A new method of analysing indicator dilution curves

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Objective: We are currently developing a new indicator dilution method of measuring cardiac output using lithium chloride as the indicator. The aim of the present study was to develop a simple and accurate method of deriving the area under the primary indicator dilution curve: that is, the area which would have been inscribed had there been no recirculation of the indicator.

Method: A model based upon the representation of the mixing in the circulation as similar to that of the passage of an impulse through a series of filter elements was studied. This was represented physically by a model which consisted of a series of mixing chambers. The model was analysed theoretically using Laplace transforms and was used to test the new method of deriving the area of primary indicator dilution curves.

Results: Theoretical analysis showed that such a filter model produces curves which closely approximate the shape of a lognormal distribution over a range of skewness greater than that of human indicator dilution curves. The single pass curves from the physical model were shown to be similar in shape to lognormal distributions, as were the curves obtained from patients to the point when recirculation occurred. A method of estimating the area under the primary curve based upon the lognormal distribution was developed and equations derived. The use of these equations to calculate flows from lithium dilution curves in the mixing chamber model was validated by comparing the results with simultaneous timed collection.

Conclusions: Theoretical justification for treating primary indicator dilution curves as lognormal is presented. A simple method of deriving the integral of the primary indicator dilution curve is described. It uses the whole of the curve up to a point short of recirculation, avoiding the problem which can occur with the classical Hamilton extrapolation method when the cardiac output is low and recirculation distorts the primary curve in the early part of the washout.