Keywords:Blood supply; Supply and demand; Vague set; Similarity measure

Introduction

According to the principle of blood supply and demand balance, it would be the sign of regional blood being at supply and demand equilibrium state that regional blood center stock's real level waves around its ideal level. For the collection and clinical usage quantities of regional blood are all impacted by many complicated factors, it is hard to control a blood center stock' real level close to an exact ideal level all the time, and the related cost is usually large, a more practical and e ective method is that, let a blood center stock level changing in a reasonable interval. However, a problem is emerging, what kind of blood center stock level interval is reasonable, that is, what kind of blood center stock level interval can satisfy the requirement of regional blood supply and demand equilibrium. At present, studies on regional blood supply and demand balance mostly focus on concept and idea, and study on the concrete model for regional blood supply and demand balance adjustment is seldom published. e following are several relevant representative research works published in the literature. Brodheim and Prastacos [1] constructed a Markov chain based model. With the application of the model, regional blood allocation strategies can be gained. Kopach et al. [2] developed a red blood cell stock management system based on a queuing model, and analyzed the e ciency of the model with simulation method. Dijk et al. [3] combined stochastic dynamic programming with simulation to develop a novel approach. e approach can deal with the tradeo between outdating and shortages of blood platelet production.

In this paper, a vague set based model is proposed for regional blood supply and demand balance adjustment with quantitative way. Blood stock level of regional blood center is chosen as expressing indicator and the ideal blood stock level interval as criteria, and considering the fuzzy characters of the indicator being subject to its criteria interval, vague set similarity measure function is applied to found a vague set based measure function for regional blood supply and demand balance extent. With the introduction of adjustment factor for regional blood supply and demand balance, derived from the measure function, an adjustment model for regional blood supply and demand balance is established. With the application of the model, and referring to the literature published blood stock operation data of several regional blood centers in China, a determination method of the aimed lower and upper limit of blood center stock control level is obtained. e aimed lower and upper limit of blood center stock control level can be an operable reference to blood center stock operation, which is helpful for regional blood center to e ectively manage its blood stock

evidence for x, and $f_v(x)$ is a lower bound on the negation of x derived from the evidence against x. $t_v(x)$ and $f_v(x)$ both associate a real number in the interval [0,1] with each point in X , where $t_v(x) + f_v(x) \leq 1$. That is $t_v: X \to [0,1]$, $f_v: X \to [0,1]$,

value $y_{i,k}$ of $y_{i,j}$ being closer to its ideal value $y_{i,m}$, the operation may become more difficult, that is, in the value interval [0,1] of regional blood supply and demand balance degree of blood type i, as $s_{i,k}$ increasing, the regional blood supply and demand balance adjustment of blood type i may become more difficult. If an adjustment factor, marked as R, is introduced to express this kind of adjustment effect,

ideal interval upper limit $\overline{\overline{\ }}$, and maximum value $\overline{\overline{\overline{\ }}}$ of y_i. Referring to the published blood stock operation data of several regional blood centers in China in the literature [7-11], and supposing the average blood usage quantity per day in a blood center during a selected period of blood type i being marked as (U_i), the parameters values in Equation 8 can be recommended as Table 3.

Basing on Table 2, concerning different adjustment goals, a series of related adjustment factor R_i values can be chosen. By Table 3 and Equation 8, according to the chosen adjustment factor R_i values, the aimed lower and upper limit coefficients and their intervals of blood center stock level of blood type i can be got as Figure 2.

In blood stock management practice of a regional blood center, the lower, upper limit of blood center stock level values of blood type i can be obtained by the lower, upper limit coefficients in Figure 2 being multiplied with the average blood usage quantity (U_i) per day of blood type i in the blood center.

From the aimed lower and upper limit coefficients of blood center stock level of blood type i in Figure 2, by Equation 2, the related regional blood supply and demand balance degree $E_{i,k}$ of blood type i can be got as Figure 3.

Analysis and discussion

(1) Considering the complexity of relationship between adjustment factor and regional blood supply and demand balance extent, the related relationship function is designed to be logarithm function, which produces the adjustment effect like that, by the same step length the adjustment factor value is raised in interval [1,10], but the increases of blood center blood stock level and regional blood supply and demand balance degree is becoming smaller and smaller. The designed adjustment effect may reflect that, the closer the real state of regional blood supply and demand balance to its ideal state, the more difficult the adjustment operation is, therefore, the less improvement of the state the same rising of adjustment factor can produce.

(2) From Tables 1 and 2 and Figure 1, we can see the following adjustment effect which is made by the designed logarithm function. If the aimed adjustment goal is “Almost eliminating excessive supply” or “Almost eliminating deficient supply”, the possibly choosing value of adjustment factor is at interval [4,7], the possibly achieved regional blood supply and demand balance degree is at interval (0.60,0.85), and the possibly achieved regional blood supply and demand balance state is “A little deficient or excessive supply” or “Near equilibrium”. If the

stock management practice of a regional blood center, the lower, upper limit of blood center stock level control values of blood type can further be got by the lower, upper limit coefficients being multiplied with the average blood usage quantity per day of blood type in the blood center.

Conclusions

The vague set based model for regional blood supply and demand balance adjustment is proposed. The model works with the help of a standardized adjustment factor, and the adjustment factor being integrated into the model is depended on the application of a vague set similarity measure function. Because of the design of logarithm function relationship between regional blood supply and demand balance extent and adjustment factor, the adjustment by the model can be practical and exact to some extent, moreover, the aimed lower and upper limit of blood center stock control level got from the model can be an operable and clear reference to blood center stock operation, which is helpful for regional blood center to effectively adjust its blood stock level according to different regional blood supply and demand balance goal. Although the adjustment effect of the model is comparatively satisfied, necessarily the model should be improved further, for the state of regional blood supply and demand balance is impacted by many complicated factors, such as the dynamic character of blood collection and usage in a region, and even blood center operation officer's risk preference, blood center