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(54) IMPROVEMENTS IN AND RELATING TO CALCULATOR DEVICES

(71) I, DONALD MARLTROP, a British subject of 43 Coniston Gardens, Wembley, Middlesex, England, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to a manual calculator device for paediatric calculations, and, in particular, to such a device for use in calculating medical drug dosages for children.

Calculation of drug requirements for a child can be based on a relationship in which the child's drug dosage is adjusted, relative to that required by an average adult having a similar medical condition, in the ratio of the child's surface area to that of the average adult. The surface of an average adult is known, as is an empirical relationship between the surface of a child and its height and weight. Thus knowledge of a child's height and weight allows calculation of the drug dosage required for the child relative to the adult dosage for that condition.

According to the invention, there is provided a manual calculator for paediatric calculations, comprising first, second and third mutually relatively movable members carrying scales, the first having a log-log scale and the second and third members having respective logarithmic scales, measuring-off means for measuring off first and second distances along the log-log scale of the first member to calculate first and second numbers respectively equalling the child's weight and height raised to respective predetermined powers, and means for multiplying the numerical value of the one of the said first and second numbers by a predetermined constant and locating the resultant product value on the logarithmic scale of the second member, the third member being operable to measure off, along the logarithmic scale of the second member and onwards from the said product value thereon, a third distance corresponding on the logarithmic scale of the second member to the value of the other of the said first and second numbers, the predetermined powers and constant being such that the final value on the logarithmic scale of the second member at the end of the said third distance is directly proportional to the child's surface area.

According to the invention, there is also provided a calculator for calculating the relationship between a drug dosage for a child and the corresponding drug dosage for an adult, according to the formula:

$$\text{child's drug dosage} = \text{adult dosage} \times W^a \times H^b \times K,$$

where W and H are respectively the child's weight and height and a, b and K are constants, the calculator comprising first, second and third concentric discs mutually pivotable about their common axis, a log-log scale on the first disc, a cursor pivotable about the said axis and carrying a reference mark and two other marks respectively displaced from the reference mark by distances corresponding, on the said first scale, with the values a and b respectively, whereby to enable calculation of the values W^a and H^b, a first logarithmic scale carried on the second disc and on which one of the W^a or the H^b values from the said scale on the first disc can be visually located, a second logarithmic scale on the second disc displaced from the said first scale thereon for multiplying the said one of the W^a and H^b values by the constant K, and a logarithmic scale on the third disc juxtaposed with the said second scale on the second disc and similar thereto and having a reference point thereon for alignment with the value on the second scale on the second disc corresponding to the product of the said one of the W^a and H^b values and the constant K, whereby the value on the second scale on the second

disc which, after the said alignment of the reference point on the third disc's scale, is aligned with the value on the scale on the third disc of the other of the W^a and H^b values corresponds to the child's drug dosage as a percentage of the adult's dosage.

A paediatric dosage calculator device embodying the invention will now be described, by way of example only, with reference to the accompanying drawing showing a diagrammatic plan view of the device.

The calculator device comprises three different-radius concentric discs 10, 11, 12 having a common concentric pivot 13. The inner disc 10 is fixed by the pivot 13 in position on top of the middle disc 11 which is arranged on top of the outer disc 12.

On a respective corresponding face of each disc are inscribed one or more circular scales formed concentrically with the discs. The inner disc 10, middle disc 11 and outer disc 12 bear respective scales 14, 15, 16, around their outer perimeters and, in addition, the middle disc 11 has a scale 17 marked around the disc at a radius at least as great as that of the inner disc 10, so that the scale 17 is visible when the inner disc 10 is in position on the middle disc 11.

On top of the inner disc 10, a transparent quadrantal cursor 18 is fixed by, and arranged to rotate about, the pivot 13. The cursor 18 has a radius at least as great as that of the outer disc 12.

The cursor 18 has inscribed thereon a radial cursor hair line 19 extending over all the scales of the three discs. Two additional radial line marks 20, 21 are formed on the cursor 18, the mark 20 extending over all the scales of the three discs and the mark 21 extending over the scale 16 of the outer disc 12.

The average adult has a surface area taken to be 1.73×10^4 cm^2.

According to Dubois and Dubois (Arch. Int. Med., 1916 *17*, 863) the surface area of an adult approximately follows the relationship:

$$\text{Surface area (cm}^2) = W^{0.425} \times H^{0.725} \times 71.84$$

where H is height in cm and W is weight in kg.

This formula has been found to be applicable to children also.

Thus, from the above,

$$\text{Child's dosage} = \frac{\text{Adulst dose} \times W^{0.425} \times H^{0.725} \times 71.84}{10^4 \times 1.73}$$

$$= \frac{W^{0.425} \times H^{0.725} \times 71.84\% \text{ of adult's dose}}{10^2 \times 1.73}$$

The calculator device provides the child's dosage as a percentage for any corresponding adult dosage, within the range of 1 to 100, given the height and weight of the child.

The outer disc scale 16 is a log-log scale ranging over the values 1.5 to 200 and extending around approximately three quarters of the circumference of the outer disc 12. All logarithms given in respect of the exemplary forms of the calculator described herein are with reference to the base 10; however it is not intended that the claims should be so limited. The primary entries of the parameters H and W are made on this scale by means of the cursor hair line 19. The two cursor marks 20, 21 are designated 'W' and 'H' respectively and are so inscribed that if the cursor line 19 were set to any required value on the log-log scale 16 the values on that scale under cursor marks 20 and 21 would represent that value raised to the power 0.425 and 0.725 respectively.

The middle disc perimeter scale 15 extending around half the circumference of the middle disc 11 is a logarithmic scale ranging from the values 1 to 10. The middle disc scale 17 adjacent to the inner disc 10 is a two cycle logarithmic scale ranging from 1 to 100 and extending over 360°.

The scale 17 is displaced anticlockwise with respect to the scale 15 to provide direct multiplication between the scales in the ratio 71.84 to 17.3.

The inner disc scale 14 bears a two-cycle logarithmic scale extending completely around its perimeter for values 1 to 100. The point representing values 1 or 100 is marked B and the diametrically opposed point representing the value 10 is marked A.

The operation of the calculator device will now be described.

The weight (in kg) of the child to be treated is located on the log-log scale 16 and the cursor hair line 19 superimposed. The scale mark on the scale 16 under the cursor mark 20 represents the parameter W raised to the power 0.425, and the corresponding numerical value on the outer scale 15 of the middle disc 11 is thereafter aligned with it. In addition, the point A on the inner disc 10 is then aligned with it, using the cursor mark 20. The point on the scale 17 of the middle disc 11 which lies opposite the numerical value on the scale 15 corres-

ponding to the parameter W raised to the power 0.425, represents the parameter W rised to the power 0.425 and multiplied by the ratio of 71.84 to 17.3.

Without moving the discs relative to one another the cursor is then displaced so that the hair line 19 is super-imposed over the value for the height parameter H (in cm) located on the log-log scale 16. The scale mark on the scale 16 under the cursor mark 21, representing the parameter H raised to the power 0.725, is noted and the same value visually located on the inner disc scale 14. Using the cursor hair line 19 the value on the scale 17 aligned with the visually located point on scale 14 is determined and this effectively carries out a multiplication between the parameter H raised to the power 0.725 (on scale 14) and the parameter W raised to the power 0.425 and multiplied by the ratio 71.84 to 17.3 (on scale 17). However in addition to this multiplication, there is also effected a division by ten due to the relative positionings of the scales 14 and 17 resulting from the positioning of the reference point A (at the numerical value 10 on scale 14) opposite the point on the scale 17 representing W raised to the power 0.425 and multiplied by the ratio 71.84 to 17.3. This division by ten is necessary because the disc 15 multiplies in the ratio 71.84 to 17.3 (instead of 71.84 to 1.73). The aligned value on the scale 17 corresponds to the percentage of the adult dose required.

The value of 10^2 in the denominator of the fraction in the formula is taken care of by the fact that on the scale 14 each value thereon represents the inscribed number multiplied by 10^{2n} where n is any integer.

The inner disc 10 is then realigned such that the mark B (representing the value 1) corresponds to the percentage value so obtained. For any given adult dosage in the range 1 to 100 units as represented on the scale 14 of the inner disc 10, there is now a corresponding child's dosage indicated on the inner scale 17 of the middle disc 11.

The surface area of the child can be readily derived from the percentage dosage value previously located on the inner scale 17 of the disc 11. This is achieved by aligning a mark C, which is inscribed at a value 1.73 (the average adult surface area in m^2) on the scale 14 of the inner disc 10, with the value 1 (or 100) on the scale 17. The value of the scale 14 which now lies opposite the percentage dosage value on the scale 17 is equal to the child's surface area in m^2 multiplied by a factor of one hundred.

In another form of the paediatric dosage calculator, the child's surface area is calculated as a step intermediate to the calculation of the losage required for the child. In this embodiment the scale 17 is differently displaced with respect to the scale 15 so as to provide direct multiplication between the scales in the ratio 71.84 to 10 (and not in the ratio 71.84 to 17.3 as used in the first described form of calculator). The same calculator manipulations are carried out as described with respect to calculation of the percentage child dosage in the first form of calculator, but now the resultant value on the scale 17 corresponds to the child's surface area in m^2 multiplied by 100. By setting the adult dose, as visually located on the scale 14, in alignment with a mark inscribed on the scale 17 at the value 1.73, the value on the scale 14 lying opposite the value of the child's surface area on the scale 17, represents the required dosage for the child.

In both the described forms of calculator the mark A can be dispensed with if the two scales 15 and 17 of the middle disc 11 are further relatively displaced by relative rotation through 180°. This effects the desired division by ten (which, in both previously described forms, is carried out by the alignment of the mark A, instead of the mark B, with the scale mark on the scale 16 representing the parameter W raised to the power 0.425).

The cursor can be made from a transparent rigid plastic material having the markings formed thereon in a colour contrasting to that of the discs. The three discs of the calculator device can be formed from an opaque plastic material. The scales are printed on the discs in a colour to provide contrast with the colour of the discs. In a preferred embodiment the discs are white in colour and the scales are printed in blue or black markings; the cursor markings are formed in red.

The dimensions of the calculator device are not critical. The calculator device can be used for metric dosage measurements expressed in terms of either weight or volume.

Advantageously the calculator device can be used for calculation of drug dosages for children between the ages of 3 months and 18 years.

WHAT I CLAIM IS:—

1. A manual calculator for paediatric calculations, comprising first, second and third mutually relatively movable members carrying scales, the first member having a log-log scale and the second and third members having respective logarithmic scales, measuring-off means for measuring off first and second distances along the log-log scale of the first member to calculate first and second numbers respectively equalling the child's weight and height raised to respective predetermined powers, and means for multiplying the numerical value of one of the said first and second numbers by a predetermined constant and locating the resultant

product value on the log-arithmic scale of the second member, the third member being operable to measure off, along the logarithmic scale of the second member and onwards from the said product value thereon, a third distance corresponding on the logarithmic scale of the second member to the value of the other of the said first and second numbers, the predetermined powers and constant being such that the final value on the logarithmic scale of the second member at the end of the said third distance is directly proportional to the child's surface area.

2. A calculator according to claim 1, in which the said multiplying and locating means comprises a second logarithmic scale carried on the second member and displaced relative to the first-mentioned logarithmic scale of that member by an amount corresponding to the numerical value of the said predetermined constant, whereby alignment of the numerical value of the said one of the first and second numbers as located on the log-log scale of the first member and on the second logarithmic scale of the second member, locates the required said product value on the first-mentioned logarithmic scale of the second member in alignment with the said aligned numerical values.

3. A calculator according to claim 1 or claim 2, in which the numerical value of the said predetermined constant is such that the final value is equal to the child's surface area expressed as a percentage of the average surface area of an adult, said percentage corresponding to the child's drug dosage expressed as a percentage of the dosage for an adult whereby any numerical value of adult dosage can be converted into the corresponding child dosage by use of the logarithmic scale of the third member.

4. A calculator according to claim 3, including second measuring-off means for measuring off along the first mentioned scale on the second member, and onwards from the said final value thereon representing the percentage value of the child's dosage, a fourth distance corresponding to the average surface area of an adult whereby the numerical value at the end of the said fourth distance represents the surface area of the child.

5. A calculator according to claim 4, in which the second measuring-off means comprises the said third member, the fourth distance being measured off along the logarithmic scale of the third member.

6. A calculator according to claim 1 or claim 2, in which the numerical value of the said predetermined constant is such that the said final value is equal to the child's surface area.

7. A calculator according to any one of the preceding claims, in which the measuring-off means for measuring off the said first and second distances is a cursor having a reference mark and two other marks respectively spaced from the reference mark by the said first and second distances.

8. A calculator according to any one of the preceding claims, in which the said members comprise concentric discs pivoted together at their common axis.

9. A calculator according to claim 8, in which the cursor is also pivoted at the said axis.

10. A calculator for calculating the relationship between a drug dosage for a child and the corresponding drug dosage for an adult, according to the formula:

$$\text{child's drug dosage} = \text{adult dosage} \times W^a \times H^b \times K,$$

where W and H are respectively the child's weight and height and a, b and K are constants, the calculator comprising first, second and third concentric discs mutually pivotable about their common axis, a log-log scale on the first disc, a cursor pivotable about the said axis and carrying a reference mark and two other marks respectively displaced from the reference mark by distances corresponding, on the said first scale, with the values a and b respectively, whereby to enable calculation of the values W^a and H^b, a first logarithmic scale carried on the second disc and on which one of the W^a or H^b values of the said scale on the first disc can be visually located, a second logarithmic scale on the second disc displaced from the said first scale thereon for multiplying the said one of the W^a and H^b values by the constant K, and a logarithmic scale on the third disc juxtaposed with the said second scale on the second disc and similar thereto and having a reference point thereon for alignment with the value on the second scale on the second disc corresponding to the product of the said one of the W^a and H^b values and the constant K, whereby the value on the second scale on the second disc which, after the said alignment of the reference point on the third disc's scale, is aligned with the value on the scale on the third disc of the other of the W^a and H^b values corresponds to the child's drug dosage as a percentage of the adult's dosage.

11. A calculator according to claim 10, in which the first disc's scale extends around the periphery of the first disc, the second disc is of lesser radius than the first disc and its first scale extends around the periphery of the second disc, the third disc is of lesser radius than the second disc and the third disc's scale extends around the peri-

phery of the third disc, the said second scale on the second disc extends around the second disc adjacent but outside the periphery of the third disc, and the said cursor has a radius at least as great as the radius of the first disc.

12. A calculator substantially as hereinbefore described with reference to the accompanying drawing.

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