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Letter to the Editor

TO THE EDITOR:

Recently, considerable interest has been expressed in these pages (1,2) and others (3) as to an appropriate, but accessible procedure that will permit accurate, consistent evaluation of precordial counting curves.

If, for computational purposes, it is acceptable that the precordial curve be semilogarithmic, then the major problems in treatment of such data are: 1) estimation of the area under the curve, extrapolated to zero time and to infinity, with recognition of the fact that even if the count rate "zero" is normalized to the background rate, this type of curve will never fall to zero count rate, and 2) correction of the total count area for the early time span when the count rate recorded is zero or much less than the full value of the extrapolated semilogarithmic curve construction.

A solution applicable to these problems is presented here. Characteristic precordial count rate data points are plotted in Figs. 1 and 2 in semilogarithmic and rectilinear forms, respectively. The exponential curve in Fig. 1, estimated visually or by a "least squares" method, indicates the initial count rate, CR_0, the half time, $t_{\frac{1}{2}}$, the 90 percent decay time, t_{90}, and the decay constant, k. In Fig. 2 the shaded area, Y, defines the rectilinear count area from zero time to the 90 percent decay time. The clear area, X, defines the early area of noncounts, while the letter, U, indicates the unrecorded count area. This extends beneath the curve from the Y area to an indefinite distance beyond the right hand border of the plot.

In order to compute the mean time of the first circulation of indicator, the count total desired should include those accumulated during the measurement, plus those "not measured", but which lie beneath the terminal portions of the constructed curve after the measurement is ended. The shaded area, Y, plus the recorded counts under the indefinitely extended right hand tail of the curve in Fig. 2, give this sum algebraically in the expression

$$C_T = (CR_0/k)[(.9Y/(X + Y) + .1] \qquad 14\Lambda$$

The derivation of this equality is detailed in the *Appendix.* This equation is easy to apply, because the few constants used are obvious characteristics of the curves, and the numerical factors, .9 and .1, facilitate simple computations. In addition, the use of the t_{90} intercept of the curve is advantageous, because a projection based upon its constant proportion to $1_{\frac{1}{2}}$ will ensure accuracy and ease in locating a geometric limit that helps considerably to minimize error in the necessary planimetric measurements. Most importantly, however, is that the method of calculation shown does solve the two problems stated above. The equation accords with the fact that a semilogarithmic curve approaches, but

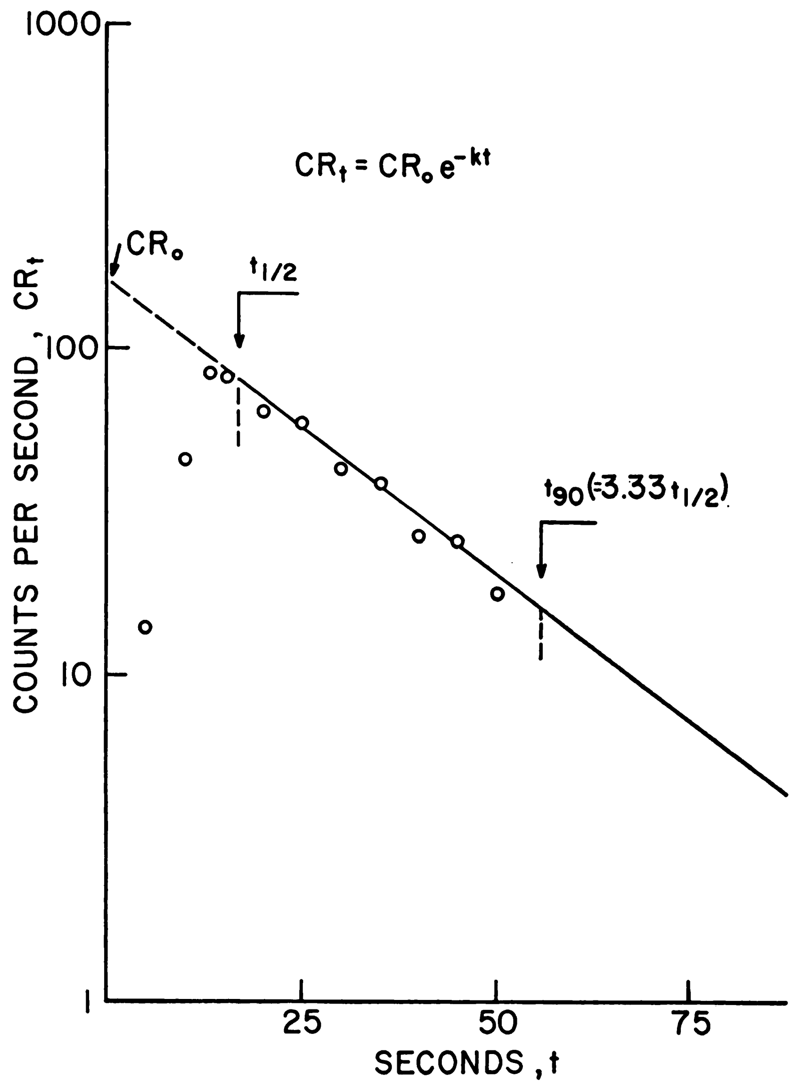

Fig. 1. Semilogarithmic plot of hypothetical precordial count rate data, corrected for background count rate.

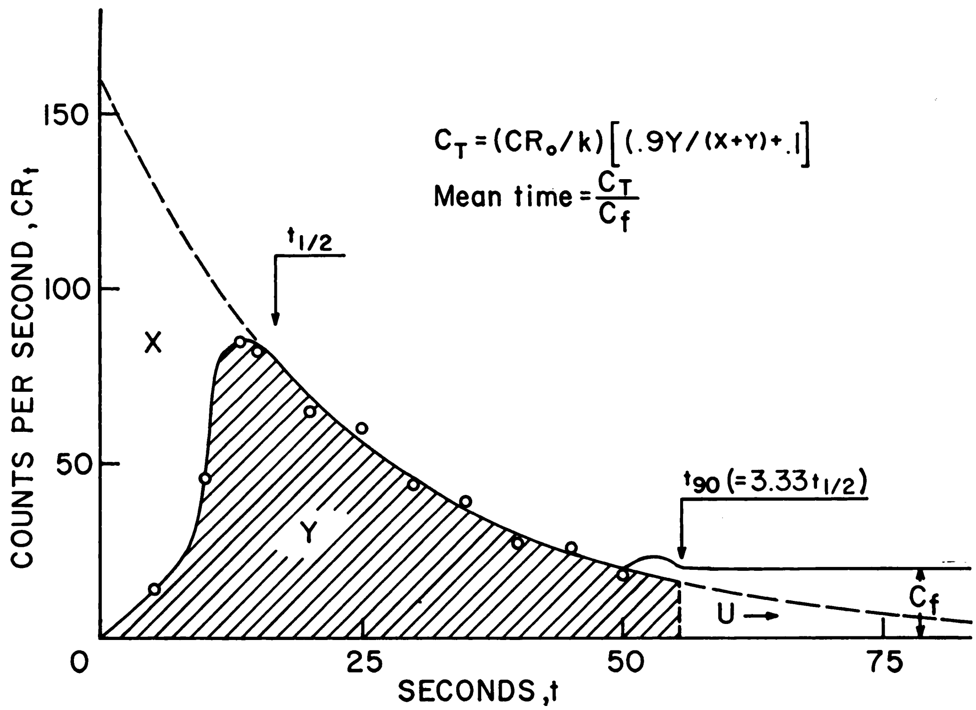

Fig. 2. Rectilinear plot of precordial data represented in Fig. 1, with background count rate normalized to zero. The height of the curve, C_f, represents blood count rate following distribution of radioisotope.

TABLE I

SAMPLE AREA CALCULATION†

Unit	*Count Rate (count-sec^{-1})*	*Time Span (sec)*		*Decay Const. (sec^{-1})*	*Areas (in^2)*		*Ratios (counts)*		*Total Counts*	*Mean Time (sec)*
Symbol	CR_o	$t_{1/2}$	t_{90}	k	X	Y	CR_o/k	$Y/(X+Y)$	C_T	
Value	160	50/3	500/9	(.693)(3)/50	5.81	10.44	3850	.643	2614	131

†Values for the symbols are taken from data plotted in Figs. 1 and 2.

never decreases, to zero. Consequently, the equation avoids improper geometrical constructions (frequently imposed with "French curves") that distort the actual path of the semilogarithmic function selected. Planimetric measurements of X and Y areas require a minimum effort. If instead, the investigator favors gravimetric measurement, the weights of the rectilinearly plotted areas, when cut along their borders, can be compared on an analytical balance to yield the area count ratio.

The planimetric solution of the data plots shown by the figures is presented in Table I. The simple computational procedure will encourage application of this approach to curves of a similar type.

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APPENDIX

Fig. 1. The equation for the semilogarithmic count rate curve is

$$CR_t = CR_0 e^{-kt} \qquad 1A$$

At t_{90}, defined as the time span when the curve has decreased by 90 percent of its original extrapolated value, CR_0,

$$CR_{90} = .1CR_0 = CR_0 e^{-k(t90)} \qquad 2A$$

Obviously, from 2A

$$e^{-k(t90)} = .1 \qquad 3A$$

and from the natural logarithms of 3 A,

$$t_{(90)} = 2.303/k \qquad 4A$$

but, since $k = .693/t_{\frac{1}{2}}$ therefore, 4A becomes

$$t_{(90)} = 3.33 t_{\frac{1}{2}} \qquad 5A$$

Fig. 2:

Figure 2 is a plot of the data on rectilinear coordinates, and illustrates the areas to be measured. The total numbers of counts to any time, t, can be computed from the integrated form of 1A.

$$C_t = \int_0^t CR_t dt = \int_0^t CR_0 e^{-kt} dt \qquad 6A$$

which amounts to

$$C_t = (CR_0/k)[(1 - e^{-k(t)})]_0^t \qquad 7A$$

The total counts that would accumulate under the curve to infinity would be

$$C_\infty = CR_0/k \qquad 8A$$

and to the time when 90 percent of the counts are collected is

$$C_{90} = (CR_0/k)(1 - e^{-k(t^{90})}) \qquad 9A$$

This expression can be simplified by introducing the value of $e^{-k(t90)}$ from 3A, giving

$$C_{90} = .9CR_0/k \qquad 10A$$

The count summation desired is the area equivalent of the sum, C_T, of counts, C_Y, in the area Y plus those unrecorded in the extended area U, or C_U. Geometrically, C_Y is proportional to the planimetric areas of X and Y.

$$CY = Y(C_{90})/(X + Y) \qquad 11A$$

From 10A and 11A,

$$C_Y = (CR_0/k)[.9Y/(X + Y)] \qquad 12A$$

and since it is clear from examination of Figure 2, 8A, and 10A that

$$\begin{aligned} C_U &= C_\infty - C_{90} \\ &= (CR_0/k) - (.9CR_0/k) \\ &= .1CR_0/k \qquad 13A \end{aligned}$$

then as defined above the total counts accumulated are, from 12A and 13A,

$$C_T = (CR_0/k)[(.9Y/(X + Y)) + .1] \qquad 14A$$