ASSOCIATION BETWEEN OPERATIONAL INDEXES AND THE UTILIZATION RATE OF A GENERAL SURGERY CENTER

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This is a prospective study that focused on the dynamics of operating rooms using operational indexes that measure optimization, resistance, overload and utilization of the surgical unit, and also identified the factors most associated with these indexes. A total of 1,908 surgeries were analyzed over a period of two months in 2007. The average rates of utilization, optimization and resistance indexes were 80.41%, 65.35% and 34.65% respectively. The difference between the positive and negative overload index was low (5.42%). Operating room rescheduling and delays were the variables that contributed the most to the increase in these indexes. In the linear regression statistical model, the utilization rate was found to be the first common variable selected in the overload, resistance and optimization indexes. It is essential to work on these operational indexes with a view to obtain satisfactory results in the management of the surgical center, with well-defined work processes and teamwork.

DESCRIPTORS: operating room nursing; surgical procedures, operative; management indicators; perioperative nursing

LA ASOCIACIÓN ENTRE LOS ÍNDICES OPERACIONALES Y LA TASA DE OCUPACIÓN DE UN CENTRO QUIRÚRGICO GENERAL

Se trata de un estudio prospectivo que analizó la dinámica de las salas quirúrgicas a través de índices operacionales que miden la optimización, resistencia, sobrecarga y ocupación del centro quirúrgico, y también identificó los factores que más se asociaron a esos índices. Fueron analizadas 1.908 cirugías, durante dos meses en el año de .2007. La tasa de ocupación y los índices de optimización y resistencia promedios encontrados fueron 80,41, 65,35 y 34,65%, respectivamente. La diferencia entre el índice de sobrecarga positivo y negativo fue bajo (5,42%). El cambio de sala y el atraso, respectivamente, fueron las variables que más contribuyeron para la elevación de esos índices. En la prueba estadística de regresión linear se observó que la tasa de ocupación fue la primera variable común seleccionada tanto en los índices de sobrecarga, resistencia y optimización. Es fundamental la actuación sobre eses índices operacionales para obtener resultados satisfactorios en la administración del centro quirúrgico, con procesos bien definidos y trabajo en equipo.

DESCRIPTORES: enfermería de quirófano; procedimientos quirúrgicos operativos; indicadores de gestión; enfermería perioperatoria

ASSOCIAÇÃO ENTRE OS ÍNDICES OPERACIONAIS E A TAXA DE OCUPAÇÃO DE UM CENTRO CIRÚRGICO GERAL

Estudo prospectivo que analisou a dinâmica das salas cirúrgicas através de índices operacionais que medem a otimização, resistência, sobrecarga e ocupação do centro cirúrgico, e também identificou os fatores que mais se associaram a esses índices. Foram analisadas 1908 cirurgias, durante dois meses de 2007. A taxa de ocupação e os índices de otimização e resistência médios encontrados foram 80,41, 65,35 e 34,65%, respectivamente. A diferença entre o índice de sobrecarga positivo e negativo foi baixo (5,42%). O remanejamento de sala e o atraso, respectivamente, foram as variáveis que mais contribuíram para a elevação desses índices. No teste estatístico de regressão linear observou-se que a taxa de ocupação foi a primeira variável comum selecionada tanto nos índices de sobrecarga, resistência como otimização. É fundamental a atuação sobre esses índices operacionais para se obter resultados satisfatórios no gerenciamento do centro cirúrgico, com processos bem definidos e trabalho em equipe.

DESCRITOES: enfermagem de centro cirúrgico; procedimentos cirúrgicos operatórios; indicadores de gestão; enfermagem perioperatória

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INTRODUCTION

The surgery center (SC) is a particular sector in any hospital, distinguished for its results, the complexity of its procedures, its power to implement definitive cures, and for being the most costly facility in the hospital[1]. The use of its maximum surgical capacity is one of its main measures of efficiency, as surgical patients represent the largest revenue in a healthcare institution[2].

Nurses are increasingly more involved in the financial decisions and in institutions' budgetary planning and have to manage scarce resources (human, material and financial). Nurses also have an important role as agents of change toward positive results, and also have to seek balance between quality, quantity and cost[3].

The adoption of systems that measure performance is an important tool that helps managers to achieve such balance. It helps them to implement improvement strategies and present good results. The firms' interest in measuring performance emerged from projects related to quality, efficiency, productivity and costs[4].

One author[5] labeled the gain in operational capacity as "optimization" and the factors that represent loss of operational capacity in the SC she labeled "resistance". These factors, such as delays and cancellations, should be minimized because they harm preoperative preparation, which results in additional costs to the hospital, discomfort to patients and their family members and also dissatisfaction within the surgical team[6]. It is recommended that nurses and managers of SC units redesign their processes related to these factors (preoperative visit, planning of the surgical schedule, human resources, materials management, among others) and use control methods to standardize or correct problems with a view to establish measures to reduce the causes of surgical cancellation, establishing and pursuing goals to be achieved[2].

It is important to mention that the development of a well-dimensioned surgical map aims to diminish Operating Room (OR) idleness and promote adequate administration of these rooms' intervals. In turn, it lessens delays, improves the estimation of availability of instruments, equipment and material necessary for surgeries and reduces risk situations to which patients are unnecessarily subjected[6]. Under-utilization should be analyzed, as should the demand for surgeries and the characteristics of surgical teams[7].

In practice, surgical teams insist on having more time available for surgery while they do not even use the quota allotted to them. On the other hand, the hospital has to manage overloads in the surgery schedule, taking into account delays of certain teams in a given OR and procedures that delay daily surgical schedules[8-9].

The efficiency of the services delivered by the SC can be characterized by monitoring surgeries' punctuality, minimum time between each surgery, flexibility in the utilization of available ORs, capacity to attend to emergencies or additional surgeries, in addition to a low rate of surgery cancellation and a high rate of utilization of ORs[9-10].

The use of the SC can be monitored by various indexes of operational performance such as the optimization and resistance indexes mentioned above[5] in addition to the overload index, which measures the difference between the actual time the OR was in use and the time scheduled by the surgeon[5].

This study aimed to analyze the dynamics of ORs through operational indexes that measure the optimization, resistance, overload and utilization of the surgical unit. Its specific objectives were to identify the factors most associated with the studied dependent variables (overload, resistance and optimization indexes) and to identify the association between the utilization rate and these indexes.

METHOD

This prospective study was carried out in a tertiary and private hospital in a city in the interior of São Paulo, Brazil. This hospital works with quality programs and organizational guidelines that establish performance goals and are monitored by operational indexes, analyzing work processes and measuring results that guide projects for continuous improvements.

All anesthetic-surgical procedures (1,908 procedures) carried out from Monday through Saturday between September and October 2007 were included. We chose to perform a global analysis of the SC because its ten ORs are uniformly equipped, present no great structural or physical differences, and their utilization rate has little variation (10%±1.5%).

The operational indexes were calculated using the times registered on the hospital admission charts, the patients' medical file and on the anesthesia charts. Data were recorded on an Excel spreadsheet.

- *Utilization rate*: Effective utilization of the SC operational capacity. Calculated by the total time (in minutes) of utilization of the OR + time spent in its cleaning and preparation divided by the total number of hours during which the SC was available (7 a.m.-6 p.m. = 660 minutes) multiplied by 100.

- *Overload index*: The overload index measures the excessive use (positive overload index) or under-used hours (negative overload index) of the OR operational capacity. The following variables were considered: the surgery's actual duration and the time the surgeon scheduled for the procedure. It is calculated by the difference between the actual time used (in minutes) and the reserved time (in minutes), divided by the reserved time multiplied by 100.

- *Optimization index*: Gain in operational capacity due to factors that facilitate procedures in the OR that countervail situations of resistance. Variables were defined as: punctuality, how much time surgeries ended ahead of schedule, rate of extra surgeries, rescheduling of surgeries; time spent to clean and prepare the OR ≤ 20 minutes.

- *Resistance index*: Loss of operational capacity caused by obstacles that interfere with the capacity of service production. Variables were defined as: delays in procedure start time (≥ 16 minutes); cancellations; OR cleaning and preparation ≥ 21 minutes.

The turnover time refers to the interval of time between the end of one anesthetic procedure and the initiation of the next within the sequence of procedures in the same OR, as registered on the anesthesia charts for that specific room. This interval was not included in the list of independent variables in the Linear Regression test because it was almost the same for the entire sample.

Statistical Analysis

The technique used was the linear regression model, which allowed selecting from a set of variables all those that independently contributed to the global variation in the outcome[11]. The significance level was defined at $p < 0.05$. For the analysis of dependent variables, the following independent variables were included: utilization rate and the variables comprising the operational indexes (optimization, resistance and overload).

The names of patients, collaborating members of the surgical unit staff and physicians were not included in the data collection forms in order to ensure their anonymity. Each form was identified only by the date of data collection and the OR number. The hospital's executive board of directors and the Research Ethics Committee of the School of Medical Sciences at the State University of Campinas (UNICAMP) approved the study's ethical and methodological aspects. No consent agreement was required because the study did not directly involve human beings.

RESULTS

In the study sample, 90% of the patients attended the scheduled surgery. Of these, 36% were outpatients and 64% remained hospitalized post surgery. The distribution of surgeries according to specialties was: Orthopedics (21.4%), General Surgery (14.9%), Gynecology and Obstetrics (11.9%), Otorhinolaryngology (11.2%), Urology (8.6%), Neurosurgery (6.4%), Head and Neck (5.8%), Proctology (5.4%), Plastic (3.6%), Vascular (3.6%), Pediatrics 2.5%) , Thorax (1.7%), Cardiac surgery (1.7%), other procedures (1.2%).

The utilization rate and optimization index were higher than the resistance index and presented a positive overload index that was relatively low (Table 1).

Table 1 - OR Operational indexes (%)

Operational indexes	Mean ± SD	Minimum	Maximum	Median
Utilization rate	80,41±8,95	59,70	115,27	79,39
Optimization index	65,35±9,70	33,33	91,36	64,06
Resistance index	34,75±9,31	8,34	66,67	35,35
Overload index				
Positive	8,33±6,60	0,96	30,32	6,20
Negative	2,91±2,40	0,45	7,82	2,19

The optimization index was mainly determined by rescheduling of the OR (41.9%) and by turnover time ≤ 20 minutes (18.1%). Delay was the variable that most contributed (65.10%) toward increasing the resistance index (Table 2).

Table 2 - Structure of the optimization and resistance indexes (%)

Indexes	Variables	% in relation to the index	% in relation to the total number of surgeries
	OR Rescheduling	41.9	27.4
	Cleaning time ≤ 20 minutes	18.1	11.8
	Punctuality	14	9,2
Optimization index (65.35%)	Surgeries ahead of time	7.1	4,6
	Slotting for elective surgeries	3.1	2
	Slotting for urgency procedures	14.6	9.5
	Slotting for emergency surgeries	1.1	0.8
	Delays	65.1	22.5
Resistance index (34.65%)	Cancellations	23.2	8.1
	Cleaning time ≥ 21 minutes	11.7	4

The overload index presented a determination index of 0.0072 (p=0.0031) (Table 3). It is important to highlight that this correlation was weak and positive. The utilization rate and punctuality were the only variables associated with overload. The utilization rate positively correlated with the overload index; it presented an estimated parameter of positive value, 63.9% of the partial R^2.

Table 3 - Variables significantly associated with the overload index.

Independent variables	Estimated Parameter	Standard error	P-value	Partial R^2
Utilization rate	0.0460	0.0154	0.0031	0.0046
Punctuality	88.6655	39.9129	0.0264	0.0026

Statistical model: p= 0.003
R^2= 0.0072

The resistance index presented a determination index of 0.0580 (p<0.0001). The utilization rate was the first variable selected, with partial R^2 value of 0.0349, which represented 60.17% of the total R^2 value. Delay was the variable that most contributed toward an increased resistance index (Table 4). It was composed of: 75.9% related to surgeons' delays, 8.6% to patients' delays, 3.6 to hospital's, 3.3% to surgical unit and 8.6% to others factors.

Cancellation of surgeries was positively associated with the resistance index, whereas 8.1% of surgeries were canceled during the study period. Causes for cancellation included: patients' personal reasons (33.1%); surgery rescheduling (16.5%); health insurance companies did not approve the procedure (12.0%); the procedure was canceled by the physician the day before (11.4%); patients' poor clinical conditions (10.1%); no beds available in the Intensive Care Unit (ICU) (6.9%) and others (4.5%).

Table 4 - Variables significantly associated with the resistance index.

Independent variables	Estimated Parameter	Standard error	P-value	R^2
Utilization rate	-0.1889	0.0232	<.0001	0.0349
Delays	3.0376	0.7390	<.0001	0.0130
Cancellations	2.9123	0.5086	<.0001	0.0084

Statistical model: p<0.001
R^2= 0.0563

The optimization index presented a determination index of 0.0521 (p<0.0001). There was a directly proportional correlation between this index and the utilization rate, whereas this variable was responsible for 59.96% of the partial R^2. In this case, the delays in procedures starting time and cancellations were found to be inversely proportional to the optimization index (Table 5).

Table 5 - Variables significantly associated with the optimization index.

Independent Variables	Estimated Parameter	Standard error	P-value	Partial R^2
Utilization rate	0.1850	0.0243	<.0001	0.0312
Delays	-3.2889	0.7716	<.0001	0.0118
Cancellation	-2.9221	0.5310	<.0001	0.0091

Statistical model: p<0.001
R^2= 0.0521

DISCUSSION

We found the dynamics of the surgical center satisfactory because the overload index was low, the optimization index was higher than the resistance index and the utilization rate reached the managerial goal (80 to 85%). In the international literature[8], the utilization rate has been around 85-95%. However, the characteristics of the surgical centers in these studies differ because surgical rooms are reserved

and charged per hour. In which case, rooms being over-utilized or under-utilized incur a financial loss[8]. In the Brazilian literature, an average of 66% was registered in a university hospital[12] and 76.21% was the average utilization rate found in a hospital with the same characteristics of the studied surgical center[13].

Results reveal that over 40% of the surgeries were included in the optimization index because they had their rooms transferred. When surgeries were transferred or arranged into empty rooms, idleness was avoided, physicians' waiting time from one surgery to the next decreased and the number of surgeries increased, which consequently reduced the hospital's costs[6,10].

The low overload index did not significantly affect the surgery schedule. For that, a good balance between the under-utilization and over-utilization of the operating rooms was achieved[8,9]. For that, the professional responsible for planning the OR schedule has to have a broad view of the process, that is, this professional has to reschedule or slot surgeries so to gain time when procedures last more or less time than expected[8,10].

Utilization rate and punctuality were the only variables associated with overload, whereas the utilization rate was directly proportional to this index. The association between punctuality and overload can be explained by the fact that punctual surgeries had a higher average duration in relation to the remaining studied surgeries. Fewer delays were found to occur in longer procedures (surgeries that exceed four hours, the standard established in this service), and even when surgeries were punctual, over-utilization[8] occurred due to the fact that the duration of the surgery exceeded the time scheduled by the surgeon.

The resistance index presented an association inversely proportional to the utilization rate, that is, the greater the resistance index, the lower the utilization rate. In regard to delays and cancellations, there was a direct and positive association.

The same variables were selected in the optimization index analysis, though, with a different interpretation: the higher the utilization rate, the greater was the optimization index; and many delays and cancellations occurred, adversely affecting the optimization index. This result seems obvious, however, it is now verified in a statistical test.

It is known that delays and cancellations cause operating room idleness[2,8-10]. In this study, the main cause of delay was the surgeon. However, getting physicians engaged in the process is a difficult task because, as clients of the hospital, they make many demands and are not willing to invest in projects for improving quality[14].

The surgical unit nurse coordinator has to be attentive to the individual characteristics of the different professionals working in the unit. The nurse has to know how each one acts and reacts in the face of situations of conflict, to better lead his/her team and guide the nursing team's relationship with the medical team[15]. Conflict is inherent in human relationships, and should not be seen as something negative. There is a perception that many conflict situations that occur in the surgical unit are important and necessary because these indicate changes and give opportunities to rethink situations so as to generate changes with a positive impact on patients' care[15].

In regard to surgery cancellations, the nurse should also use strategies to minimize them, analyzing the causes generating the problem[2]. A study on surgical cancellations revealed that most cancellations were potentially evitable. Administrative planning, redesign of work processes, measures to educate the staff and preoperative evaluation are strategies recommended to minimize this kind of event[2].

Although the cleaning and preparation time was not an independent variable included in the linear regression model (it was almost a constant in the statistical test), it should be noted that some surgical teams attribute delays to the time taken to clean the rooms, whereas it might also be related to the anesthesia and surgery teams and to patients[16].

According to the literature, cleaning and preparation begins after the auxiliary who takes the patient to the post anesthetic recovery room or to the ICU[1] returns, and according to some authors the average time spent in cleaning exceeded 30 minutes[1,5,16]. However, at the studied hospital, the cleaning procedure begins as soon as the anesthetic procedure ends, regardless of whether the patient has left the OR or not. The hospital's goal is to ensure that the interval between the end of one anesthetic procedure and the beginning of the next does not exceed 20 minutes, which was achieved in 88.3% of the studied surgeries. This is compatible with the turnover time mentioned by one international author[8], in which one surgery was scheduled to start 20 minutes after the time scheduled for the previous one to end.

The three studied indexes were associated with the utilization rate, since this rate was the first variable selected in the overload, resistance and optimization indexes. Thus, pro-actively intervening in these indexes might result in better operational management of the surgical unit. Interventions require confronting ingrained attitudes, emphasizing teamwork and effective methods of interpersonal communication, and encouraging all those involved in the operation of ORs to get involved[17].

FINAL CONSIDERATIONS

Nurses who occupy management positions in health institutions have to have scientific knowledge and technical expertise, especially in a surgical center, where there is a considerable diversity of professionals. Plans of action need to be adequate to clients' profiles and management has to be based on facts and procedures previously defined, effective practices should be emphasized, and proactive actions and ongoing training encouraged.

The study's results can be the basis of the development of operational scores to evaluate the services of the surgical unit because they permit a critical analysis of a surgical unit's global performance. Operational scores also enable a critical review of the main processes and routines involved in the surgical production, which can have greater or lesser impact depending on how many professionals of different categories become involved.

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