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Authors: Hamidreza Ensafian, Saeed Yaghoubi, Mohammad Modarres Yazdi

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Raising quality and safety of platelet transfusion services in a patient-based integrated supply chain under uncertainty

Hamidreza Ensafian\textsuperscript{a}, Saeed Yaghoubi\textsuperscript{id1}, Mohammad Modarres Yazdi\textsuperscript{b}

\textsuperscript{a} School of Industrial Engineering, Iran University of Science and Technology, Tehran, Iran
\textsuperscript{b} School of Industrial Engineering, Sharif University of Technology, Tehran, Iran

Highlights:
- We propose a patient-based integrated platelet supply chain to reduce shortage and wastage costs.
- We incorporate the ABO-Rh priority matching rules and age-differentiated demand into mixed-integer programming model.
- To predict the number of donors in each period, we apply a finite-state Markov chain model as an input to mathematical model.
- Using the two measures of Substitution Index (SI) and Complexity Index (CI), we analyze blood groups and present management strategies.
- We develop a scenario-based stochastic model and propose an improved approach for scenario reduction.
- Numerical results inspired from a real case study are shown to validate the proposed approach.

Abstract

This paper develops a stochastic multi-period mixed-integer model for collection, production, storage, and distribution of platelet in Blood Transfusion Organizations ranging from blood collection centers to clinical points. In this model, the age of platelet and ABO-Rh priority matching rules are incorporated based on the type of patient to raise the quality and safety of platelet transfusion services. At first, a discrete Markov Chain Process is applied to predict the number of donors. Afterwards, the uncertain demand is captured using a two-stage stochastic programming. A challenging aspect of applying stochastic programming in a dynamic setting is to construct an appropriate set of discrete scenarios. Therefore, we introduce an improved approach for scenario reduction which well represents multivariate stochastic processes for uncertain parameters. To manage risk, a straightforward approach to reduce the expected value and variance of cost is proposed. Finally, management strategies inspired from a real case study are presented.

Keywords: Blood platelet supply chain; ABO-Rh priority matching rules; Donor prediction; Two-stage stochastic programming; Scenario reduction

\textsuperscript{1} Corresponding Author: Tell: +982173225053; Fax: +982173225098, \textit{E-mail Address}: yaghoubi@ust.ac.ir
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