Mathematical modeling for hemoglobin change due to blood loss due to hookworm infection

Sir,

Hookworm is an important tropical infection that can result in blood loss and hypochromic microcytic anemia. The pathophysiology of blood loss due to hookworm infection is very interesting. Here, the authors try to use the medical mathematical modeling for the explanation of the blood loss due to hookworm infection. Basically, the normal hemoglobin level is physiologically maintained, and the normal red blood cell pool in blood is physiological observed. This can be represented as "red blood cell pool = red blood cell production – red blood cell destruction" or "hemoglobin pool = hemoglobin production – hemoglobin destruction." The turnaround time of red blood cell or red blood cell lifespan is 120 days or 4 months or estimated 3 g/dL of hemoglobin decrease at 1 month. At this physiological level, the stabilizing can be seen. Hence, "red blood cell stabilizing value = fixed rate of red blood cell production – fixed rate of normal red blood cell decay" or "hemoglobin stabilizing rate = fixed rate of hemoglobin production – fixed rate of hemoglobin decay" can be expected in a 1-month period. This can be simply presented as "hemoglobin stabilizing value = hemoglobin production – hemoglobin destruction." This condition can be altered by pathological condition. At a physiology condition, the nonanemic reference level of hemoglobin due to the WHO criteria is 12 g/dL. There will be a fixed rate of red blood turnaround value to maintain the hemoglobin stabilizing value. Hence, "12 = hemoglobin stabilizing value = hemoglobin production – hemoglobin destruction."

The hookworm infection is an important cause of loss of blood, which also means loss of hemoglobin. In case of hookworm infection, the equation will be "hemoglobin pool in hookworm infection = hemoglobin stabilizing value – hemoglobin loss due to hookworm infection = 12-hemoglobin loss due to hookworm". As noted by Martinez-Torres *et al.*, a patient with a hookworm infection can lose up to 0.03 ml, of blood, daily.[1] Using the referencing data that 1 unit of blood (450 mL) can result in increased 1.14 g/dL hemoglobin,[2] the mentioned loss due to hookworm infection will result in 0.000076 decreased of hemoglobin per day or 0.00228 decreased of hemoglobin per month.

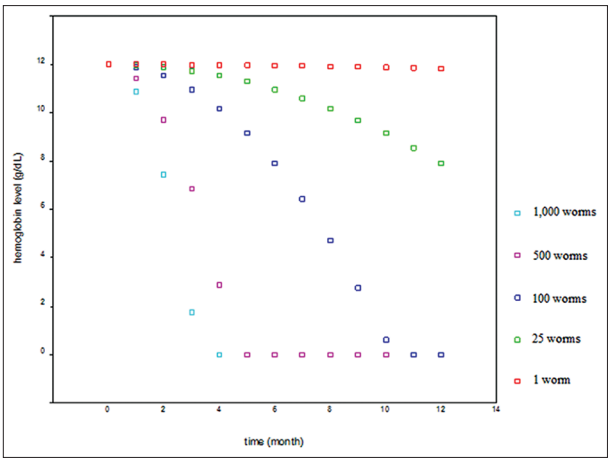

Figure 1: Expected hemoglobin level (g/dL) at different period simulating varied number of worm

At a time (month), the rate of hemoglobin pool in hookworm infection at that time (H[t]) will be "fixed rate of red blood turnaround value-0.00228t. Using integral equation to get the overall accumulated hemoglobin pool in hookworm infection, the final equation will be derived as "$_0\int^t H(t) = 12\text{-}0.00228t^2/2 = 12\text{-}0.00114t^2$." Nevertheless, this equation is based on the assumption that there is only 1 worm, hence the additional parameter to be considered is the number of worm. Here, the number of worm is assigned as X; then, the derived equation is "12t – $0.00228t^2X/2$." The expected hemoglobin level at different period simulating varied number of worm is shown in Figure 1.

Based on this model, the heavier infection, more worms, result in more severe of disease. More decreased hemoglobin can be seen in heavier infection. Furthermore, a clear clinical problem seems to occur when time is more than 1 month.

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Conflicts of interest

There are no conflicts of interest.

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REFERENCES

1. Martinez-Torres C, Ojeda A, Roche M, Layrisse M. Hookworm infection and intestinal blood loss. Trans R Soc Trop Med Hyg 1967;3:373-83.

2. Hoque MM, Adnan SD, Karim S, Al Manmun MA, Nandy S, Faruki MA, *et al*. Equilibration and increase of hemoglobin concentration after one unit whole blood transfusion among patients not actively bleeding. J Dhaka Med Coll 2014;23:161- 6.

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