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LETTERS TO THE EDITOR

Measurement of auditory loss. Equation for its calculation

Medida de la pérdida auditiva. Ecuación para su cálculo

Dear Editor:

Hearing loss should be calculated according to the guidelines established in the legislation on disability. Royal Decree 1971/1999 of 23rd December, on the Procedure for Recognition, Declaration and Rating of the Degree of Impairment (State Bulletin of 26th January and 13th March 2000)[1] sets out in Annex I-A of Chapter 13, the rules to calculate the percentage of monaural hearing loss.

Regardless of whether one may criticise that the calculation of hearing loss is carried out based on air pathway thresholds, regardless of the type of hearing loss involved (conductive/sensorineural), in order to calculate the percentage of hearing loss, we start from the air pathway thresholds for the 4 frequencies considered as conversational (500, 1,000, 2,000 and 3,000 Hz).

The Royal Decree states that average thresholds, for conversational frequencies better than 25 dB, pose no hearing loss. From this figure, each average loss of a decibel represents a hearing loss of 1.5%; therefore, a hearing loss with a hearing level of 91.7 dB will be considered as a 100% loss.

If we compare the percentage of hearing loss on an X-axis and the average threshold for conversational frequencies by an air pathway on a Y-axis, we can plot a line following the guidelines established by the Royal Decree.

The general equation of a straight line has the form:

$$y=m.x+n$$

In our case, "y" represents the percentage of hearing loss, and "x" is the average in dB HL for conversational frequencies by air pathway. The coefficient of "x", "m", is defined as the slope of the line and represents the variation experienced by the ordinate variable "y" for each unit increase in "x". As mentioned in the Royal Decree, this coefficient is positive and its value is 1.5. The independent term "n" is the value taken by "y" when "x" is zero, which in this case is subtracting 37.5 (subtracting 25 times 1.5).

Therefore, the formula of the equation becomes:

$$y=1.5x-37.5$$

where "y" is the percentage of monaural hearing loss and "x" is the average threshold for the four conversational frequencies by air pathway.

If we substitute "x" by " x′ ", taking " x′ " as the sum of thresholds of the 4 conversational frequencies by air pathway, we must divide its coefficient by 4, since " x′ " is four times "x". The equation would then become:

$$y=0.375x'-37.5$$

where "y" remains the percentage of monaural hearing loss, but " x′ " is the sum of the thresholds of the 4 conversational frequencies (Figure).

Previously, a similar formula was published in this Journal by Drs Garcia Callejo et al.[2] that seemed inaccurate. In my opinion, they constructed a regression line from the values exposed in the table of the Royal Decree considering these values as a point cloud, therefore carrying an error that stems from the fact that the table offers the percentages of hearing loss with only one decimal place.

Clearly, if we subtract 25 from the average of the 4 conversational frequencies and we multiply the result by 1.5, we obtain the percentage of monaural hearing loss, in a way that is also accurate.

When referring to "hearing loss", if this is not specified to be monaural then it is understood to be binaural. To

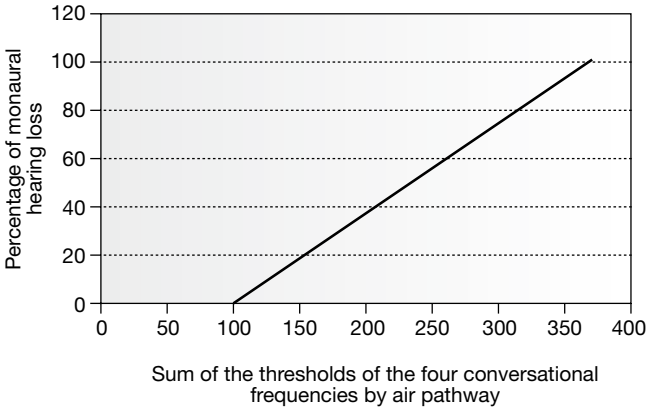

Figure Slope that links the sum of the thresholds of the four conversational frequencies in dB HL (X-axis) and percentage of hearing loss using the rule of Royal Decree 1971/1999 of 23rd December (State Bulletin, BOE, from 26th January and 13th March 2000).

calculate the binaural hearing loss, the Royal Decree establishes a weighted average of the percentage of loss in both ears. In this weighted average, the better ear weighs five times more than the worst. Thus, we must multiply the percentage of loss of the better ear by 5, add to it the percentage of loss of the worst and divide the result by 6.

It is also interesting to note that when the percentage of binaural hearing loss reaches 96.5%, the patient is recognised as having percentage of disability of 40%, which is the highest awarded due to hearing loss.

References

1. El Real Decreto 1971/1999, de 23 de diciembre de Procedimiento para el Reconocimiento, Declaración y Calificación del Grado de Minusvalía (BOE de 26 de Enero y 13 de Marzo de 2000), Anexo 1A, Capítulo 13.
2. García Callejo FJ, Orts Alborch MH, Peña Santamaría J, Morant Ventura A. Medida de la pérdida auditiva. Una ecuación para su cálculo rápido. Acta Otorrinolarigol Esp. 2005;55:179-80.

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Measurement of auditory loss. Equation for its calculation: Response

Medida de la pérdida auditiva. Ecuación para su cálculo: Respuesta

Dear Editor:

We read with great interest the letter from our colleagues in reference to the development of an equation for the calculation of hearing loss. It generates satisfaction to know the concern of other study groups for simplifying and quantifying the degree of hearing impairment for the monitoring of this disorder and the completion of reports to that effect with a clinical, work-related or even legal emphasis.

Indeed, hearing loss is measured in accordance with Royal Decree 1971/1999 from 23rd December, on the Procedure for Recognition, Declaration and Classification of the Degree of Disability.[1] The current legislation works with the thresholds by air pathway detected in conversational frequencies recorded through a liminal tonal audiometry (500, 1,000, 2,000 and 3,000 Hz). In this sense, the sum of these 4 thresholds determines the percentage of hearing loss, considering normal hearing or 0% hearing loss when this sum of thresholds is less than or equal to 100 dB HL.

In relation to this circumstance, the Royal decree provides a table of quantitative equivalences between the percentage of monaural hearing loss and the sum of the 4 frequencies described. In turn, this table of equivalences is derived from the established fact that no hearing impairment is considered in a tone when the threshold by air pathway is equal to or less than 25dB HL.

In a very enlightening manner, our colleagues point out that, above this threshold, by each dB that the threshold increases, hearing loss increases by 1.5%, so that in a single frequency a hearing level of 91.7 dB HL conditions a degree of hearing loss of 100%

These increases enable our colleagues to develop the equation for the calculation of hearing loss in a single frequency:

$$y = 1.5x - 37.5,$$

where "y" expresses the percentage of hearing loss and "x" represents the hearing threshold determined by air pathway in the explored frequency.

Since this equation only concerns a mono-frequency gradient, the degree of loss assumed by the current legislation requires the 4 frequencies already described to be assumed, which effectively leads to the calculation:

$$y = 0.375x - 37.5,$$

where "y" continues to express the percentage of hearing loss, this time in the 4 conversational frequencies, and by law the hearing loss in one ear, and "x" is the result of adding the thresholds by air pathway of these 4 frequencies. Assuming the loss in 4 frequencies requires lowering the value of the slope of the equation to a quarter of its value, from 1.5 to 0.375.

Starting from the same documentary source, our estimate of hearing loss followed a comparative analysis of the 2 quantitative variables offered by the Royal Decree, which indeed are parameters with one decimal point. The result of the equation which we obtained was:

$$y = 0.3745x - 37.395,$$

where "y" and "x" express the same values as those described by our colleagues. It can be appreciated that variations in both the value of the slope (0.3745) and in the intercept (–37.395) are remarkably similar to those reported in the recent article. In addition, our graph showed a linearity coefficient of $R^2=1$, which ultimately generates maximum reliability in the calculation of monaural hearing loss.[2]

Under these conditions, it does not seem to us that the elaboration of our equation can be described as inaccurate.