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MODELLING THE HUMAN ERYTHROCYTE SEDIMENTATION RATE

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Precise cathetometric measurements have been made of the erythrocyte sedimentation rate (ESR) of human blood. These data invalidate the usual sigmoidal representation of the sedimentation curve, the time-plot of the location of the plasma-erythrocyte interface in a sedimenting column of blood. A special feature, an "elbow" or a sudden increase of sedimentation rate, is observed. Three phases are defined to describe the settling process of a blood column in a tube. They are the fall of individual cells, the descent of cell aggregates, and finally the packing of the aggregates at the bottom. It should be noted that the aggregation is relatively sudden but not instantaneous and it appears to develop to a specific size. A model of a piece-wise continuous curve is suggested for fitting the sedimentation data. It consists of two straight lines followed by a curve.

The following factors have been investigated: the relationship between whole blood and Westergren (dilution of blood with 3.8 sodium citrate) ESRs; the reproducibility of the ESR test in a series of samples from the one donor; and effect on the sedimentation curve of storage time (period between sampling and testing), haematocrit (the volume fraction of red blood cells) and plasma protein concentrations.

The dependence of the ESR on the haematocrit and on the plasma proteins (fibrinogen, globulin and albumin) has been established. It provides the basis for a physical model of the sedimentation process. Several ESR Models, both physical and statistical, have been studied.

Two parameters are introduced in this study. The first one is the "set up" time, that is the time lapse before a sudden increase of sedimentation occurs. The second one is the slope of the second phase, that is, the falling rate of the aggregates. The results show these two parameters can provide more information than the one hour ESR value, enabling better differentiation between normal and pathological samples, and further work to clarify their use in this respect is suggested.

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