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Reducing waiting times of elective surgical procedures: effectiveness evaluation of a multi-interventions approach

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Key words: Surgical waiting times, operating room, multidimensional approach, surgical scheduling

Parole chiave: Tempi di attesa chirurgici, sala operatoria, approccio multi-intervento, programmazione chirurgica

Abstract

Background. *Increasing waiting times for elective surgery is a major concern for policymakers and healthcare staff in many countries, due to its effect on health, patient satisfaction and the perceived quality of healthcare. Many organizational models to reduce surgical waiting times have been studied, but the international literature indicates that multidimensional interventions on different aspects of the surgical pathway can be more effective in reducing waiting times than interventions focused on optimizing a single aspect.*

Aim. *The aim of the study is to evaluate the effectiveness of a multidimensional intervention in reducing waiting times for elective surgery.*

Study design. *We used a pre-post approach to evaluate the effect of a multidimensional project to reduce waiting times and lists.*

Methods. *In a district general hospital (Italy) with three elective surgery operating rooms open 6 hours/day, 5 days/week (surgery specialties: general surgery, orthopaedics, gynaecology and urology), a project for reducing surgery waiting times was implemented in October 2018. The project focused on three aspects: i) separation of the flow of day surgery from that of ordinary surgery; ii) increasing available operating time by reorganizing the staff; iii) allocation of operating sessions flexibly in proportion to the waiting list. Waiting times for surgery in the periods 1/10/2019-31/12/2019 and 1/10/2018-31/12/2018 were compared by t test.*

Results. *Waiting times for non-high-priority cases shortened significantly for all specialities ($p<0.01$), except for urology. For general surgery, orthopaedics and gynaecology, mean waiting times for day surgery*

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decreased from 198 to 100 days (-50%) and for ordinary operations from 213 to 134 days (-37%). Waiting times for high-priority cases also shortened.
Conclusions. *Our multidimensional project based on reorganization of staff and facilities and on improved scheduling proved effective in reducing waiting times for elective surgery.*

Introduction

Due to their consequences on patient health and satisfaction and on the perceived quality of healthcare, long waiting times for elective surgery have always been a major concern for policymakers, managers and healthcare staff in many countries, especially those with public health systems, where it is more difficult to balance supply and demand for treatment (1-6).

The problem was further exacerbated by the recent impact of the COVID-19 pandemic on the organization of health services. Indeed, during the first wave of the pandemic, elective operations were postponed in many countries, creating a backlog and long waiting lists (7-9).

Over the years, various policies have been studied to reduce lists' size and waiting times. They have mainly been based on allocating additional resources and/or using existing resources more efficiently, but results have been patchy and not straightforward (1, 4, 6, 10-13). According to the international literature, effective measures to reduce waiting times should be multidimensional and should focus on improving/optimizing waiting list management, surgical schedules, surgical pathway and use of operating rooms (13).

In Italy, where healthcare is financed by the state and most hospitals are publicly owned, the problem of long waiting lists for healthcare treatments has gradually worsened, due to an aging population and to the technological innovation (6). Moreover, during the first wave of the COVID-19 pandemic, it was calculated that reductions in operations reached peaks of about 80% for ordinary and 90% for day surgery, with a consequent lengthening of waiting times (8-9). To set up a prioritization strategy on waiting lists and to incorporate equity criteria, the Italian Ministry of Health developed the National Waiting Lists Management Plan, issued for the first time for the three-year period 2010-2012 and recently updated for the three-year period 2019-2021. The plan established priority classes and timing for access to National Health Services (14-15). The priority classes for elective surgery were: A = surgery to be performed within 30 days, B = within 60 days, C = within 180 days, and D = within 12 months from diagnosis. When surgery is prescribed, the specialist who examines the patient assigns a priority class on the basis of the type of pathology, symptoms and the general condition of the patient.

In this paper we describe the development and results after 12 months of a multidimensional project conducted in a local general hospital in Tuscany (Central Italy) from 2017 to 2019. The hospital has 150 beds and serves a population of about 100,000. When the project began, the Region regulated the surgery priority classes as follows: class A operation within 30 days, class B within 60 days and class C within 90 days from diagnosis (16). This classification was updated in 2019 and the priority class timing aligned with those of the National Waiting Lists Management Plan (17). In 2016, the mean waiting time for cancer surgery in

Tuscany, usually considered class A, was 36 days (18), while mean waiting times for procedures such as knee replacement, hip replacement, cholecystectomy, laparoscopic cholecystectomy, usually considered class B or C, were about 120 days (6). These times are certainly longer than the standards established by the Regional government of Tuscany. On the basis of this background, along Local Health Authority guidelines, in 2016, the hospital management established a multidisciplinary project group (constituted by surgeons of different specialties, the operating rooms nurse coordinator and a MD of the hospital management as coordinator), to develop and implement an elective surgery reorganization project whose main aims were: i) to make surgery sessions more efficient by improving the allocation of operating time; ii) to decrease waiting times for elective surgery. The aim of this study is to evaluate the effectiveness of the reorganization project in reducing waiting times for elective surgery.

Methods

Setting

Before the reorganization project, the hospital had 3 operating rooms (ORs) for elective surgery open 6 hours/day from 8 am to 2 pm (six-hours block), Monday to Friday, 1 OR for emergencies and 1 for caesarean sections, both open 24/7. In the afternoons and on holidays only the OR for emergencies was active with a nursing team and an anaesthesiologist on call. The operating suite also included a room for monitoring patients after surgery. The surgical specialities were general surgery, orthopaedics, gynaecology/obstetrics and urology. The distribution of hours for weekly scheduled activity was as follows:

- General surgery: one six-hours block for 5 days + a second six-hours block for 1 day (total 6 blocks = 36 hours/week of operating time)
- Urology: one six-hours block a week (6 hours/week of operating time)
- Orthopaedics: one six-hours block for 5 days (total 5 blocks =30 hours/week of operating time)
- Gynaecology/obstetrics: one six-hours block for 3 days (total 3 blocks=18 hours/week of operating time).

This allocation of operating time was fixed and independent of the size and length of the waiting lists.

Surgical nursing shifts were arranged according to the surgical service blocks planned for the day. The nursing operating team of each OR was composed of three scrub nurses regardless of the type and complexity of the operation. The three healthcare assistants of the staff of the operating suite were not part of the operating team but only had support functions, such as room cleaning.

Each surgical speciality scheduled day surgery and other more complex operations within its assigned blocks.

The surgical pathway was managed by a computer application that put patients on the waiting list at the visit with the surgeon, managed pre-hospitalization procedures, and recorded surgical, anaesthesiologic and nursing data (electronic operating register). Pre-hospitalization procedures were handled by a specific office, run by nurses, who called the patients, organized preoperative examinations and scheduled weekly operating lists.

Study of the project

Development of the project began with an analysis of the waiting lists and the identification of the main organizational issues of pathway for elective surgery.

Waiting list data were extracted from the surgery records in February 2018. The following considerations emerged from a descriptive analysis of the historical data (years 2016, 2017 and early 2018):

1. the flow of new requests for surgery was almost constant;

2. there was a certain balance between the requests for surgery registered in a year and the number of operations carried out that same year.

For example, in 2017 there were a total of 2,492 requests for surgery and 2,453 operations were completed (Δ=39), so the supply seemed to meet the demand. The problem was accumulated delays. Theoretically, once the backlog of requests had been dealt with, the system could remain in balance, probably with some organizational changes, such as assigning operating time blocks to the different specialities on the basis of the actual length of the waiting lists and the average waiting times.

The main organizational issues of the elective surgical pathway were:

- assignment of operating sessions to the various specialities on a historical basis without taking into account changes in the number of patients on the waiting list;
- the same path for ordinary operations and day surgery;
- the composition of the surgical nursing team was not flexible and was unrelated to the complexity of the operations, which limited the time available for surgery.

On the basis of this preliminary analysis and the main critical issues, a hypothesis of new surgery scheduling/planning and organization was developed. The key points of this hypothesis were:

1. separating the flow of ordinary activity from that of day surgery;
2. increasing the time available for surgery (in order to deal with the backlog of requests and bring the system back into balance) through reorganization of staff, especially the nursing team;
3. allocating operating sessions in a flexible manner on the basis of the waiting list.

Developing the hypothesis

1. Separating the flow of ordinary activity from that of day surgery

In the period December 2017-January 2018, as part of the reorganization, a fourth OR for elective surgery, intended exclusively for day surgery, was renovated in the operating suite. The activity in this OR began experimentally in June 2018 and steadily in October 2018. It was planned to concentrate much of the day surgery of all specialities in this room, making more operating time available for ordinary activity in the other ORs.

2. Increasing the time available for surgery

Under this heading, the working group tried to develop a system that did not require additional staff. For the medical staff (surgeons and anaesthesiologists), a small budget was allocated to pay hourly rates for sessions outside the institutional timetable. For the nursing staff, the project envisaged reorganization of the surgical nursing team from a fixed (three scrub nurses for any type of operation) to a flexible composition (always ensuring the minimum number required by current regulations) to optimize the distribution of staff.

As of June 2018, the training of three healthcare assistants of the operating suite staff made it possible to include one of them in the operating team as circulating nurse instead of a scrub nurse. Many assistant functions (such as room cleaning) were delegated to the staff of the cleaning contractor. In this way, an additional 30 hours per week (120 hours per month) of operating time were thrived by employing one healthcare assistant as circulating nurse 6 hours a day for 5 days.

3. Flexible allocation of operating sessions on the basis of the waiting list

On the basis of the number of emergency

operations, it was decided to assign 10% of the extra 120 hours now available to the emergency OR. The remaining 108 additional hours for elective activity were assigned to the different specialities in proportion to their need, e.g. to the length of their waiting lists and to the average waiting times. Part of the 108 hours (6 h/week = 24 h/month) was assigned to the new eye surgery service that started experimentally in February 2018. To assign the remaining 84 hours, we developed a simulator that created different OR time distribution scenarios starting from the waiting list data, and calculated which scenario most rapidly could reduce the waiting lists for all specialities. With the collaboration of the Postgraduate School of Hygiene and Preventive Medicine of the University of Siena, a predictive model was developed to analyse waiting time data. Based on the analysis of historical data, this simulator estimated the time necessary to reduce waiting times. The simulation algorithm for the estimation and correction of waiting times was based on the descriptive statistical analysis of data collected in previous years, the modelling of surgery time distributions using Gaussian curves and the optimization of downtime. The algorithm was implemented in a multiparametric way, where the operator could enter different options to simulate a wide range of scenarios. For each surgical speciality and priority class, the following statistical values were evaluated from data of the year 2017: number of requests, average wait (days), standard deviation of wait (days), average operating time (minutes), standard deviation of operating time (minutes), 68% confidence intervals of wait (days). The following parameters could be set: operating time of operating suite (minutes), number of days per week per speciality, overrun (%) and cleaning interval (minutes). On the basis of the 2017 empirical results and model parameters, the following quantities were simulated: duration of a single operation, upper value of the 68% confidence interval (minutes), number of operations per surgical time block, total available time per week (minutes), number of model-estimated weekly, monthly and quarterly operations, total number of weekly and quarterly operations to be programmed, total number of operations to be programmed, average real waiting time (days), target waiting time (days), real number of patients on waiting list, target number of patients on waiting list, extra patients on waiting list, extra OR time to clear backlog, number of extra model-estimated weeks, number of additional operations per week, weeks needed to clear backlog, total number of operations per week including weeks to clear backlog, total number of quarterly operations including weeks to clear backlog.

The best scenario simulated by the algorithm, using the waiting list data extracted in February 2018, envisaged an assignment of 40 hours/month to general surgery, 26 hours/month to orthopaedics, 14 hours/month to gynaecology-obstetrics and 4 hours/month to urology. This assignment of hours would bring average waiting times back within National Plan limits in 61 weeks for general surgery, 58 weeks for orthopaedics, 44 weeks for obstetrics and gynaecology and 53 weeks for urology.

Effectiveness evaluation and statistical analysis

One year after the implementation of the project, the mean waiting times of patients undergoing surgery in the period 01.10.2019-31.12.2019 were compared with those of patients in the same period of the previous year using the t test. The evaluation was carried out for the different specialities and for type of hospital admission (day surgery or ordinary). Waiting time in days was calculated by subtracting the day the patient was put on the waiting list from the day when surgery was performed. The characteristics of patients operated in the two periods were

Table 1 - Average waiting times (in days) of patients operated in the period 1.1.2017 to 31.12.2017 (by priority class and type of hospital admission)

Priority class	TYPE	General Surgery (N=872)	Orthopedics (N=786)	Gynecology/ obstetrics (N=473)	Urology (N=181)
A	Day Surgery	27	18	17	44
(to be operated within 30 days)	Ordinary	26	40	20	47
B	Day Surgery	157	101	78	175
(to be operated within 60 days)	Ordinary	162	110	121	208
C	Day Surgery	204	120	102	223
(to be operated within 90 days)	Ordinary	220	141	153	154

compared by t test for continuous variables and by test for proportion for categorical variables.

Results

Preliminary analysis and implementation

Table 1 shows the results of the preliminary analysis of the waiting list data extracted in February 2018. The waiting times before project implementation were considerably longer than those established by the Region for classes B and C (60 and 90 days, respectively), whereas for class A they were acceptable. Project implementation began in October 2018. The surgical scheduling plan with additional operating hours assigned to the various specialities was processed monthly (Figure 1). The actual assignment of hours from October 2018 to September 2019 is described in Table 2. The distribution of the additional operating hours was re-evaluated every three months on the basis of the waiting lists.

In total, 682 additional OR hours (70% for day surgery) were scheduled in 12 months (excluding July and August) against a target of 840 hours, covering >80% of the additional operating time deemed necessary to achieve the objective. Figure 2 shows surgical production in the first 12 months of the project compared with the same period of the previous year. The greatest increase concerned general surgery (+23%), followed by urology (+15%), obstetrics/gynaecology (+13%) and orthopaedics (+12%).

Project effectiveness evaluation

Table 3 shows the characteristics of patients operated in the period 01/10/2019-31/12/2019 compared with those of patients operated in the same period of the previous year. No statistically significant differences

Table 2 - Total additional hours actually scheduled compared to those estimated October 2018-September 2019*

	Estimated	Scheduled
General Surgery	400	322
Orthopedics	260	190
Gynecology/obstetrics	140	122
Urology	40	48
TOTAL	840	682

*in July and August 2019 the project was suspended due to the summer reduction in operating activity

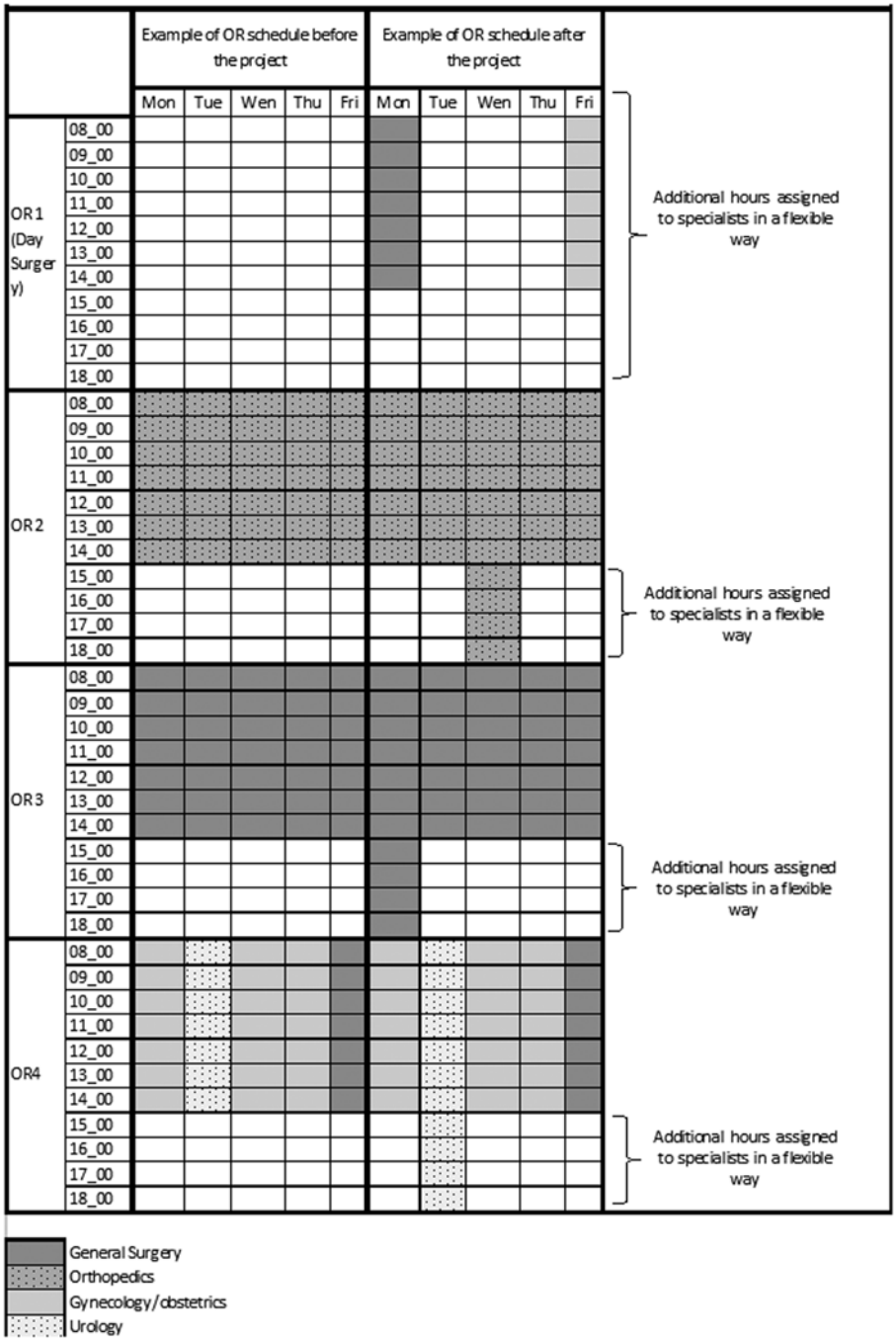

Fig. 1 - Example of assignment of weekly operating time before et after the project

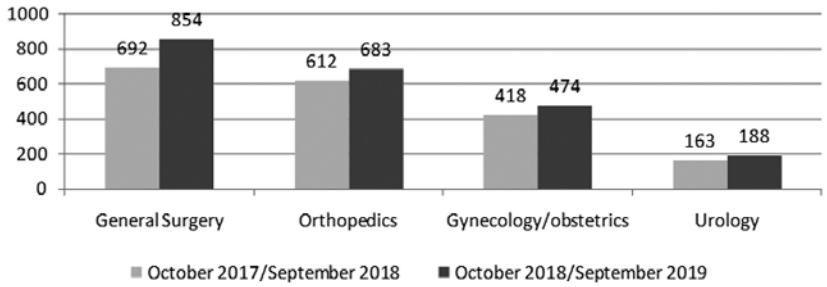

Fig. 2 - Number of elective surgical operation by speciality from October 2018 to September 2019 and in the same period od the previous years (excluding the months of July and August)

in gender distribution, mean age or province of origin were found between the two groups.

Table 4 shows the average waiting times of patients undergoing surgery in the period October-December 2019 compared with those of patients operated in same period of the previous year. The waiting times for priority classes B and C decreased significantly for all specialities, except urology.

As regards general surgery, mean waiting time for day surgery with priority class A (<30 days) decreased from 25 to 23 days (p=0.769), priority class B (<60 days) from 172.2 to 88.9 days (p<0.001) with a decrease of about 50%, and priority class C (<90 days) from 244.5 to 123.8 days (p<0.001) with a decrease of about 50%. Mean waiting time for ordinary surgery with priority class A decreased from 32 to 30 days (p=0.784), priority class B from 224.8 to 111.7 days (p<0.001) with a decrease of about 50%, and priority class C from 247.2 to 153.5 days (p<0.001) with a decrease of about 40%.

Regarding orthopaedics, mean waiting time for day surgery with priority class A decreased from 41 to 25 days (p<0.001), with a decrease of about 40%, mean waiting time for day surgery interventions with priority class B from 155 to 104 (p<0.001) with a decrease of about 30% and class C from 200 to 115 days (p=0.006) with a decrease of about 40%. Mean waiting time for ordinary surgery with priority class A decreased from 37 to 28 days (p=0.195), class B from 150 to 118.5 days (p=0.005) with a decrease of about 20% and mean waiting time for ordinary interventions with priority class C from 202 to 131 days (p=0.001) with a decrease of 35%.

Regarding obstetrics and gynaecology, mean waiting time for day surgery with

Table 3 - Characteristics of patients operated in the period 01/10/2018 to 31/12/2018 (n=634) compared with those of patients operated in the period 01/10/2019 to 31/12/2019 (n=635)

	2018	2019	p
Female	58%	57%	0.548*
Male	42%	43%	
Mean Age	60	58	0.075**
Siena Province residents	75%	76%	0.190*

* test of proportions
** t test

priority class A decreased from 29 to 22 days (p=0.127), class B from 187.5 to 123 (p<0.001) with a decrease of about 30% and class C from 234 to 123 days (p=0.006) with a decrease of 50%. Mean waiting time for ordinary surgery with priority class A decreased from 46 to 25 days (p=0.070), class B from 241 to 156 days (p<0.001) with a decrease of about 34%, whereas class C increased from 214 to 243 days (p=0.330).

Regarding urology, mean waiting time for day surgery with priority class A decreased from 32 to 30 days (p=0.557), that for ordinary surgery with priority class A did not change (from 39.4 to 39.0, p=0.952) and that for ordinary surgery with priority class B decreased from 158 to 134 days (p=0.436). For all other categories, the number of cases was too small for statistical analysis.

Discussion

Our results showed sustained reductions in waiting times for elective surgery over one year and an increase in the number of operations performed. The project was particularly effective in decreasing waiting times for non high-priority operations (classes B and C) for all specialities, except urology. The non-significant decrease in waiting time for urologic surgery probably depended on the small number of operations.

The measures used to reduce the waiting lists were multidimensional and involved increasing capacity and more efficient use of existing capacity.

Overall operating capacity increased by 682 OR hours, which was an increase of about 20% with respect to the annual OR hours available before implementation of the project. As mentioned above, we estimated that the additional operating time needed to achieve our objective was 840 hours. The discrepancy between our target and the additional hours actually made available was mainly due to the need to combine surgical scheduling with hourly availability of the professional and nursing staff of the surgery unit.

Renovation of an operating room dedicated to day surgery was a fundamental step in increasing operating capacity, as were reorganization of the nursing staff and reallocation of support staff. In fact, being able to programme most of the day surgery in a dedicated OR, not only made it possible to increase the number of day-surgery operations performed each week, but also the number of ordinary operations, freeing the main theatres for more complex procedures (19-21).

Regarding the measures implemented to use existing capacity more efficiently, a key aspect was the optimization of surgical planning/scheduling, that proved to have an important role in decreasing the waiting lists (13, 22-24). In our study, many measures were taken to improve surgical planning/scheduling. First of all, establishment of a multidisciplinary supervisory group at hospital management level made it possible to define objectives and evidence-based criteria for the monthly and annual surgery schedules and the weekly operating lists. In fact, since this supervisory group understood the constraints, characteristics and needs of each speciality, it designed a system that went beyond empirical management dictated by the needs of individual professional staff (25-27).

Secondly, the analysis of waiting lists and surgical data and the use of an algorithm that allocates surgery slots to the different specialities made it possible to overcome the critical issues of the previous system, based mainly on historical OR utilization and on the empirical experience of professional staff. The project transformed the system from rule-of-thumb to one based on evidence. As widely described in the literature, the establishment of an effective planning system for surgery scheduling, supported by data analysis and mathematical models,

Table 4 - Comparison of average waiting times (in days) of patients operated in October-December 2019 and in the same period of the previous year

		General Surgery			Orthopedics			Gynecology/obstetrics			Urology		
Priority class	Type of hospital admission	Oct-Dec18 (95% C.I.) N=267	Oct-Dec19 (95% C.I.) N=210	p	Oct-Dec18 (95% C.I.) N=179	Oct-Dec19 (95% C.I.) N=202	p	Oct-Dec18 (95% C.I.) N=137	Oct-Dec19 (95% C.I.) N=167	P	Oct-Dec18 (95%C.I.) N=51	Oct-Dec19 (95%C.I.) N=56	p
A	DS	25.1 (17.3-32.9)	23.4 (14.7-32.2)	0.769	40.7 (33.9-47.6)	24.8 (21.8-27.7)	<0.001	28.7 (22.1-35.4)	21.9 (17.5-26.5)	0.127	32.3 (27.8-36.8)	30.1 (22.7- 37.4)	0.557
	Ordinary	32.3 (24.2-40.4)	30.3 (16.7-43.9)	0.784	36.8 (26.8-46.9)	28.8 (25.6-32.1)	0.195	45.7 (28.0-63.4)	25.2 (21.6-28.9)	0.070	39.4 (32.9-45.8)	39.0 (28.3-49.7)	0.952
B	DS	172.2 (132.1-212.3)	88.9 (71.8- 106.1)	<0.001	155.2 (124.8-185.7)	104.3 (92.4-116.3)	<0.001	187.5 (173.1-201.8)	122.84 (114.5-131.2)	<0.001	-	NO OBS	-
	Ordinary	224.8 (200.2-249.4)	111.7 (83.2-140.1)	<0.001	150.05 (134.4-165.7)	118.5 (102.8-134.2)	0.005	241.4 (211.3-271.6)	156.3 (136.7-175.9)	<0.001	158.2 (116.5-199.8)	134.1 (83.5-184.8)	0.436
C	DS	244.5 (227.5-261.5)	123.8 (106.1-141.5)	<0.001	199.9 (123.7-276.0)	114.7 (88.4-141.0)	0.006	234 (196.3-271.7)	122.6 (90.3-154.8)	<0.001	-**	-***	-
	Ordinary	247.2 (221.1-273.3)	153.5 (127.3-179.7)	<0.001	202.3 (169.7-234.9)	131.4 (104.8-157.9)	0.001	-*	-*	-	NO OBS	NO OBS	-

* 2 observations
** 1 oservation
*** 3 observations
DS=day surgery

can ensure more efficient use and better performance of operating rooms (22, 24-26, 28-34).

Another important aspect that emerged from the study was the role of a flexible surgery schedule based on real needs, namely on the waiting lists of the different specialities. At the beginning of the project, based on analysis of the data and using the algorithm, a schedule of surgical time blocks was drawn up according to the length of the waiting lists. As we monitored how the waiting lists evolved, we realized that our allocation of operating room hours was no longer in line with the real needs of the various specialities. By September 2019, the waiting list situation had changed so much that, if we had continued to use the operating time assignment established, average waiting times would have aligned with the standards in 4 weeks for general surgery, 27 weeks for orthopaedics, 30 weeks for obstetrics/gynaecology and 64 weeks for urology. This would have created disparity among specialities, some fully and quickly reaching the objectives and others seeing their waiting times lengthened. To ensure an equal possibility of reducing the waiting lists of the various specialities and equal access for patients, it was therefore essential to adjust the distribution of operating room hours on the basis of changes in the waiting lists.

It was therefore decided to redistribute the blocks of operating time in favour of gynaecology/obstetrics, orthopaedics and urology, balancing the time necessary to reach the target waiting times:12 additional hours per month for general surgery, 36 hours for orthopaedics, 24 for obstetrics/gynaecology and 12 hours for urology. As mentioned above, on the whole, general surgery showed the greatest increase in surgical production (+23%), in line with its greater allocation of additional hours until September 2019. However, if we look at the data from October to December 2019, after changing the distribution of additional hours, we notice a turnaround: compared with the period October-December 2018, general surgery showed a 21% decrease in the number of operations, while orthopaedics and obstetrics/gynaecology showed 13% and 22% increases, respectively (Table 4). For this aspect too, the project transformed a rigid stereotyped system - based on tradition - to a flexible evidence-based system that adapts to changing needs.

The above indications have particular relevance in the current situation, in which many health facilities have to deal with the backlog of operations postponed during the COVID-19 pandemic. This has a significant impact on the capacity of surgery departments and is a source of stress and anxiety for patients. Some studies showed that patients who had operations cancelled complained of stress and frustration and expressed moderate or severe concern about a deterioration of their condition (35-37). To address and manage the treatment backlog in surgical units, traditional perioperative care protocols may need to be revised to enhance production and reduce the backlog. In the literature, the following measures have been named as key elements for short-term recovery of surgical services: i) assessing surgical workload and patient populations, such as assessment of baseline demand and patient prioritization; ii) ensuring adequate hospital capacity and facilities; iii) enhancing workforce capacity; iv) reconfiguring services (7, 37).

Many of these aspects were included in the multidimensional model described in this paper:

• data analysis and development of an algorithm helped estimate the time needed to reduce the waiting list (considering patient priority code) and, therefore, to reallocate the cancelled operations. It was also very useful for scheduling activities and allocating resources (operating room time and staff time). Being able to quantify

backlog-clearing times has important positive implications in terms of anxiety and stress for patients, as it allows the hospital to give more precise indications on when patients can expect their operation;

• the results of this project demonstrate the important role of flexibility in surgery scheduling, in allocation of operating room hours and in the reorganization of staff for adequate operating capacity;

• dedicating an operating room to day surgery in the backlog-clearing phase proved to be appropriate, because day surgery was more affected than ordinary surgery by the reduction in elective surgery during the first wave of COVID-19. It also freed operating theatres for more complex procedures, increasing operating capacity.

Future developments

The next step in optimizing the surgical schedule will be to use an algorithm to programme the weekly operating lists. After improving the medium-long-term planning system preparing the surgical master plan, it will be essential to introduce a system for the compilation of short-term operating lists that considers the average duration of operations by type of operation, by surgeon, by priority class and by the increase in the number of waiting days.

This system will make it possible: i) to reduce the risk of inactive operating theatres or overruns; ii) to control the average waiting time because for a given priority class, the system will yield patients who have been waiting the longest; iii) to make operating room use more efficient and optimize the number of operations performed in relation to the hours the room is available (31).

Limits

This study has some limits. Firstly, mainly descriptive observational study can have bias and confounding factors that prevent demonstration of a causal link between the measures implemented and the outcomes. Secondly, the follow-up period (1 year) was probably too short to evaluate the feasibility of the measures implemented and the reliability of the results over time. The study was only an initial evaluation of the project. Further follow-up period will be necessary, possibly including more data and variables, in order to confirm the results in the long run. Another critical issue may be the study location, a small to medium hospital with a limited number of operating rooms, specialities and types of operations carried out. Implementation of the measures proposed for the reduction of waiting lists may not be replicable in more complex situations or may not obtain the same results. Prospective and multicentre studies will be needed to validate the results in different types of hospital.

Conclusion

As observed in the literature, our study confirmed that multidimensional measures, that address improving surgical scheduling, optimizing the use of operating rooms and making organization of staff more efficient and flexible, are effective in reducing waiting times for elective surgery. An additional follow-up period will be requested to verify long-term effects, feasibility and sustainability of the project in larger and more complex realities.

Declarations
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Conflict of interests: none declared

Riassunto

Ridurre i tempi di attesa delle procedure chirurgiche in elezione: valutazione dell'efficacia di un approccio multi-intervento

Background. L'allungamento dei tempi di attesa per la chirurgia elettiva rappresenta uno dei principali ambiti

di attenzione per policy makers ed operatori sanitari in molti paesi del mondo a causa delle conseguenze sulla salute e sulla soddisfazione dei pazienti nonchè sulla qualità percepita dell'assistenza sanitaria. Sono stati studiati molti modelli organizzativi per ridurre i tempi di attesa chirurgici ma, secondo la letteratura internazionale, gli interventi multidimensionali, che riguardano cioè diversi aspetti del percorso chirurgico, possono essere più efficaci per ridurre i tempi di attesa chirurgici rispetto ad interventi focalizzati sull'ottimizzazione di un singolo aspetto.

Obiettivo. Valutare l'efficacia di un intervento multidimensionale nel ridurre i tempi di attesa per interventi chirurgici in elezione.

Disegno dello studio. In questo lavoro descriviamo i risultati di un progetto multidimensionale per ridurre i tempi di attesa chirurgici utilizzando un approccio di valutazione pre-post.

Metodi. In un ospedale zonale del Centro Italia dotato di 3 sale operatorie di chirurgia elettiva aperte 6 ore al giorno per 5 giorni alla settimana (specialità chirurgiche: chirurgia generale, ortopedia, ginecologia e urologia) nell'ottobre 2018 è stato implementato un progetto per la riduzione dei tempi di attesa chirurgici basato su 3 punti cardine: i) separazione del flusso di Day Surgery da quello dell'attività ordinaria; ii) aumento del tempo operatorio disponibile attraverso la riorganizzazione del personale; iii) assegnazione delle sessioni operatorie in modo flessibile in proporzione alla lista di attesa. Utilizzando il t test è stato confrontato il tempo medio di attesa degli interventi effettuati dal 01/10/2019 al 31/12/2019 con quello degli interventi effettuati dal 01/10/2018 al 31/12/2018.

Risultati. I tempi di attesa per i casi non ad alta priorità sono stati significativamente ridotti per tutte le specialità ($p < 0{,}01$) tranne l'urologia. Per la chirurgia generale, ortopedia e ginecologia, il tempo medio di attesa degli interventi di day surgery diminuisce da 198 a 100 giorni (-50%), quello degli interventi ordinari da 213 a 134 giorni (-37%). Anche il tempo di attesa per i casi ad alta priorità è stato ridotto.

Conclusioni. Un progetto multi-intervento basato sulla riorganizzazione del personale e delle strutture e sul miglioramento delle metodologie di programmazione chirurgica si è rivelato molto efficace nel ridurre i tempi di attesa per interventi chirurgici elettivi.

References

1. Ballini L, Negro A, Maltoni S, et al. Interventions to reduce waiting times for elective procedures. Cochrane Database Syst Rev. 2015 Feb 23; (2): CD005610. doi: 10.1002/14651858.CD005610.pub2.
2. Siciliani L, Hurst J. Explaining waiting time variations for elective surgery across OECD countries. Paris: OECD Publishing; 2003 (OECD Health Working Papers; No. 7).
3. Siciliani L, Hurst J. Tackling excessive waiting times for elective surgery: a comparative analysis of policies in 12 OECD countries. Health Policy. 2005 May; **72**(2): 201-15. doi: 10.1016/j.healthpol.2004.07.003.
4. Kreindler SA. Policy strategies to reduce waits for elective care: a synthesis of international evidence. Br Med Bull. 2010; **95**: 7-32. doi: 10.1093/bmb/ldq014. Epub 2010 May 10.
5. Riganti A, Siciliani L, Fiorio CV. The effect of waiting times on demand and supply of elective surgery: Evidence from Italy. Health Econ. 2017 Sep; **26**(Suppl 2): 92-105. doi: 10.1002/hec.3545.
6. Lungu DA, Grillo Ruggieri T, Nuti S. Decision making tools for managing waiting times and treatment rates in elective surgery. BMC Health Serv Res. 2019 Jun 11; **19**(1): 369. doi: 10.1186/s12913-019-4199-6.
7. Uimonen M, Kuitunen I, Paloneva J, et al. The impact of the COVID-19 pandemic on waiting times for elective surgery patients: A multicenter study. PLoS One. 2021 Jul 6; **16**(7): e0253875. doi: 10.1371/journal.pone.0253875.
8. Agenzia Regionale Sanità Toscana. Volumi e tempi di attesa per la chirurgia programmata in Toscana: effetti della pandemia di COVID-19. Maggio 2020. Available on: https://www.ars.toscana.it/images/approfondimenti/2020/Bachini/Report_TA_maggio_2020_definitivo.pdf [Last accessed: 2021 October 16].
9. Istituto Superiore di Sanità. Impatto dell'emergenza COVID-19 sui volume di attività della chirurgia protesica ortopedica in sette Regioni italiane. Rapporto ISS COVID-19 n° 7/2021 Rev. Available on: https://www.iss.it/documents/20126/0/Rapporto+ISS+COVID-19+7_2021+Rev.pdf/d1f25e22-c9f7-7e5b-a088-42796f4de76a?t=1618819016173 [Last accessed: 2021 October 16].
10. Kreindler SA. Watching your wait: evidence-informed strategies for reducing health care wait times. Qual Manag Health Care. 2008 Apr-Jun; **17**(2): 128-35. doi: 10.1097/01.QMH.0000316990.48673.9f.
11. Siciliani L, Borowitz M, Moran V, Eds. Waiting time policies in the health sector:

What works? OECD Health Policy Studies. Paris: OECD Publishing; 2013. http://dx.doi.org/10.1787/9789264179080-en.
12. Siciliani L, Moran V, Borowitz M. Measuring and comparing healthcare waiting times in OECD countries. Health Policy. 2014 Dec; **118**(3): 292-303. doi: 10.1016/j.healthpol.2014.08.011. Epub 2014 Sep 1.
13. Bachelet VC, Goyenechea M, Carrasco VA. Policy strategies to reduce waiting times for elective surgery: A scoping review and evidence synthesis. Int J Health Plann Manage. 2019 Apr; **34**(2): 1-21. Epub 2019 Feb 22.
14. Conferenza Permanente per i rapporti tra lo Stato, le Regioni e le Province Autonome di Trento e Bolzano. Accordo 28 ottobre 2010.Intesa, tra il Governo, le Regioni e le Province autonome di Trento e di Bolzano sul Piano nazionale di governo delle liste di attesa per il triennio 2010-2012, di cui all'articolo 1, comma 280, della legge 23 dicembre 2005, nº 266. (Repertorio atti n. 189/CSR del 28 ottobre 2010). GURI [Official Gazette of Italian Republic], nº 274, del 23/11/2010 (Suppl. Ord. nº 259).
15. Ministero della Salute. Piano nazionale di governo delle liste di attesa per il triennio 2019-2021. Available on: https://www.salute.gov.it/portale/listeAttesa/dettaglioPubblicazioniListeAttesa.jsp?lingua=italiano&id=2824 [Last accessed: 2021 May 25].
16. Regione Toscana. Decreto Dirigenziale n° 5580 del 19/12/2013. Approvazione codifica delle classi di priorità per i ricoveri ospedalieri. Available on: http://www301.regione.toscana.it/bancadati/atti/ [Last accessed: 2021 May 25].
17. Regione Toscana. Delibera Giunta Regionale n°604 del 06/05/2019. Piano RegionaleGovernoListe di Attesa 2019–2021. Available on: https://www.regione.toscana.it/bancadati/atti/ [Last accessed: 2021 May 25].
18. School of Advanced Studies, Institute of Management, Pisa. Performance Evaluation System 2016. Available on: https://performance.santannapisa.it/pes/start/start.php [Last accessed: 2021 May 25].
19. Saia M, Mantoan D, Buja A, et al. Increased rate of day surgery use for inguinal and femoral hernia repair in a decade of hospital admissions in the Veneto Region (north east Italy): a record linkage study. BMC Health Serv Res. 2013 Sep 12; **13**: 349. doi: 10.1186/1472-6963-13-349.
20. Bhamra JS, Dhinsa BS, Patel S, Davies C, Oliver M. Does a dedicated orthopaedic day surgery list improve delivery of trauma services? J Perioper Pract. 2017 Nov; **27**(11): 263-7.
21. NHS Improvement. Operating theatres: opportunities to reduce waiting lists. 2019. Available on: https://improvement.nhs.uk/documents/3711/Theatre_productivity_report__Final.pdf [Last accessed: 2021 May 25].
22. Cardoen B, Demeulemeester E, Beliën J. Operating room planning and scheduling: A literature review. Eur J Operational Res. 2010; **201**(3): 921-32.doi: 10.1016/j.ejor.2009.04.011.
23. Valsangkar NP, Eppstein AC, Lawson RA, Taylor AN. Effect of lean processes on surgical wait times and efficiency in a tertiary care veterans affairs medical center. JAMA Surg. 2017 Jan 1; **152**(1): 42-7. doi: 10.1001/jamasurg.2016.2808.
24. Gür Ş, Eren T. Application of operational research techniques in operating room scheduling problems: Literature Overview. J Healthc Eng. 2018 Jun 13; 2018: 5341394. doi: 10.1155/2018/5341394.
25. Heslin MJ, Doster BE, Daily SL, et al.Durable improvements in efficiency, safety, and satisfaction in the operating room.J Am Coll Surg. 2008 May; **206**(5): 1083-9; discussion 1089-90. doi: 10.1016/j.jamcollsurg.2008.02.006.
26. Marjamaa R, Vakkuri A, Kirvelä O. Operating room management: why, how and by whom?Acta Anaesthesiol Scand. 2008 May; **52**(5): 596-600. doi: 10.1111/j.1399-6576.2008.01618.x.
27. Cima RR, Brown MJ, Hebl JR, et al. Surgical Process Improvement Team, Mayo Clinic, Rochester.Use of lean and six sigma methodology to improve operating room efficiency in a high-volume tertiary-care academic medical center. J Am Coll Surg. 2011 Jul; **213**(1): 83-92; discussion 93-4. doi: 10.1016/j.jamcollsurg.2011.02.009. Epub 2011 Mar 21.
28. Van Houdenhoven M, van Oostrum JM, Hans EW, Wullink G, Kazemier G. Improving operating room efficiency by applying bin-packing and portfolio techniques to surgical case scheduling. Anesth Analg. 2007 Sep; **105**(3): 707-14. doi: 10.1213/01.ane.0000277492.90805.0f.
29. Wachtel RE, Dexter F. Tactical increases in operating room block time for capacity planning should not be based on utilization. Anesth Analg. 2008 Jan; **106**(1): 215-26.
30. Fei H, Meskensa N, Chub C. A planning and scheduling problem for an operating theatre

using an open scheduling strategy. Computers & Industrial Engineering. 2010 Mar; **58**(2): 221-30. doi: 10.1016/j.cie.2009.02.012.
31. Pandit JJ, Tavare A. Using mean duration and variation of procedure times to plan a list of surgical operations to fit into the scheduled list time. Eur J Anaesthesiol. 2011 Jul; **28**(7): 493-50. doi: 10.1097/EJA.0b013e3283446b9c.
32. Levine WC, Dunn PF. Optimizing operating room scheduling. Anesthesiol Clin. 2015; **33**(4): 697-711.
33. Xiangyong L, Rafaliya N, FazleBaki M, Chaouch BA. Scheduling elective surgeries: the trade off Among bed capacity, waiting patients and operating room utilization using goal programming. Health Care Manag Sci. 2017 Mar; **20**(1): 33-54. doi: 10.1007/s10729-015-9334-2. Epub 2015 Jul 17.
34. Mei TC. A study on the effect on scheduling and management of surgeries with the introduction of excellent medical information. Stud Health Technol Inform. 2016; **225**: 824-5.
35. Istituto Superiore di Sanità. Gruppo di lavoro Malattie rare CPVID 19. Censimento dei bisogni (23 marzo-5 aprile 2020) delle persone con malattie rare in corso di pandemia da SARS-CoV-2. Versione del 30 maggio 2020. Roma: Istituto Superiore di Sanità; 2020. (Rapporto ISS COVID-19, n° 39/2020).
36. Herrod PJJ, Adiamah A, Boyd-Carson H, et al. Winter cancellations of elective surgical procedures in the UK: a questionnaire survey of patients on the economic and psychological impact. BMJ Open. 2019; 9. doi: 10.1136/bmjopen-2018-028753.
37. Al-Jabir A, Kerwan A, Nicola M, et al. Impact of the Coronavirus (COVID-19) pandemic on surgical practice - Part 1. Internat J Surg. 2020 Jul; **79**: 168-79. https://doi.org/10.1016/j.ijsu.2020.05.022. Epub 2020 May 12.

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