

Bielefeld, 30 September 2022

Abstract for a presentation

Design of animal experiments investigating leukemia treatment outcome

Leukemia is the most frequent type of cancer for pediatric patients. It causes the production of proliferating white blood cells that are less functional. Chemotherapy is one of the most common treatment forms and it aims at destroying the leukemia cells. Treatment effects and disease progression are initially usually studied by animal experiments, often in mice. Since ethical and financial considerations speak for only as few animals as necessary being used, medical scientists are interested in taking measurements of samples as efficiently as possible.

Based on an underlying mechanistic model, the temporal dynamics of cell composition can be represented by a system of ordinary differential equations with unknown parameters. Statistical inference aims to determine parameter values and to reveal differences between the dynamics of treatment groups. In order to obtain data reflecting the dynamics, the measuring procedure allows to choose a measurement time for each animal individually. However, only one measurement of cell composition can be taken per animal, as it has to be sacrificed.

This work presents simulative as well as analytical methods to select measurement time points more efficiently. Thereby, it accounts for practical considerations that require different approaches. An iterative selection produces a minimal data set that suffices to estimate parameters reliably. Moreover, it shows how to allocate measurement times optimally given a fixed budget of resources. Subsequently, it enables to quantify the value of additional measurements.

The results of this work provide medical scientists with methods to improve the selection of measurement times for animal experiments. It aims to achieve a good balance between minimum resource use and maximum knowledge gain. Furthermore, this work yields starting points to establish a loop process of data collection and analysis. In form of an application, it can support medical scientists to conduct experiments iteratively based on thorough statistical analyses.