brano, T., Colorimetric determination of serum cholinesterase and its genetic variants by the propionylthiocholine–dithiobis(nitrobenzoic acid) procedure. *Selected Methods Clin. Chem.* 8, 41–46 (1977).

5. King, J., Studies on human serum cholinesterases. Ph.D. thesis, University of Glasgow, 1974.

6. Garry, P. J., Serum cholinesterase variants: Examination of several differential inhibitors, salts and buffers used to measure enzyme activity. *Clin. Chem.* 17, 183–191 (1971).

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The authors of the paper in question respond as follows:

To the Editor:

In reply to the Letter of Dr. McQueen, who is disturbed that $E_1^u E_1^u$, $E_1^u E_1^a$, and $E_1^a E_1^a$ variants of cholinesterase all give about the same fluoride inhibition in the Selected Method: the answer is indeed simple. We selected the fluoride concentration to do *exactly that*, since we believed it would be easier to interpret results if reduction of fluoride inhibition *always* indicated the presence of E_1^f.

The choice of fluoride concentration used in our method is based on the results shown in the figure below. The upper difference curve shows that the distinction between $E_1^u E_1^u$ and $E_1^f E_1^f$ would have been a little greater at 2 mmol/L fluoride concentration, but we elected to use 4 mmol/L to inhibit "usual" sera by about 80%. In the case of the much more frequent $E_1^u E_1^f$, both concentrations of fluoride give the same distinction. The greater inhibition of the $E_1^a E_1^a$ sera than the $E_1^u E_1^u$, shown in the the $E_1^u E_1^u$, shown in the figure, was also figure, was also observed by Garry (*1*). We, too, have observed the anomalous inhibition of atypical cholinesterase by fluoride when benzoylcholine is the substrate. This is another reason for the choice of substrate and inhibitor concentrations used in the Selected Method (*2*). Other criteria for the selection of parameters for the method have been reported (*3*).

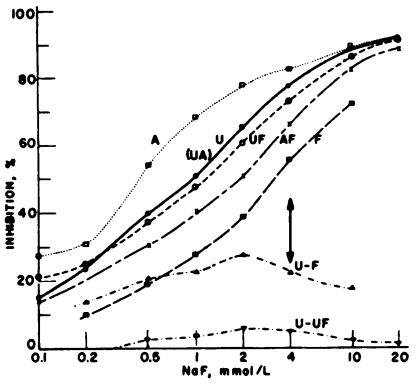

Fig. 1. Inhibition of propionylthiocholine (2 mmol/L) hydrolysis by varying fluoride concentrations with sera of different cholinesterase phenotypes.

The upper difference curve (*U-F*) represents the difference between $E_1^u E_1^u$ and $E_1^f E_1^f$ sera, and the lower difference curve the difference between $E_1^u E_1^u$ and $E_1^u E_1^f$. The *arrow* indicates the recommended fluoride concentration.

The data given in our figure do not entirely agree with those of King cited by McQueen, presumably taken from his reference 5. We cannot account for the differences; although the substrate concentration is not given, we doubt if it could account for the resulting differences.

References

1. Garry, P. J., Serum cholinesterase variants: Examination of several differential inhibitors, salts, and buffers used to measure enzyme activity. *Clin. Chem.* 17, 183–191 (1971).

2. Dietz, A. A., Rubinstein, H. M., Lubrano, T., Colorimetric determination of serum cholinesterase and its genetic variants by the propionylthiocholine–dithiobis(nitrobenzoic acid) method. *Selected Methods Clin. Chem.* 8, 41–46 (1977).

3. Dietz, A. A., and Rubinstein, H. M., Criticism of a Selected Method: Propionylthiocholinesterase. *Clin. Chem.* 21, 1041 (1975). Letter (response).

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Expressing Lower Limits of Normal

To the Editor:

The problem of expressing lower limits of normal, addressed in the Letters of Altman and of Haymond and Knight [*Clin. Chem.* 25, 492–493 (1979)], lends itself to a practical solution, albeit a compromise. When the sensitivity of a test does not permit reliable measurements at concentrations near zero and (or) when there is no known clinical significance to low values (as with most enzymes), the "normal range" should be stated as "up to x," where x is whatever has been established as an appropriate upper limit of normal. In these instances, a statement of the mean or median value may also be helpful. In addition, low concentrations may be reported as "less than y," where y is the lowest concentration at which a reliable analytical result may be obtained. These approaches simplify both the analytical and interpretation problems attending low values.

We have used this system of reporting for some time and have received no objections from the medical community.

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Aperometric Liquid Chromatography of Catecholamines

To the Editor:

The work of Kissinger and co-workers (*1*, *2*) offers a unique means for the electrochemical detection of catecholamines in biological fluids, because of the appropriate sensitivity of this detector, coupled with the resolving power of "high-performance" chromatography.

Used in actual biological measurements, this instrumental approach has at times been made confusing and unnecessarily difficult. We report here some modifications that should minimize difficulties with this methodology.

To separate norepinephrine and epinephrine (Figure 1) we use an Altex 110A pump and a 3.2 × 250 mm re-

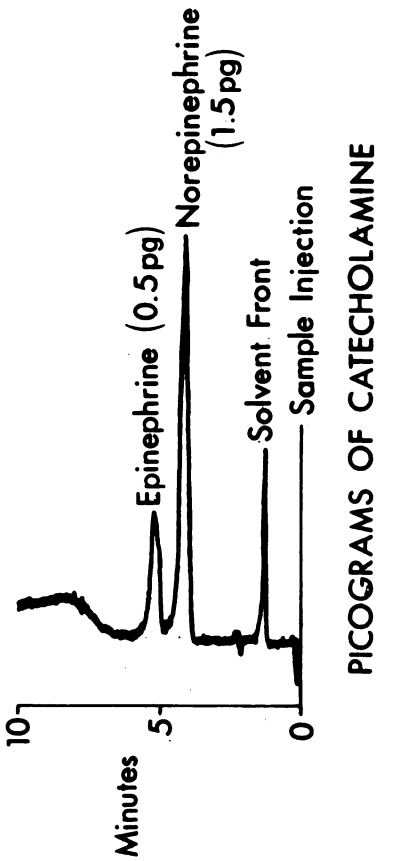

Fig. 1. Chromatographic results

Flow rate was of 1.0 mL/min with a detector setting of 0.5 V and an offset of 12 nA with the LDC pump or 80 nA with the Altex pump. Sensitivity is 20 nA/V, full scale