Modelling drug release from polymer-free drug-eluting stents and thermoresponsive polymeric systems

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Abstract:
In this talk, I will present models of drug release from a polymer-free drug-eluting stent and a drug delivery system based on a thermoresponsive polymer and a cooling device.

Polymer-free drug-eluting stents (DESs) are an innovative new treatment for coronary heart disease which is the leading cause of death globally. In these polymer-free stents, the drug is either sprayed directly onto a bare metal surface or infused in a metallic porous medium. They have the potential to overcome problems associated with the current best treatment: polymer-coated DESs. However, with no polymer to control drug release, it is unclear how desired release rates can be achieved. The first model of drug elution from polymer-free stents has been developed. The generalised model is capable of predicting the drug release from a number of polymer-free systems including those that exhibit nanoporous, nanotubular and smooth surfaces. The model is based principally on dissolution theory and the theory of diffusion in porous media. Drug release profiles are provided, and design recommendations are offered so that the release profile may be tailored to achieve the desired outcome.

A model has been also developed to evaluate the feasibility of an in-vivo implanted drug delivery system. The proposed delivery device consists of a cooling material coated by a drug-loaded thermoresponsive polymeric film. Drug release is initiated by remotely dropping the temperature of the cooling material sufficiently for the temperature throughout the polymer coating to drop below its volume phase transition temperature (VPTT), causing the polymer to swell and release the drug. Drug release switches off again when heat conduction from an external fluid medium increases the polymer temperature to above the VPTT causing the polymer to collapse. The model provides an upper bound for the temperature the cooling material must be dropped to for drug release to be initiated in the thin polymer film limit. The model predicts that the duration a thin polymer will continue to release the drug in a single cycle is proportional to the square of the thickness of the cooling material. It is found that the system may be realized for realistic parameter values and materials.