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Quantifying the influence of nanoparticle polydispersity on cellular delivered dose

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Nanoparticles provide a promising approach for the targeted delivery of therapeutic, diagnostic and imaging agents in the body. However, it is not yet fully understood how the physicochemical properties of the nanoparticles influence cellular association and uptake. Cellular association experiments are routinely performed in an effort to determine how nanoparticle properties impact the rate of nanoparticle-cell association. To compare experiments in a meaningful manner, the association data must be normalised by the amount of nanoparticles that arrive at the cells, a measure referred to as the delivered dose. The delivered dose is calculated from a model of nanoparticle transport through fluid. A standard assumption is that all nanoparticles within the population are monodisperse, namely, the nanoparticles have the same physicochemical properties. We present a semi-analytic solution to a modified model of nanoparticle transport that allows for the nanoparticle population to be polydisperse. This solution allows us to efficiently analyse the influence of polydispersity on the delivered dose. Combining characterisation data obtained from a range of commonly-used nanoparticles and our model, we find that the delivered dose changes by more than a factor of two if realistic amounts of polydispersity are considered.

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