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RISK MEASURE OF DOMESTIC TRANSMISSION OF CHAGAS' DISEASE, THROUGH A NEW ENTOMOLOGICAL INDICATOR

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The long evolution, the remarkably chronic character of Chagas' disease, the difficulties of human case detection in its acute phase, and the fact that all the control action is pointed to domiciliated vector populations, indicate the necessity for entomological indicators sensitive enough, to evaluate these control actions. Many measurements have been proposed, but none of them alone serves to determine the risk of domiciliary transmission of disease by triatominea.

It is virtualy impossibile to obtain a straight measure of the frequency and probability of contact between healthy man and infected vector. Also there are great differences in species behaviour that influence the process of diffusion of the disease. This means the data has to be examined as a whole in relation to specific areas or situations.

In current use are the following indicators (OMS, 1983; OPAS, 1978; SUCAM, 1980):

$$\text{Dispersion Index: } \frac{\text{N}^{\text{o}} \text{ of positive localities for triatominea X 100}}{\text{N}^{\text{o}} \text{ of investigated localities}}$$

$$\text{Infestation Index: } \frac{\text{N}^{\text{o}} \text{ of habitations positive for triatominea X 100}}{\text{N}^{\text{o}} \text{ of habitations investigated}}$$

$$\text{Natural Infection Index: } \frac{\text{N}^{\text{o}} \text{ of positive triatominea X 100}}{\text{N}^{\text{o}} \text{ of examined triatominea}}$$

$$\text{Colonization Index: } \frac{\text{N}^{\text{o}} \text{ of habitations with triatominea nymphs X 100}}{\text{N}^{\text{o}} \text{ of habitations positive for triatominea}}$$

$$\text{Density Index: } \frac{\text{N}^{\text{o}} \text{ of collected triatominea X 100}}{\text{N}^{\text{o}} \text{ of investigated habitations}}$$

$$\text{Crowding Index: } \frac{\text{N}^{\text{o}} \text{ of collected triatominea X 100}}{\text{N}^{\text{o}} \text{ of habitations with triatominea}}$$

The accurate interpretation of the results revealed by these indexes require elaborate analysis since these variables are connected and must be investigated in their interrelation.

Nevertheless, the degree of transmission risk will always be presumptive.

The indicator we present uses the rate of house infestation as an indirect estimator of man-vector contact. It takes into consideration the fraction of people living in infested habitations as part of the population. This is a real indicator of the relative quantity of infested habitations. In man-infected vector contact there are some passive factors involved which are measured with information obtained from the routine process of sistematic research of triatomineas. We consider it logical to include them in the model presented here. We also consider in this model the additive and multiplier effect of the various components. The quantity of infested habitations in a certain area alone is an insufficient indicator of the possibilities of infection risk. Factors such as the prevalent specie of triatominea in the area, presence or absence of triatominea colonies inside of habitations, presence or absence of infected triatominea in the habitation and the proportion of infected triatominea in each colony, will change the value of that indicator in its performance in the entomological estimator of the transmission potential. In fact, the absence of colonies within habitations and/or infected triatominea inside of habitation, tend to reduce the quantity of infested habitations, in which a real infection risk exists.

Consequently, we intend to try and measure the quantity of existing habitations that do posses effective capacity to produce human cases of Chagas' disease. To that purpose, we correct the observed quantity of infested habitations by quantifying expressions of factors mentioned above. As one of the factors of correction, the rate of observed colonization need to be, itself, corrected by the presence and

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proportion of infected triatominea in the observed colonies. We apply in the proposed indicator the factors of correction that may reduce the number of colonies, observed by the quantities of colonies that effectively constitute risk of transmission of the disease. In this way, the observed rate of infestation, $Io = \frac{Dp\ 100}{D_E}$ (where Io = observed rate of infestation expressed in percentage; D_p = Infested habitations; and D_E = Number of habitations studied). This assumes the following expression:

$$I_R = \frac{D_p . (P_1 + CP_2 + CD_T TP_3) \times 100}{D_E . (P_1 + P_2 + P_3)} \quad \text{or} \quad I_R = \frac{D_P [P_1 + C (P_2 + D_T TP_3)] \times 100}{D_E . (P_1 + P_2 + P_3)}$$

where:

- I_R = Habitation infestation rate taking into account only habitations with effective risk of transmission
- D_p = Number of infested habitations by one specie of triatomine observed in the area
- D_E = Number of habitations in the area
- C = Coefficient of colonization in the area
- D_T = Coefficient of infested habitations with infected triatomines
- T = Proportion of infected triatominae observed in the area, and
- P_1, P_2 and P_3 represent, respectively measures of the potential risk associated with the finding of specimens of one certain species in the infested habitations, habitations with colonies, and habitations infested only by infected triatomines. All values of the formula, except P_1, P_2 and P_3, are obtained from data collected during triatomine capture. The value C is obtained from the division of the quantity of habitations positive for nymphs by the total of positive habitations to any stage of triatomines. D_T is obtained with division of the quantity of positive habitations for infected triatominea by the total of infested habitations by any variety of triatomine.

This is obtained from the proportion of infected triatominea by the total of triatominea detected in the area.

$$C = \frac{\text{number of habitations positive for nymphs at any stage}}{\text{total number of positive habitations for any species of triatomine}}$$

$$D_T = \frac{\text{number of positive habitations for infected triatomine}}{\text{total number of positive habitations for any species of triatominea}}$$

$$T = \frac{\text{number of infected triatomine}}{\text{total number of triatomine captured and investigated}}$$

The values of P_1, P_2 and P_3 are arbitrary functions of the participation of each specie in the known mechanisms of transmission of the endemic disease. However they may be obtained in future by means of calculation starting from the quantification of factors involved in bionomics of each species. The proposed above indicator results as we can see, from the combination of data presently obtained in the ordinary process of triatomine capture which were grouped in different index and are apparently unconnected among themselves. The indicator presents the advantage of representing the integrated result of the mutual action of variables in an easier manner.

It is important to observe that the model does not include an indicator of importance in the determination of the transmission risk. That is the quantity of triatomine available for each inhabitant in a given area. This depends on the fact that, at the moment, we do not have the technical resources to connect the data to compare this variable with the precision required. The tendency to reduce the value of the rate of infestation observed in situations of low potential of transmission and of preserving the value of this rate in situations of high potential gives the proposed indicator added value as a sensitive measure of the variations mentioned above.

Through the formulae we can see that the final value of I_R changes between a minimum limit which is equal to the number of habitation units infested by a certain species multiplied by P_1 and divided by the sum of these values. When the sum of the factor products multiplied by P_2 and P_3 is equal to zero, and the maximum value is equal to the observed rate of infestation multiplied by 1 the factors resulting from multiplication by P_2 and P_3 are equal to P_2 and P_3 respectively. Such variation is adjusted at will, to the intuitive notion of the variation of risk potential with the values of variables included in the model.

The importance of variables P_1, P_2 and P_3 in modulation of result of each I_R is obvious. The values attributed to P_1, P_2 and P_3 depend:

1º) on the degree of domiciliation and anthropophily of the species resulting in, adaptation to domicile and association with man;

2º) on the fact that the species is autochthonous and still present in sylvatic ecotopes or introduced in the area and then domiciliated.

Recognising that infestation or presence of vector in the domicile producing colonization and carrying infection are necessary conditions for the occurence of transmission, we suggest:

1º) For species exclusive or almost exclusively domiciliated *T. infestans* and possibly *P. megistus,* in part of North-east of the country – a high value for P_1, also in function of its importance, already demonstrated, as vector of Chagas' disease; while P_2 and P_3 will assume in this case, minor values;

2º) On the contrary, for native species with modest participation in transmission like *Rhodnius neglectus* or *Rhodnius nasutus* less adapted or in initial phase of adaptation to domicile the P_2 value must be greater, because the simple presence of these species in houses will not represent a big risk, unless they colonize habitations.

We think that will be necessary to adjust the emphasis to the characteristics of different species, mainly with respect to habits and behaviour, in the specific area studied.

To facilitate treatment of data and to use the sum of P_1, P_2 and P_3, we believe will be convenient to be equal to 10 or to multiples of this value.

The indicator presented must be better tested, using the available information and from the simulation of known situations.

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