Analyzing Operating Room Utilization in a Private Medical Center in Israel

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ABSTRACT: **Background:** Surgery is a core activity in hospitals. Operating rooms have some of the most important and vital functions in medical centers. The operating rooms and their staff are a valuable infrastructure resource and their availability and preparedness affect human life and quality of care.

Objectives: To prepare operational suggestions for improving operating room utilization by mapping current working processes in the operating rooms of a large private medical center.

Methods: Data on 23,585 surgeries performed at our medical center between August 2016 and March 2017 were analyzed by various parameters including utilization, capacity, working hours, and surgery delays.

Results: Average operating room utilization was 79%, while 21% was considered lost operating room time. The two major factors that influenced the lost operating room time were the time intervals between planned usage blocks and the partial utilization of operating room time. We calculated that each percent of utilized operating room time translates into 440 surgeries annually, resulting in a potential annual increase in income.

Conclusions: Increasing operating room utilization would result in an improvement of operating room availability and an increased number of procedures. Our analysis shows that operating room utilization in the private healthcare system is efficient compared to the public healthcare system in Israel. Therefore the private healthcare system should be treated as a contributing factor to help lower surgery waiting times and release bottlenecks, rather than being perceived as contributing to inequality.

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KEY WORDS: hospital management, operating room (OR), operating room optimization

Surgery is a core activity in hospitals, therefore operating rooms (ORs) and their staff are considered a valuable resource to the infrastructure of a medical center, and their availability and preparedness affect human life and quality of care [1]. In most hospitals, various departments share several facilities, including ORs, the pharmacy, laboratories, recovery units, and imaging units. These facilities have a critical influence on the hospital's effectiveness and on the continuing treatment of the patient. Due to current practices of OR utilization, they are considered bottleneck resources that cause long waiting times for surgery [2,3].

The Israeli healthcare system is publicly funded by the government and is available through four health maintenance organizations (HMOs) to any citizen needing medical attention regardless of that person's ability to pay [4]. The public healthcare system in Israel is currently in need of resources and as a result many patients are turning to private healthcare. Although the proportion of ORs in private hospitals is only 11% of all ORs in Israel, approximately one-quarter of the total number of surgeries are conducted in the private healthcare system [1] where patients use their private or HMO's supplementary insurance [5]. In private hospitals, only elective procedures are performed [6]. Our medical center is a private chain of five medical centers owned by one of the state's HMO. Three of the medical centers have ORs and outpatient care. The medical centers provide services directly to patients, through the HMO's insurance companies, and to medical tourists [5].

Organizing the OR schedule is a challenge to many hospitals. The most common scheduling issue is assigning planned surgeries to a limited number of available ORs. Additional factors affecting scheduling include the variations in the demand for surgeries and their duration [2]. Scheduling of ORs is a complicated process with several steps [7]. First, the number of hours required by each surgical field must be estimated. This estimation is influenced by the budget, previously planned schedules, demand, and patient preferences [2]. Second, OR blocks, which are the sequence of operations performed by the same surgeon in the same OR, are allocated to each surgical team. OR blocks are time slots of varying lengths. The purpose of the OR block is to schedule an OR activity with the least possible variation. The surgical team receives a block allocation and then embeds the appropriate number of surgeries to fit the assigned block. Last, the OR schedule team estimates the required time for each surgery based on the procedure type, required equipment, and the surgical team. This estimation is used to prepare a detailed OR schedule containing information on the planned OR activity [2,7]. Usually OR scheduling con-

siders elective surgery and emergency procedures [8]. Elective patients do not need emergency medical treatment and their time of operation can be pre-determined [9].

In this article, we focused solely on elective surgeries because these surgeries are the only types performed at our medical centers.

Proper management of ORs and their optimal utilization are of great importance since ineffective management may lead to delaying, postponing, and even cancelling of surgeries [10]. Consequently, waiting times for surgery are extended, leading to a waste of economic, human, and infrastructure resources. In addition, long waiting times could cause suffering, deterioration in quality of life, and anxiety to patients. Even more so, public trust in the health system could also decline due to the waste of hospital resources, which are already in permanent shortage [11].

The aim of this study was to formulate operational procedures for improving the utilization of ORs. To fulfill this goal, we mapped the current working processes in the ORs of our medical center.

PATIENTS AND METHODS

DATA COLLECTION

Data on all surgeries performed at our medical centers between August 2016 and March 2017 were collected by the business intelligence team. Small procedures that did not involve the surgical ORs were excluded from the analysis. Surgeries with missing data were also excluded. In addition, to achieve a better understanding of the existing OR scheduling and utilization processes, the OR management and scheduling teams, the planning and organization department, and hospital management were consulted.

PARAMETERS ANALYZED

To evaluate current OR utilization, we analyzed the average surgery time in minutes. The set-up time was defined as the time between surgeries during which the cleaning staff prepared the OR and the OR block.

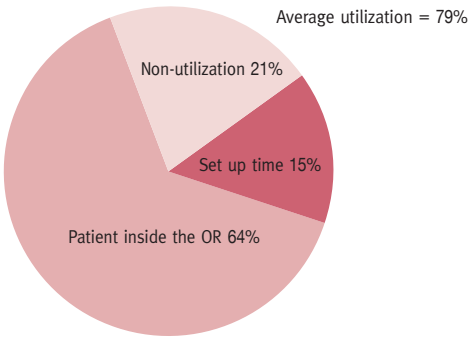
OR capacity (45,632 hours) was calculated by multiplying the 198 workdays in the duration of the study by the daily operating hours of the ORs. Actual working time was defined as the time in which the OR was occupied (patient undergoing surgery plus the set-up time). Utilization was calculated by dividing the actual working time by the total OR capacity.

Delayed first block was calculated by counting the number of cases in which the first surgery in the block was delayed, then dividing this number by the OR capacity to understand the proportion of these delays out of the total utilization lost.

STATISTICAL ANALYSIS

The measured variables and derived parameters were tabulated using descriptive statistics. For the categorical variables, the summary tables provided the sample size and absolute and relative frequencies. Statistical analyses were performed using the Statistical Package for the Social Sciences software version 24 (SPSS Inc., Chicago, IL, USA).

Figure 1. Average operating room utilization during the analyzed period



OR = operating room

RESULTS

A total of 23,585 surgeries were performed at the medical center between August 2016 and March 2017. Of these, 23,205 surgeries (46,160 OR hours) were included in the analysis. Total OR capacity during the study period was 45,632 hours.

OR UTILIZATION

The average monthly OR utilization during the analyzed period was 79%, which consisted of 64% operating time and 15% set-up time [Figure 1]. The remaining 21% was considered lost OR time. The average duration of a single surgery was 60 ± 12 minutes. OR utilization varied by month, with the lowest utilization (69%) in October 2016 and the highest (83%) in February 2017 [Figure 2].

Figure 3 presents the scheduled OR occupancy (surgery scheduled time). Delays, over-estimation of block duration,

Figure 2. Average operating room utilization by month

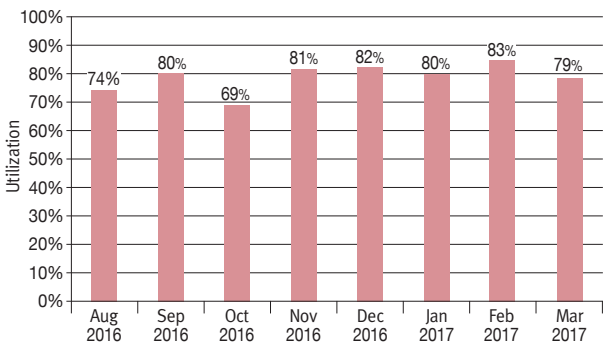
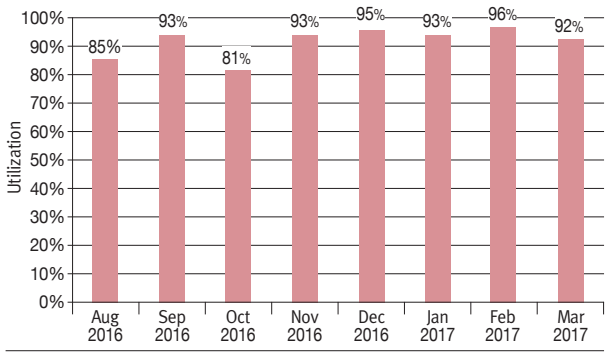


Figure 3. Scheduled operating room occupancy by month



and lack of demand of ORs are based on calculations needed to reach the overall capacity.

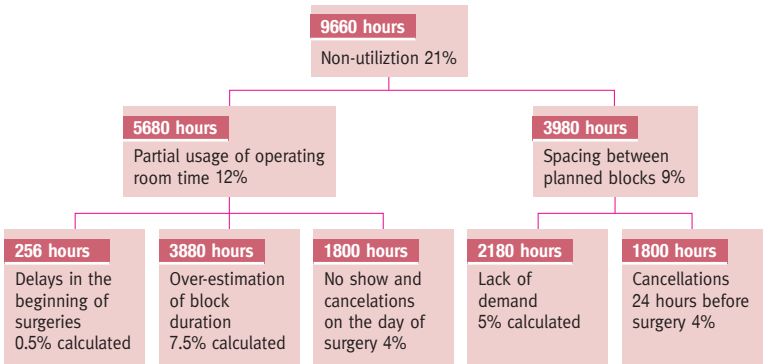
FACTORS AFFECTING OR UTILIZATION

We analyzed the reasons for lost OR times and found that 9% of the lost OR time was due to the scheduling process that caused intervals between planned blocks. Specifically, a lack of demand (5%) and cancellation of surgeries 24 hours prior to surgery (4%) contributed to the intervals. Another 12% of lost utilization was due to a partial utilization of OR time caused by surgery cancellations (4%), including no-show cancellations and cancellations at the time of surgery, over-estimation of the block's duration (7.5%), and delays in the beginning of surgeries (0.5%) [Figure 4].

REVENUE LOSS

Improving OR utilization has the potential to increase the efficiency and patient satisfaction as well as to improve the revenues of the medical center. Based on our calculations, each percent of increased utilization has the potential to increase the annual OR time by approximately 440 hours and as the average duration of a surgery in our medical center is 60 minutes, each increased utilization percentage would allow 440 additional surgeries annually.

Figure 4. Factors influencing the utilization of operating rooms



Measured between August 2016 and March 2017

PROBLEMS IN THE CURRENT OR UTILIZATION

There are several issues that require improvement in the current OR scheduling process. First, as the OR schedule is completed only one day prior to the surgeries, some of the control points in the scheduling process do not allow an effective response. Second, the OR scheduling computer system has a number of drawbacks including the need to manually input surgery schedules and inaccurate system recommendations for surgery duration, which result in longer block durations than actually required. Third, the lack of comprehensive computing tools for optimizing shift operation affects surgery performance. Last, the OR management does not have a defined target for OR utilization or a separate computerized system for managing resource constraints.

DISCUSSION

In this study, we described OR utilization in the largest private hospital system in Israel, between 2016 and 2017. The average utilization rate was 79%, with the lowest utilization in August (74%) and October (69%). These 2 months are characterized by vacation time (August) and religious holidays (October). As the surgeries performed in the hospital are elective and therefore not urgent, we assumed that the patients tended to postpone their medical procedures, as was previously reported [12]. Notably, this utilization pattern has been observed repeatedly over the years at the hospital (internal data, not shown in this study). At present, there is no uniform global benchmark for optimal OR utilization. Several studies have tried to evaluate the optimal utilization with little success [13,14]. According to the accepted practice in western countries, the minimum desirable OR utilization rate is 70–80% of the OR capacity which, in Israel, is 7.5 hours per day allocated for morning surgery [1].

Our observed OR utilization rate of 79% is higher than the 72% reported by the state comptroller in May 2017 for public hospitals in the Israeli public healthcare system [1]. The state comptroller's report also noted that the allocation of ORs to departments is not performed optimally. Allocation is performed by the departments rather than by an OR scheduling team and some departments do not even use the time allotted to them for surgery. In the public hospitals that were examined, there were no computerized systems that supported the scheduling process and some hospitals did not fully measure or monitor OR utilization.

In addition, the comptroller's report also discussed delays in surgeries, delays in the transition time between surgeries, limited use of ORs in the afternoon, postponement or cancellation of surgeries, the long waiting times for surgery, and deficient human resources due to lack of anesthesiologists and OR nurses. At our hospital ORs are utilized for 16 hours per day from Sunday to Thursday and for 8 hours on Fridays. Thus, in contrast to the public hospitals, we are relatively success-

ful in avoiding the insufficient use of expensive technological infrastructure.

PROCEDURE TYPES

There is an essential difference between public and private hospitals in Israel. While OR activity in the private sector is based solely on elective surgeries, in public hospitals OR activities include both elective surgeries and unplanned emergency surgeries. As a result, the OR schedule in private hospitals can be followed more easily, as almost no unplanned activity is registered. This finding could explain the higher utilization rate observed in our analysis compared to that reported for the public sector in Israel. Thus, we believe that improving the scheduling ability is extremely important, as optimal planning should lead to higher utilization.

The average duration of a single surgery in our hospital was 60 minutes. As a result, each block comprised 3 to 6 surgeries. Each new surgery could lead to lost OR time due to team replacements and cleaning procedures. Longer surgeries, which are more common in public hospitals, have a potential for higher utilization. Hence, the difference between the public and private healthcare systems could have been even higher than that reported in this article.

FUTURE PLANS TO IMPROVE UTILIZATION

There are a number of ways to improve OR utilization. Planning ability can be improved by setting organizational goals for OR utilization, obtaining a higher level of accuracy for the recommended surgery intervals by running the computer model on a weekly or monthly basis, consolidation of the computerized systems in order to manage resource allocation and OR scheduling on the same system, and reducing cancellation of surgeries by mapping the reasons for surgery cancellation. To increase OR performance, shift management capabilities and real-time decision making can be improved by adding all the necessary information to the shift manager's work station, decreasing surgery delays and improving process control by adjusting the checkpoints.

ECONOMIC AND HEALTH CARE INFLUENCE

Improved utilization in the private healthcare system could benefit the entire healthcare system in Israel. There is a debate in Israel regarding the role of the private healthcare system. Those who oppose private healthcare argue for a slippery slope leading to under-the-table payments [16] and increasing health inequality [17]. Alternatively, due to growing demands and the aging of the population in the coming years, some features of healthcare will be provided mainly by the private sector [18]. Moreover, public healthcare in Israel has many problems such as deprivation of resources, peripheral medical centers [19] and more.

In Israel, the average waiting period for elective surgeries in the public healthcare system may reach 1.5 years [15]. The extent of OR utilization in the private healthcare system in Israel, represented by the results from our hospital data, suggests that this system has a crucial role in reducing the public healthcare system's burden. Considering that only 25% of all surgeries are performed in the private healthcare system and ORs in private medical centers have longer service hours compared to those in public hospitals [16], elective surgeries should be shifted to the private healthcare system.

Notably, in 2017 the Israeli Ministry of Health initiated an end-of-year surgeries shifting program. The aim of the program was to shorten the waiting time for surgery in Israel. We suggest that such a shifting program be scheduled throughout the year, as it would result in shorter waiting periods for surgeries. The private healthcare system should be treated as a contributing factor to relieve bottlenecks, rather than the common perception, which sees it as a worsening inequality factor. In addition, improved OR utilization would necessarily result in improved OR availability leading to additional surgeries. Consequently, improved OR utilization should lead to a potential annual increase in income.

We think that improving utilization of ORs should be a major goal of our organization. Thus, we intend to allocate the necessary resources to implement plans aimed at increasing utilization. We suggest a comprehensive process that analyzes the different factors that contribute to reduced OR utilization and bring forth operative suggestions for increasing OR utilization. The hospital's management recognizes the importance of this issue and is willing to collaborate with key players in the public healthcare system on learning and applying the required actions to achieve increased utilization and consequently provide better medicine, shorter waiting, and improved quality of care in Israel.

The differences between the private and the public healthcare system in Israel may impede the adoption of suggestions regarding OR utilization by the public healthcare system. However, we believe that the current model used in our medical center is close to the ideal situation and therefore, an effort by all of the relevant factors should be performed to increase OR utilization.

LIMITATIONS

The analysis was performed in the course of a short period of 8 months. During this time the "Arrangements Law" that aimed to empower the public healthcare in Israel was applied. This law had several restrictions on the private healthcare in Israel and as a result, it is possible that during the study period a lack in demand was observed, resulting in lower utilization of our private medical center. In addition, under this law, the government intended to shorten waiting times for surgeries by allocating financial resources to the public healthcare in Israel at the expense of the private healthcare system.

CONCLUSIONS

Although limited implementation possibilities exist, we think that increasing utilization in the private system would benefit

the entire healthcare system and could also lead to improved OR utilization in the public healthcare.

To the best of our knowledge, this is the first study that quantitatively examined the OR utilization in Israel. Improving utilization should be a major goal of the healthcare system in Israel and worldwide. The presented work suggests a comprehensive process that analyzes the different factors that contribute to reduced OR utilization and brings four operative suggestions for increasing OR utilization. Adopting the suggested model is the first step in improving the current situation in the healthcare system. Improved OR utilization would necessarily result in improved OR availability such that additional procedures could be performed.

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Capsule

Placental growth factor regulates the generation of T_H17 cells to link angiogenesis with autoimmunity

Helper T cells actively communicate with adjacent cells by secreting soluble mediators, yet crosstalk between helper T cells and endothelial cells remains poorly understood. **Yoo** et al. found that placental growth factor (PlGF), a homolog of the vascular endothelial growth factor that enhances an angiogenic switch in disease, was selectively secreted by the T_H17 subset of helper T cells and promoted angiogenesis. Interestingly, the 'angio-lymphokine' PlGF, specifically induced the differentiation of pathogenic T_H17 cells by activating the transcription factor STAT3 via binding to its receptors and replaced the activity of interleukin-6 in the production of interleukin-17, whereas it suppressed the generation of regulatory T cells. Moreover, T cell-derived PlGF was required for the progression of autoimmune diseases associated with T_H17 differentiation, including experimental autoimmune encephalomyelitis and collagen-induced arthritis, in mice. Collectively, these findings provide insights into the PlGF-dictated links among angiogenesis, T_H17 cell development and autoimmunity.

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