OPTIMIZATION OF PARAMETERS AND OPTIMAL CONTROL OF DRAGS IN THE MATHEMATICAL MODEL OF OSTEOPOROSIS DESCRIBED BY SIEWE AND FRIEDMAN

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ABSTRACT

Osteoporosis is an aging disease, which is characterized by loss of bone mass, where bones become fragile and more likely to fracture. Bone density begins to decrease after age 50, and a state of osteoporosis is defined by loss of more than 25%. Cellular senescence is a permanent arrest of normal cell cycle, while maintaining cell viability. The number of senescent cells increase with age. It is natural to consider the question to what extend senescent cells induce bone density loss and osteoporosis. In [1] the authors developed mathematical model of osteoporosis depending on several parameters and controls (senolytic drugs like fisetin and quercetin). Parameters are adjusted by making simulations. Similarly treatment of drugs are done by making simulations and comparing with empirical data. The model consists of fourteen ordinary differential equestions depending on variables like density of non-senescence mesenchymal stem cells, density of osteoblasts, density of precursor osteoblasts, bone density, density of osteoclasts and so on. Essential point is that these equations depend also on many parameters of which part is choesen flexible. In our opinion we should optimize the choice of parameters according to some ruls. It is obvieus that the ruls here means a kind of functional which should measure behavior of interesting us result with respect to these parameters. By interesting result we mean bone density and number of cellular senescence. That functional should also contain a term related to treatment of drugs as well as of a time when we must start treatment. Having such a functional we can formulate an optimal control problem. One of the aim of the paper is to formulate a new sufficient optimal conditions in a form of verification theorem. As a final result, basing on verification theorem, we state algorithm allowing for efficient calculation to find optimal parameters as well as optimal treatment of drugs in best time.

REFERENCES

[1] N. Siewe and A. Friedman: *Osteoporosis induced by cellular senescence: A mathematical model*, PLOS ONE **19** (2024), 1–21.