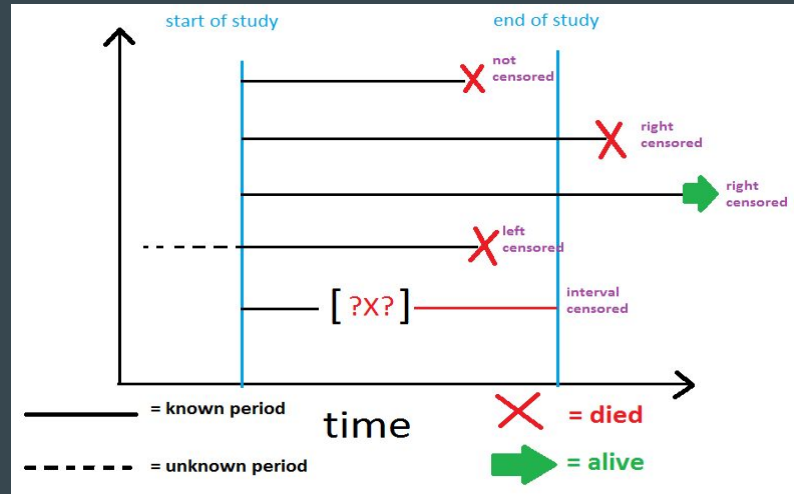# Survival Analysis

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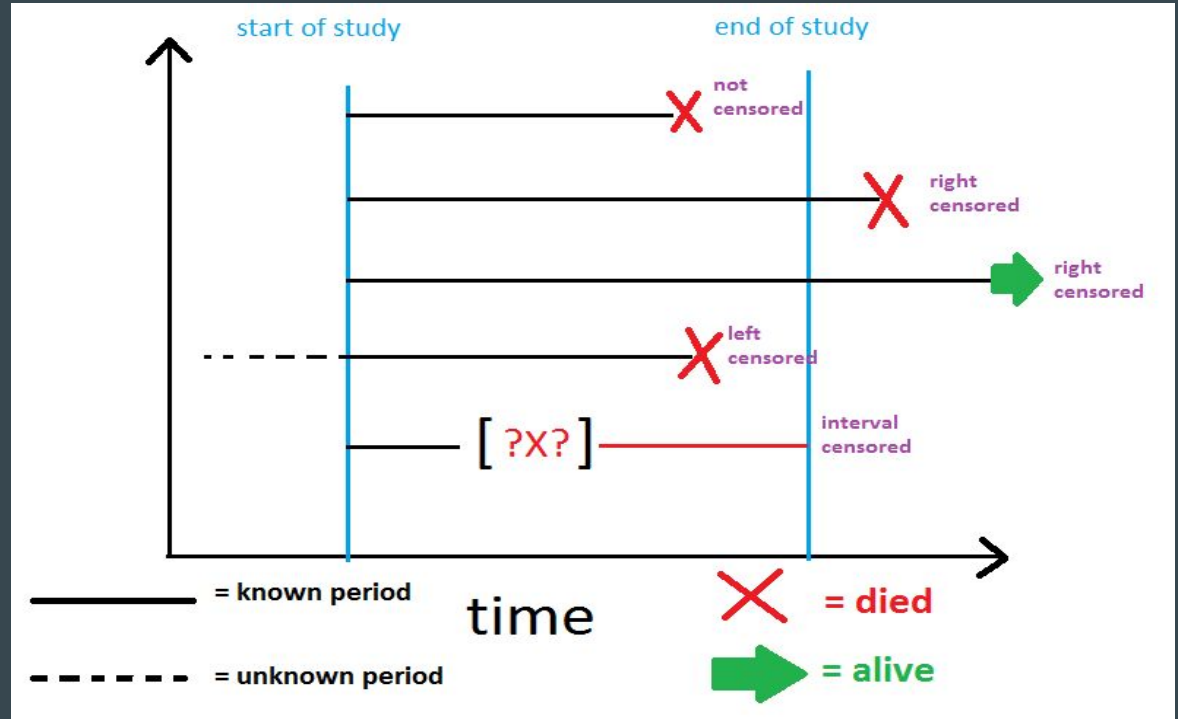Daoming Liu
Mentor: Nina Galanter

What is Survival Analysis?

- Survival Analysis is the statistical approach to analyze the time until an event of interest occurs.

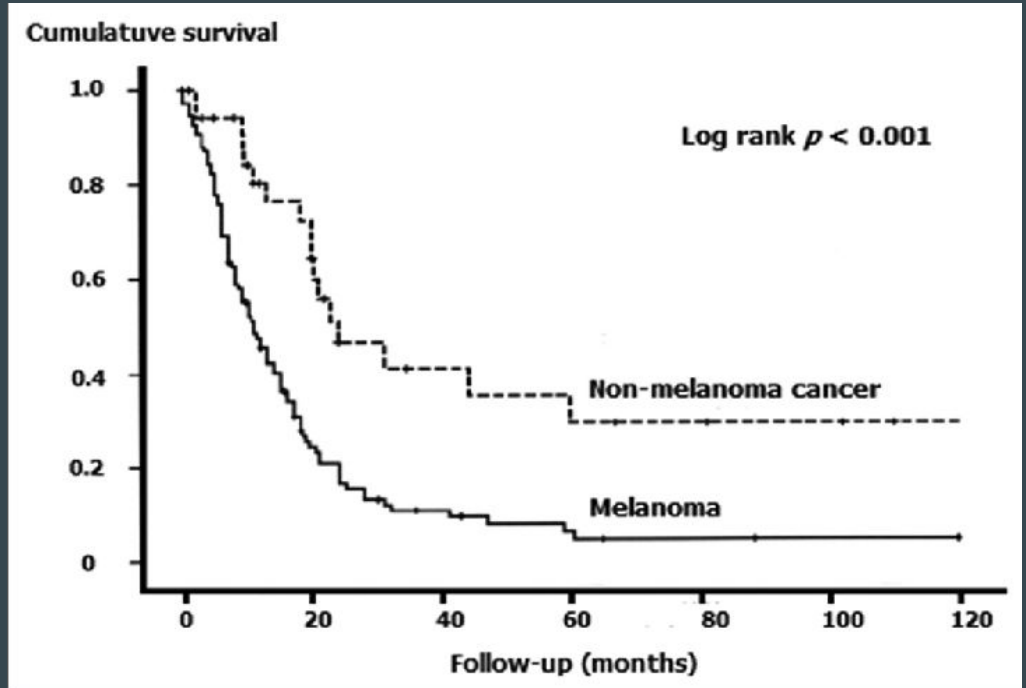- The event of interest is usually death, but it can be anything.

Terminologies:

- Survival time
- Failure
- Censoring

Terminologies:

- Survival function
  - The probability that a subject survive pass a specified time t.
- Kaplan-Meier Curve
- Log Rank Test

Cumulatuve survival

Log rank $p < 0.001$

Non-melanoma cancer

Melanoma

Follow-up (months)

Terminologies:

- Hazard function
  - The instantaneous potential per unit time for the event to occur, given that the individual has survived up to time t.

- Cox Regression
  - Estimates the association parameter

- Time-Dependent Covariates
  - Covariates whose values change during the study period.
  - Age, disease status, exposure to risk factors, etc...
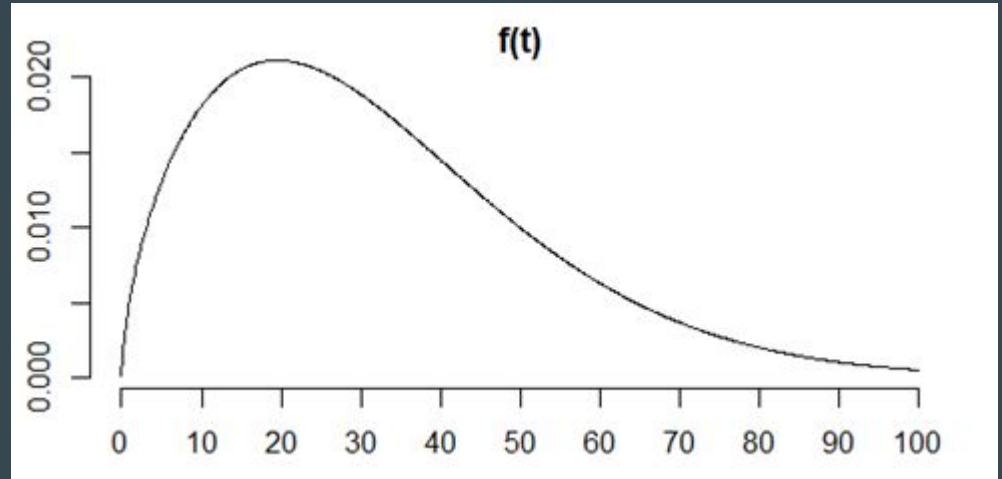
Data Analysis: Data set background

- Various factors that can influence the outcomes of unrelated donor hematopoietic stem cell transplantation (UD-HSCT) in pediatric patients.

- Compared the outcomes of patients who received peripheral blood stem cell transplantation (PBSCT) versus bone marrow transplantation (BMT)

- Used a retrospective analysis of 187 pediatric patients (112 male and 75 female) who underwent unrelated donor hematopoietic stem cell transplantation (UD-HSCT) between 2000 and 2008.

Higher $CD34^+$ and $CD3^+$ Cell Doses in the Graft Promote Long-Term Survival, and Have No Impact on the Incidence of Severe Acute or Chronic Graft-versus-Host Disease after In Vivo T Cell-Depleted Unrelated Donor Hematopoietic Stem Cell Transplantation in Children

Krzysztof Kałwak,[1] Julita Porwolik,[1] Monika Mielcarek,[1] Ewa Gorczyńska,[1] Joanna Owoc-Lempach,[1] Marek Ussowicz,[1] Agnieszka Dyla,[1] Jakub Musiał,[1] Dominika Paździor,[1] Dominik Turkiewicz,[1,2] Alicja Chybicka[1]

Data Analysis: Variables in the Data Set

- There are 37 variables in total

- Key variables:

  - ABO match: Compatibility of the donor and the recipient of hematopoietic stem cells according to ABO blood group (matched - 0, mismatched - 1)

  - aGvHD: Development of acute graft versus host disease (Yes - 0, No - 1)

  - Time to aGvHD: Time to development of acute graft versus host disease

  - Survival time: Time of observation (if alive) or time to event (if dead) in days

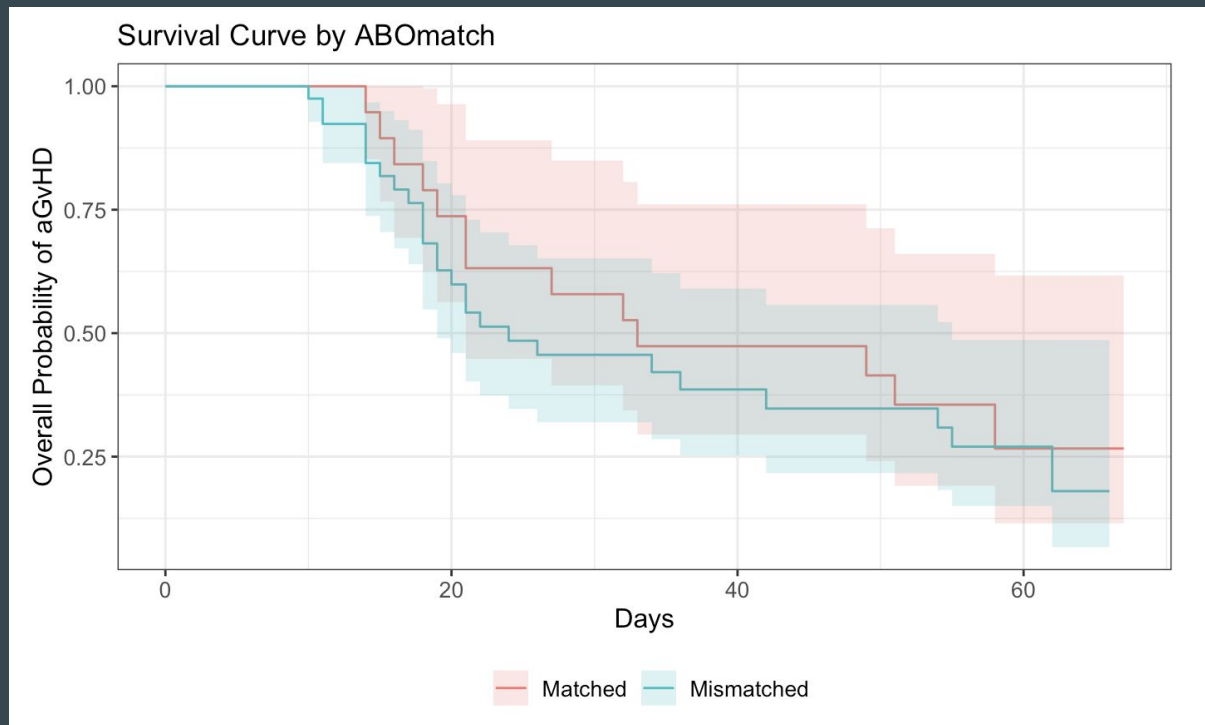 - Survival status: Survival status (0 - alive, 1 - dead)

Research Question 1:
Blood Group Compatibility v.s. Development of Acute Graft versus Host Disease

- Outcome: acute graft versus host disease

- Predictor of interest: ABO blood group compatibility

- Model: Kaplan-Meier Estimate

- H_0: There is no association between Blood Group Compatibility and the

  Development of Acute Graft vs Host Disease.

- Significance level: 0.05

Results: ABO Match vs aGvHD

- P-value = 0.5.
- Unable to reject the Null Hypothesis.

Research Question 2:
Development of aGvHD vs Survival

- Outcome: Survival

- Predictor of interest: acute graft versus host disease & Time to aGvHD

- Model: Cox Regression

- H_0: There is no association between the Development of Acute Graft vs Host Disease and the survival time and status

- Significance level: 0.05

Results: aGvHD v.s. Survival

- Hazard Ratio: 1.85
- P-value: 0.01
- 95% Confidence Interval: [1.14, 3.00]

Limitation and Conclusion

Limitations:

- Assuming non-informative censoring
- Assuming constant hazard ratio

Conclusion:

- We don't have enough evidence to conclude that there is an association between ABO blood group compatibility and the development of acute graft versus host disease in recipients of hematopoietic stem cells.
- The development of acute graft versus host disease stage has an association with decreased survival.

References:

https://www.karlin.mff.cuni.cz/~pesta/NMFM404/survival.html

https://www.theanalysisfactor.com/survival-analysis-interpreting-shapes-of-hazard-functions/

Kałwak, K., Porwolik, J., Mielcarek, M., Gorczyńska, E., Owoc-Lempach, J., Ussowicz, M., Dyla, A., Musiał, J., Paździor, D., Turkiewicz, D., & Chybicka, A. (2010). Higher CD34(+) and CD3(+) cell doses in the graft promote long-term survival, and have no impact on the incidence of severe acute or chronic graft-versus-host disease after in vivo T cell-depleted unrelated donor hematopoietic stem cell transplantation in children. Biology of blood and marrow transplantation : journal of the American Society for Blood and Marrow Transplantation, 16(10), 1388–1401. https://doi.org/10.1016/j.bbmt.2010.04.001