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Surgery case scheduling in a multistage operating room department: A literature review

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***Abstract*—Operating room planning and scheduling decisions play a key role in hospital management system while the operating theater is known as a highly strategic service in a hospital given it is the most expensive and complex sector. It involves both human and material resources. The operating theater interacts with other facilities such as the Public Health Unit (PHU), Intensive Care Unit (ICU), and/or Post-Anesthesia Care Unit (PACU). So, it is required to integrate the adjoincing facilities in the planning and scheduling decisions to improve the global performance.**

It is noted that a few authors addressed the operating theater planning/scheduling problem by considering PHU, PACU, and/or ICU as a stage of service or a resource. Also the research that studied literature reviews have presented detailed classifications of researchs based on research methodology, policy, decision models, resolution approaches and decision levels.

In this search, we presented the works which studied the surgery case scheduling in a multistage operating room deparement.

***Keywords*—Scheduling, Planning, Multistage, Operating theater, Literature review**

I. INTRODUCTION

The management of operating room department has been widely the subject of many studies. It indicated that this area consists one of the most important sectors in a hospital which constitutes a melting pot between different systems and different actors.

Generally the methodologies for scheduling surgical problem include two sub-problems: the first step allowsthe allocation of surgeries to the operating rooms. In the second step, the surgeries are sequenced within each operating room.

The two subproblems are often treated as separate combinatorial optimization models.

An operating room departement involves three stages: Public Health Unit (PHU), Operating Rooms (OR) and Post-Anesthesia Care Unit (PACU).

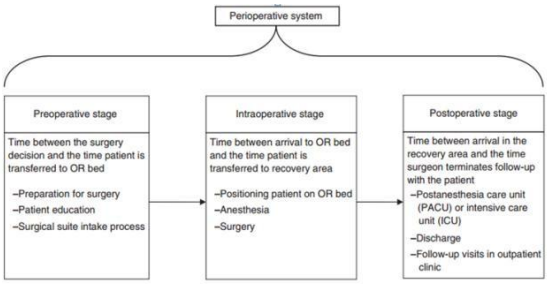

Fig. 1 The overall surgery process

Before the presentation of the previous studies, we describe the operating room process which manifested in three phases:

Pre-operative phase

This phase starts by decision to have surgery from the surgeon. Examinations or medical tests or administrative procedures may be required. It is often considered as a planning problem oriented on a strategic level.

A. The actual intraoperative phase

It seems as the most important part of the operating process which required different resources: operating rooms, recovery rooms, biology laboratories, sterilization facilities, surgical teams, surgical equipment, administrative services, logistics services, radiology and clinical

services consultations. During this phase, patients are first anesthetized and transferred to the operating room where surgical teams will operate them. After being operated on, they will be transferred to the recovery room and stay there until the permit anesthesiologists to return to their hospitalization or intensive care areas. It is oriented on a tactical level that it concerns the scheduling of a master surgery.

B. The post-operative phase

After leaving the operating room, the patient will be directed to the inpatient department or to intensive care and resuscitation if the state of patient is critical. During this phase, all the care required is covered.

Many of the studies in literature focus in the actual intraoperative phase itself however other facilities of the surgical suite can affects the efficiency and the quality of service. Literally, there are closed intgaration between the OR on the one hand and preoperative and postoperative facilities on the other hand. For instance, if the PACU leads to patient backing up in ORs, causing longer than anticipated turnover times between surgeries. This could result in overtime or surgery cancellations.

The integration can also be inferred from the ICU rejection rate, which can mount up to 24% for elective cases [1]. Without close coordination with ICU, a scheduled elective case can be rejected on its surgery day owing to a full ICU, resulting in unused OR time and negative impact on the patient. Hence, only with regard to the whole OR suite's activities can an efficient use of resources be achieved.

Weinbroum, Ekstein and Ezri [2] identified the cause of OR idle time during the stages of surgery: 17% in PHU, 65% in OR which is portionned in: 30% in nurse shortage, 15% in PACU or ICU, 10% in surgeon unavailability and 3% in Transport. This study shows that is useful to take into account all necessary resources involved by the overall surgery process to enhance the utilization of operating theatre facility.

It is evident that integration must exceed facilities of the same hospital to covert multi-facility or multi-theater operating room planning and scheduling that are effectively emerging. This integration increased complexity both in formulation and in computation of the decision process. Therefore, this last seems as one of major reasons to see that almost half of the contributions limit their scope to an isolated operating theater.

In this study, we reviewed recently papers on operating theater planning and scheduling. We analyzed only the contributions which study the operating theater in interaction with other facilities on various levels. Sever surgery flow stages and various resources considered in OR management allows a comprehensive evaluation of scheduling result.

The recovery area can be the bottleneck for operating theater at certain times. Therefore, resources such as PACU, ICU and other hospital beds required after surgery and staff should be considered during the scheduling process [3].

II. SURGERY CASE SCHEDULING WITH INTEGRATION OF RECOVERY AREA

Many researchers have used simulation methods to analyze more complex multi-OR surgical environments with recovery areas. Schmitz et al. [4] used simulation to analyze a multi-OR surgical suite with recovery rooms to determine the number of ORs to open on a day given that the number of surgeries to be performed is known. They also study the impact of an increase in the number of ORs on recovery room usage and determine the need for recovery room capacity given that some of the surgeries are done in the outpatient setting.

Kwak et al. [5] test 5 simulation scheduling rules based on period's response and alarm clock. The authors do not determine the best rule scheduling but show that the choice of a rule has an impact on the rate use of OR and recovery area.

Kharraja et al. [6] consider the problem as a flow-shop hybrid with locking constraint, the patient remains in the operating room as a recovery bed is not available. They propose a heuristic approach with a goal of minimizing the makespan of the recovery room.

In [7], the autors use lagrangian relaxation for the scheduling of the ORs, recovery room and the rooms' clean-up activities with "no-wait" constraint. The objective to be minimized is a sum of the criteria: a criterion per patient and that is a function of the completion time of all activities related to this patient.

Fei et al. [8, 9] propose a genetic algorithm to minimize the makespan both of the recovery room than the operating rooms, with suggestion that thewake-up can start in the operative room.

In the first article [8], assuming that the allocation already respects the availability of the surgeons, so the scheduling does not question the assignment of patients to the operating rooms while in a second article [9] additional constraints for surgeons are taken into account so the assignment of patients to the operating rooms may be difficult in order that interventions of the same surgeon will be planned for the same period.