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Inventory Rotation of Medical Supplies for Emergency Response

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Abstract

We investigate an inventory control system for a national medical reserve to rotate its long-life perishable product to a hospital. This work is motivated by the serious expiration problem existing in reserves prepared for emergency response. We explicitly consider the perishability of a long-life product, such as latex gloves, and study the joint rotation and ordering decisions. The optimal policy is characterised by two thresholds, and the whole shelf life horizon can be divided into two phases: non-rotation and then rotation after a critical period. We characterise the monotonicity of the order-up-to levels. We find that the optimal policy structure preserves well when extended to scenarios with a capacity constraint and multiple planning horizons. This system possesses an easy-to-implement optimal policy structure, and moreover, implies that we should not always ignore the perishability of long-life products.

Keywords: inventory control, long-life perishable product, rotation, Markov decision process

1. Introduction

To prepare for emergencies, many countries hold back-up medical supplies, which are referred herein as "the reserve." Typical products in the reserve include anti-flu drugs, gloves, gowns, syringes, vaccines, etc. Governments usually require the reserve to maintain a minimum stock level so that it will contain sufficient supplies for most emergencies (e.g., New Zealand Ministry of Health, 2009). This minimum stock level is quite high, because it targets the fulfilment of demand from the whole affected population after an emergency. Although the shelf life of items in the reserve may be as long as several years, the likelihood of a large-scale public health emergency during that period is relatively low. Thus, after several years sitting in the reserve, many medical stocks expire before being used; even non-pharmacy items such as gloves and syringes have expiry dates due to perishability and seals on sterile packaging. This causes substantial waste as the reserve must dispose of expired items and replace them with new items. New Zealand has recently dumped almost 1.5 million doses

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