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Factorial analysis to increase operating room performance and decrease cancellation of elective surgery

El análisis factorial para aumentar el rendimiento del quirófano y disminuir la cancelación de cirugía electiva

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Key words:
Canceled surgery, operating room performance, factorial analysis.

Palabras clave:
Cirugía cancelada, rendimiento del quirófano, análisis factorial.

ABSTRACT

Introduction: The cancellation of elective surgeries and the low performance of operating room are problems that affect the quality of medical care. **Objective:** To evaluate the use of factor analysis, to identify the causes of underperformance in the operating room, in order to reduce the rate of surgery cancellation and increase performance. **Methods:** Through a prospective study; to the staff that works in the operating room, we ask them to write down ten problems that prevent the optimal use of the operating room, adding the solutions they propose; a factorial analysis is performed. With the results an operational decision is taken that is applied at the beginning of the turn. The performance, rate and causes of suspension are identified. **Results:** Factor analysis identified two related factors: lack of coordination of anesthesiologists and operating room. With an operative decision, a performance of 100% and an elective surgery cancellation rate of 4.9% were obtained. The causes of major cancellation were: lack of surgical time 48.5%, emergency surgery 17.1% and hypertensive patient 10.5%. **Conclusion:** Factor analysis identified causes that, through an operative decision, increased performance, decreasing the rate of cancellation of elective surgeries to an acceptable range.

RESUMEN

Introducción: *La cancelación de cirugías electivas y el bajo rendimiento de los quirófanos son problemas que afectan la calidad de la atención médica.* ***Objetivo:*** *Evaluar el uso del análisis factorial para identificar las causas de bajo rendimiento del quirófano y así poder disminuir la tasa de cancelación de cirugía y elevar el rendimiento.* ***Métodos:*** *Mediante un estudio prospectivo se pidió al personal que labora en el quirófano que anotara diez problemas que impiden su uso óptimo, agregando las soluciones que proponen, y se realizó un análisis factorial. Con los resultados se tomó una decisión operativa que se aplicó al inicio del turno. Se identificó el rendimiento, tasa y causas de suspensión.* ***Resultados:*** *El análisis factorial identificó dos factores relacionados: falta de coordinación de anestesiólogos y de quirófano. Con una decisión operativa se obtuvo un rendimiento de 100% y una tasa de cancelación de cirugía electiva de 4.9%. Las causas de mayor cancelación fueron: falta de tiempo quirúrgico 48.5%, por cirugía de urgencia 17.1% y por paciente hipertenso 10.5%.* ***Conclusión:*** *El análisis factorial identificó causas que mediante una decisión operativa elevaron el rendimiento, disminuyendo la tasa de cancelación de cirugías electivas a un rango aceptable.*

INTRODUCTION

Timely surgical treatment is an attribute of the quality of care, interpreted as efficiently satisfying health needs at the required moment.[1,2] However, in Mexico it is insufficient as a result of the financial crisis that health institutions are going through; 6.2% of the GDP goes to the health sector and, due to the current macroeconomic environment, this figure tends to decrease,[3] limiting the capacity to provide surgical care. Furthermore, population growth and improved life expectancy[4] have increased demand, making it necessary to redouble efforts with scarce resources, in order to improve surgical services that are frequently inefficient, which impacts on hospital costs and a bleak prognosis for the patient, all leading to frustration and impotence in patients and their families.[5]

Surgery is in enormous demand in secondary and tertiary hospitals,[6] and as demand exceeds

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the capacity of available resources, waiting lists for elective surgery have been established.[7]

Another inconvenience is surgery cancellation once the patient is hospitalized and waiting to be operated on. Suspension or cancellation is seen in both public and private hospitals at a rate between 4.07% and 23.79%.[5,8,9] This is considered a serious problem, which has led to publications with proposals to solve it, decrease the cancellation rate and increase operating rooms' performance.[2,10,11]

Cancellation of elective surgery is an indicator for assessing the quality both of patient care and the administrative system.[12] Indicators help understand how an operating suite works, thus determining its efficiency. One of the causes of inefficiency is the underutilization of available resources;[13] consequently, efforts should be made to improve efficiency and reach the highest level with the available resources, in order to provide the greatest social benefit and satisfaction at the lowest cost and avoiding waste.[14]

In private and public hospitals around the world, the cost of operating suites has increased;[2,11,15-17] in the private sector, it results from the growing numbers of insured patients,[18] whereas in the public sector, it is due to the economic crises and an increased demand for care.[15,19] Pressure to improve healthcare systems with decreased budgets forces institutions to optimize efficiency, since surgery occupies a priority position,[6] and operating rooms account for over 40% of a hospital's total expenses, as well as part of its income.[5,20]

Historically, surgical services in Mexico started on an empirical basis,[21] so the distribution of roles and responsibilities was not clear. Each specialty within the operating suite answers hierarchically to its own chief,[22] and they do not always share the same objective, leading to confusion. Efficient use of the operating rooms depends on an understanding among all the staff, in order to fulfill specific functions in the scheduled time periods.[23]

The goal of the large number of published medical articles is to increase operating room performance at low costs, with no waiting lists, no lost time slots, no delays in initiating surgery, no staff overtime and with a low cancellation rate.[2,20,24,25] This is why new procedures and strategies to balance demand with surgical capacity have been proposed,[7,20,26] such as factor analysis, which identifies those factors that explain operating room variability.[27]

The aim of this prospective study was to determine the usefulness of factor analysis to increase operating room performance and decrease the rate of cancellation of surgeries scheduled for the afternoon shift at Hospital General Xoco.

METHODS

After due protocol authorization by the research and ethics committee, we conducted a prospective study during the afternoon shift on the central operating suite of Hospital General Xoco; this is a secondary level hospital run by the Health Ministry of the Mexico City government. The study was conducted between March 1, 2014, and February 28, 2015. The staff were unaware that they were participating in a research project. It consisted of two stages.

In the first stage, all individuals involved in operating room procedures –i.e., surgeons, anesthesiologists, nurses, clinicians, and orderlies– were asked to point out, from their perspective, ten problems that hinder the optimal use of operating rooms and to propose solutions. They were asked to consider the problems and solutions according to their magnitude, feasibility and degree of necessity, all expressed as percentages. Factor analysis was applied to the results.

In the second stage, with the factors obtained through the analysis, an operative decision was applied at the beginning of the afternoon shift, that consisted in assigning the anesthesiologists and patients that were waiting for an operating room. The study was conducted on business days; weekends and holidays were not included. The numbers of personnel, equipment and central operating rooms were the same throughout both years of the study.

Data collected were: bed number; patient's name, gender, and age; specialty; type of surgery; cause of cancellation; anesthesiologist;

and surgeon. Procedures were classified as elective surgery, emergency surgery, waiting list surgery and morning shift surgery.

We checked whether there were operating rooms occupied by surgeries from the previous shift. Once patients were registered, their fasting status was confirmed with the surgical specialty residents, as well as whether they had the necessary material, laboratory results and pre-operative assessment. Surgery was subsequently assigned to the available anesthesiologists and nurses in the shift (emergency surgery was classified according to its priority into red, yellow and green), by the complexity of the procedure and the available operating rooms. With this assignment done before entering the operating room, the anesthesiologists and nurses prepared the rooms according to the needs for each procedure. Before applying the operative decision, a baseline record was obtained for a month, to determine surgeries performed and cancelled during the research in the operating suite in the afternoon shift.

At the end of the shift, performed and cancelled surgeries were recorded, as well as the reason for cancellation. Surgery was considered cancelled if it was assigned and for any reason it was not performed during the shift. To measure performance, the year of the study was compared to the previous year, using the records of the hospital's statistics service for 2013 and 2014 on surgeries performed by surgeons in the afternoon shift. The study did not include gynecological surgeries or those performed under local anesthesia, since they took place in other operating rooms.

Analysis

Statistical analysis was performed with descriptive statistics, contingency tables, factor analysis, Cronbach's alpha and t test for related samples, with an alpha value of 0.05, and using the SPSS statistics package, version 12.

RESULTS

In the first stage, 16 participants were included, amounting to 80% of the personnel employed that year in the operating suite. Among those employees, 35% were anesthesiologists; 12%, general surgeons; 12%, nurses; 12%, plastic surgeons; 12%, orthopedists; 11%, ophthalmologists; and 6%, orderlies, out of the total staff. Their answers were grouped into 33 problems, all with the magnitude, solutions, level of need and feasibility that the employees considered pertinent. Factor analysis identified two factors with autovalues above one, that accounted for 60% of the overall variability and with a Cronbach's alpha of 0.792. These factors were integrated as follows: factor one, related to operating room coordination: a) absence of janitorial staff, b) delay in surgery from the previous shift; factor two, related to the anesthesiology department: a) lack of coordination among anesthesiologists, b) lack of anesthetic supplies. The solution to both factors was the dynamic scheduling and coordination by anesthesiologists; this meant, both at the beginning of the shift and before entering the operating room, rescheduling patients who were in the ideal conditions for surgery and with the necessary human and material resources available.

In the second stage, the records of the hospital's statistics department showed that 912 surgeries were performed in the afternoon shift in 2013 (mean 59, standard deviation 49); in 2014, there were 1,856 (mean 103, standard deviation 73), double the number than the previous year ($p = 0.000$). Cancellation rates were 3% and 2%, respectively. The hospital's statistics department only records surgeries performed, but neither the rates nor the causes for cancellation by specialty; the method for collecting these data is different to the one used in the research project. The number of personnel, operating rooms and equipment was the same throughout both years.

In the prospective study, during 12 months 1,531 surgeries were assigned, out of which 1,168 (76.3%) were completed and 363 (23.7%) were cancelled. In the baseline record obtained one month prior to the implementation of the operative decision, 66 surgeries were assigned, 39 (59.1%) were completed and 27 (49.9%) were cancelled *(Figure 1)*.

All assigned surgeries required an anesthesiologist; in the operating suite where the study was carried out, no surgeries under local anesthesia are performed in the afternoon shift.

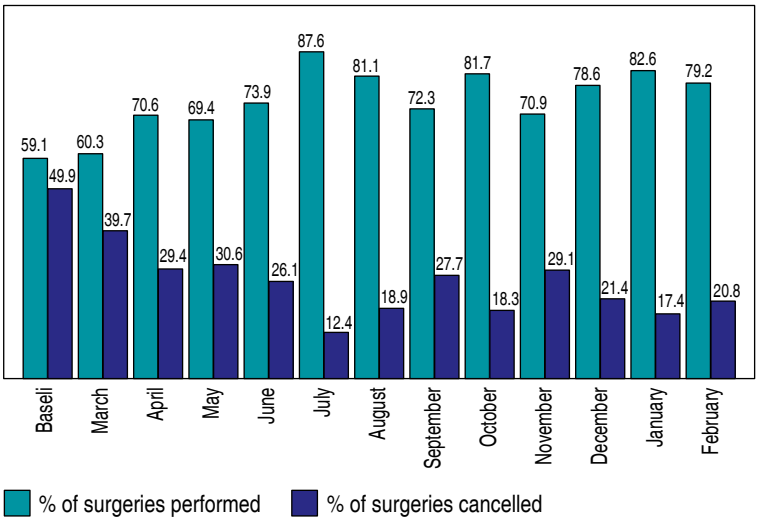

Figure 1: *Rate of performed and cancelled surgeries by month in the baseline registry before applying the operative decision.*

Table 1: Performed and cancelled surgeries.

Department	Surgeries performed n / %	Surgeries performed Cumulative %	Surgeries cancelled n / %	Surgeries cancelled Cumulative %
Orthopedics	471 / 30.8	30.8	213 / 13.9	13.9
General surgery	465 / 30.4	61.2	134 / 8.8	22.7
Neurosurgery	90 / 5.9	67.1	3 / 0.19	22.89
Joint surgery	57 / 3.7	70.8	3 / 0.19	23.08
Opthlamology	56 / 3.6	74.4	3 / 0.19	23.2
Plastic surgery	27 / 1.8	76.2	7 / 0.5	23.7
Organ procurement	2 / 0.1	76.3	0 / 0	23.7
Total	1,168 / 76.3	76.3	363 / 23.7	23.7

Table 2: Cancelled surgeries by type of scheduling.

Scheduling	Surgeries performed n / %	Surgeries cancelled n / %
Elective	434 / 28.3	75 / 4.9
Emergency	455 / 29.7	42 / 2.7
Waiting list	261 / 17.0	245 / 16.0
Morning shift	18 / 1.2	1 / 0.1
Total	1,168 / 76.3	363 / 23.7

Table 3: Causes of surgery cancellation.

Cause for cancellation	Surgeries cancelled n / %	Surgeries cancelled % cumulative
Lack of surgical time slot	176 / 48.5	48.5
Emergency surgery	62 / 17.1	65.6
High blood pressure	38 / 10.5	76.1
No fasting	34 / 9.3	85.4
No material	34 / 9.3	94.7
Lack of nurse	7 / 1.9	96.6
Lack of equipment	6 / 1.7	98.3
Patient was not admitted	3 / 0.8	99.1
No pre-operative assessment	1 / 0.3	99.4
Was already operated	1 / 0.3	99.7
Not scheduled	1 / 0.3	100
Total	363 / 100	100

The departments that performed the most surgical procedures were orthopedics, with 471 (30.8%), and general surgery, with 465 (30.4%), amounting to 61.2% of all surgeries; however, they were also the services that cancel the most surgeries, accumulating 22.7% of all cancellations between them. Seventy five elective surgeries (4.9%) were cancelled *(Tables 1 and 2)*.

Out of the 363 cancelled surgeries, the most frequent causes were lack of a surgical time slot, 176 (48.5%); emergency surgery, 62 (17.1%); and high blood pressure in the patient, 38 (10.5%). These causes account for a cumulative 76.1% that may be considered as unavoidable. Cancellations due to lack of fasting (34; 9.3%) and lack of material (34; 9.3%) are shown in *Table 3*.

As for cancelled elective surgeries, the most frequent causes were lack of a surgical time slot, 31 (41.34%); lack of material, 16 (21.34%); emergency surgery, 9 (12.00%); high blood pressure in the patient,

Table 4: Causes of elective surgery cancellation.

Cancelled surgeries		
Cause of cancellation	n / %	Cumulative %
Lack of surgical time slot	31 / 41.34	41.34
Lack of material	16 / 21.34	62.68
Emergency surgery	9 / 12.00	74.68
High blood pressure	8 / 10.67	85.35
No fasting	4 / 5.33	90.68
Patient not admitted	2 / 2.67	93.35
Was already operated	1 / 1.33	94.68
Not scheduled	1 / 1.33	96.01
Lack of nurse	1 / 1.33	97.34
Lack of equipment	1 / 1.33	98.67
Lack of pre-operative assessment	1 / 1.33	100.00
Total	75 / 100	100.00

8 (10.67%); and others, 11 (14.65%). The avoidable cancellations added up to 27 (35.99%) *(Table 4)*.

DISCUSSION

Throughout this research project, the number of surgeries performed during the afternoon shift doubled. The main causes for cancellation identified were lack of a surgical time slot and emergency surgery, with an overall rate of 23.7% and an elective surgery cancellation rate of 4.9%.

An efficient operating room must have a low surgery cancellation rate; otherwise, the operating room is underused, the patient waiting list grows and costs rise. The goal of efficiency is to satisfy the needs of patients, avoiding waste and health risks as far as possible.[16,28]

Most authors recognize that, if resources are not correctly put to use, the population suffers, and particularly that segment depending on public hospitals for health care.[26,29] Based on this premise, it is necessary to increase the operating rooms' performance by increasing efficiency and thus reducing the cancellation of surgeries.[11]

It has been suggested to conduct a survey among the staff working in the surgical area to find out how efficient the operating suite is;[30] however, questionnaires are not validated. Thus, a factor analysis and Cronbach's alpha test were applied in this study to our employees' responses, to obtain a construct validation.[27,31] This analysis identified two problems that hinder efficiency and that may be summarized as a lack of organization in the employees' functions, particularly those of anesthesiologists. Based on this result, an operative decision was taken that, when applied to a hospital unit, is more effective than a strategic decision.[7,20]

The operative decision consisted in assigning surgeries to anesthesiologists, taking into consideration the available human and material resources, and giving priority to elective and emergency surgeries. The assignment of emergency surgery was established by priorities: red, yellow or green,[16] adding patients from the waiting list.[7] This way, the operating suite's performance doubled with the same personnel, number of operating rooms and equipment. Since this project did not have a control group, data registered in the hospital's statistics department throughout the year of the study and the previous one were used to measure the number of surgeries with the same procedure. In order to estimate the cancellation rate, we used the baseline registry obtained prior to the application of the operative decision, and observed that the cancellation rate decreased as performance increased *(Figure 1)*. The operative decision was implemented to improve efficiency, since sometimes, patients scheduled for elective surgery, or patients for emergency surgery with a yellow or green priority, do not comply yet with the requirements to be taken into the operating room; if these patients are moved into the OR, they either wait there or are removed later, after using up a surgical slot

that could be assigned to a patient fulfilling all the requirements.[27]

During the prospective study, 1,168 surgeries were performed, with a high overall cancellation rate but with a regular elective surgery cancellation rate.[1]

The performance achieved is superior to that reported in two publications. a) In Italy, an operating suite management or administration system was developed, using a digital system with hardware and software in a project named "surgical patient route", consisting of a data registry and a system of operating room management, all of which increased the number of surgeries by 44% and 56%.[32] b) In Norway, a redesign of the scheduling of elective surgeries was developed, increasing the number of surgeries performed by 17% and decreasing the cancellation rate from 8.5% to 4.9% per month over a two-year period.[29]

Surgical capacity is always exceeded by demand. as reported in Australia, where it was found that hospital admissions for elective surgery increased 3.6% every year during a four-year period. In order to decrease cancellations, the National Partnership Agreement on the Elective Surgery Waiting List was introduced, to achieve efficiency by planning the hospitals' scheduling system. A change from static scheduling to dynamic scheduling was proposed, due to the ever-present variability and uncertainty in surgical departments.[33]

In the world's literature, surgery cancellation rates vary widely between hospitals, particularly due to differences in definitions and the lack of indicator standardization to measure the performance and efficiency of the operating suite.[34] Furthermore, methods for data collection are different, and hence cancellation rates vary widely, from 3.6% to 36.9%, even within the same hospital, as seen in the statistics department at Hospital Xoco and in our study. The causes for cancellation also differ from one hospital to another.[2,5,8,9,12,15,17,35-37]

In our study, out of 363 cancelled surgeries, the most frequent cause for cancellation was the lack of a surgical time slot, with a rate of 48.5%, a frequently observed problem around the world. In the United Kingdom, the lack of a surgical time slot is the most frequent cause of surgery cancellation, attributed to the fact that 50% of surgeons incorrectly estimate the duration of the procedure when scheduling it.[38] In another study in the United Kingdom, out of 978 cancellations over a five-year period, the most frequent causes were attributed to the patient (40%) and to the lack of surgical time slots (21%).[11] In a prospective study conducted in India, out of 7,272 patients scheduled for elective surgery, 1,286 cancellations were reported, of which 63% were due to the lack of a surgical time slot.[12]

It is hard to define whether the lack of surgical time slots is avoidable or unavoidable,[11] since it results from several factors: the variability of the patient's physical status –given that each patient is different–,[7] the surgeon's experience, the composition of the surgical team, and the type of procedure, because the procedures' variability and complexity are also different. For example, the comparison between a laparoscopic cholecystectomy and a laparoscopic Nissen fundoplication, measured with the index for difficulty of surgery (IDS), yields a score of 17 and 26 points, respectively.[23,39] This leads to conclude that it is difficult to predict the time needed to perform a surgical procedure.

The second cause for cancellation in our study was emergency surgery, with a rate of 17.1%. Decreasing this rate is difficult, since the admission of emergencies is unpredictable. *Hospital de Xoco* is an emergency hospital, so assigning elective or emergency surgeries is difficult. There are two alternatives: one is a mixed approach, whereby emergency surgery will be assigned to any available operating room; the second approach involves devoting specific operating rooms for elective and non-elective procedures. However, the latter is not cost-effective, since it adds to the waiting list for elective surgeries and increases costs.[7,16,25] In Canada, the benefit of devoting an operating room exclusively for emergencies was evaluated; the rate of surgery cancellation decreased from 1.5% to 0.7%, but the daily use of the operating room varied between 0% and 100%, with an overall average of 53% (standard deviation ± 25%) during the six-month study.[40] In our study, the mixed method was adopted.

Several studies have been conducted to test different interventions to decrease the

rate of surgery cancellation. To date, with the pre-operative assessment clinics, better results have been obtained. On the other hand, there are few studies on the long-term effects of combined interventions to decrease the rates of elective surgery cancellation. In Australia, a retrospective study compared the usefulness of the pre-operative assessment clinics recording only the anesthetic causes for cancellation, and obtained a rate of 0.46%.[41]

As for prospective research projects, there are a few proposals, such as one from France (Gaucher et al.). In a multicenter randomized controlled trial, a pre-operative standardized list administered via an automated telephone system was used in order to reduce last-minute cancellation of ambulatory surgeries. Two groups were formed; the standardized list was applied to one group, whereas the other followed the usual protocol. No significant differences were found in the cancellation rates between groups: the rate was 5.6% in the group in which the intervention was applied and 5.8% in the control group.[37]

Another proposal was published in the United Kingdom, suggesting the creation of a post-operative surgical unit for major elective surgery; this led to an increase in performance from 317 to 737 surgeries performed, and a decrease in the cancellation rate from 36.9% to 0.67% over a one-year period.[36]

To increase operating room productivity and efficiency in Iran, they investigated the usefulness of the Six Sigma philosophy, a systematic approach to organization used in industries to decrease production defects and errors. A decrease in the cancellation rate from 3.6% to 1.4% was observed due to ear, nose and throat surgeries, that prior to the intervention had a rate of 2.7% and decreased to 0.35% after the intervention; the remaining services had no changes.[42]

In the Republic of Korea, the cancellation rates over a 100-day period were assessed before and after adding two operating rooms to those previously available. The number of surgeries performed increased from 1,982 to 2,198, with an increase in the cancellation rate from 20.5 to 23.8% due to the lack of hospital beds.[43]

In the publications from the United Kingdom reviewed, the productivity in terms of surgical procedures doubled by simply building a post-operative unit for major surgery. In our study, productivity doubled merely by optimizing the available resources based on the results of factor analysis and with the strategic decision applied. In our study, cancellation rates attributable to the patient and the hospital are low, probably because patients are hospitalized. It is possible to reduce avoidable causes with adequate supervision.[10]

Improving efficiency requires sensible administration and management, but little importance has been given to this necessity.

Having a successful operating suite requires well-structured organization, with interdisciplinary collaboration, distribution of functions and responsibilities and a director that leads. The person in charge must possess leadership skills and emotional intelligence.[22,24]

CONCLUSION

Factor analysis is a useful tool, since it identifies underlying relations within a set of observed variables recorded in a database, making it possible to find dimensions or factors that link apparently unrelated variables. On the basis of this information, decisions are taken which, in our case, involved reassigning patients in ideal situations to the operating room with available material and staff; this increased performance and decreased the cancellation rate of elective surgery to an acceptable range.

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REFERENCES

1. Galván MA, Flores NG. La suspensión de cirugía programada como un indicador de calidad en la atención hospitalaria. Rev Hosp M Gea Glz. 2006; 7: 59-62.
2. Leslie RJ, Beiko D, van Vlymen J, Siemens DR. Day of surgery cancellation rates in urology: Identification of modifiables factors. Can Urol Assoc J. 2013; 7: 167-173.
3. World Health Organization. The financial crisis and global health report of a high-level consultation; Geneva 2009 Jan 19. Available in: http://www.who.int/mediacentre/events/meetings/2009_financial_crisis_report_en_.pdf?ua=1
4. Villanueva EL. Los adultos mayores. Una mirada al futuro. Rev Hosp Gral Dr M Gea González. 2000; 3: 5-6.

5. Aguirre-Córdova JF, Chávez-Vázquez G, Huitrón-Aguilar GA, Cortés-Jiménez N. ¿Porqué se suspende una cirugía? Causas, implicaciones y antecedentes bibliográficos. Gac Méd Méx. 2003; 139: 545-551.
6. División Técnica de Información Estadística en Salud. El IMSS en cifras. Las intervenciones quirúrgicas. Rev Med Inst Mex Seguro Soc. 2005; 43: 511-520.
7. Pandit JJ, Pandit M, Reynard JM. Understanding waiting lists as the matching of surgical capacity to demand: are we wasting enough surgical time? Anaesthesia. 2010; 65: 625-640.
8. Betanzos VL. Causas frecuentes de suspensión de cirugía programada en el Hospital Regional de Alta Especialidad Ciudad Salud durante el periodo enero-diciembre de 2013. Evid Med e Invest Salud. 2014; 7: 33.
9. López J ML, Sastre NO, Ruiz VG, Rodea RH. La suspensión de cirugía electiva en un hospital público de tercer nivel. Frecuencia y causas. Cir Gen. 2008; 30: 34-40.
10. Dexter F, Maxbauer T, Stout C, Archbold L, Epstein RH. Relative influence on total cancelled operating room time from patients who are inpatients or outpatients preoperatively. Anesth Analg. 2014; 118: 1072-1080.
11. Rymaruk S. A retrospective observational study of patient cancellations on the day of surgery in the general surgical directorate. J Perioper Pract. 2011;21:337-341.
12. Kumar R, Gandhi R. Reasons for cancellation of operation on the day of intended surgery in a multidisciplinary 500 bedded hospital. J Anaesthesiol Clin Pharmacol. 2012; 28: 66-69.
13. Moreno-Martínez R, Martínez-Cruz Rocío A. Eficiencia hospitalaria medida por el aprovechamiento del recurso cama en un hospital de segundo nivel de atención. Rev Med Inst Mex Seguro Soc. 2015; 53: 552-557.
14. Fernández HVM, Sotelo GEM. Los derechos humanos y la salud pública. Rev Fac Med UNAM. 2000; 43: 238-242.
15. González-Arévalo A, Gómez-Arnau JI, de la Cruz FJ, Marzal JM, Ramírez S, Corral EM y cols. Causes for cancellation of elective surgical procedures in a Spanish general hospital. Anaesthesia. 2009; 64: 487-493.
16. Sandbaek BE, Helgheim BI, Larsen OI, Fasting S. Impact of changed management policies on operating room efficiency. BMC Health Serv Res. 2014; 14: 224.
17. Dhafar KO, Ulmalki MA, Felemban MA, Mahfouz ME, Baljoon MJ, Gazzaz ZJ, et al. Cancellation of operations in Saudi Arabian hospitals: frequency, reasons and suggestions for improvements. Pak J Med Sci. 2015; 31: 1027-1032.
18. Peters JA, Dean HM, Enhancing OR capacity and utilization. Healthc Financ Manage. 2011; 65: 66-71.
19. Karidis PN, Dimitroulis D, Kouraklis G. Global financial crisis and surgical practice: the Greek paradigm. World J Surg. 2011; 35: 2377-2381.
20. Peltokorpi A. How do strategic decisions and operative practices affect operating room productivity? Health Care Manag Sci. 2011; 14: 370-382.
21. Fajardo GO. Hitos en la planeación médica en el IMSS. Rev Med Inst Mex Seguro Soc. 2002; 41: 85-88.
22. Marjamaa RA, Kirvelä OA. Who is responsible for operating room management and how do we measure how well we do it? Acta Anaesthesiol Scand. 2007; 51: 809-814.
23. Zheng B, Panton O, Al-Tayeb T. Operative length independently affected by surgical team size: data from 2 Canadian hospitals. Can J Surg. 2012; 55: 371-376.
24. Marjamaa R, Vakkuri A, Kirvela O. Operating room management: why, how, and by whom? Acta Anaesthesiol Scand. 2008; 52: 596-600.
25. Persson MJ, Persson JA. Analysing management policies for operating room planning using simulation. Health Care Management Science. 2010; 13: 182-191.
26. Chang JH, Chen KW, Chen KB, Poon KS, Liu SK. Case review analysis of operating room decisions to cancel surgery. BMC Surg. 2014; 14: 47.
27. Olguín PJ. Octubre 2010. En Anaya RP Programación dinámica de quirófanos y valoración pre anestésica el día de la hospitalización, para obtener eficiencia quirúrgica en cirugía electiva en un Hospital General de Zona. En Anaya RP. 34º Congreso Internacional de Cirugía General realizado en Guadalajara, Jal México.
28. Carrada-Bravo T. Desarrollo y usos de la epidemiología clínica. Rev Inst Nal Enf Resp Mex. 2000; 13: 170-179.
29. Hovlid E, Bukve O, Haug K, Aslaksen AB, von Plessen C. A new pathway for elective surgery to reduce cancellation rates. BMC Health Serv Res. 2012; 12: 154.
30. Macario A. Are your hospital operating rooms "efficient"? Anesthesiology. 2006; 105: 237-240.
31. Fajardo-Gutiérrez A, Yamamoto-Kimura LT, Garduño-Espinoza J, Hernández-Hernández DM, Martínez-García MC. Consistencia y validez de una medición en la investigación clínica pediátrica. Definición, evaluación y su interpretación. Bol Méd Hosp Infant Méx. 1991; 48: 367-381.
32. Agnoletti V, Buccioli M, Padovani E, Corso RM, Perger P, Piraccini E, et al. Operating room data management: improving efficiency and safety in a surgical block. BMC Surg. 2013; 13: 7.
33. Kargar ZS, Khanna S, Sattar A. Using prediction to improve elective surgery scheduling. Australas Med J. 2013; 6: 287-289.
34. Fixler T, Wright JG. Identification and use of operating room efficiency indicators: the problem of definition. Can J Surg. 2013; 56: 224-226.
35. Mesmar M, Shatnawi NJ, Khader YS. Reasons for cancellation of elective operations at a major teaching referral hospital in Jordan. East Mediterr Health J. 2011; 17: 651-655.
36. Heller J, Murch P. Development in service provision. Making major elective surgery happen. The development of a postoperative surgical unit. Nurs Crit Care. 2008; 13: 97-104.
37. Gaucher S, Boutron I, Marchand -Maillet F, Baron G, Douard R, Bethoux J-P, et al. Assessment of a standardized pre-operative telephone checklist designed to avoid late cancellation of ambulatory surgery: the AMBUPROG multicenter randomizedcontrolled trial. PLoS One. 2016; 11: e0147194.
38. Pandit JJ, Carey A. Estimating the duration of common elective operations: implications for operating list management. Anaesthesia. 2006; 61: 768-776.
39. He W, Ni S, Chen G, Jiang X, Zheng B. The composition of surgical teams in the operating room and its impact

on surgical team performance in china. Surg Endosc. 2014; 28: 1473-1478.
40. Heng M, Wright JG. Dedicated operating room for emergency surgery improves access and efficiency. Can J Surg. 2013; 56: 167-174.
41. Emanuel A, Macpherson R. The anaesthetic pre-admission clinic is effective in minimising surgical cancellaton rates. Anaesth Intensive Care. 2013; 41: 90-94.
42. Gheysari E, Yousefi H, Soleymani H, Mojdeh S. Effect of six sigma program on the number of surgeries cancellation. Iran J Nurs Midwifery Res. 2016; 21: 191-196.
43. Yoon SZ, Lee SI, Lee WH, Lim HJ, Yoon SM, Chan SH. The effect of increasing operating room capacity on day-of-surgery cancellation. Anaesth Intensive Care. 2009; 37: 261-266.

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