Krajowa Konferencja Zastosowań Matematyki w Biologii i Medycynie

Regietów, 22nd–26th September 2015

SIGNIFICANT MULTI-DOSE RADIOTHERAPY IMPROVEMENTS BY NUMERICAL SIMULATION AND GA SEARCH

Monika Joanna Piotrowska[1], **Simon Douglas Angus**[2]

[1]Faculty of Mathematics, Informatics and Mechanics, University of Warsaw,
ul. Banacha 2, 02-097 Warsaw,
[2] Department of Economics, Monash University,
Clayton 3800, VIC Australia,
[1]monika@mimuw.edu.pl, [2]simon.angus@buseco.monash.edu.au

ABSTRACT

Multi-dose radiotherapy protocols (fraction dose and timing) currently used in the clinic are the product of human selection based on received wisdom, physician experience and intra-day patient timetabling. However, due to combinatorial considerations, the potential treatment protocol space for a given total dose or treatment length is enormous and beyond the capacity of traditional in-vitro methods. In contrast, high fidelity numerical simulation of tumour development is well suited to the challenge. Building on our previous single-dose numerical simulation model of EMT6/Ro spheroids, a multi-dose irradiation response module is added and calibrated to the effective dose arising from 18 independent multi-dose treatment programs examined experimentally. With the developed model a constrained, non-linear, search for better performing cadidate protocols is conducted within the vicinity of two benchmarks by genetic algorithm (GA) techniques. The candidate protocols were identified by the GA which conferred an average of 9.4% (max benefit 16.5%) and 7.1% (13.3%) improvement (reduction) on tumour cell count compared to the two benchmarks, respectively. This study provides powerful evidence towards the hypothesis that even simple inter-fraction timing variations for a given fractional dose program may present a facile, and highly cost-effecitive means of significantly improving clinical efficacy.

ACKNOWLEDGEMENTS

This work was financed in part by the Polish Ministry of Science and Higher Education within the Iuventus Plus Grant: "Mathematical modelling of neoplastic processes" (grant No. IP2011041971) from the budget for science in years the 2012-2014. The authors acknowledge the support of technical staff at the Multi-modal Australian ScienceS Imaging and Visualisation Environment facility (MASSIVE) (http://www.massive.org.au/).

REFERENCES

[1] S. D. Angus and M. J. Piotrowska: *A Matter of Timing: Identifying Significant Multi-Dose Radiotherapy Improvements by Numerical Simulation and Genetic Algorithm Search*, PLoS ONE **9** (December 2, 2014), e114098.