

Cancer Survival Statistics: an Overview

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Reasoning

- ① Usage of the same concepts
- ② Three advanced seminars so far:
 - Does the choice of timescale influence the CIF estimates in a competing risks setting? Correspondence of competing risks and relative survival by Nikolaos Skourlis
 - Modelling multiple time-scales using flexible parametric models by Nurgul Batyrbekova
 - Making life tables using multiple time-scale flexible parametric models by Enoch Yi Tung Chen

- 1 Introduction
- 2 Overview of measures and frameworks
- 3 Cause-specific framework
- 4 Relative survival framework
- 5 Discussion

- Registry data
- Talk based on but not limited to Eloranta S et al. 2020. Cancer survival statistics for patients and healthcare professionals – a tutorial of real-world data analysis.

Advantages over clinical trials:

- Price and time (clinical trials are more expensive and take much more time)
- Cohort of all patients (clinical trials with inclusion/exclusion criteria)
- Possible to study long effect or side effect of the treatment
- Long follow-up
- Linkage between different cohorts, especially in Sweden

Overview of approaches ¹

| | | Measure | |
|-------------------|-------------------|-------------------------|---|
| | | Net | Crude |
| Estimation Method | Cause of Death | Cause-specific survival | Crude probability of death using cause of death information |
| | Expected Survival | Relative Survival | Crude probability of death using expected survival |

Figure: Measures of Cancer Survival. Figure downloaded from National Cancer Institute: <https://surveillance.cancer.gov/survival/measures.html>

- Crude survival (measure)
 - Cause-specific framework
 - Relative survival framework
- Net survival (measure)
 - Cause-specific framework
 - Relative survival framework

¹Summarised from Dickman2015 (Estimating and modeling relative survival)

Choose a measure based on:

The purpose of the study:

- Crude survival
 - Presence of dying from other causes rather than only the disease of interest.
 - Clinical decisions for a specific patient
- Net survival
 - hypothetical world, absence of dying from other causes
 - comparisons over time or groups (countries)

Overview of measures and frameworks

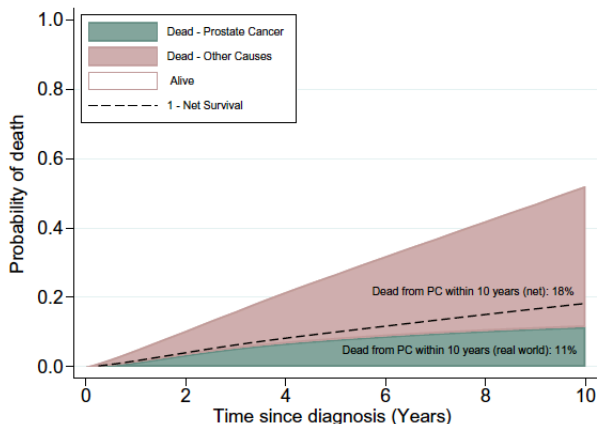


Fig. 2 Probabilities of death due to prostate cancer and deaths due to other causes in 75-year-old men diagnosed in 2007 in the presence and absence of competing risks, respectively.

Figure: Eloranta2020. Shaded areas: considering competing risks (real world); dashed line: patients can only die from the disease of interest (hypothetical world)

Choose framework based on:

(For sure, your research question of interest)

Availability of cause of event info:

- Cause-specific framework - the cause of event of interest is **known** and accurate
- Relative survival framework - the cause of event of interest is **unknown** or not reliable (**preferable**)

- Advantage: It requires the cause of the event.
 - Cause-specific hazard \rightarrow cumulative incidence function (probability of patients that have died from cause K at time t)²
 - Multi-state settings
- Disadvantage: It requires the cause of the event.
 - The cause of death info might not be complete.

²Hincliffe2013. Flexible parametric modelling of cause-specific hazards to estimate cumulative incidence functions.

Cause-specific framework

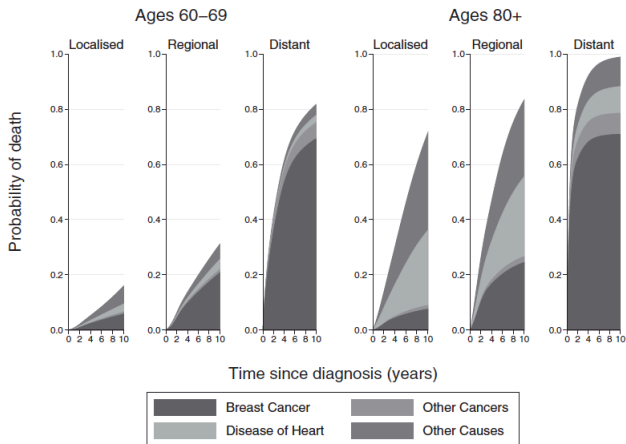


Figure 4 Stacked cumulative incidence function plots by stage for ages 60-69 and 80+ .

Figure: Hinchliffe2013. Modeling cause-specific hazards and transform them to cumulative incidence functions.

Cause-specific framework

- Measure crude survival: competing risks settings, patients might die from other causes than the disease under study.
- Measure net survival: censor all the other causes

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Figure: Measures of Cancer Survival. Figure downloaded from NCI

Relative survival framework

- Advantage: It does not require the cause of the event → can incorporate both direct and indirect causes
- Relative survival is estimated as comparison of survival in the cohort with survival in the general population → need of life tables
- The Human Mortality Database ³

³<https://www.mortality.org/>

Assumptions to interpret as Net survival

- **Exchangeability** If a cancer patient did not have cancer, he/she would have the same probability to survive as a similar person in the general population
- **Conditional independence** between cancer deaths and other causes of death

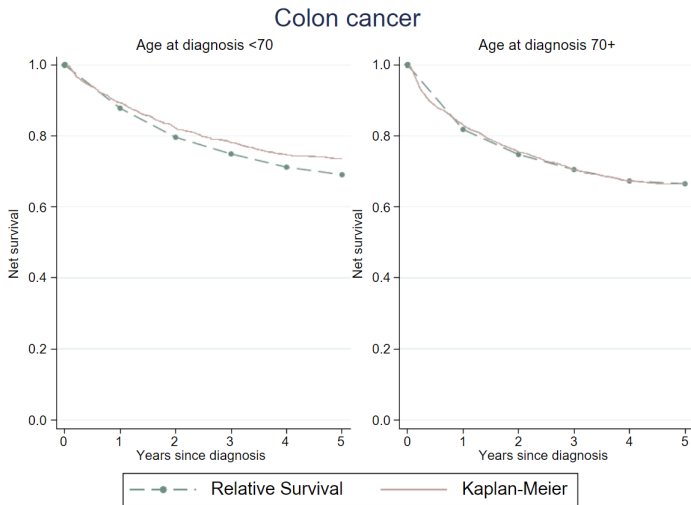


Figure: Eloranta, S. et al Cancer survival statistics for patients and healthcare professionals – a tutorial of real-world data analysis

Crude survival

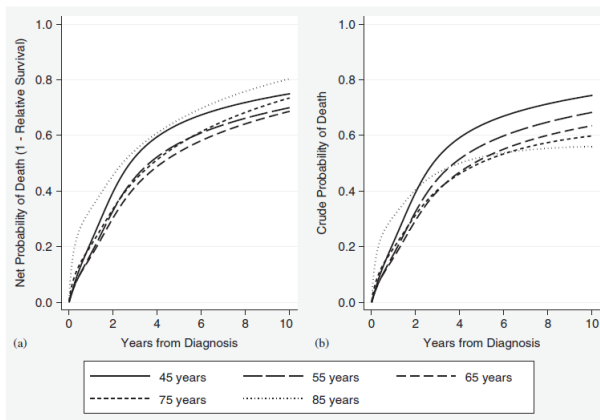


Figure 3. Net probability of death, $1 - R(t)$, and crude probability of death due to cancer for ages 45, 55, 65, 75 and 85 from a non-proportional hazards model with 5 df for the log cumulative excess hazard and 12 df for the time-dependent effects for age.

Figure: Lambert, P. et al Estimating the crude probability of death due to cancer and other causes using relative survival models

What measure? What framework?

- Nick: Does the choice of timescale influence the CIF estimates in a competing risks setting?
- Nurgul: Modelling multiple time-scales using flexible parametric models
- Enoch: Making life tables using multiple time-scale flexible parametric models.
- Welcome to sign up the upcoming presentations!!

What measure? What framework?

- Nick: Does the choice of timescale influence the CIF estimates in a competing risks setting? **Crude survival measure - cause-specific survival framework**
- Nurgul: Modelling multiple time-scales using flexible parametric models **Net survival measure - cause-specific framework**
- Enoch: Making life tables using multiple time-scale flexible parametric models. **Net survival measure - relative survival framework**
- Welcome to sign up the upcoming presentations!!

- ① What is the purpose of net survival/crude survival?
- ② If you want to estimate fertility rate, which framework should be use?
- ③ What is missing in the interpretation of the survival from Figure on the right 5: 5 years after the diagnosis 66% of elderly men would still be alive.
- ④ The net probability of death underestimates / overestimates real-world probability of death from cancer.



Eloranta, S. and Smedby, K. E. and Dickman, P. W. and Andersson, T. M. (2021)
Cancer survival statistics for patients and healthcare professionals – a tutorial of
real-world data analysis
Journal of Internal Medicine 289(1), 12 – 28.



Lambert, P. C., Dickman, P. W., Nelson, C. P., Royston (2010)
Estimating the crude probability of death due to cancer and other causes using
relative survival models
StatMed 29(7-8), 885 – 95.