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A MATHEMATICAL MODEL TO PREDICT GROWTH AND SIZE OF METASTATIC TUMORS UNDER THERAPY

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The identification and quantification of metastases is necessary to find the optimal treatment for an individual patient suffering from cancerous diseases. Due to limited possibilities of medical imaging techniques, it is currently technically too difficult to find metastases of very small sizes. These micro metastases though can highly influence the treatment success. About 90% of cancer deaths do not occur due to primary tumors and their resulting symptoms but metastases, of which most are undiscovered at the time point of primary diagnosis [1]. Mathematical models capable of describing metastases growth are therefore of high clinical interest to assist choosing an appropriate treatment setting.

A McKendrick-von Foerster equation introduced by Iwata et al. [2] was modified to describe different scenarios and aspects of the metastatic seeding process. The numerical implementation of those scenarios facilitated a possible comparison to clinical data of lung cancer patients under treatment, from whom model parameters could be gathered. The model is defined in a continuous setting which allows it to also model the transition of a single primary tumor towards a metastatic disease, thus indicating the metastatic cascade necessary to develop multiple metastatic tumors.

The resulting prognostic possibilities were used to quantify the total metastatic burden at the time point of primary diagnosis retrospectively for those patients and to forecast their further development and seeding behaviour. In these sets of clinical data, the framework could correctly predict sizes of metastases which were not yet discovered at the primary diagnosis. Further analysis included *in silico* experiments of different therapeutic schedules with differing medications and time plans.

The work described in this abstract was also presented during the Poster session of the DSABNS 2020.

NB: This work was also presented as a Poster.

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References

[1] Weinberg, R. A. & Chaffer, C. L. (2011). *A Perspective on Cancer Cell Metastasis*. Science, 331(6024), 1559-1564. https://doi.org/10.1126/science.1203543

[2] Iwata, K., Kawasaki, K. & Shigesada N. (2000). *A Dynamical Model for the Growth and Size Distribution of Multiple Metastatic Tumors*. Journal of Theoretical Biology 203(2), 177-186.

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