Applied Survival Analysis Using R
Chapter 1: Introduction

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Def

Survival Analysis

Survival analysis is the study of survival times and of the factors that influence them.

Characteristics

Characteristics:

- The response variable is a non-negative discrete or continuous random variable, and represents the time for a well-defined origin to a well-defined event.
- A second characteristics of survival analysis, censoring, arise when the starting or ending events are not precisely observed

Censoring

Examples

1. *right censoring* is results when the final endpoint is only known to exceed a particular value.
2. left censoring is events are known to have occurred before a certain time.
3. interval censoring is failure time is only known to have occurred within a specified interval of time.

Censoring

Symbols

- T^*: the random variable representing the time to failure(exact event time)
- U: the random variable representing the time to a censoring event(censoring time)
- $T = \min(T^*, U)$: the *observed* event time
- $\delta = I(T^* < U)$: δ is 0 means T is a censored time, 1 means T is an observed failure time

Censoring

Types

1. Type I censoring is the censoring times are pre-specified.
2. Type II censoring occurs the experimental objects are followed until a pre-specified fraction have failed(rare in biomedical studies)
3. *Random censoring* is when each subject has a censoring time that is statistically independent of their failure time. The observed value is the minimum of the censoring and failure times; subjects whose failure time is greater than their censoring time are right-censored.

Random Censoring

Cause

- In biomedical settings, one cause of random censoring is patient drop out
  - If the dropout occurs truly at random, and is unrelated to the disease process, such censoring may not cause any problems with bias in the analysis.
  - If patients who are near death are more likely to drop out than other patients, serious biases may arise.
- Another cause of random censoring is competing events, when a patient dies of another cause first, then that patient will be censored(Chapter 9)
- The cause of the censoring is essential in order to avoid biased survival estimates.

Clinical Trials

- The most common source of random censoring is *administrative censoring*, which results because some patients in a clinical trial have not yet died at the time the analysis is carried out
- For these patients, the survival times are only partially observed, we know that these patients survived until the end of follow-up, such times are said to be right-censored

Clinical Trials

Table 1.1 Survival data

Patient	Survtime	Status
1	7	0
2	6	1
3	6	0
4	5	0
5	2	1
6	4	1

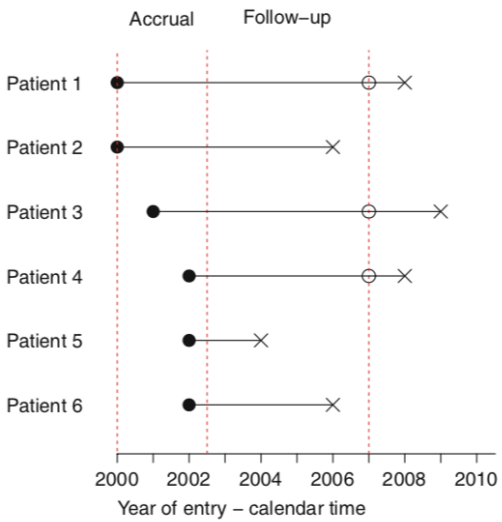

Fig. 1.1 Clinical trial accrual and follow-up periods. The *vertical dashed lines* indicate the trial start, end of accrual, and end of follow-up. The X's denote deaths and the *open circles* denote censoring events

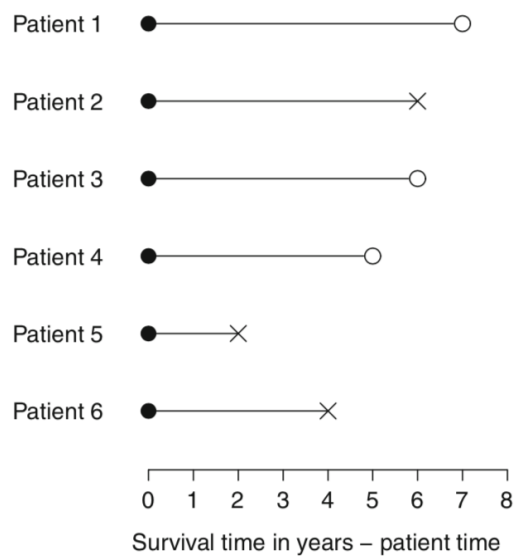

Fig. 1.2 Clinical trial survival data, patient time

Goal

The goals of survival analysis are to estimate the survival distribution, to compare two or more survival distributions, or (more generally) to assess the effects of a number of factors on survival.