**Appendix A-I**

|  |  |  |
| --- | --- | --- |
|  |  | (A-1) |
|  | Where | (A-2) |
|  |  | (A-3) |
|  |  | (A-4) |
|  |  | (A-5) |
|  |  | (A-6) |

These expressions satisfy the constraints,

|  |  |  |
| --- | --- | --- |
|  |  | (A-7) |
|  |  | (A-8) |
|  |  | (A-9) |

**Appendix A-II**

Here, represents the requirement for blood cross-matching at hospital i during period t, and this follows a normal distribution (,).The term denotes the outdated blood products at hospital i during period t. Additionally, p represents the cross-matching to transfusion ratio, which is the proportion of transfused units relative to cross-matched units. At the same time, we define .

Freshly ordered blood products will only be cross-matched after completing the cross-matching of existing inventory. The cross-matching process adheres to the FIFO (First In, First Out) policy. In this context, the age of the freshly ordered blood products is. This age refers to the time fresh blood products spend in unassigned inventory before their turn for cross-matching. When first entering the unassigned inventory, the blood products without cross-matching amount to , which equals . Therefore, the age of the freshly ordered blood products is:

|  |  |  |
| --- | --- | --- |
|  |  | (A-10) |

At this point, the time the fresh blood products spend in unassigned inventory before they are first cross-matched is represented by a random variable Λ. Since cross-matching requirements approximately conform to a normal distribution, they are subjected to an inverse Gaussian distribution. Consequently, Λ also adheres to a normal distribution. This allows us to determine ,,.defines the cross-matching quantity of blood products from the unassigned inventory during this period. This quantity must consider the release of the cross-matched blood products from the inventory of the previous period. Here, d denotes the Cross-Matching Release Period, which is a cycle from cross-matching to release.

Owing to the unpredictable demand for blood products, the daily level of unassigned inventory undergoes dynamic changes. We posit that the unassigned inventory level cannot fall below the optimal inventory level . Hence, the probability distribution of can be expressed as follows:

|  |  |  |
| --- | --- | --- |
|  |  | (A-11) |
|  |  | (A-12) |

The average blood products usage is:

|  |  |  |
| --- | --- | --- |
|  |  | (A-13) |

The variance of blood products usage is:

|  |  |  |
| --- | --- | --- |
|  |  | (A-14) |

The average inventory days of blood products are:

|  |  |  |
| --- | --- | --- |
|  |  | (A-15) |

The variance of fresh inventory days in blood products are:

|  |  |  |
| --- | --- | --- |
|  |  | (A-16) |

The outdating amount of blood products are:

|  |  |  |
| --- | --- | --- |
|  |  | (A-17) |

When the demand for cross-matched blood exceeds the unassigned inventory level, the average blood shortage can be represented as follows:

|  |  |  |
| --- | --- | --- |
|  |  | (A-18) |

**Appendix A-III**

(1) Analysis of (s, Q) Strategy

The (s, Q) strategy, also known as the quantitative order control strategy, involves setting a reorder point s in advance and continuously monitoring the inventory level. When a hospital places an order, it needs to verify the inventory level each time to see whether the inventory has fallen below the preset s. If the inventory level drops to s, a new order is triggered with the purchasing quantity set at Q, which is the economical batch quantity. The order quantity is , and the decision is expressed as follows:

|  |  |  |
| --- | --- | --- |
|  |  | (A-19) |
|  |  | (A-20) |

Firstly, the s is determined as s, . where SS is the safety stock level, and is the maximum possible demand for blood products during the lead time. Z signifies the number of standard deviations under the given service level of blood products, while represents the standard deviation of blood product demand during the lead time.

Having calculated s for each day of a week, we can analyze the effect of different parameter combinations on key indicators, such as blood shortage and outdating, through parameter comparison operation experiments. This analysis allows us to determine the optimal inventory control parameters, a suitable (s, Q) combination.

Simulations enable us to arrive at an appropriate parameter combination (s, Q). The settings for s and the economical batch quantity Q are detailed in Appendix B.

(2) Analysis of (s, S) Strategy

The (s, S) strategy involves establishing minimum and maximum inventory control levels in advance. The minimum inventory level (reorder point) is denoted s, and the maximum inventory level (order-up-to-level) is denoted s. After the hospital satisfies the blood demand, the inventory level is checked at the end of the period. If the inventory level is less than the reorder point s, replenishment orders are dispatched to the blood center. Otherwise, no orders are placed. The decision-making expression is:

|  |  |  |
| --- | --- | --- |
|  |  | (A-21) |
|  |  | (A-22) |

The reorder point s is determined as in section (1). The order-up-to-level s is examined through parameter comparison experiments to identify the optimal parameter combination. Results are presented in Appendix B. When the reorder point s and the order-up-to-level s are set to the current level, blood shortage and outdating are relatively balanced, with a better performance observed in terms of blood shortage.

(3) Analysis of (T, S) Strategy

The (T, S) strategy involves periodical inventory control, where replenishment occurs at regular intervals T to the order-up-to-level s. The purchasing quantity is:

|  |  |  |
| --- | --- | --- |
|  |  | (A-23) |
|  |  | (A-24) |

Initially, the order-up-to-level s is set as in Section (2). Simulations are run with periods T=1, T=2, and T=3, and s is adjusted bidirectionally to find the optimal parameter combination. When the ordering cycle T and the target inventory s are set at the current level, blood shortage is relatively balanced, and the shortage level is relatively low.

(4) Analysis of EWA-based Strategy

This paper presents an inventory strategy based on the traditional EWA strategy. This strategy accounts for potential outdated amounts in replenishment decision-making, catering to the dynamic process of blood product replenishment while aiming to minimize blood shortages. It also considers the inventory of older blood products when deciding whether to increase replenishment quantities.

The decision-making process involves two steps. First, the hospital decides on the production quantity based on the current inventory level and the order-up-to-level, in line with the traditional order point replenishment strategy. Second, the hospital calculates the ratio of older blood inventory (remaining validity threshold j) to total inventory. If this ratio surpasses the predetermined threshold δ, this portion of older blood is added to the production plan. The decision is as expressed as follows.

First,

Second,

**Appendix Table B-I**

Table I: Parameters of blood agent

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Agent Type | Parameter1 | Parameter2 | Parameter 3 | Parameter 4 |
| Blood Agent | Blood Type | Blood Age | — | — |
| Order Agent | Ordering Hospital | Demand Type 1  (Blood Type) | Demand Type 2 (Acute， Emergency) | Blood Amount |

**Appendix Table B-II**

Table II: Blocks in agent modeling kibrary (anyLogic simulation platform)

|  |  |
| --- | --- |
| **Name of the block** | **Description of the Block** |
| A black text on a white background  Description automatically generated with medium confidence | This block simulates various types of agents, establishing the same internal environment for similar agents. It only requires changes in parameters, eliminating the need for repeated creations. |
| A black text on a white background  Description automatically generated with medium confidence | It simulates agent parameters such as the donor's method of blood donation, the volume of blood donated, the lifespan of blood quality, order source, order volume, and inventory strategy control parameters, among others. In addition, different inventory policies are entered as control parameters. |
| A black text on a white background  Description automatically generated with medium confidence | Numerical updates through certain operations primarily simulate the model's running situation. This includes specifics like inventory holding amount, blood shortage amount, overdue amount, and number of blood donations at a particular time. |
| A black text on a white background  Description automatically generated with medium confidence | This module is primarily used to simulate blood inventory, order collection, and blood donor queuing. Paired with the blood agent type, it enables accurate simulation of details regarding blood center age. |
| A black text on a white background  Description automatically generated with medium confidence | The module comes in two forms. The first returns a value and is used in this paper to control the occurrence of certain behaviors. The second form involves behavior without a return value, used here to simulate various agent behaviors as previously described. |
| A black text on a white background  Description automatically generated with medium confidence | It is employed to simulate the operation of the BSC. In this paper, the function module is used to run events. |
| A picture containing font, logo, graphics, design  Description automatically generated | This module is used to input and call statistical analysis data on the number of blood donors. |
| A black text on a white background  Description automatically generated with medium confidence | It simulates the behavior of blood donors choosing blood donation vehicles. |
| A black text on a white background  Description automatically generated with medium confidence | This module stores key indicator data for parameter change experiments and sensitivity analysis. |

**Appendix Table B-III Demand Information of blood supply chain**

Table III: The demand information for platelets in hospitals under the seasonal blood shortage

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| hospital | MON | | TUE | | WED | | THU | | FRI | | SAT | | SUN | |
|  | ED | SD | ED | SD | ED | SD | ED | SD | ED | SD | ED | SD | ED | SD |
| 1 | 7.03 | 3.63 | 6.56 | 1.93 | 6.36 | 3.44 | 4.01 | 6.79 | 6.6 | 1.30 | 6.13 | 2.19 | 6.83 | 3.98 |
| 2 | 7.69 | 3.81 | 5.61 | 1.99 | 7.02 | 4.62 | 6.88 | 8.32 | 7.26 | 1.16 | 5.67 | 2.95 | 6.37 | 4.50 |
| 3 | 13.48 | 4.25 | 9.14 | 1.78 | 9.81 | 4.93 | 8.27 | 7.40 | 11.05 | 1.28 | 10.78 | 2.90 | 12.48 | 3.28 |
| 4 | 7.37 | 2.83 | 6.32 | 2.58 | 6.7 | 3.41 | 4.98 | 9.49 | 6.94 | 0.99 | 6.58 | 2.54 | 7.28 | 4.46 |
| 5 | 6.89 | 2.26 | 5.37 | 2.35 | 6.22 | 4.84 | 5.11 | 8.12 | 6.46 | 1.42 | 6.19 | 2.96 | 6.89 | 3.27 |
| 6 | 7.06 | 2.2 | 5.49 | 2.59 | 6.39 | 3.33 | 6.29 | 9.93 | 6.63 | 1.37 | 6.36 | 2.66 | 7.06 | 4.30 |
| 7 | 6.66 | 1.56 | 5.62 | 1.91 | 5.62 | 4.42 | 5.08 | 9.29 | 6.23 | 1.34 | 5.55 | 2.09 | 7.25 | 3.47 |
| 8 | 7.57 | 3.09 | 5.14 | 2.58 | 6.9 | 4.59 | 4.77 | 8.68 | 7.14 | 1.37 | 6.38 | 2.52 | 6.08 | 3.40 |
| 9 | 13.61 | 5.92 | 12.2 | 2.47 | 10.94 | 4.18 | 9.99 | 7.19 | 11.18 | 1.16 | 9.66 | 2.17 | 13.36 | 3.14 |
| 10 | 6.91 | 2.93 | 5.88 | 2.28 | 6.24 | 4.76 | 7.25 | 10.13 | 6.48 | 1.28 | 6.17 | 2.24 | 6.87 | 2.96 |
| 11 | 6.93 | 2.32 | 5.24 | 2.16 | 6.26 | 4.78 | 5.19 | 7.53 | 6.5 | 1.26 | 6.62 | 2.78 | 8.32 | 3.32 |
| 12 | 3.39 | 1.94 | 2.73 | 2.00 | 2.33 | 4.33 | 1.66 | 10.01 | 2.96 | 1.23 | 2.98 | 2.57 | 2.68 | 4.13 |
| 13 | 7.55 | 3.91 | 5.69 | 2.43 | 6.88 | 3.52 | 4.76 | 7.37 | 7.12 | 1.11 | 4.48 | 2.41 | 5.18 | 4.24 |
| 14 | 2.97 | 0.97 | 1.9 | 1.97 | 1.31 | 3.65 | 0.27 | 7.93 | 2.54 | 1.10 | 2.16 | 2.67 | 4.86 | 4.07 |
| 15 | 7.67 | 3.6 | 5.87 | 1.82 | 7 | 3.60 | 5.18 | 6.86 | 7.24 | 1.20 | 6.22 | 2.88 | 6.92 | 2.73 |
| 16 | 6.92 | 2.28 | 5.92 | 2.45 | 6.25 | 3.36 | 5.09 | 8.94 | 5.49 | 1.09 | 5.54 | 2.65 | 6.24 | 4.36 |
| 17 | 8.07 | 3.84 | 6.31 | 2.36 | 7.4 | 3.47 | 4.84 | 7.21 | 7.64 | 1.37 | 5.86 | 2.60 | 6.56 | 4.52 |
| 18 | 3.95 | 0.83 | 2.21 | 2.40 | 0.68 | 4.31 | 0.97 | 6.70 | 2.56 | 1.46 | 2.73 | 2.65 | 5.43 | 4.22 |
| 19 | 7.34 | 3.58 | 6.41 | 2.34 | 5.67 | 4.84 | 2.26 | 9.25 | 6.91 | 0.99 | 6.51 | 2.55 | 3.21 | 2.80 |
| 20 | 7.47 | 3.92 | 5.78 | 2.14 | 4.87 | 3.88 | 3.08 | 7.84 | 5.04 | 1.24 | 6.17 | 1.94 | 6.87 | 3.45 |

Table IV: The demand information for RBCs in hospitals under the seasonal blood shortage

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| hospital | MON | | TUE | | WED | | THU | | FRI | | SAT | | SUN | |
|  | ED | SD | ED | SD | ED | SD | ED | SD | ED | SD | ED | SD | ED | SD |
| 1 | 86.91 | 20.34 | 73.42 | 11.26 | 71.86 | 12.04 | 68.64 | 10.28 | 82.74 | 11.16 | 37.19 | 2.752 | 43.36 | 86.91 |
| 2 | 56.58 | 16.94 | 49.34 | 10.58 | 47.8 | 11.26 | 45.6 | 9.952 | 57.04 | 10.14 | 23.75 | 2.662 | 29.81 | 56.58 |
| 3 | 94.07 | 22.17 | 75.32 | 15.54 | 73.72 | 16.39 | 69.62 | 12.29 | 85.98 | 18.72 | 30.09 | 3.522 | 36.35 | 94.07 |
| 4 | 46.48 | 14.62 | 42.34 | 11.05 | 40.82 | 10.29 | 39.14 | 9.222 | 49.26 | 10.02 | 22.03 | 2.392 | 28.05 | 46.48 |
| 5 | 69.62 | 19.52 | 58.37 | 13.68 | 56.81 | 14.43 | 53.96 | 10.82 | 67.1 | 13.46 | 25.95 | 2.982 | 32.09 | 69.62 |
| 6 | 16.06 | 6.772 | 21.26 | 4.252 | 19.8 | 4.72 | 19.64 | 4.532 | 25.76 | 4.932 | 16.89 | 1.12 | 22.75 | 16.06 |
| 7 | 4.56 | 4.312 | 13.27 | 2.522 | 11.84 | 2.182 | 12.27 | 2.162 | 16.88 | 3.852 | 14.93 | 0.662 | 20.73 | 4.56 |
| 8 | 29.51 | 10.12 | 30.57 | 6.902 | 29.1 | 7.442 | 28.26 | 6.832 | 36.14 | 6.912 | 19.16 | 1.282 | 25.09 | 29.51 |
| 9 | 37.4 | 12.34 | 36.04 | 8.052 | 34.54 | 7.342 | 33.31 | 7.52 | 42.24 | 9.942 | 20.49 | 1.732 | 26.46 | 37.4 |
| 10 | 38.04 | 5.432 | 36.5 | 8.092 | 35 | 7.412 | 33.74 | 7.562 | 42.74 | 9.022 | 20.6 | 1.752 | 26.59 | 38.04 |
| 11 | 17.31 | 7.012 | 22.12 | 4.422 | 20.66 | 4.882 | 20.46 | 4.662 | 26.74 | 5.132 | 17.09 | 1.252 | 22.96 | 17.31 |
| 12 | 3.8 | 0.462 | 2.635 | 0.62 | 1.22 | 0.612 | 2.44 | 0.582 | 5.04 | 0.392 | 12.33 | 0.142 | 18.05 | 3.8 |
| 13 | 44.42 | 11.34 | 40.9 | 10.45 | 39.4 | 9.082 | 37.81 | 7.062 | 47.66 | 8.782 | 21.68 | 1.332 | 27.69 | 44.42 |
| 14 | 16 | 5.772 | 21.20 | 5.252 | 19.76 | 4.72 | 19.60 | 4.522 | 25.72 | 4.922 | 16.87 | 1.22 | 22.73 | 16 |
| 15 | 54.06 | 13.62 | 47.58 | 11.35 | 46.06 | 10.03 | 43.98 | 9.772 | 55.1 | 12.86 | 23.31 | 2.592 | 29.37 | 54.06 |
| 16 | 17.96 | 6.132 | 22.56 | 5.52 | 21.1 | 4.972 | 20.86 | 4.732 | 27.24 | 5.242 | 17.2 | 1.272 | 23.07 | 17.96 |
| 17 | 11.86 | 5.942 | 18.33 | 4.672 | 16.88 | 4.092 | 16.96 | 3.072 | 22.52 | 4.232 | 16.17 | 1.132 | 22.01 | 11.86 |
| 18 | 1.74 | 3.092 | 11.32 | 2.022 | 9.9 | 2.352 | 10.46 | 2.072 | 14.7 | 2.252 | 14.45 | 0.452 | 20.25 | 1.74 |
| 19 | 14.98 | 4.572 | 20.5 | 4.112 | 19.06 | 5.052 | 18.96 | 3.412 | 24.94 | 5.062 | 16.7 | 1.062 | 22.55 | 14.98 |
| 20 | 9.76 | 1.082 | 3.355 | 0.682 | 1.96 | 0.662 | 3.1 | 0.692 | 5.84 | 0.752 | 12.51 | 0.152 | 18.23 | 9.76 |

Table V: Collectable volume information of blood products under the seasonal blood shortage

|  |  |  |
| --- | --- | --- |
| Time | Statistical distribution | Characteristic parameter |
| Monday | Normal |  |
| Tuesday | Normal |  |
| Wednesday | Normal |  |
| Thursday | Normal |  |
| Friday | Normal |  |
| Saturday | Normal |  |
| Sunday | Normal |  |

**Appendix Table B-IV Control parameters of blood inventory in each hospital**

Table VI: Reorder points for platelets under the seasonal blood shortage

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Hospital | MON | TUE | WED | THU | FRI | SAT | SUN |
| 1 | 10.2065 | 13.158 | 19.883 | 8.613 | 11.5915 | 14.684 | 12.6565 |
| 2 | 9.2565 | 13.818 | 22.753 | 9.273 | 11.1315 | 14.224 | 13.3165 |
| 3 | 12.7865 | 16.608 | 24.143 | 13.063 | 16.2415 | 20.334 | 19.1065 |
| 4 | 9.9665 | 13.498 | 20.853 | 8.953 | 12.0415 | 15.134 | 12.9965 |
| 5 | 9.0165 | 13.018 | 20.983 | 8.473 | 11.6515 | 14.744 | 12.5165 |
| 6 | 9.1365 | 13.188 | 22.163 | 8.643 | 11.8215 | 14.914 | 12.6865 |
| 7 | 9.2665 | 12.418 | 20.6065 | 8.243 | 11.0115 | 15.104 | 12.2865 |
| 8 | 8.7865 | 13.698 | 20.2965 | 9.153 | 11.8415 | 13.934 | 13.1965 |
| 9 | 15.8465 | 17.738 | 25.5165 | 13.193 | 15.4845 | 21.4285 | 20.903 |
| 10 | 9.5265 | 13.038 | 22.7765 | 8.493 | 11.9945 | 14.9385 | 14.203 |
| 11 | 8.8865 | 13.058 | 20.7165 | 8.513 | 12.4445 | 16.3885 | 14.223 |
| 12 | 6.3765 | 9.128 | 17.1865 | 4.973 | 8.8045 | 10.7485 | 10.683 |
| 13 | 9.3365 | 13.678 | 20.2865 | 9.133 | 10.3045 | 13.2485 | 14.843 |
| 14 | 5.5465 | 8.108 | 15.7965 | 4.553 | 7.9845 | 12.9285 | 10.263 |
| 15 | 9.5165 | 13.798 | 20.7065 | 9.253 | 12.0445 | 14.9885 | 14.963 |
| 16 | 9.5665 | 13.048 | 20.6165 | 7.503 | 11.3645 | 14.3085 | 14.213 |
| 17 | 9.9565 | 14.198 | 20.3665 | 9.653 | 11.6845 | 14.6285 | 15.363 |
| 18 | 5.8565 | 7.478 | 16.4965 | 4.573 | 8.5545 | 13.4985 | 11.243 |
| 19 | 10.0565 | 12.468 | 17.7865 | 8.923 | 12.3345 | 11.2785 | 14.633 |
| 20 | 9.4265 | 11.668 | 18.6065 | 7.053 | 11.9945 | 14.9385 | 14.763 |

Table VII: Reorder points for RBCs under the seasonal blood shortage

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Hospital | MON | TUE | WED | THU | FRI | SAT | SUN |
| 1 | 92.0023 | 91.7293 | 85.6053 | 101.1573 | 41.7308 | 48.5773 | 120.4743 |
| 2 | 66.8003 | 66.3823 | 62.0208 | 73.7743 | 28.1423 | 34.0208 | 84.5343 |
| 3 | 100.9643 | 100.7668 | 89.9018 | 116.868 | 35.9013 | 43.9928 | 130.6538 |
| 4 | 60.5758 | 57.8018 | 54.3563 | 65.7963 | 25.9768 | 31.7163 | 70.6063 |
| 5 | 80.9453 | 80.6228 | 71.8163 | 89.3123 | 30.8703 | 38.1158 | 101.8313 |
| 6 | 28.2758 | 27.588 | 27.1178 | 33.8978 | 18.738 | 24.8818 | 27.2338 |
| 7 | 17.4313 | 15.4403 | 15.8373 | 23.2358 | 16.0223 | 21.8223 | 11.6748 |
| 8 | 41.9583 | 41.3793 | 39.5328 | 47.5448 | 21.2753 | 27.3703 | 46.2113 |
| 9 | 49.3258 | 46.6543 | 45.718 | 58.6443 | 23.3478 | 29.5818 | 57.7643 |
| 10 | 49.8518 | 47.2298 | 46.2173 | 57.6263 | 23.4908 | 29.5963 | 47.0028 |
| 11 | 29.4163 | 28.7153 | 28.1523 | 35.2078 | 19.1558 | 25.0258 | 28.8798 |
| 12 | 3.658 | 2.2298 | 3.4003 | 5.6868 | 12.5643 | 18.2678 | 4.5623 |
| 13 | 58.1458 | 54.3853 | 49.4623 | 62.1503 | 23.8778 | 31.2408 | 63.1343 |
| 14 | 29.8708 | 27.548 | 27.0663 | 33.8413 | 18.883 | 24.908 | 25.5238 |
| 15 | 66.3108 | 62.6128 | 60.1038 | 76.3223 | 27.5868 | 33.4488 | 76.5363 |
| 16 | 31.668 | 29.3038 | 28.6678 | 35.8893 | 19.2988 | 25.413 | 28.0778 |
| 17 | 26.0438 | 23.6318 | 22.0288 | 29.5028 | 18.0378 | 24.1748 | 21.6643 |
| 18 | 14.6563 | 13.7808 | 13.8788 | 18.4158 | 15.1958 | 21.2763 | 6.8418 |
| 19 | 27.2848 | 27.3958 | 24.5898 | 33.2923 | 18.4523 | 24.4673 | 22.5238 |
| 20 | 4.4803 | 3.0523 | 4.2418 | 7.0808 | 12.7608 | 18.4808 | 11.5453 |

Table VIII: Inventory strategy parameters for platelets under the seasonal blood shortage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Hospital | Q | S |  | EWA-base |
| 1 | 29.43921 | 31.08571 | (1,31.0857) | 31.08571 |
| 2 | 31.56779 | 33.21429 | (1,33.2142) | 33.21429 |
| 3 | 51.93207 | 53.57857 | (1,53.5785) | 53.57857 |
| 4 | 31.33207 | 32.97857 | (1,32.9785) | 32.97857 |
| 5 | 29.16064 | 30.80714 | (1,30.8071) | 30.80714 |
| 6 | 30.69636 | 32.34286 | (1,32.3428) | 32.34286 |
| 7 | 28.36064 | 30.00714 | (1,30.0072) | 30.00714 |
| 8 | 29.76779 | 31.41429 | (1,31.4142) | 31.41429 |
| 9 | 56.16779 | 57.81429 | (1,57.8142) | 57.81429 |
| 10 | 31.06779 | 32.71429 | (1,32.7142) | 32.71429 |
| 11 | 30.53921 | 32.18571 | (1,32.1857) | 32.18571 |
| 12 | 11.73207 | 13.37857 | (1,13.3785) | 13.37857 |
| 13 | 28.11064 | 29.75714 | (1,29.7571) | 29.75714 |
| 14 | 9.789214 | 11.43571 | (1,11.4357) | 11.43571 |
| 15 | 31.28207 | 32.92857 | (1,32.9285) | 32.92857 |
| 16 | 27.96064 | 29.60714 | (1,29.6071) | 29.60714 |
| 17 | 31.69636 | 33.34286 | (1,33.3428) | 33.34286 |
| 18 | 11.58921 | 13.23571 | (1,13.2357) | 13.23571 |
| 19 | 25.71779 | 27.36429 | (1,27.3642) | 27.36429 |
| 20 | 26.41064 | 28.05714 | (1,28.0571) | 28.05714 |

Table IX: Inventory strategy parameters for RBCs under the seasonal blood shortage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Hospital | Q | S |  | EWA-base |
| 1 | 193.1834 | 212.7657 | (1,220.7657) | 214.7657 |
| 2 | 182.494 | 200.9543 | (1,208.9542) | 202.9543 |
| 3 | 245.87 | 272.5143 | (1,280.5142) | 274.5143 |
| 4 | 152.1185 | 171.3543 | (1,179.3542) | 173.3543 |
| 5 | 202.5104 | 226.0857 | (1,234.0857) | 228.0857 |
| 6 | 79.93277 | 87.94857 | (1,95.9485) | 89.94857 |
| 7 | 53.25584 | 58.41714 | (1,66.4171) | 60.41714 |
| 8 | 107.3717 | 119.76 | (1,127.76) | 121.76 |
| 9 | 124.1313 | 138.4171 | (1,146.4171) | 140.4171 |
| 10 | 131.3396 | 145.6914 | (1,153.6914) | 147.6914 |
| 11 | 88.32656 | 96.62286 | (1,104.6228) | 98.62286 |
| 12 | 28.41414 | 30.43714 | (1,38.43714) | 32.43714 |
| 13 | 148.2171 | 166.4629 | (1,174.4628) | 168.4629 |
| 14 | 78.12849 | 87.79429 | (1,95.79428) | 89.79429 |
| 15 | 163.8178 | 183.5486 | (1,191.5485) | 185.5486 |
| 16 | 82.31486 | 92.42286 | (1,100.4228) | 94.42286 |
| 17 | 69.28263 | 77.99143 | (1,85.99142) | 79.99143 |
| 18 | 45.7037 | 50.04 | (1,58.04) | 52.04 |
| 19 | 77.60949 | 85.39429 | (1,93.3942) | 87.39429 |
| 20 | 35.30613 | 37.43143 | (1,45.4314) | 39.43143 |

**Appendix Table B-V**

Table X: The relative proximity ranking of TOPSIS method

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **strategies** | **(s，Q)** | **(s，S)** | **(T，S)** | **EWA-based** |
|  | 0.0005 | 0.1587 | 0.2457 | 0.0921 |
|  | 0.2457 | 0.0870 | 0.0008 | 0.1536 |
|  | 0.9981 | 0.3541 | 0.0033 | 0.6249 |
| ranking | 4 | 2 | 1 | 3 |

Note: The length of the maximum distance is . The length of the minimum distance is . The relative closeness is

**Appendix Table B-VI**

Table XI: Correlation coefficient of grey correlation method

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Performance indicators** | **(s，S)** | **(s，Q)** | **(T，S)** | **EWA-based** |
| outdating | 0.2081 | 0.2081 | 0.2079 | 0.2082 |
| shortage | 0.1663 | 0.2118 | 0.2491 | 0.1900 |
| grey correlation degree | 0.1872 | 0.20995 | 0.2285 | 0.1991 |
| ranking | 4 | 2 | 1 | 3 |

**Appendix Figure C-I**



Figure C-1: Multi-agent simulation model of BSC system based on anylogic 8.7.0

**Appendix Figure C-II**



Figure C-2: The process of analyzing control parameters of inventory strategies

**Appendix Figure C-III**

A picture containing text, line, plot, screenshot

Description automatically generated

Figure C-3: Time series of platelets outdating under different inventory strategies