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Analyzing a Decision Support System for Resource Planning and Surgery Scheduling

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Abstract

This study aims to propose a decision support system based on optimization modelling for operating room resource planning and sequence dependent scheduling of surgery operations. We conduct a simulation experiment using real world data collected from the local hospital to evaluate the proposed model. The obtained results are compared with real surgery schedules, planned at the local hospital. The experiment shows that the efficiency of schedules produced by the proposed model are significantly improved, in terms of less surgery turnover time, increased utilization of operating rooms and minimized make-span, compared to the real schedules. Moreover, the proposed optimization based decision support system enables analysis of surgery scheduling in relation to resource planning.

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Keywords: Scheduling; Turnover time; Operating rooms; Healthcare; Optimization; Decision support system.

1. Introduction

The proportion of elderly people is continuously growing whereas most countries are meeting increased demand and cost for healthcare services. Balancing rising cost to preserve and provide quality healthcare are challenges faced

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by many healthcare providers today. Operating room (OR) is one of the most complex and cost-intensive environments in the hospital. The cost for setup of an OR and the revenue generated are the highest in the hospital and the need for efficiency is inevitable. OR efficiency is commonly measured by number of surgical cases performed per time unit (commonly a day) and resources.

This paper aims to evaluate and propose a novel approach, based on earlier work described by Holmgren and Persson, of how to increase operating room efficiency by sequence dependent parallel operating room scheduling8. A simulation experiment is conducted with real world data to evaluate the performance of the proposed decision support system. Results show significantly improved efficiency when using the proposed model compared to real schedules, planned at the hospital.

The paper is organized as follows: In Section 2 we present how the proposed model schedule the surgeries and optimize the surgical time. Section 3 describes the related work that is addressed by the literature to solve the scheduling problem. Section 4 presents how the experiment is setup and run to produce the output schedules. Section 5 presents the output schedules of 3 different scenarios for a given set of input values. In section 6 we analyze the output schedules by comparing the results produced by the optimization model with the real schedule planned at hospitals. Section 7 concludes the paper describing the performance of the new optimization for better resource planning and surgery scheduling in hospitals and propose future work to address the limitations and future challenges of the model.

2. Background

Turnover time denotes the time between surgical cases. In literature, surgical turnover time either includes or excludes the post- and pre- procedure of two subsequent surgical cases scheduled in the same OR. In short, the proposed model facilitates by using overlapping surgical activities. The aim is to start the pre-procedure of the up-coming surgical case (Surgery B) before the ongoing surgical case (Surgery A) is closed, see figure 1 below. However, during the overlaps, additional operating room resources are required. This extra resource will serve as an extra OR team, assisting the current OR teams to start up the up-coming surgical case in each of the OR, respectively. Commonly one OR team is allocated to one OR. For simplicity, we here consider a surgical case to be divided into three activities; i) surgical pre-, ii) per-procedure, and iii) post-procedure.

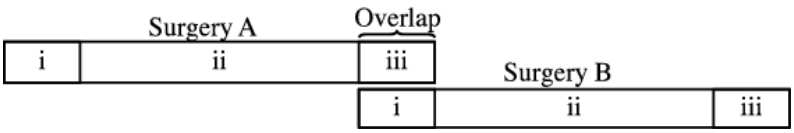

Fig. 1. Surgery overlap

It should be noted that surgical post-procedure is not equal to post-operative care. During post-operative care, many patients are simultaneously monitored for possible post-operative complications, e.g., hemorrhage and/or respiratory insufficiency. During the surgical post-procedure, however, the anesthesia is stopped, the instruments is wrapped up and the OR is cleaned up.

Consider a case where one extra OR team is assisting 3 OR teams in 3 ORs. The challenge is to sequence the surgeries for each OR such that the number of overlaps are scheduled subject to a limited number of OR resources (here 4), see figure 2.