3D cellular automata method of oncolytic virotherapy in pancreatic cancer

Created on: 07-01-2021 - Last modified on: 07-01-2021

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Organisation

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Partners and collaborations

Delft University of Technology, Technion

SCOPE OF THE METHOD

The Method relates to	Human health
The Method is situated in	Translational - Applied Research
Type of method	In silico

DESCRIPTION

Method keywords

cell proliferation

mutation
apoptosis
cellular automata model
hybrid model
partial differential equations
pancreatic cancer
oncolytic virotherapy

Scientific area keywords

computational modelling
cancer treatment
mathematical model
stochastic model
probabilistic model
Monte Carlo simulations

Method description

We developed a cellular automata model of oncolytic virotherapy with an application to pancreatic cancer. The fundamental biomedical processes (like cell proliferation, mutation, apoptosis) are modelled by the use of probabilistic principles. The migration of injected viruses (as therapy) is modelled by diffusion through the tissue. The resulting diffusion-reaction equation with smoothed point viral sources is discretised by the finite difference method and integrated by the IMEX approach. Furthermore, Monte Carlo simulations are done to quantitatively evaluate the correlations between various input parameters and numerical results. As we expected, our model is able to simulate the pancreatic cancer growth at early stages, which is calibrated with experimental results. In addition, the model can be used to predict and evaluate the theapeutic effect of oncolytic virotherapy.

Lab equipment

Only computer resources

Method status

Published in peer reviewed journal

PROS, CONS & FUTURE POTENTIAL

Advantages

- The method does not need any animal tests;
- The model is able to simulate cancer progression at early stages;
- The model is scalable and the speed of cancer progression can be adjusted by variation of the input parameters.

Challenges

Unfortunately, the experimental validation has only been carried out from a qualitative point of view. A mode quantitative validation is still missing. In the future, we aim at improving this, which also implies further model improvements, as well as adjustment of input parameters.

Modifications

Further clinical experimental studies are necessary to optimise the viral therapy in terms of dealing with cancer, leaving as few viral particles as possible. A medical research group at the University of Twente, in the Netherlands, headed by prof Jain Prakash, is interested in the method to reproduce their clinical findings.

Future & Other applications

We think that the model can be used to predict and evaluate therapeutic effects of oncolytic virotherapy.

REFERENCES, ASSOCIATED DOCUMENTS AND OTHER INFORMATION

References

J. Chen, D. Weihs, F.J. Vermolen. A cellular automata model of oncolytic virotherapy in pancreatic cancer. Bull Math Biol 82, 103 (2020), https://doi.org/10.1007/s11538-020-00780-5

Links

Fred Vermolen at Computional Mathematics

Other remarks

The method was developed in the framework of the PhD-research by Dr. Jiao Chen at the Delft University of Technology in the Netherlands. Fred Vermolen has acted as the daily supervisor, and he has, during the project, moved the university of Hasselt. Furthermore, Prof Daphne Weihs, from Technion in Israel, has contributed as an external expert.

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Financed by