Mathematical modelling of clot-dissolving therapy and model-based optimisation of treatment protocols for improved treatment outcomes and reduced risk of side effects

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Blood clots formed or lodged in arteries cause life-threatening events such as heart attack, ischaemic stroke and pulmonary embolisms by blocking the blood supply to major organs. One of the treatments for such diseases is called thrombolysis or clot-dissolving therapy where tissue plasminogen activator is intravenously administered to the patient to restore the bloodstream. Despite its proven effectiveness, this may cause bleeding complications in a subset of patients. In this work, we have developed a mathematical model of clot-dissolving therapy by incorporating key drug transport phenomena and biochemical reaction kinetics. The developed model allows us to assess the effects of a wide range of therapeutic parameters on the effectiveness and risk of side effects of thrombolytic therapy by mimicking various clinical scenarios computationally, i.e., clot characteristics and patient-specific conditions. Furthermore, we have developed a model-based optimisation framework to identify improved therapeutic strategies by adjusting treatment protocols depending on the patient's clot and plasma properties. This work can lay the foundation for future personalised treatment.