LETTERS TO THE EDITOR

SIR:

I would like to comment on the article entitled "Influence of Anaesthetics on Rheology of Human Blood" by Ben-Zion Aronson *et al.*, which appeared in this Journal (15: 244, 1968).

I was happy to notice that Dr. Aronson's results and conclusions agree so well with ours.¹ At the time of our publication, we chose not to include the yield stress and a Casson plot of the viscosity data because we thought its importance to anaesthetists was questionable, but any interested individual could easily make a Casson plot and calculate yield stress from our published data. We are providing this plot now (Fig. 1), and there is good agreement with the results published by Dr. Aronson.

MEAN VALUES OF 9 STUDIES WITH 15% ETHER

FIGURE 1. Square root of shear stress versus square root of shear rate for whole blood as drawn, blood equilibrated in a tonometer with 5 per cent CO_2 in O_2 (Tonometer Control), and blood equilibrated in the same tonometer with 15 per cent ether (Tonometer Ether). The ordinate intercept is the square root of blood yield stress ψ , in $\sqrt{\text{dynes/cm}^2}$.

Our measurements of shear stress and viscosity were made in the range of shear rates from 230 to 11.5 sec^{-1} with a Brookfield Model LVT Viscometer. *In vivo* shear rates have been estimated to range from 108 sec^{-1} in the normal aorta to 10 sec^{-1} in arterioles of 100 μ diameter.² Higher shear rates are probably of little physiological significance. Shear rates in the capillaries and venules are much lower, and viscosity is therefore markedly increased in these vessels. To measure viscosity at shear rates lower than about 10 sec^{-1} , one would have to

use an instrument different from the ones available to us and to Dr. Aronson, such as the Gilinson, Dauwalter, Merrill (GDM) viscometer,³ which permits measurements down to shear rates of 0.02 sec.^{-1} .

Other workers⁴ have found good agreement between values obtained with the GDM device and those obtained with the Wells-Brookfield instrument used by Dr. Aronson and ourselves.

MARJAM G. BEHAR, PH.D.
Research Associate
Department of Anesthesiology
University of Pennsylvania

REFERENCES

1. BEHAR, M. G. & ALEXANDER, S. C. *In Vitro Effects of Inhalational Anesthetics on Viscosity of Human Blood*. *Anesthesiology*. 27: 567 (1966).
2. WELLS, R. E., JR. & MERRILL, E. W. Influence of Flow Properties of Blood upon Viscosity-Hematocrit Relationships. *J. Clin. Invest.* 41: 1591 (1962).
3. GILINSON, P. J.; DAUWALTER, C. R.; & MERRILL, E. W. A Rotational Viscometer Using an A.C. Torque to Balance Loop and Air Bearing. *Trans. Soc. Rheology*. 7: 319 (1963).
4. CHARM, S.; MCCORNIS, W.; TEPDA, C.; & KURLAND, G. Effect of a Fatty Meal on Whole Blood Viscosity. *J. Appl. Physiol.* 18: 1217 (1963).