BLOOD-ALCOHOL CALCULATIONS BY INSTRUMENT

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In previous articles[1,2] I explained a comparatively simple formula by means of which it is possible to calculate the volume of alcohol absorbed in a human body from body weight (lb.) and blood-alcohol % w/v. A formula such as this which, in reality, is a derivation of the internationally acknowledged Widmark formula,[3,4] is liable to encounter certain obstacles in a court of law. Under cross-examination the district surgeon might be asked to explain its derivation in detail, and this requires memorizing of the facts and the application of algebraic equation.

Even the original Widmark formula requires manipulation, because the concentration of alcohol is stated as 'mg. alcohol per g. blood', while analytical reports give this concentration as 'blood-alcohol % w/v', i.e. g. alcohol per 100 ml. blood.

$$\text{(mg. alcohol per g. blood} = \frac{10 \times \text{blood-alcohol \% w/v}}{1{\cdot}056}$$

where 1·056 equals the average S.G. of blood.)

Closer consideration of Widmark's formula is necessary in order to clarify some of its aspects. It states that the number of g. of alcohol in a body equals the body weight in kg. multiplied by the concentration of alcohol in the blood, expressed as mg. alcohol / g. blood, multiplied by a factor 'r', i.e. the ratio between the concentration of alcohol in the body to that in the whole blood.[4] It is also stated[3] that 'r' is the ratio in weight between soft tissues and body. Herein then lies the true medical function of this formula, because it is the responsibility of the district surgeon to decide what the value of the factor 'r' is to be.

For purposes of calculation, 'r' is generally taken to be 2/3 or 0·67.[3,4] In his research Widmark[5] found that for spirits this factor in males varies between 0·60 and 0·76 and in females between 0·50 and 0·60. If these Widmark factors are taken into consideration, it would seem more

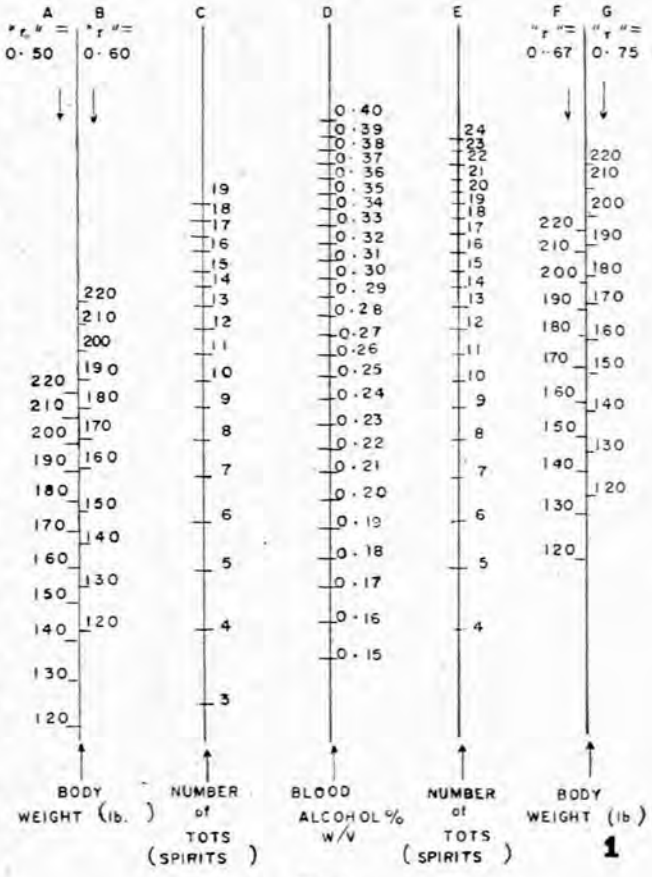

Fig. 1

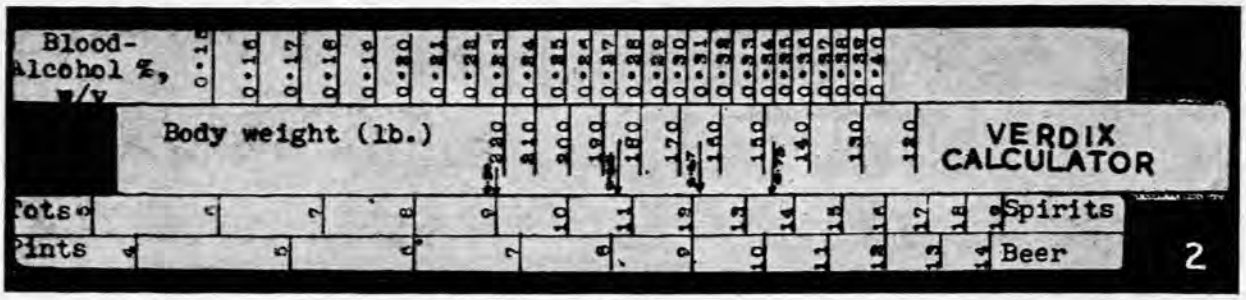

Fig. 2

appropriate to use the following values for spirits when calculations are made:

'r'= 0·60 (males); 'r'= 0·50 females

By so doing one is assured that only the absolute minimum amount of alcohol consumed is accounted for. This point of view is by no means novel, for it is actually suggested by the British Medical Association.[5] (For ease of calculation, the following values for 'r' were suggested by the Government Pathologist: minimum $\frac{1}{2}$, average $\frac{2}{3}$ and maximum $\frac{3}{4}$; in other words, 0·50, 0·67 and 0·75).

For the purpose of rapid calculation it was realized that various values could be placed in tabular form, i.e. plotting blood-alcohol % w/v against body weight (lb.), with the horizontal and perpendicular lines of intersection crossing each other at values denoting absorbed alcohol in weight[4] or in volume.[2] But this would provide no compromise between the use of a formula already established and one derived from the former. Moreover, a similar tabulation would have to keep count with 4 values for 'r', viz. 0·50, 0·60, 0·67 and 0·75, and would require 4 tables.

By means of a nomogram (Fig. 1), it is possible to avoid the use of these 4 tables. Here a straight line between blood-alcohol % w/v (scale D) and body weight (scales A, B, F and G respectively for 'r' values of 0·50, 0·60, 0·67 and 0·75) will intersect scale C or E, indicating the number of tots (spirits) consumed, i.e. alcohol absorbed by the body tissues and expressed in tots. Consider the following examples:

'r'= 0·50 (scale A); blood-alcohol= 0·23% w/v (scale D); body weight= 170 lb. This line intersects scale D at a value which is slightly less than 7 tots.

'r'= 0·67 (scale F); blood-alcohol= 0·27% w/v (scale D); body weight= 150 lb. This line intersects scale E at a value which is slightly less than 10 tots.

However, it will be realized that the use of a nomogram for the purpose of rapid calculation required in a witness box, is not very satisfactory and hence it was decided to construct a simple instrument as shown in the photograph.

Verdix Calculator

The 'Verdix' calculator (Fig. 2) resembling a small slide rule, has a size of only 7 × 1½ inches. The top scale, denoting blood-alcohol % w/v, is calibrated from 0·15 to 0·40 because it was found that a large portion of results from the chemical analysis of blood gave values between 0·20% and 0·30% alcohol, w/v. The bottom scale is especially calibrated for South African conditions, because a 'tot' is legally defined as one-quarter gill or 1¼ fl. oz.[6] and spirits as having a minimum alcoholic strength of 25° under proof or approximately 43% alcohol by volume.[7] Similarly a light beer such as Lager or Pilsener contains about 3·5% of alcohol by volume.[4] In other countries this calibration would have to be changed; e.g. in Great Britain a 'whisky', i.e. a tot of whisky, has a volume of approximately 5/6 fl. oz.[5]

The centre, or sliding, scale is calibrated in lb. body-weight from 120 to 220, which should cover the weight of most individuals. This calibration can also be changed to kg. for countries where the decimal system is in use. Furthermore the sliding scale has 4 arrows, each of which represents a different value for 'r'.

The reverse of the calculator—not shown in the photograph (Fig. 2)—gives instructions for operating. Mention is made of the numbered arrows, as well as of the alcoholic strengths of spirits and beer.

Operation is carried out by bringing body weight into line with the value for blood-alcohol % w/v. The relevant 'r' arrow will then on the bottom scale show the number of tots of spirits or pints of beer containing the same weight of alcohol as that absorbed by the body at the time when the blood sample was taken. In the photograph one sees 0·24% blood alcohol w/v, in line with 210 lb. body-weight. By calculation it was found that such a body would then have absorbed an amount of alcohol equivalent to that contained in slightly more than 12 tots (taking 'r' as 0·67) or 9 tots (taking 'r' as 0·50). The readings given by the 'Verdix' agree with these values.

An instrument of this type need not necessarily be constructed so as to resemble a slide rule; a model, thin enough to be inconspicuous between the pages of a book, has been made of cardboard. The ideal construction would probably be a hexagonally shaped metal rod, about the thickness of a pencil, partly surrounded by a metal sleeve, with both sleeve and rod appropriately calibrated.

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