Optimising WB component supply

Optimising WB component supply - A Monte Carlo simulation model

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INTRODUCTION

A recent UK study that piloted the use of a group ORhD negative Whole Blood (WB) component demonstrated that due to its short shelf-life (14 days) and limited use to pre-hospital trauma patients only, component wastage was high. Reducing component wastage is essential for the future feasibility of this component.

AIMS

Examine the trade-off between component wastage due to time expiry and unmet demand using simulation methods.

METHODS

A supply and demand model for a WB component was developed. The model was developed using data collected as part of a 2-year UK pre-hospital WB pilot study.

FIFO model: A First in First Out (FIFO) stock management model was created using MS Excel. Demand and supply variables were used to populate the FIFO model. The FIFO model was generated using the following parameters:

- 14-day WB shelf-life
- 3-day lead time on orders
- Units delivered at 2 days old
- 1-day lead time ad-hoc orders possible

Demand Variable: Daily demand was modelled as a discrete random variable using a Poisson distribution with a λ of 0.70 (mean pre-hospital WB component demand). The RAND function in MS Excel was used to generate different demand profiles sampled from this Poisson distribution.

Supply Variable: A total of 7 inventory management policies were tested. Heuristic methods were used to determine the algorithms used in each of the inventory management policies generated (Table 1). Each was inventory management policy was compared against a baseline.

Table 1: A table of the inventory management polices evaluated. No data is represented by (-).

	Basic Order	Ad hoc orders
Baseline	2 units 5 days a week (pilot study supply)	
Model 1	If inventory <10 order 3	If inventory ≤6 order 2
Model 2	If inventory <12 order 2	If inventory ≤6 order 2
Model 3	If inventory <12 order 3	If inventory ≤6 order 2
Model 4	If inventory <12 order 2	If inventory ≤8 order 2
Model 5	If inventory <14 order 2	If inventory ≤6 order 2
Model 6	If inventory <6 order 2	-
Model 7	If inventory <8 order 2	-

Simulation: Each model had a run length of 732 days with 1000 trials. Random demand profiles, following a Poisson distribution, were generated for each model. These demand profiles were used as input values for the demand element of the FIFO model to generate outputs of mean component usage; mean component wastage and mean unmet demand. All outputs were based on the average of 1000 trials.

RESULTS

All of the models 1-7 outperformed the baseline model in % component wastage. The best performing model was model 6, with a mean wastage of 97.00 units, representing 16% component wastage. This model did, however, have the largest mean unmet demand of 5.795, which overall represented 1.1% unmet demand over the 732-day run period.

Table 2: A table representing the results of the inventory management policies evaluated.

	Component Usage	Component Wastage	Unmet Demand	% Wastage
	Mean [SD]	*Mean [SD]*	*Mean [SD]*	
Baseline	515.79 [26.88]	682.81 [26.8]	-	57%
Model 1	515.97 [26.33]	278.02 [21.84]	0.086 [0.39]	35%
Model 2	516.49 [27.46]	249.36 [20.77]	0.025 [0.20]	33%
Model 3	516.71 [26.80]	340.31 [22.33]	0.026 [0.21]	40%
Model 4	518.06 [26.01]	263.48 [20.20]	0.009 [0.13]	34%
Model 5	517.27 [26.44]	308.59 [20.40]	0.005 [0.08]	37%
Model 6	509.25 [25.68]	97.00 [14.45]	5.795 [3.53]	16%
Model 7	512.71 [26.92]	153.95 [17.55]	1.024 [1.44]	23%

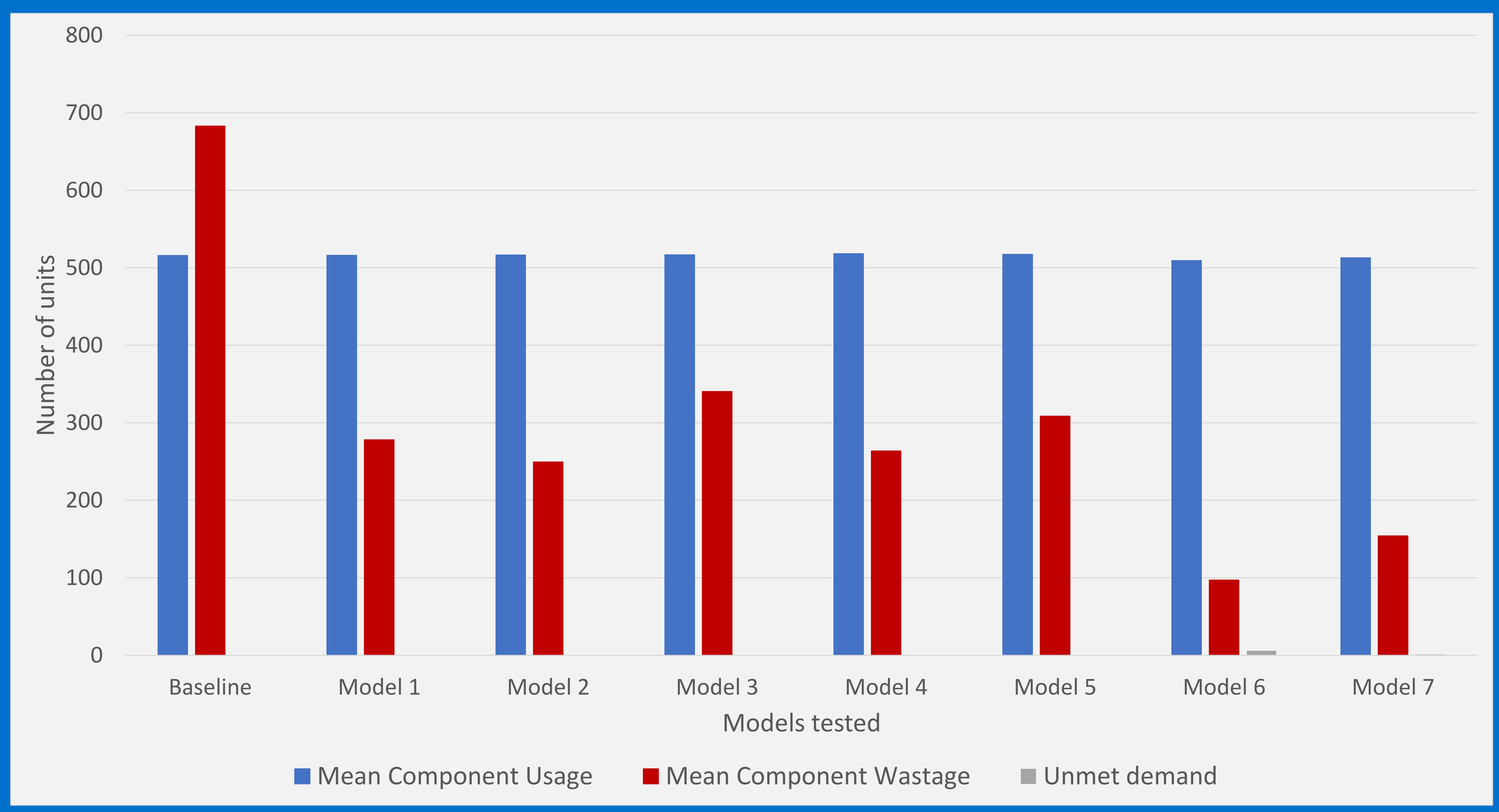

Figure 1: A graph representing the results of the inventory management policies evaluated.

CONCLUSIONS

The supply and demand model developed in this this study has demonstrated that by altering WB supply, component wastage can be reduced. However, there are trade-offs between unmet demand and component wastage that need to be considered.

REFERENCES

J. McCullagh et al. Making every drop count: reducing wastage of a novel blood component for transfusion of trauma patients. BMJ Open Qual. 2021 Jul;10(3):e001396. doi: 10.1136/bmjoq-2021-001396..

CONTACT INFORMATION

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