

7.1 Censoring in follow-up studies

JH would use a different word for the so-called ‘censoring’ that removes a subject from pool of candidates for the transition of interest.

7.2 Competing causes

A good way to visualize how things play out over time is to use a table with rows for time intervals, and 3 columns (one can also show columns of cumulative totals for the transitions):

interval	no. candidates	transitions, type 1	transitions, type 2
interval	no. candidates	transitions, type 1	transitions, type 2
...
interval	no. candidates	transitions, type 1	transitions, type 2

The numbers of transitions of type i , when the transition rates are λ_1 and λ_2 , in an interval of length w ,¹ are:

$$\text{no. of candidates} \times (1 - \exp\{-\lambda_i \times w\})$$

If λ_i is a smooth function of age or time, then we replace the $\lambda_i \times w$ product by the integral $\int \lambda_i(t)dt$ over the interval.

The number of candidates for the next interval is the number for the previous one minus the sum of the numbers of transitions in that previous interval.

The number of candidates at the beginning of an interval can also be calculated as

$$\text{initial no. of candidates} \times \exp\{-\Sigma(\lambda_1 + \lambda_2) \times w\}$$

where the summation (or integral, if the λ 's are smooth functions of age or time) is over the time span already elapsed.

Supplementary Exercise 7.1. The BIOS602 website has, under the tab ‘Competing Risks’, data on age-specific breast cancer incidence and mortality, as well as all cause mortality.

1. Use these (and if you wish, the R code provided) to calculate the ‘lifetime’² risk of being diagnosed with breast cancer.
2. Compare your answers with those given by the Cancer Society (see refs. in R file).
3. Calculate the risk in the absence of competing causes of removal from the candidate pool.
4. Calculate how many more years of life, on average, women could expect to live if all deaths from breast cancer mortality could be averted. Carry the calculations out to age 105, using a sensible extrapolation of the breast cancer mortality curve.

Supplementary Exercise 7.2. The website also has, under the same tab, data on the 767 men reported on in Albertsen et al. 2005 article on prostate cancer mortality in men who had their prostate cancer managed conservatively. See also the statistical methods in the 1998 and 2005 articles.

1. Use Poisson regression to fit a model for the rate (incidence density, hazard) function governing all-Other-cause mortality – ie fit a smooth $\lambda_O(\text{age})$ function Hint: you will probably find that Gompertz’ law gives an acceptable fit.
2. Use Poisson regression to fit a separate model for the rate (incidence density, hazard) function governing prostate Ccancer mortality – ie fit a smooth-in-time $\lambda_C(\text{Gleason} - \text{category}, t)$ function where t is the number of years elapsed since the date of diagnosis.
3. Compute ‘3-ply’ curves, of the types contained in the articles, for a few selected combinations of age-at diagnosis, and Gleason score categories.

¹C&H use h for the duration of a ‘click.’

²Since the available breast cancer rates only go as far as age 92 or so, and are negligible before age 20, consider the lifespan from 22 to 92.