**STAT 417: Survival Analysis Methods**

**Reading and Homework Assignment 1: Due Monday 1-13-2025 (11:59pm)**

Read through page 14 of the Course Notes and Workbook.

1. Eight rats, labeled A through H, have been exposed to carcinogens by injecting tumor cells into their foot-pads. The rats should eventually develop tumors, become ill, and die. The times to develop a tumor of a given size are observed. The investigator decides to terminate the experiment after 1 year. Rats B, C, E, and H develop tumors after 10, 26, 35, and 50 weeks, respectively. Rats A and D are tumor-free by the end of the study. Rat F was removed from the study for unknown reasons after 13 weeks. Rat G died from unspecified causes without any tumors after 18 weeks of observation.

(a) Describe the time-to-event random variable.

T = Number of weeks until a tumor of a given size is observed on the rat

(b) Identify the rats (by letter) who had complete event times and provide their complete event times.

B (10 weeks)

C (26 weeks)

E (35 weeks)

H (50 weeks)

(c) Identify the rats who had censored event times, and provide their censored times. What type of censoring occurred? Be as specific as possible.

A (52+ weeks; informative right-censoring due to no tumor developing)

D (52+ weeks; informative right-censoring due to no tumor developing)

F (13+ weeks; noninformative right-censoring due to removal for unknown reasons)

G (18+ weeks; noninformative right-censoring due to death with unknown cause)

For the studies described in Problems (2)-(4):

* Describe the event of interest, beginning of time, time metric, and time-to-event random variable for this example.
* State which type(s) of censoring (i.e. left, right, or interval) may be present in each study, and briefly explain your answers.

2. Survival/sacrifice experiments are designed to determine whether a suspected agent accelerates the time until tumor onset in experimental animals. For such studies, each animal is assigned to a prespecified dose of a suspected carcinogen, and examined at sacrifice or death, for the presence or absence of a tumor. Suppose the protocol for a particular experiment is to sacrifice all subjects at 24 months. Since a lung tumor is occult (detectable only by microscopic examination or chemical analysis), the time until tumor onset is not directly observable. Instead, we observe only a time of sacrifice or death.

event of interest: Presence of lung tumor

beginning of time: Administration of suspected carcinogen

time metric: Months

time-to-event RV: T = Months until presence of lung tumor

censoring present:

right censoring - if the animal is removed before the end of the study and does not have a tumor

interval censoring - we cannot directly observe the tumor, therefore if a tumor is observed we can only say that it happened between the start of the study and when it was observed

3. In a double blind clinical trial to compare treatments for the inhibition of relapse after primary therapy has healed an ulcer, patients are randomized to receive one of two treatments. Regular visits to a clinic were arranged for the patients, and endoscopies were performed 6 months and 12 months after randomization. A positive endoscopy result indicates that an ulcer has recurred in the time since the last negative result.

event of interest: Recurrence of ulcer (positive endoscopy result)

beginning of time: When primary therapy has healed the ulcer

time metric: Months

time-to-event RV: T = Months until recurrence of ulcer

censoring present:

right censoring - if a subject is removed before the end of the study and does not have an ulcer

interval censoring - since we can only get results after the endoscopies performed at 8 and 12 months, we do not know the exact time the ulcer may have reappeared. Therefore, if an ulcer is observed we can only say that it between the star of the study and when it was observed

4. A study (Turnbull and Weiss, 1978) was conducted to determine the age at which marijuana was first used among high school boys in California. Researchers asked 191 high school boys the question: “When did you first use marijuana?” Possible answers were: exact age, “I never used it,” and “I have used it but cannot recall just when the first time was.”

event of interest: Age at first use of marijuana

beginning of time: Birth (Age = 0)

time metric: Years

time-to-event RV: T = Age at first use of marijuana

censoring present:

left censoring - If the subject has used marijuana, but is unsure of when the first time was

right censoring - If the subject has not yet used marijuana

5. **[Article].** Read pages 547 through 553 (up to the section Nonparametric estimation of the hazard function) of the article “What determines the survival of internet IPO’s?” (located in the Homework 1 folder on Canvas). Answer the following questions:

(a) Describe the event of interest discussed in the article. For this event, describe the beginning of time, time metric, and time-to-event random variable.

event of interest: Internet IPO gets delisted on the NASDAQ stock exchange due to negative results

beginning of time: Date of first trading on NASDAQ

time metric: Months

time-to-event RV: T = Months until internet IPO is delisted from the NASDAQ stock exchange for negative reasons

(b) Comment on whether censoring or truncation is present and if so, whether it is left or right censoring/truncation. Note that it is possible for different types of incomplete data to be present.

right censoring: If the IPO is still listed on the NASDAQ at the end of the study (March 21, 2005)

6. **[Article].** Read pages 1-2 of the article “Factors associated with the duration of hospitalisation among COVID-19 patients in Vietnam: A survival analysis” (located in the Homework 1 folder on Canvas). Answer the following questions:

(a) Describe the event of interest discussed in the article. For this event, describe the beginning of time, time metric, and time-to-event random variable.

event of interest: COVID 19 patient release from hospital

beginning of time: Date admitted to hospital for COVID 19

time metric: Days

time-to-event RV: T = Days until COVID 19 patient is released from hospital

(b) Comment on whether censoring or truncation is present and if so, whether it is left or right censoring/truncation.

right censoring: If a patient is still admitted to the hospital at the end of the study (April 8, 2020)

left truncation: Excluded patients admitted 2 weeks before April 8, 2020