

System Dynamics Modelling in Systems Biology and Applications in Pharmacology

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Abstract—Mathematical modelling of complex biological systems is one of the key issues in System Biology and several computational methods based on computer simulation have been applied up to now to determine the behaviour of nonlinear systems. System Dynamics is an intuitive modelling methodology based on qualitative reasoning whereby a conceptual model can be described as a set of cause-effect relationships between variables of a system. Starting from this structure it is possible to get a set of dynamical equations describing quantitatively the system behaviour. Focusing on pharmacologic systems, compartmental modelling is often used for solving a broad spectrum of problems related to the distribution of materials in living systems in research, diagnosis and therapy at whole-body, organ and cellular levels.

In this paper we present the System Dynamics modelling methodology and its application to the modelling of a pharmacokinetic-pharmacodynamic compartmental model of the anaesthetic depth effect in patients undergoing surgical interventions, deriving a simulation model under the OpenModelica object oriented simulation environment. System Dynamics can be viewed as a powerful and easy-to-use educational tool and in teaching of Systems Biology.

Keywords—System Dynamics, Qualitative Modelling, Compartmental Models, OpenModelica