Available online at www.sciencedirect.com
ScienceDirect
Omega 37 (2009) 853–863
omega
The International Journal of Management Science
www.elsevier.com/locate/omega

Health economic modeling to support surgery management at a Swedish hospital☆

Marie Persson*, Jan A. Persson

Department of Systems and Software Engineering, Blekinge Institute of Technology, SoftCenter, 372 25 Ronneby, Sweden

Received 24 August 2007; accepted 22 May 2008
Available online 1 June 2008

Abstract

Elective surgery management typically deals with a queue of patients that have to be scheduled for surgery within a certain time frame, considering both medical and economic constraints. In order to prevent the patient queue and waiting times from growing, surgery management has to decide whether to temporarily increase patient throughput at the regional hospital or have some patients scheduled for surgery at another hospital. In Sweden, a newly passed law states that patients who decide to receive surgery should not have to wait more than 90 days before this surgery is carried out. Therefore, if a patient decides to apply the new law by requesting surgery within 90 days, the regional hospital is obliged to arrange and pay for either in-house surgery or surgery at another hospital. In this paper, we suggest an approach using simulation including optimization for modeling surgery management decisions. We study a case based on data from a General Surgery Department at a Swedish hospital and present our results as a health economic evaluation. The results indicate an increase in the mean waiting times for medium prioritized patients when the new law is applied.

Keywords: Simulation; Optimization; Health service; Scheduling; Management

1. Introduction

Today's health care works under both medical as well as economic pressure. Along with the improvements in medical science the medical treatments get increasingly complex. Different parts of the patient treatment have to be synchronized, combined and organized in order to achieve a sufficiently good outcome. In order to strengthen the patient's position, the Swedish government has recently passed a law (November 1, 2005) stating that patients that are scheduled for elective surgery can only be put on hold for 90 days or less before the surgery is conducted; if this is not possible at the regional hospital, the hospital management is obliged to arrange and pay for surgery at another hospital. This fact exercises great pressure on the organizational activities within the hospital and motivates further investigation by the research community. The purpose of this paper is to introduce a simulation model to be used for analyzing connections between surgery management decisions, available resources and the environment (e.g. the recently passed law). In accordance to the case studied, we assume emergency patients (emergency cases) are handled separately and because of this assumption that group will have no major

☆ This manuscript was processed by Area Editor B. Lev.

* Corresponding author. Tel.: +46 457385838.
E-mail addresses: map@bth.se, Marie.Persson@bth.se (M. Persson), Jan.Persson@bth.se (J.A. Persson).

0305-0483/$ - see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.omega.2008.05.007

impact on the management of elective surgery from an economic perspective.

It is particularly interesting to study how the recently passed law effects the surgery management and how this in turn influences the patient queues and patient waiting times. Throughout the last decades, applications of simulation and optimization techniques in health care have become increasingly wide spread [1,2]. Operating room planning and scheduling is a commonly addressed problem that is often either modeled with simulation [3–5] or optimization [6–8]. Similarly to the studies presented by Lowery [3], Vissers et al. [8] and Kim and Horowitz [4], we also consider resources of post-operative care to the operating room planning. But as a distinction, we benefit by using both simulation and optimization techniques. Thus, one of the main contributions of this paper is a method that combines optimization for operating room scheduling with a simple simulation to enable analysis of a rolling time horizon. The reason for using optimization is to obtain a suitable way of modeling the expected planning and scheduling given changes in policies and resources. The method also provides an opportunity for economic evaluation in relation to management decisions and policy choices.

Health economic evaluation is based on comparative studies where several courses of action are analyzed in terms of monetary costs and other consequences [9]. The evaluation can be viewed as a choice of different treatments or health care programs with associated costs and consequences. There are some examples of the use of optimization techniques for this type of analysis in health care. As an example, Sendi and Al [10] use an integer programming approach to reach optimal budget allocation given different costs and effects related to different treatment alternatives. They use a model in order to find the best mix of treatments in relation to different compositions of patients and different assumptions of budget requirements. Similarly, in our model the optimization is used to find a suitable mix of surgery alternatives represented by the choice of when to operate on a patient and where—at the local hospital or at another hospital (out-sourced surgeries)—given different scenarios of patient queues. In addition to the requirements of a medical priority and time waited, the model also has to cope with the requirement of meeting the demand from the recently passed law in a similar way as a planner would. The introduced optimization model and its scheduling decisions represent a rather knowledgeable and rational planner of elective surgery.

The rest of the paper is organized as follows: in Section 2, we introduce the Department of General Surgery and describe its general characteristics. Then we present the simulation and optimization model in Sections 3 and 4 followed by a description of the Blekinge hospital case in Section 5. The experiment is described in Section 6 and finally, in Section 7, we present some conclusions and discuss some directions for future work.

2. Department of General Surgery

The Department of General Surgery in Sweden (elective surgery) deals with a waiting list of patients with different surgical diseases and medical priorities. The priority of patients for elective surgery is generally divided into three priority groups where priority one corresponds to the patients that need surgery within one, or at the most, two weeks. Priority two corresponds to patients that need surgery within four to eight weeks, and finally, priority three (no priority) corresponds to patients that need surgery within a "reasonable time frame." The waiting times corresponding to the third priority varies according to the number of patients waiting with higher priority (priority one and two). Hence, the patients with medical priority three are the patients that are most probable to request surgery at another hospital according to the new law. From now on we will refer to the patients that get surgery at another hospital in order to comply with the law of a maximum time limit of 90 days, as out-sourced.

Usually, the Department of General Surgery is divided according to surgical specialty where each specialty usually controls, or is assigned, a defined number of operating rooms with attendant resources, i.e. anesthetists, nurses, etc. In practice, this means that each surgical specialty has its own patient queue to manage where patients are selected and scheduled for surgery with respect to medical priority, time waited and resources available. The operating schedule is gradually completed one week at a time in a rolling time horizon of about four to six weeks (see Section 3.1 below for further discussion about this). After surgery, the patients stay at the recovery unit for post-operative probation during a couple of hours (on the condition of no major complications). Hereafter the patients are transferred to the surgery ward for post-operative care before they are discharged. How long the patients remain in the ward varies according to type of surgery, the patient's condition, etc. Hence, in addition to available operating rooms, the selection and scheduling of patients is also affected by the availability of beds at the surgery ward. See Fig. 1 for an illustration of patient flow.