Online Allocation and Routing for Blood Delivery in Conditions of Variable and Insufficient Supply: A Case Study in Thailand

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Abstract : Blood is a perishable product which suffers from physical deterioration with specific fixed shelf life. Although its value during the shelf life is constant, fresh blood is preferred for treatment. However, transportation costs are a major factor to be considered by administrators of Regional Blood Centres (RBCs) which act as blood collection and distribution centres. A trade-off must therefore be reached between transportation costs and short-term holding costs. In this paper we propose a number of algorithms for online allocation and routing of blood supplies, for use in conditions of variable and insufficient blood supply. A case study in northern Thailand provides an application of the allocation and routing policies tested. The plan proposed for daily allocation and distribution of blood supplies consists of two components: firstly, fixed routes are determined for the supply of hospitals which are far from an RBC. Over the planning period of one week, each hospital on the fixed routes is visited once. A robust allocation of blood is made to hospitals on the fixed routes that can be guaranteed on a suitably high percentage of days, despite variable supplies. Secondly, a variable daily route is employed for close-by hospitals, for which more than one visit per week may be needed to fulfil targets. The variable routing takes into account the amount of blood available for each day's deliveries, which is only known on the morning of delivery. For hospitals on the variables routes, the day and amounts of deliveries cannot be guaranteed but are designed to attain targets over the six-day planning horizon. In the conditions of blood shortage encountered in Thailand, and commonly in other developing countries, it is often the case that hospitals request more blood than is needed, in the knowledge that only a proportion of all requests will be met. Our proposal is for blood supplies to be allocated and distributed to each hospital according to equitable targets based on historical demand data, calculated with regard to expected daily blood supplies. We suggest several policies that could be chosen by the decision makes for the daily distribution of blood. The different policies provide different trade-offs between transportation and holding costs. Variations in the costs of transportation, such as the price of petrol, could make different policies the most beneficial at different times. We present an application of the policies applied to a realistic case study in the RBC at Chiang Mai province which is located in Northern region of Thailand. The analysis includes a total of more than 110 hospitals, with 29 hospitals considered in the variable route. The study is expected to be a pilot for other regions of Thailand. Computational experiments are presented. Concluding remarks include the benefits gained by the online methods and future recommendations.
Keywords : online algorithm, blood distribution, developing country, insufficient blood supply
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