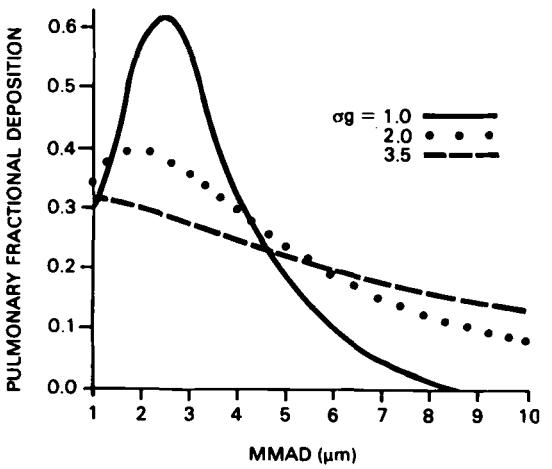
STUDY OF THE EFFECTS OF POLYDISPERSITY OF AEROSOLS ON REGIONAL DEPOSITION IN THE RESPIRATORY TRACT

I. Gonda, Department of Pharmacy, University of Aston in Birmingham, Gosta Green, Birmingham B4 7ET, U.K.

The pulmonary deposition of monodisperse aerosols with aerodynamic diameters in the range 2-4 μm in human volunteers inhaling by mouth frequently exceeds 50% of the dose delivered (Chan & Lippmann 1980; Stahlhofen et al 1980). Yet very substantially lower values of pulmonary deposition were deduced from bioavailability studies on human volunteers inhaling medicinal aerosols with mass median aerodynamic diameters (MMAD) in similar size ranges as the monodisperse aerosols (Davies 1975). Condensation growth of the particles in therapeutic aerosols was suggested to be a reason for the reduced pulmonary deposition (Gonda & Byron 1978). It was noticed recently that aerosol polydispersity could either reduce (Gonda 1981a) or increase (Gonda 1981b) pulmonary deposition compared to monodisperse aerosols. A semi-empirical model based on experimental and theoretical results for monodisperse aerosols (Gonda 1981b) enabled us to compute systematically the expected pulmonary deposition for log-normally distributed aerosols with MMAD = 1-10 μm and polydispersities characterised by geometric standard deviations σg = 1-3.5. The results in fig. 1 for tidal volume 2.15 dm^3 and respiratory frequency 15 min^{-1} indicate that the pulmonary deposition of a highly polydisperse aerosol would, indeed, be expected to be much lower than the value for a monodisperse aerosol if the MMAD were designed to be at the optimum size around 3 μm. The opposite effect is seen at MMAD > 5 μm. Analogous calculations for the tracheo-bronchial compartment show that whereas there is an almost 10-fold variation in the deposition fraction in the size range 1-10μm for monodisperse aerosols, this is reduced to less than 4-fold variation for σg = 2. The fractional deposition becomes almost independent of MMAD when the polydispersity reaches σg = 3.5 Thus, the deposition of highly polydisperse aerosols is likely to be less sensitive to changes in MMAD resulting from manufacture, storage or generation but it cannot be expected to achieve the maximum pulmonary and tracheo-bronchial deposition values obtained with monodisperse aerosols.



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