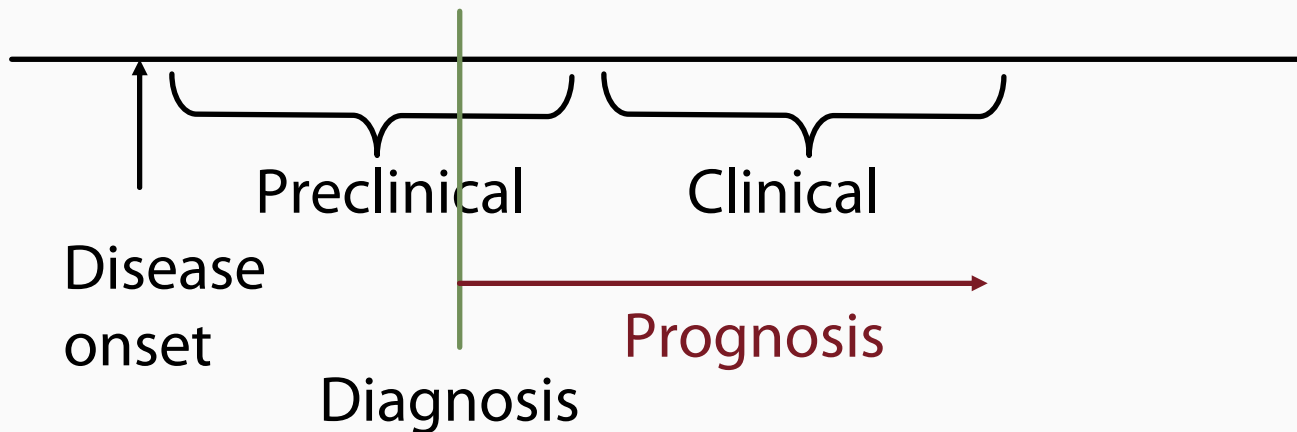
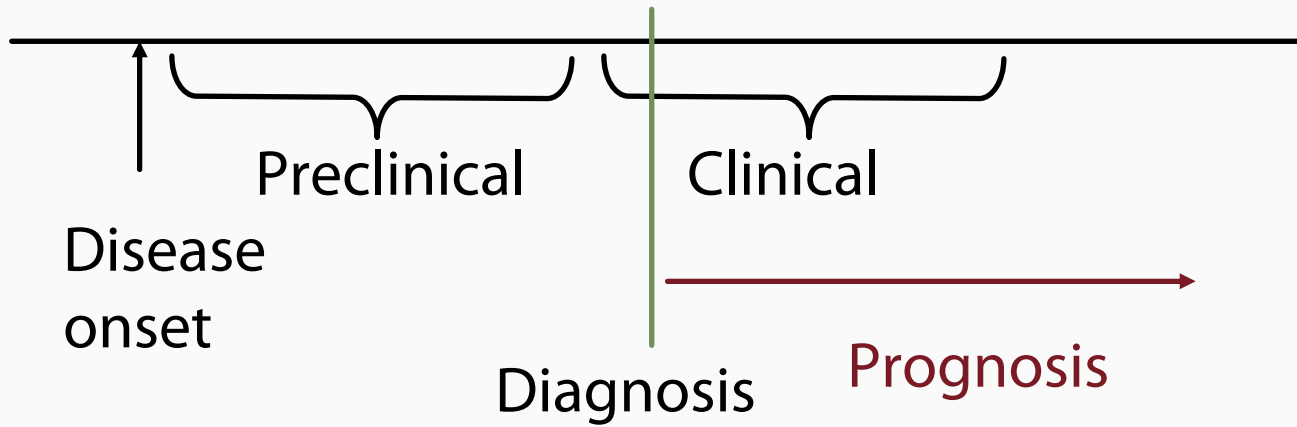
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# Quantifying the Prognosis

- A person who was just diagnosed with a disease would be interested in the prognosis of the disease
- **Prognosis** is predicting the progress or outcome of the disease
- Any measures used to quantify prognosis must then be case-based
  - That is, the denominator is the number of people with the specified disease

# Natural History of Disease



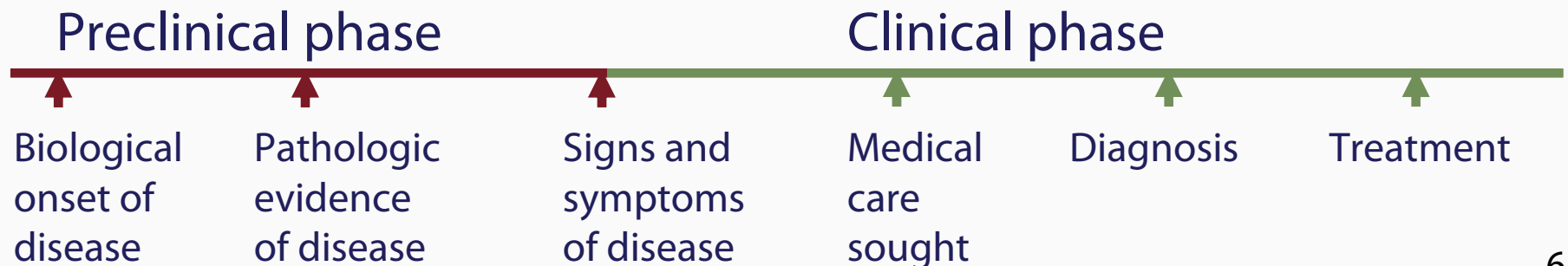
# *Identifying the Onset of Disease*

- Infectious diseases
  - Exposure (bite, infection, etc.)
  - Biological culture
  - Presence of antibody responses, viral DNA and RNA

# Identifying the Onset of Disease

## ■ Cancer

- Initial damage from radiation or chemicals
- First cancer cell division
- Lost of cell replication
- Screening for pathologic changes during preclinical phase
- First evidence of signs and symptoms
- Medical diagnosis of disease



# *Identifying the Endpoints of Disease*

- Death
- Cure
- Remission
  - A decrease in, or disappearance of, signs and symptoms of disease
- Recurrences
  - A return of disease

# *Expressing Prognosis*

- Case-fatality (rate) or CFR
- Five-year survival
- Observed survival rate
- Median survival time
- Relative survival rate



# Expressing Prognosis: Case-Fatality Rate (CFR)

## ■ **Case-fatality (rate) =**

$$\frac{\text{number of people who die of a disease}}{\text{number of people who have the disease}}$$

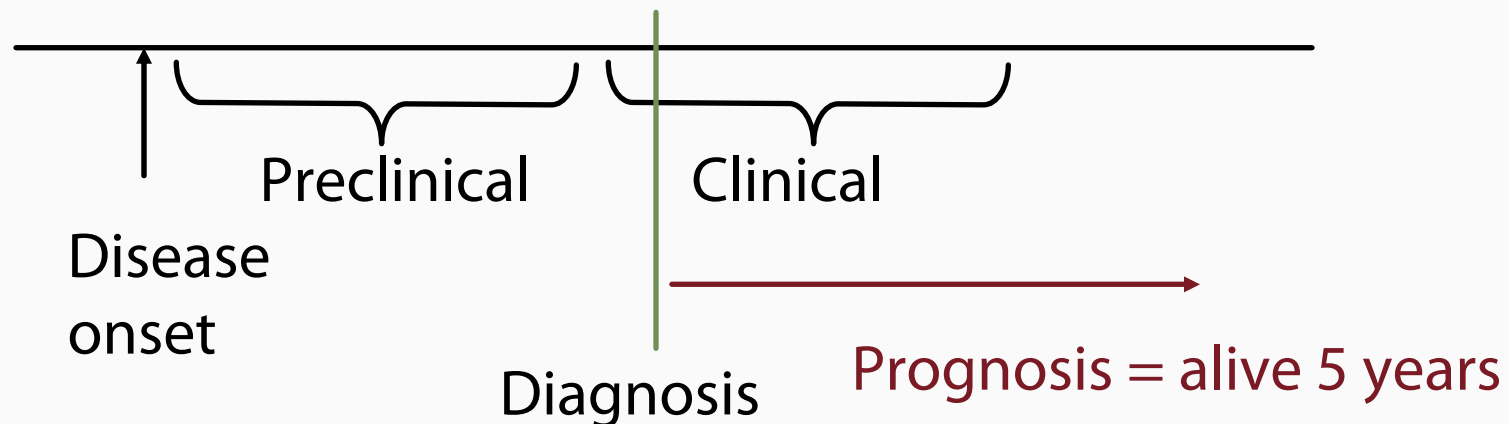
## ■ Example

- 200 people with the disease
- 20 deaths from the disease
- $\text{CFR} = \frac{20 \times 100}{200}$
- 10%

# Expressing Prognosis: Five-Year Survival

- **Five-year survival** is the proportion of patients who are alive five years after diagnosis

$$\frac{\text{number of persons with the specified disease surviving 5 years}}{\text{total number of persons with the specified disease}}$$



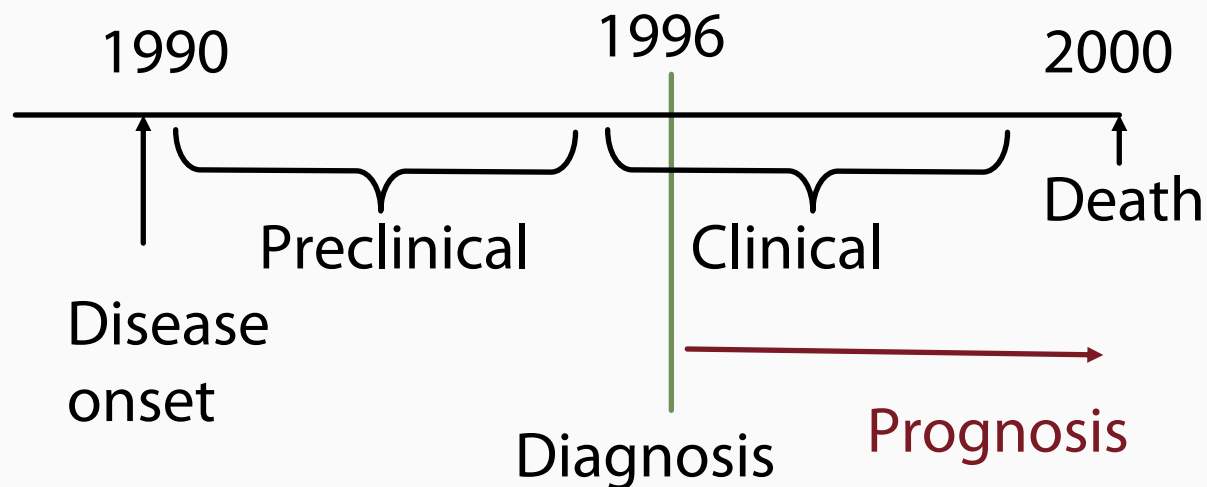
## *Example: Five-Year Survival*

- The five-year survival rate for women with localized (stage I) breast cancer
  - 1940s: 78%
  - Now: 97%

## *Interpreting Five-Year Survival*

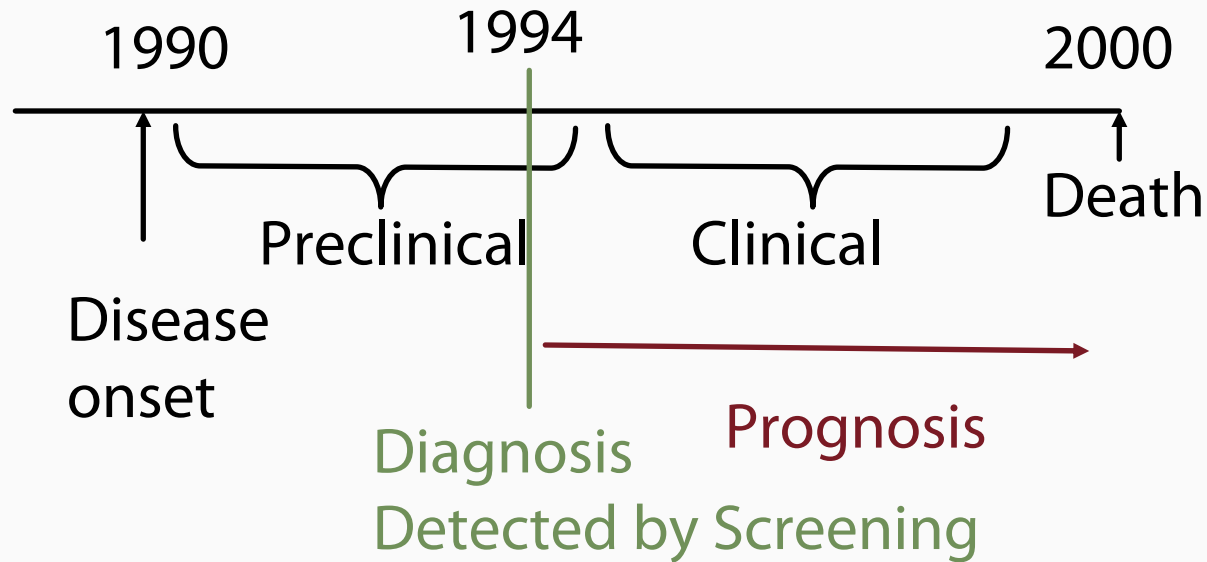
- Increased five-year survival for cancer patients over time is generally inferred to mean that cancer treatment has improved and that fewer patients die of cancer
- Increased five-year survival, however, may also reflect diagnosing early-stage cancer and/or finding people who would never have become symptomatic from their cancer

# Surviving Five Years?



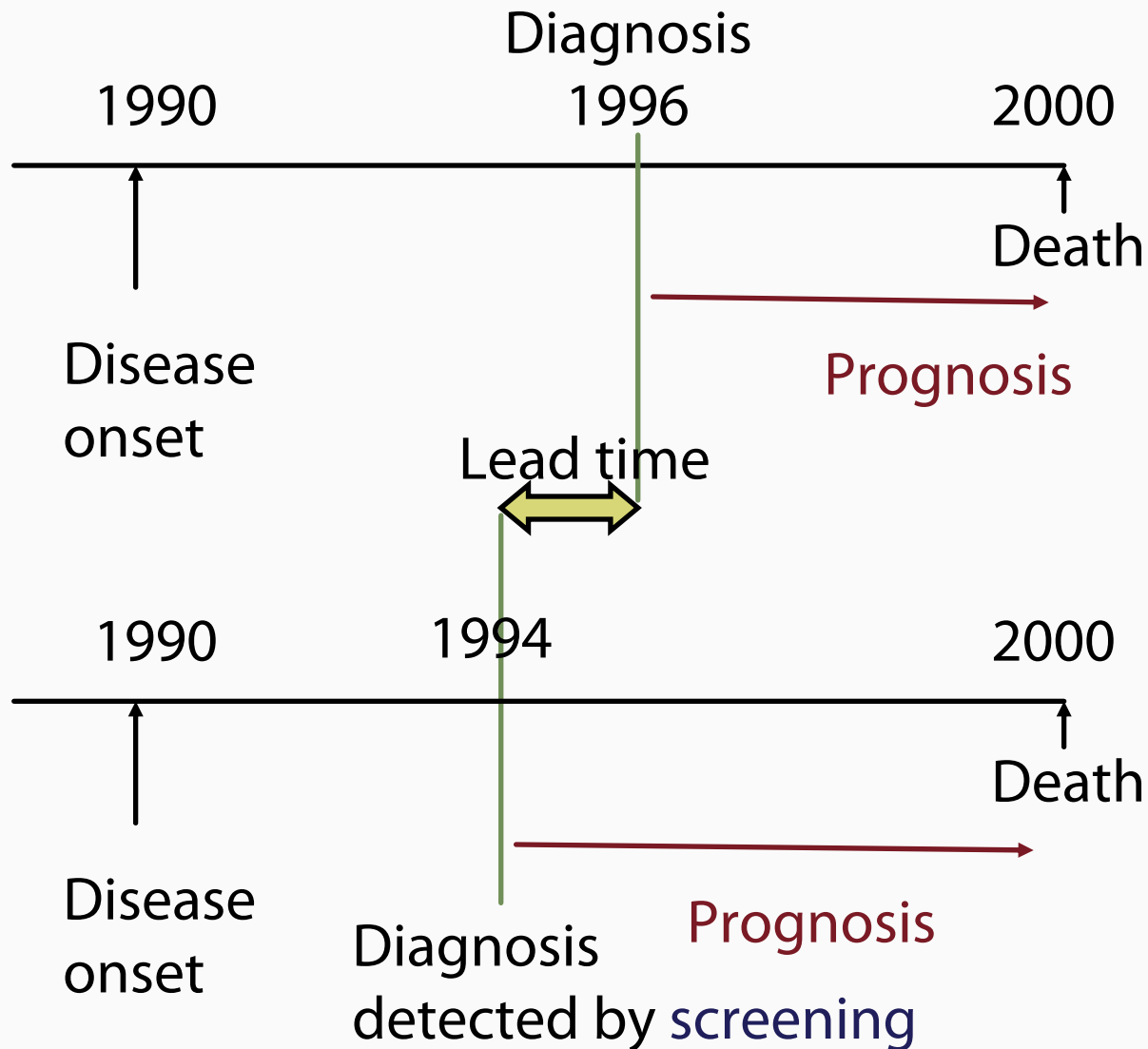
- Did this patient survive five years?

# Five-Year Survival in Screened Population



- Did this patient survive five years?

# Problem of Five-Year Survival in Screened Population



**If early detection is ineffective in preventing death,**

# Lead Time

- **Lead time** is the time between the early detection of disease (e.g., by screening) and the time of its usual clinical diagnosis
- **Lead time bias** occurs because of the failure to account for the lead time when calculating survival
- Some cancer screening programs were thought to improve survival until lead time bias was addressed



# Issues of Five-Year Survival

- The measure requires five years of follow-up to know that a person survives five years
- Survival may reflect changes in diagnosis or treatment over time
  - The measure is better used in an epidemiologic study, such as a clinical trial (when prognosis of subjects with different treatments are compared in similar time period over time) rather than an evaluation of a cancer prognosis over time (without comparison)

# Survival Proportion and Survival Rate

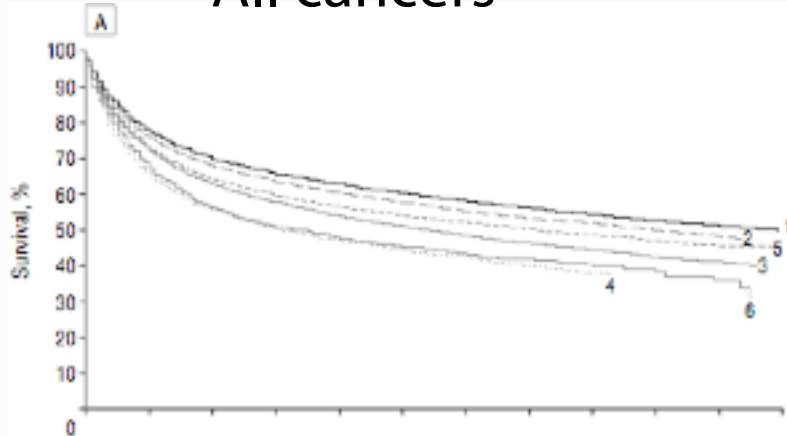
- Example: a study of 10 patients
  - 4 died at the end of the five-year study period
- Case fatality (rate) is  $4/10=40\%$
- Survival proportion is  $6/10=60\%$
- This value does not consider the varying length of time that each patient was followed (alive)
- **Survival (rate)** accounts for the varying length of follow-up
  - It is really a proportion, but it is often called a rate

## *Expressing Prognosis: Observed Survival Rate*

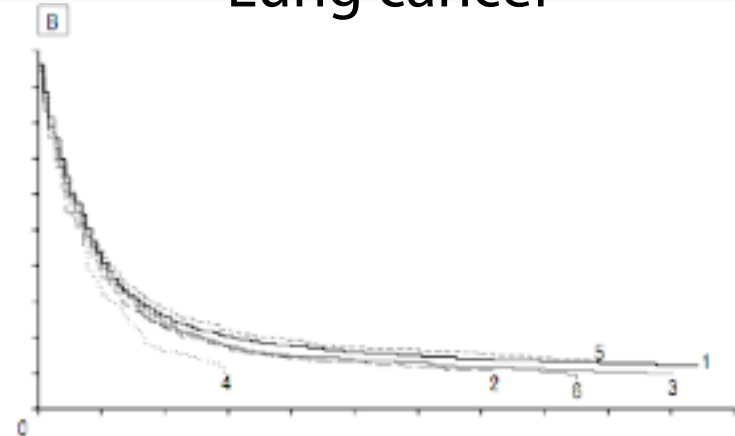
- The **observed survival (rate)** is an estimate of the probability of surviving
- (Cumulative) probability of surviving can be calculated using the technique of life table or Kaplan-Meier
- Survival curve plots percent survival (cumulative probability of survival) by time (time since the beginning of study)

# Male Survival by Race or Ethnicity, SEER (1988–1997)

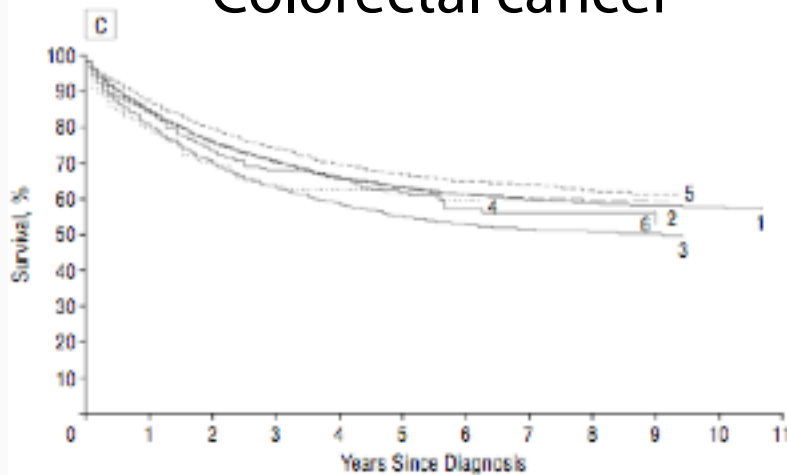
## All cancers



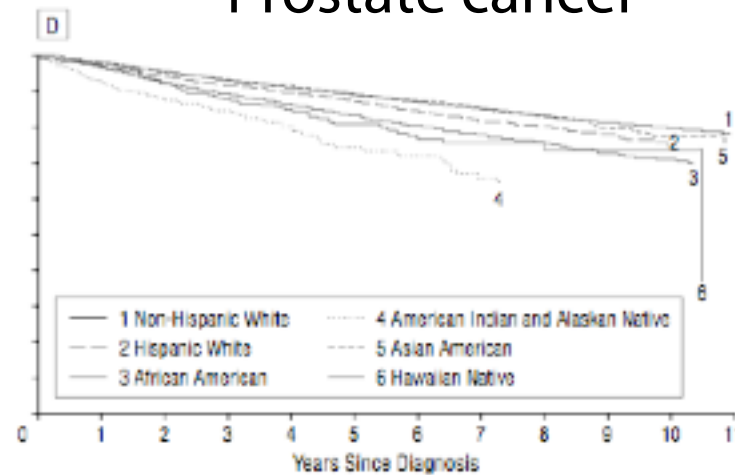
## Lung cancer



## Colorectal cancer



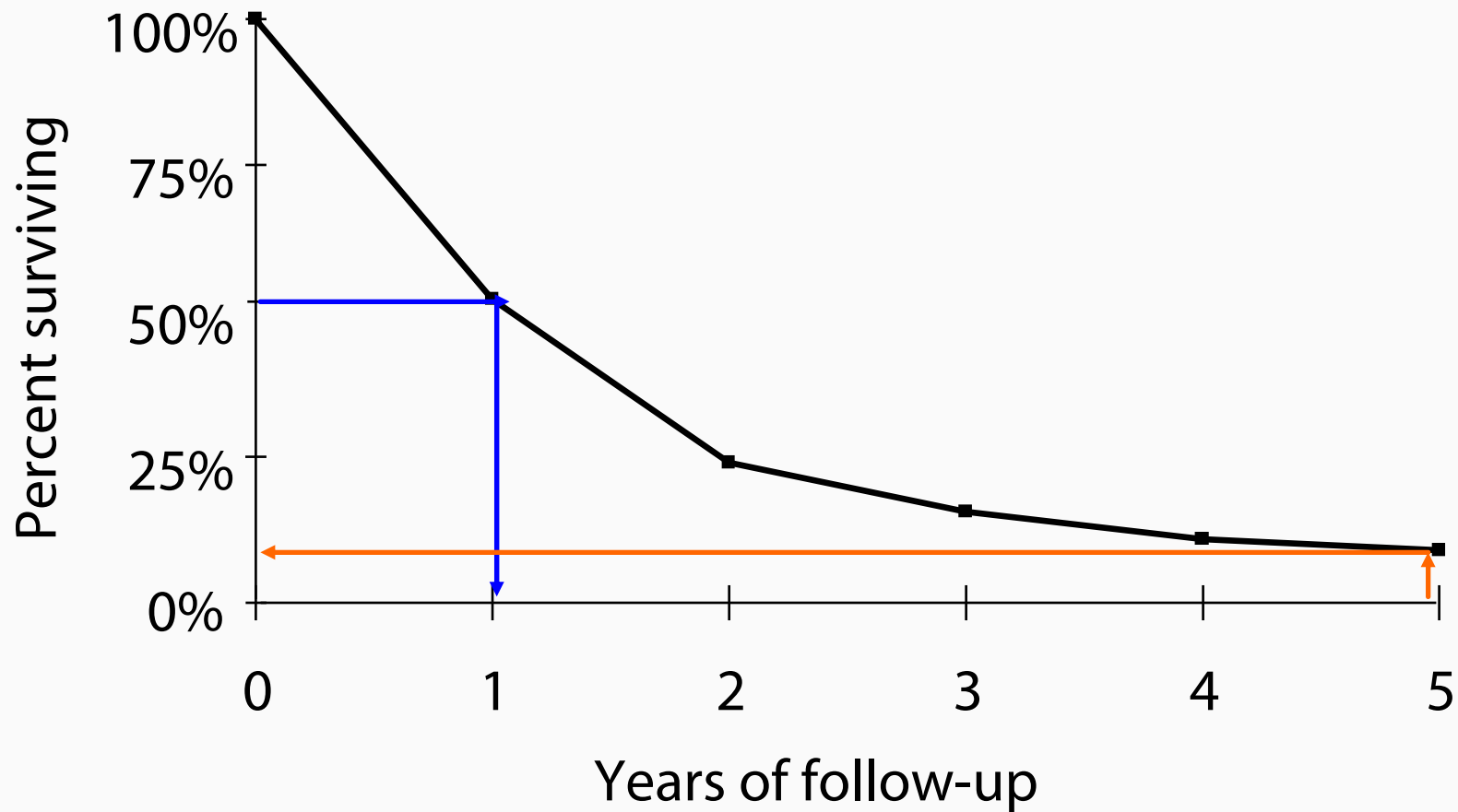
## Prostate cancer



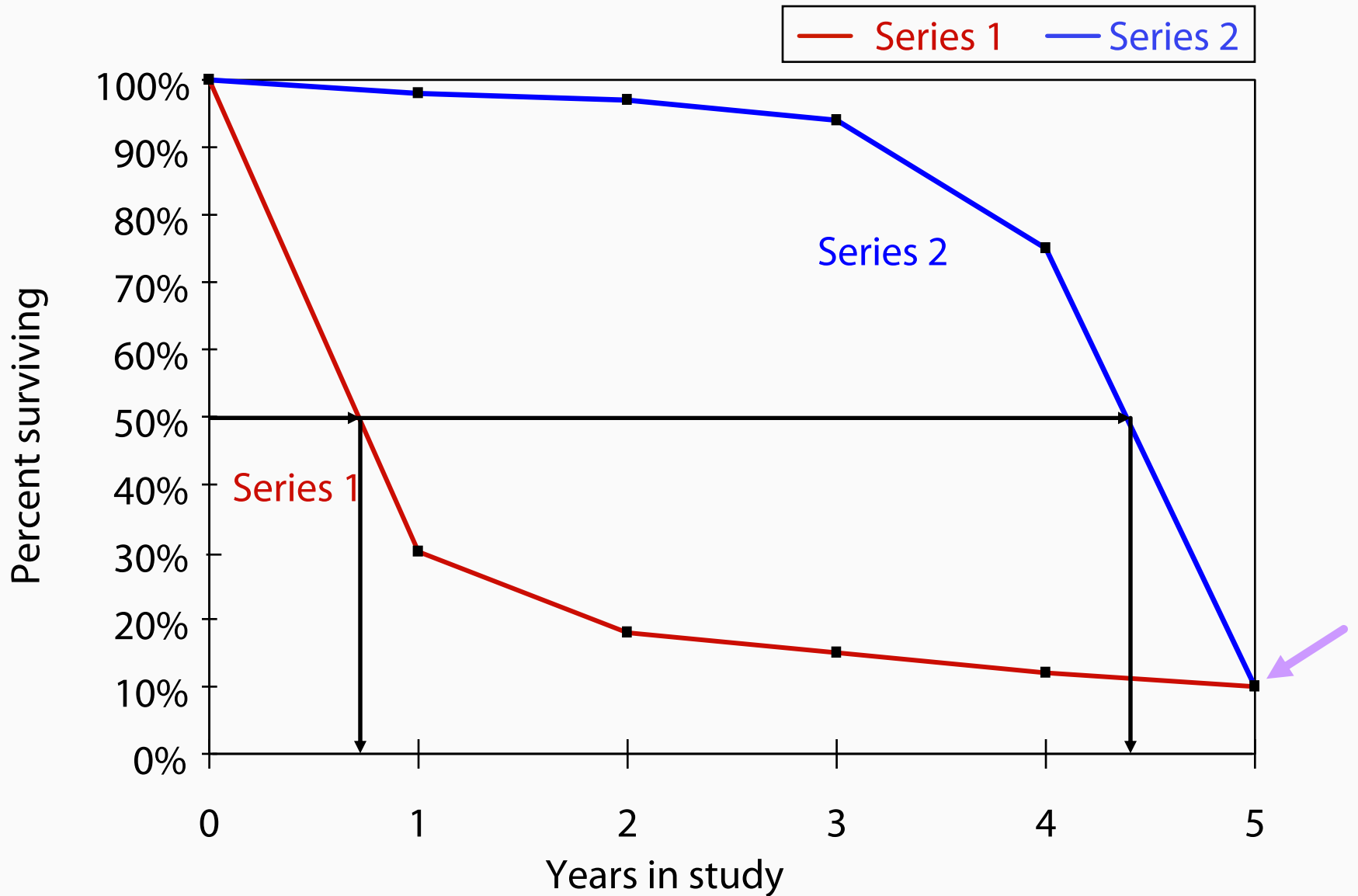
## *Expressing Prognosis: Median Survival Time*

- **Median survival time** is the length of time that half of the study population survives

# Median Survival Time



# Comparison of Two Survival Curves



## *Issues with Observed Survival*

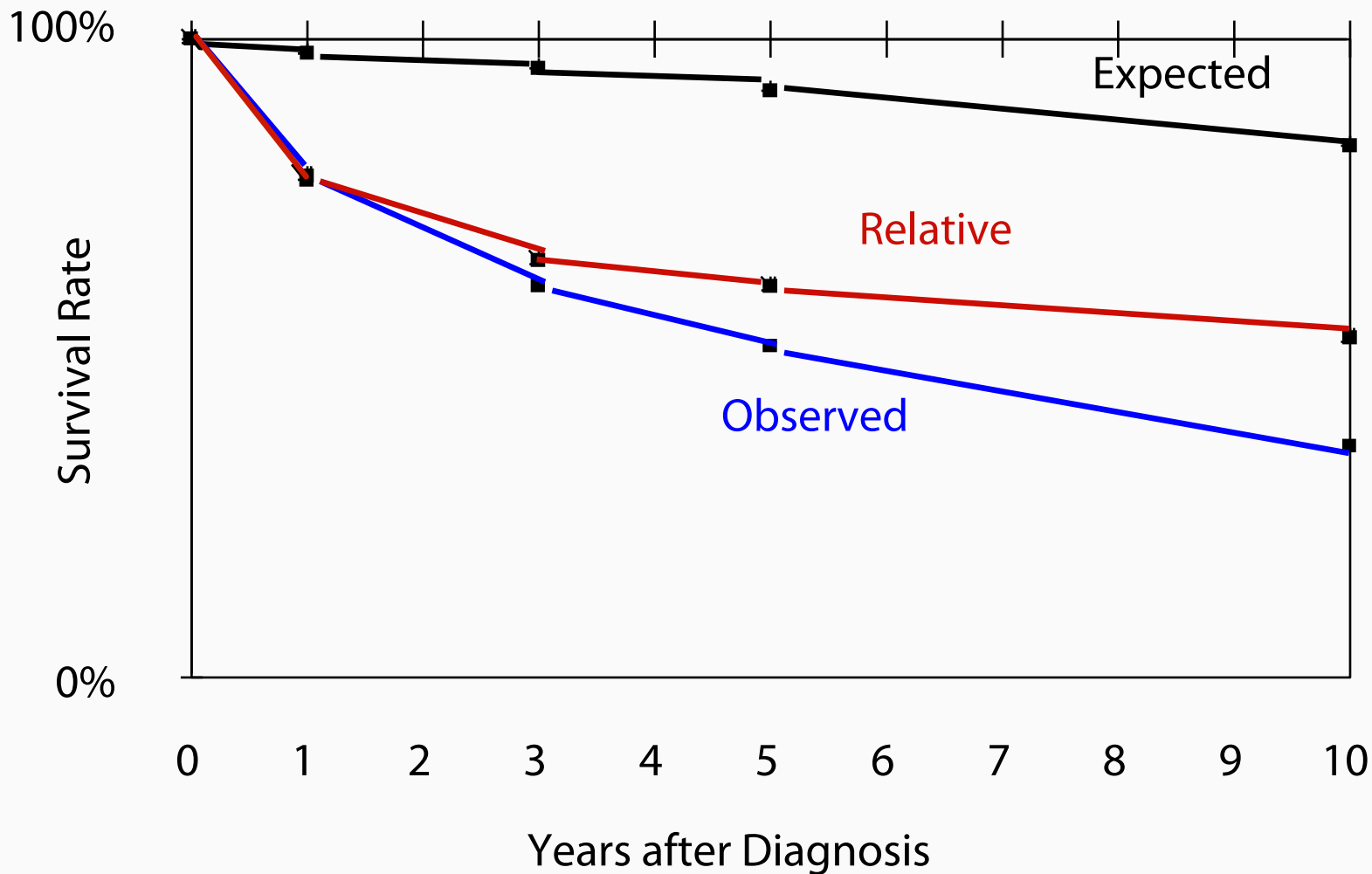
- Deaths from diseases other than the disease of interest are not excluded from the calculation of observed survival
- As the result, observed survival value will be underestimated (lower)
- Need to adjust the observed survival by removing the effect of other causes



# Expressing Prognosis: Relative Survival Rate

- **Relative survival rate** is the **ratio** of the observed survival (rate) to the expected survival (rate)
- It compares survival in the study group (e.g., cancer) to the survival of a comparable group without the disease of interest
- It removes from the observed survival the effect of deaths from all other causes
- Comparison group could be persons in the general population similar to the patient group with respect to age, sex, race, and calendar year of observation, and free of disease of interest, such as free of cancer
- Its value can be above 100%
  - Suggesting that observed survival is better than the survival expected from the general population

# Observed vs. Relative Survival Rates: Cancer, All Sites



# Survival Rates by Age for Patients with Colon Cancer

- SEER 1981–1987

Age at Diagnosis	Five-Year Survival Rate	
	Observed	Relative
45–54	57.1	59.2
55–64	53.6	58.5
65–74	47.8	57.8
75+	31.7	54.1

- List measures of prognosis
- What is the problem with the use of observed survival?
- Are the following measures a rate, a ratio, or a proportion?
  - Case fatality
  - Five-year survival
  - Observed survival
  - Relative survival