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EVALUATION OF QUALITY TIME INDICATORS IN THE SURGICAL CENTER FOR ELECTIVE PROCEDURES IN A TERTIARY HOSPITAL OF SANTA CATARINA

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Abstract: Objective: To evaluate the time indicators of the surgical center of a medium-sized and high-complexity private hospital in western Santa Catarina. Methods: This is a descriptive cross-sectional study using primary data obtained through timekeeping prospectively performed by the researchers (150 surgeries), and secondary data from the hospital's information system (3291 surgeries). Results: The mean time interval between the patient's entry into the operating room and the start of surgery was 21.9 minutes, and from the end of the operation to the patient's exit from the room, 14.3 minutes. The average total time of patient stay in the operating room was 82.6 minutes, of which 62.1 minutes correspond to the period that the patient remained anesthetized, and 45.2 minutes in operation. The average total time in non-operative processes (turnover) was 32.3 minutes. The comparative analysis of the results with the time averages obtained by the hospital's information system showed a certain equivalence between the times, with an average difference of 2.4 minutes. Conclusion: Based on the results presented, it was possible to analyze the operating dynamics of the operating room and identify satisfactory and unsatisfactory indicators. The non-operative time was the one that was farther from the ideal, highlighting the period that concerns the end of cleaning until the entry of the next patient.
Keywords: Quality Indicators in Health Care, Time, Elective Surgical Procedures, Surgical Rooms.

INTRODUCTION

The Surgical Center (SC) of a hospital is a complex environment that depends on the joint work of a qualified multiprofessional team, made up of doctors, nurses, technicians, instrument technicians, room circulators and cleaning staff, and an adequate physical and organizational structure. . For the general good functioning of the hospital, it is necessary to establish a dynamic routine, in order to guarantee cost reduction, increase in team productivity and quality of patient care (GOMES; DUTRA; PEREIRA, 2014).

The different types of materials, medicines, supplies and equipment that need to be constantly reorganized, transported and sterilized, depending on the surgical procedure that will be performed, in addition to the clinical conditions and different origins of the patients treated, who can come from home, from the emergency room, the ward or the intensive care unit (ICU) make the operation and management of this sector an extremely challenging task. Therefore, for everyone involved to work harmoniously and effectively, and for the patient to receive a quality service, the various steps involved in the surgical procedure must be thought out, systematized, performed and constantly reviewed by health management professionals. et al., 2015; DUARTE; FERREIRA, 2006).

In the 1980s, in an attempt to evaluate health programs, the physician Avedis Donabedian created the Donabedian Triad, a model for evaluating the quality of health services based on the following categories: structure, process and outcome. Even with the development in the health area, this triad is still used in the evaluation of services, and from adaptations it is applied to the different spheres of health, including tertiary care (CASTRO, 2000).

The structure encompasses physical installation, available equipment/materials and professional staff. The process involves everything that aims to achieve the result, from the sterilization of materials to the performance of the operation. This category also includes management issues, such as delay of professionals, average time to perform each activity, occupancy rate of operating rooms, number of surgeries performed per

team and percentage of procedures described. Finally, the result includes the product of all processes, which can be evaluated as the patient's health status, and their satisfaction with the procedure. Often the results are seen individually, however when it comes to health, especially surgical treatments, it is necessary to evaluate the three spheres together (DUARTE; FERREIRA, 2006).

For the optimization of services, the hospital institution must be continuously committed to the resolution, quality and low costs of the medical procedures performed. In this sense, excellence in resource management only becomes possible when it is possible, primarily, to identify waste, and then to devise strategies that aim to eliminate or significantly reduce it (PERROCA; JERICÓ; FACUNDIN, 2007).

Waste is defined as any resource that is spent beyond what is necessary (inputs, human effort, energy, technology) for the execution of the service, generating expenditure at normal costs without adding any type of improvement for the customer. Therefore, when work processes become inadequate, the cost of products or services increases (PERROCA; JERICÓ; FACUNDIN, 2007).

The understanding and schematization of the process indicators, made through the timing and analysis of the different times that make up the surgical production chain, can facilitate the visualization of the operation of the SC, in the search for the optimization of processes that may be deficient when compared to what the literature considers it ideal (JERICÓ; PERROCA; PENHA, 2011; COSTA et al., 2015). In view of the technical and professional complexity present in this environment, prospective data collection added to the use of data from the hospital's information system becomes fundamental for a reliable understanding of the functioning of this sector.

Although there is a pre-stipulated amount to be paid to health, administration, cleaning and maintenance professionals, when the time indicators are not satisfactory, there is an expense of extra money, which is often not perceived by the hospital management. These expenses are mainly due to low room occupancy rates, which leads to waste of materials, electricity and workforce. This way, it is clear that the time that the patient remains in the SC is closely linked to hospital expenses. In addition, the patient's stay for long hours in this environment makes the postoperative recovery slower and the physiological damage greater (COSTA et al., 2015).

GOALS

To evaluate the CC time indicators in elective operations of a medium-sized and high-complexity private hospital in western Santa Catarina.

METHODS

This is a cross-sectional descriptive study with primary data prospectively collected by researchers in six SC rooms, together with data from the hospital's information system (IS). The study location was a medium-sized, high-complexity private hospital in western Santa Catarina. The sample of 150 operations consisted of the procedures carried out during the period from July to December 2019. Data collection took place from Monday to Friday in all operating rooms, with the aid of duly certified and tested stopwatches. Elective surgeries performed in sequence were included, during the routine operating hours of the SC, between 7 am and 6 pm. The last surgeries of each day were excluded, as well as surgeries with local anesthesia without sedation (which do not require the performance of the anesthesiologist), so that all timed times could be considered, in addition to emergency surgeries, in view of the unpredictability.

the emergence of this demand. The turnover time, which corresponds to the period from which a patient leaves the operating room until the next one enters, was analyzed in a special way, excluding procedures with more than 90 minutes, considering that theoretical references consider that these cases due to gaps in the surgical schedule. For direct observation of the events, a structured instrument was developed, composed of items for characterizing the surgeries (shift, specialty, operating room, type of anesthesia, isolation cohort and times). The processes that took place in the rooms were separated and timed according to the following variables:

- Time 1 (T1): time between the patient's arrival in the room and the beginning of anesthesia.

- Time 2 (T2): time between the beginning of anesthesia until the patient is anesthetized. The start of anesthesia was considered according to each anesthetic procedure.

- Time 3 (T3): time between the anesthesia and the beginning of the operation;

- Time 4 (T4): time from start to end of the operation. The incision was considered the beginning of the operation. Procedures without surgical incision were considered according to their specificities.

- Time 5 (T5): time between the end of the operation and the end of anesthesia. The completion of the suture was considered as the end of the operation. Sutureless procedures were considered according to their specificities.

- Time 6 (T6): time between the end of anesthesia until the patient is removed from the room.

- Time 7 (T7): time between the patient leaving the room and the start of cleaning.

- Time 8 (T8): time between the start and end of cleaning.

- Time 9 (T9): time between the exit of a patient and the entry of the other (turnover).

- Time 10 (T10): total time of the patient in the operating room. Considered from the patient's entry into the operating room until his departure to the recovery room.

- Time 11 (T11): time to prepare the room for the next surgery. Considered from the departure of the cleaning team until the arrival of the next patient.

The data collected by the researchers were compared with data obtained from the hospital's IS, in order to assess whether it represents times compatible with the observed reality. The system is powered by the SC professionals themselves, and calculates the monthly average of the times of the procedures performed in all the hospital's operating rooms. In addition, the data collected were analyzed based on theoretical references on the subject, in order to assess the time used in each step that involves the surgical process.

The research project was approved by the Ethics and Research Committee of the institution, opinion number 3,445,749/2019, CAAE: 13251919.4.0000.5564, and data collection was only started after formal authorization through a term signed by the coordination of hospital management. Patients participating in the research signed the Terms of Free and Informed Consent (FICT).

RESULTS

A total of 3291 surgeries were performed from July to December 2019. Of these, 150 (4.5%) were prospectively monitored by the researchers and subsequently evaluated. The variety of surgical specialties was very significant, the sample being composed of orthopedic procedures (21.3%), ophthalmology (14%), otolaryngology (12%), urology (10.6%), gastroenterology (10.6%), gynecology (7.3%), neurosurgery (5.3%), vascular surgery (4.6%), pediatric surgery (4%), head and neck surgery (2.6%), general

surgery (2 %), plastic surgery, dermatology, oncology and mastology (1.3% for each). The degree of complexity of the procedures was also very diverse, ranging from catheter removals and ocular infiltrations, to breast reconstructions and bariatric surgeries. For better projection of the data, they were analyzed together and then divided by surgical specialty and precautionary measures. Regarding these measures, only 2% are isolation surgeries. The test: *t student* revealed a significant association ($p<0.05$) between cleaning time and type of precautionary measure (isolation or not).

The time between patient admission and the start of anesthesia (T1) had an overall mean of 6.2 minutes. The specialties of oncology, general surgery, vascular, neurosurgery, gastroenterology and orthopedics, in addition to the group of surgeries in isolation cohort, had the highest means.

The time between the anesthesiologist's release and the patient leaving the room (T6) had an average of 7.1 minutes. The time between the beginning and the end of cleaning (T8) had an average of 6.2 minutes, with a standard deviation of approximately 3 minutes. Isolation surgeries had an average twice as high as non-isolated surgeries, taking into account that cleaning for this class must be complete, including the walls and ceiling of the room.

The time between leaving the room and starting cleaning (T7) had an average of 5.2 minutes, with a significant standard deviation in most of the groups evaluated. The turnover time (T9) presented a general average of 32.3 minutes. And the time that the room remains without activities (T11) presented an average of 20.9 minutes.

The **Table 1** presents the temporal analysis referring to anesthetic, operative and operating room procedures. The **Table 2**, on the other hand, covers the analysis of the times in which the patient is being prepared for surgery, that is, it comprises all the processes that go from the patient's entry into the room to the beginning of the surgical incision, and the time elapsed between the end from suturing until the patient is removed from the room.

Still regarding operative time, the surgeries

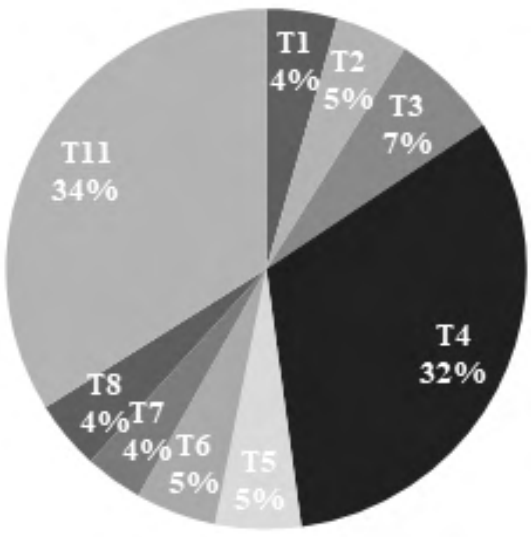

Figure 1. Percentage graphic representation of the surgical steps of 150 procedures, in a medium-sized and high-complexity hospital in the West of Santa Catarina, from July to December 2019.

Source: Prepared by the author.

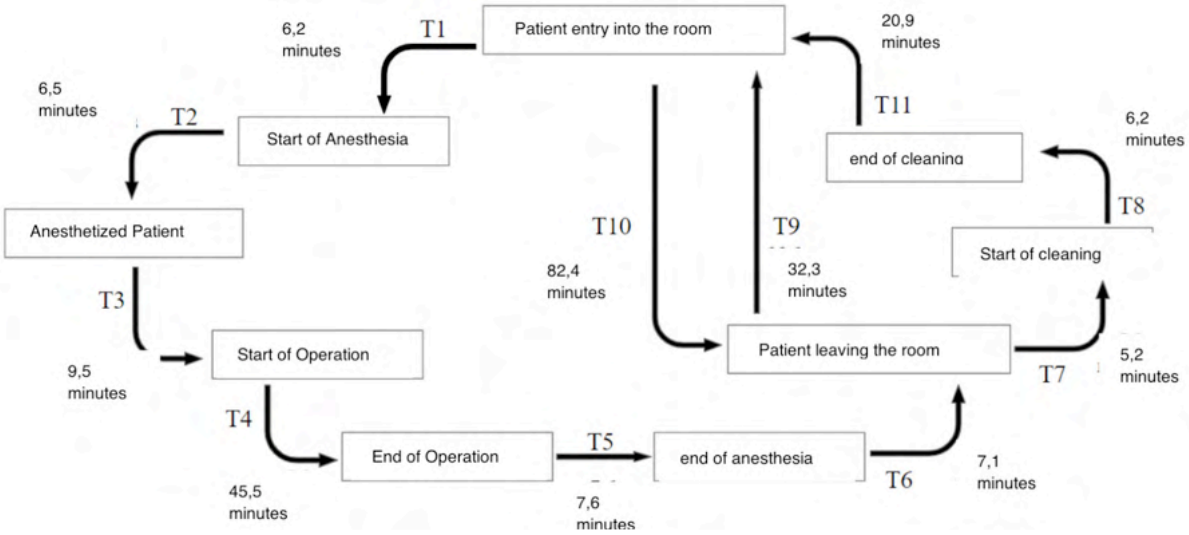

Figure 2. Procedural outline of the surgical steps of 150 procedures, in a medium-sized and high-complexity hospital in the west of Santa Catarina, from July to December 2019.

Source: Prepared by the author.

	Time intervals	Average	Median	Standard deviation
T4	**Time in Operation**	45,5	35,0	46,4
T2 + T3 + T4 + T5	**Weather in Anesthesia**	69,07	59,0	55,2
T10	**Total time in the operating**	82.3	76.5	59.8

Table 1- Time in minutes of patient stay in the operating room, time in operation and anesthesia time of 150 procedures performed in a medium-sized and high-complexity hospital in western Santa Catarina, from July to December 2019.

Source: Prepared by the author.

	Time intervals	Average	Median	Standard deviation
T1 + T2 + T3	**Patient entry into the room until the start of the operationroom**	22,1	21,0	11,4
T5 + T6	**End of the operation until the patient leaves the room**	14,7	14,0	10,1

Table 2- Operative time in minutes that the patient remains in the operating room out of operation of 150 procedures performed in a medium-sized and high-complexity hospital in western Santa Catarina, from July to December 2019

Source: Prepared by the author.

were evaluated according to the anesthetic procedure. The highest average is observed in surgeries with general anesthesia, with 86.8 minutes being the time the patient remains anesthetized until the anesthetist is released from the operating room, and 8 minutes from the anesthesiologist's release to the removal from the room. Then the surgeries with regional anesthesia with 55.1 minutes until the anesthesiologist was released and 6.7 minutes until the removal of the room, and more quickly the surgeries performed under local anesthesia associated with sedation, with 16.2 minutes until the anesthesiologist was released. and 4.4 minutes until removal from the room.

The **Table 3** shows the comparison between the time of use of the room in operative and non-operative processes (turnover time) and in preparation for the next surgery.

Table 4 shows the comparison between the indicators from the prospective collection carried out by the researchers and the data from the hospital's IS.

DISCUSSION

The prospective analysis of 150 operations performed during six months made it possible to obtain means, medians and standard deviations of the times of the operative and non-operative processes that occur in the operating rooms. The average duration of operations (T4) was approximately 45 minutes, which is far below the average referenced in the literature, around 120 minutes (SMI GROUP, 2012). However, it is known that this time is extremely unpredictable and variable, as it depends on individual patient characteristics, such as age and associated comorbidities, the surgeon's skill, and the possible complications that may arise during the procedure. For these reasons, it is of little relevance to guide hospital management.

Regarding the operative times, expressed in **Table 2**, after comparison with theoretical references, extensions were identified in the average time between the patient's entry into the room and the beginning of the operation

	Time intervals	Average	Median	Standard deviation
T10	**Total patient time in the room**	82,3	76,5	59,8
T9	***turnover time***	32,3	26	22,19
T11	**Room preparation time for the next surgery**	0,9	16	19,56

Table 3. Time in minutes of room use with the patient, without the patient and in the absence of activities in 150 surgeries performed in a medium-sized and high-complexity hospital in western Santa Catarina, from July to December 2019.

Source: Prepared by the author.

	T1	T2+T3	T4	T5	T6	T7	T8	Total
Hospital information system (3291)	7,3	14,2	47,0	6,7	5,5	3,0	7,7	91,3
Data collected prospectively by the researchers (n:150)	6,2	15,9	45,5	7,6	7,1	5,2	6,2	93,7

Table 4. Mean time in minutes of indicators timed by the hospital's information system and by the researchers, in a medium-sized, high-complexity hospital in western Santa Catarina, from July to December 2019.

Source: Prepared by the author.

(T1+T2+T3) and also in the average time between the end of the operation and the patient leaving the room (T5+T6).

The first had an average of approximately 22 minutes, very close to the ideal (19 minutes) (SMI GROUP, 2012). It is worth mentioning that for the beginning of the anesthetic procedure, it is recommended that all the professionals involved in the surgery are present, therefore, the delay of professionals or the patient can cause the prolongation of T1, and consequently of this preoperative time. And the second, about 15 minutes, while the literature recommends that it be up to 12 minutes (SMI GROUP, 2012). Thus, there is a potential for improvement in the operative time indicators of approximately 6 minutes: [(22-19) + (15-12)].

The **Table 1** compares the mean operative time with the time the patient remains anesthetized, demonstrating that the latter is approximately 24 minutes longer (69 - 45), that is, the patient is actually being operated on for two thirds of the anesthetized time. It is known that practically all anesthetics impair thermoregulation, and the longer the time between anesthetic induction and the end of surgery, the greater the amount of cold intravenous fluids injected (SABISTON, 2010). These conditions favor a hypothermic condition, which reduces the immune response, generates coagulation disorders and delays the patient's awakening. According to data from the North American literature, a variation of only 1.5 ºC below normal is associated with adverse outcomes that add hospitalization costs from 2500 to 7000 dollars per surgical patient (LAURENCEL et al., 2015).

And also in **Table 1**, it is possible to observe the general average of the time that the patient is actually being operated on (T4= 45 minutes), while in **Table 2**, the general average of all preoperative and postoperative processes is represented, excluding the mean time of surgery (T1+T2+T3+T5+T6= 36.8 minutes). Comparing these data, it can be seen, in general, that the time allocated for organizing the surgical material, patient preparation, antisepsis, field setup, anesthesia, intubation, extubation, identification of biopsies when necessary and removal of the patient from the room represent the equivalent of 80% of the time that the patient is actually being operated on. It is known that the time that the patient remains in the SC is directly related to a higher occurrence of pulmonary, urinary, systemic and wound infections (SABISTON, 2010). Therefore, reducing this indicator will help to minimize these risks and, consequently, the postoperative recovery will be faster.

The time in operative processes can still be evaluated according to the anesthetic procedure. It was possible to identify a decreasing order in the times in which the patient remained anesthetized and when the anesthetist was released for referral to the recovery ward. Surgeries with general anesthesia had longer times, followed by regional and local anesthesia (with sedation), this discrepancy confirms the direct relationship between surgical complexity, anesthetic time, and awakening time.

The non-operative time, represented in **Table 3**, which does not involve the presence of the patient in the room, is not so strongly linked to individualities and eventualities that may arise, therefore, it can be more easily planned, evaluated and optimized if there is no is within the parameters considered ideal. In this way, it is the most important time for the organization and management of the sector. This time includes T7, T8 and T11, in addition to T9 (turnover) which corresponds to the entire period from the time one patient leaves the room until the next one enters.

The time between the patient leaving the room and the entry of the cleaning team (T7),

also known as pre-cleaning (VILELA et al., 2016), had an average of 5.2 minutes, with a median of 3. Due to the absence of an ideal value for this interval, the comparison with other studies that analyzed this same time becomes valid. In 2011, a teaching hospital with a sample of 101 cleaning procedures (JERICÓ et al., 2011), obtained an average of 21.1 minutes in this indicator, another, carried out in 2015, also in a university hospital with a sample of 4,160 procedures (VILELA et al., 2016) obtained 3 minutes in this interval. It is worth mentioning that between the end of the surgery and the entry of the cleaning team, it is necessary that the circulating room organize and remove the equipment used in the previous surgery. Therefore, the extension of T7 may be related not only to the delay in the arrival of the cleaning team, but also to the delay in the removal of materials by the circulators.

The total cleaning time (T8), which takes into account the surgeries in the isolation cohort and the non-isolated surgeries, had an overall average of approximately 6.2 minutes. According to the references, it is recommended that this time be less than 20 minutes (NEPOTE, 2003), so this indicator is within the ideal parameters. Even the surgery group in the isolation cohort, which requires more thorough cleaning, when analyzed separately, had an average time lower than the recommended one (12 minutes).

The interval between the departure of a patient and the entry of another in the operating room (turnover), defined as T9, is an important indicator for the evaluation of efficiency and productivity, considering that it depends on the organized work of different professionals. It includes the transport of the operated patient to the recovery ward, the removal of materials used in the surgery by the circulators of the room, the entry and exit of the cleaning team, the organization and replacement of the new materials needed for the next operation, and finally , moving the next patient from the waiting room, ward, or ICU to the operating room.

Considering that the Brazilian literature does not have studies that establish ideal turnover values, data from foreign literature were taken as a basis. According to an American score, turnover time is essential to classify the performance of the CC functioning, being divided into three categories: high performance (<25 minutes), medium (between 25 and 40 minutes) and poor (>40 minutes) (MACARIO, 2006; DONHAM; MAZZEI; JONES, 1996). It is worth mentioning that turnover times above 90 minutes are considered gaps in the operating room schedule, so they are not only influenced by the cleaning and preparation time for the next operation, justifying their exclusion (DEXER et al., 2005).

The average turnover time of the sample resulted in an average value of 32.3 minutes, therefore, in this indicator there was an increase in time of approximately 7 minutes [(32.3-25)], and can be classified as average performance. In order for the room turnover processes to occur in a more optimized way and without professional overload, it is necessary to offer continuing education and qualification for all those involved, in addition to an adequate number of employees for each function. It is worth mentioning that the organization of the CC studied is active, that is, although there is a daily planning, according to the delay of the surgeries and availability of the rooms, there is the possibility of changes, allowing a better distribution in search of a more effective use, which bring benefits to patients and professionals involved.

It is known that the charge for a surgical service varies according to the degree of complexity of the operation, the material used and the structure, for this reason, the

SC time is considered the most expensive when compared to the others in the hospital chain. In the United States, the average cost of performing surgery is about US$1,000 (US$) per hour, not including medical fees, and this cost can increase from US$60 to US$100 per minute when there is time. idle in an operating room (GARNER, 2012).

In São Paulo, Hospital Albert Einstein has a tabulated record of the price per hour according to the surgical procedure, with room hours ranging from R$950 to R$1,012.50, excluding expenses with surgeons and assistants. (COSTA et al., 2015; HIAE, 2018). However, the Brazilian literature does not have data that relate idle minutes with the expenses they imply, for this reason, even with some differences in management between countries, it is again necessary to analyze the data based on American studies.

The sum of the times that exceeded the ideal, both operative and non-operative, was 13 minutes (6 minutes corresponding to the operative time + 7 minutes of the non-operative time). For the purposes of a hypothetical exercise, multiplying the minimum cost per idle minute (US$ 60.00) by the sum of the time that exceeded the ideal (13 minutes) results in an extra expense of US$ 780.00 by surgery. If we apply this amount to the 3291 surgeries performed in the period from July to December 2019, we will account for an amount of US$ 2,566,980.00 arising from the time exceeded in half a year of the CC operation.

Another important analysis refers to the surgeries that started, or not, at the scheduled time. As the hospital has a dynamic organization, with room change according to availability, it becomes relevant to assess the delay time in the first surgeries in each room, which impacts the activities performed later. In relation to the total sample of 150 surgeries, 42 (28%) correspond to the first surgery in the morning shift. Of these, 16.7% started at the scheduled time, 7.1% were early, and 76.2% were late, ranging from 1 minute to 68 minutes. Evaluating this sample as a whole, there was an initial delay of 306 consecutive minutes during the collection period, negatively impacting the productivity of the service, because when the first surgery is delayed, the organization of the sector will hardly be able to recover the planned progress during the day.

Finally, **Table 4** compares the data obtained during the prospective collection (150 surgeries) with the monthly averages recorded in the hospital's SI (3291 surgeries), in order to assess whether there are statistical equivalences between the two. The time interval that presented the greatest difference was between the patient leaving the room until the beginning of cleaning (T7), being 2.2 minutes. And what showed the smallest difference was between the end of the operation and end of anesthesia (T5), being 0.9 minutes. In addition, when the sums of the averages of all time intervals are compared, it is possible to notice a difference of only 2.36 minutes (93.69 - 91.33), demonstrating that the system data are depicting the reality of the dynamics of CC operation.

However, despite the existence of the necessary records, the SI does not calculate the turnover time on its platform, and it is precisely this that presented the greatest increase after analysis and comparison. We remind you that the value found in our research was 32.3 minutes (average performance). This result was only possible thanks to prospective data collection, so there is no doubt that the addition of the analysis of this important interval in the SI would make it more complete and efficient (LANGABEER et al., 2009).

Organizational quality improvement practices have gained wide acceptance in

the manufacturing industries in recent decades, and a substantial amount of content has been produced based on Six Sigma and Lean methods, which today represent the main improvement initiatives. The health sector, however, has been slow to adopt these methods, making it necessary for them to be more widely disseminated in this environment (LANGABEER et al., 2009).

The core philosophy of Six Sigma is primarily based on reducing variability, with the assumption that each process must be within certain acceptable limits. This variability is expressed through standard deviations, which can be considered errors or defects in the production chain, so the greater these deviations, the less optimized the service. However, it is worth remembering that there are incomparable variables in the hospital environment, especially those that depend on the individualities of the procedures and the patient (LANGABEER et al., 2009).

For the application of this method in the CC, an active and rigorous approach is necessary, aiming to define the maximum and minimum capacities of each process for further mathematical and statistical computation of the data that still do not have stipulated ideal values. Thus, the prospective timing of the different surgical times can serve as a foundation for this objective. During the elaboration of the work, this scarcity of data regarding ideal values was noticed, reaffirming the idea that this management method is still little used in the hospital environment (LANGABEER et al., 2009).

The Lean method of quality management seeks primarily to reduce waste through simple paths with the standardization of production processes, avoiding redundancies or exaggerations. Since the SC is the place where patients from the most varied locations converge (emergency room, ward, ICU and home), it needs to be a dynamic environment, with several alternative paths that allow the continuity of the service to function without overloading it (COSTA et al. ., 2015).

All workers in the sector need to be prepared to act in the event of eventualities or possible errors, through continuing education, information technologies and efficient communication. With this, it becomes possible to quickly change the operating rooms when necessary and the effective transfer of the new organization of the sector to all members of the team. In addition, managers need to have a leadership profile, and be readily prepared for unforeseen events with a well-structured and easy-to-execute action plan. Therefore, the best way to avoid an error is to be prepared for when it does occur.

CONCLUSION

The understanding of the time indicators of the processes that involve the surgical chain becomes a fundamental tool for the identification of deficits in the functioning that can be corrected, culminating in the optimization of the use of operating rooms.

Through the research, it was possible to identify satisfactory and unsatisfactory indicators when compared with performance references in the literature. Despite the vast majority being satisfactory, the indicator that proved to be the most distant was the turnover time, which comprises non-operative activities. On the other hand, cleaning time, which is part of non-operative activities, was well below the limit, noting that what has been prolonging turnover time is the delay in organizing for the next surgery, after the cleaning team leaves.

In addition, it was possible to determine that the IS is correctly portraying the surgical dynamics. However, this system does not calculate the worst performing period.

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