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Application of Digital Technology in a Surgical Center of a Brazilian Hospital

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ABSTRACT

Surgical planning is essential, and its effectiveness depends on alignment with essential sub-processes such as supplies, bed management, intensive care unit and material sterilization center. Above all, one of the most relevant pieces of information when planning operating rooms is the duration of each surgical procedure. Therefore, the aim of this research is to present an approach to collect surgical procedure times using digital technology. METHOD: As for the research methodology, this article was developed within a qualitative interface and the action-research method was implemented. RESULTS: The results directly show that the proposed approach can effectively help hospital managers in the indicated context, and the proper use of this digital technology can optimize care, reduce waiting times and minimize the total number of surgeries canceled monthly. CONCLUSION: The conventional approach used in manufacturing, of timing processes on production lines, is still widely used, but within the operating room it is impractical and not very applicable. Therefore, this research presents an innovative tool to assist in the planning of surgeries, with regard to the collection of surgical procedures and, consequently, to improve the efficiency of hospital management in the context studied, through more effective surgical planning.

Keywords: Digital Technology, Operating Rooms, Surgery Planning, Time Collection.

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I. Introduction

Surgery planning is extremely important, and its effectiveness depends on a coherent alignment with essential sub-processes such as supplies, bed management, intensive care unit and material sterilization center. One of the most relevant pieces of information when planning operating rooms is the duration of each surgical procedure.

The "production" master plan is something essential in operations and services, widely used and depends on the accuracy of process times to have reliability [1], [2]. However, this same situation does not apply to the planning of surgeries in a hospital environment. The operating rooms are popularly known as the heart of the hospital and represent an area of considerable spending in a hospital's budget [3]. Analysis of operation center utilization is essential to improve operation effectiveness, and reliable sizing of operation time not only reduces operation costs, but also increases the efficiency of healthcare systems. The time of the surgical procedure is of great importance, affecting the surgical result, complications and daily surgical scheduling with financial implications [4].

In this context, surgery planning is therefore extremely important, and one of the most relevant pieces of information when planning operating rooms is the duration of each surgical procedure.

It is important to point out that the conventional manufacturing approach [1] of timing process times on production lines is still widely used, especially in Production Line Balancing [5], but within the surgical center it is something unfeasible and little used.

Therefore, it is imperative to use a specific and assertive approach within the operating rooms. To fill this gap, the objective of this present article is to present an approach to collect the times of surgical procedures. Thus, the action-research method was implemented, and the final results directly demonstrate that the proposed approach can effectively help hospital managers.

II. Literature Review

The services provided in the surgical center play an important role in the finances of a hospital [6]. The most important issue for the operating room is the scheduling and management of surgeries, as a schedule can increase the effectiveness of using the operating room. Therefore, introducing accurate medical information can boost the productivity of healthcare workers and reduce the workload to achieve "win-win" benefits in management and performance.

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There are several studies that explore the planning of the operating room and the uncertainty related to the time of the surgical procedure, and the arrival of the patient and its effects [7]–[9].

The operating rooms are extremely important for a hospital, consuming a considerable part of its total budget [10]. Generally, more than 60% of patients admitted to a hospital are treated in the operating room. Patient management, i.e., the decision to treat a patient and the timing of treatment, is often constrained by limitations in operating room capacity or the availability of surgeons and skilled personnel. Therefore, and for cost containment, care planning, that is, planning which patient to operate and when to operate is of fundamental importance [11], [12].

Emergency procedures, great diversity of processes, dependency on capacity elsewhere in the process, and a large number of specialties competing for operating room facilities make planning complex. Optimal planning can only be achieved when reliable forecasts are available about the time required for elective operations.

When an operation takes longer than anticipated, subsequent operations may need to be postponed or even canceled. However, if the actual time is less than expected and planned, the operating room remains unused, thus causing "waste" within the operation. Therefore, the lack of accuracy of time is something undesirable and costly [13]. Furthermore, in the absence of reliable forecasts, the use of the advanced planning technique is not assertive.

It is also worth noting that the cancellation of surgeries is something that not only affects the entire agenda of the day and underutilizes the time in the rooms, but also affects family members, various employees and the health system as a whole, increasing the costs of the operation [14].

Finally, while much progress has been made in planning methodology, especially for day-of-surgery planning, there are still opportunities and gaps for further improvement through better preoperative prediction of operating times for individual cases based on the history collected from the times of surgeries.

III. METHODS

The present study was applied in a University Hospital. This hospital has a huge population coverage, being part of a foundation that encompasses both the educational activity and the hospital part. It currently serves 16 micro-regions, corresponding to 191 municipalities, with an estimated population of 3,500,000 inhabitants.

This hospital has the only general emergency room in the region that is part of the reference system for urgent and emergency care. In addition, it has elective care, care for high-risk pregnant women (level III), high complexity level II neurosurgery, traumatology, orthopedics, corneal transplants, kidney transplants, adult, neonatal and pediatric intensive care unit type II.

The ability to perform surgeries is quite variable, as it depends on several factors. However, it can be estimated that the aforementioned hospital performs an average of 16 surgical procedures per day, and has a team that can handle low, medium and high complexity procedures. In this context, the approach for collecting data from the previous examination was applied in the surgical center of this University Hospital.

An unanswered question is the essential premise for starting research, that is, seeking a solution to a real-world problem is something that justifies the design of an applied research project. In this context, the question for the present research project was: "How should we collect the times of surgical procedures in an agile and reliable way?" The answer lies in the new approach presented.

In fact, what leads to carrying out scientific research can be intellectual reasons such as the desire and satisfaction to know, or practices such as the desire to do something that can impact the real world [15].

It is important to emphasize that research is defined as a rational and systematic procedure that aims to provide answers to the problems that are proposed [16]. And applied research is characterized by its practical interest, that is, in the solution of problems that occur in reality [17].

The present research is, therefore, classified as of an applied nature, as it is characterized by its practical interest, that is, that the results are applied in the solution of real-world problems [18]. Still, applied research would be raised by commercial objectives through the development of new processes or products oriented to market needs [19].

As for the objectives, the research is classified as normative, as the interest is in the development of technologies, strategies and actions to improve the results available in the existing literature, to find an optimal solution for new definitions of problems or to compare several strategies related to a problem. specific problem [20].

The research approach is qualitative, as it considers that there is a dynamic relationship between the real world and the subject. The natural environment is the direct source for data collection and the researcher is the key instrument.

Finally, it can be said that the method employed is action research, as researchers and participants representing the situation or problem are involved in a cooperative or participatory manner [18]. Fig. 1 summarizes the approach for collecting the processing times of operations in operating rooms. In "stage 01", the medical team employee must enter the secure surgery digital technology platform with their personal data for authentication.

Soon after, in "stage 02", the same collaborator enters the specific data about the surgical procedure in question. In "stage 03" the data is stored on the hospital's server in an agile way and respecting all the premises of the General Data Protection Law (LGPD).

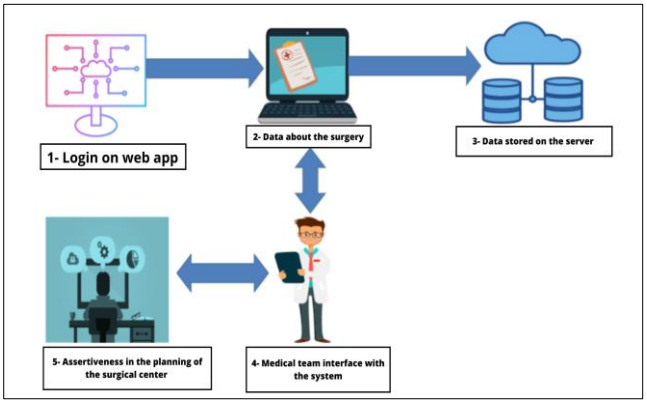

Fig. 1. Approach to collecting times.

Finally, in “stages 04 and 05”, some patient information and the times of the surgical procedures obtained are used to carry out and update the surgical map for the following day.

It is important to emphasize that there is a field called surgical intercurrence, which must be properly filled in by the doctor or nurse, so that it is possible to justify the variability (especially regarding the sample standard deviation) resulting in the times of the procedures.

Fig. 2 presents in detail all the data that will be necessary to complete the information of “step 02”. There is a division on the type of data in this step: “Confirm Patient Identification”, “Medicine Information” and “Surgical Control”. In the latter, all times of surgical procedures will be collected, as soon as the nurse or circulator presses the start button. The time-taking process ends when this nurse presses the “finalize” button. Soon after, all information is stored in the database.

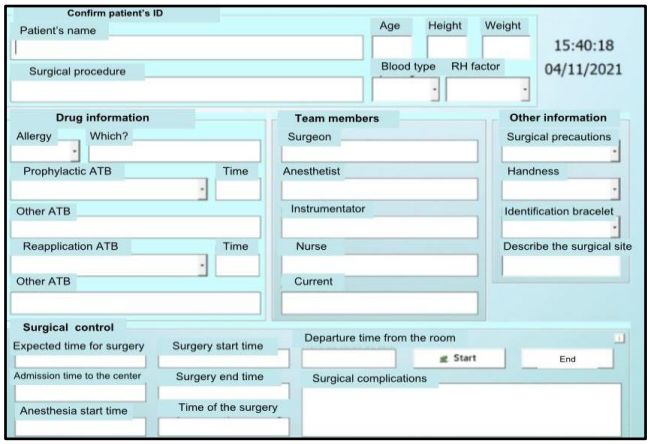

Fig. 2. Data about the surgery.

IV. RESULTS

Table I displays the times of surgical procedures in minutes, collected over four months, and includes information from 424 patients within a total of 52 surgical procedures. Therefore, in this considered period, many patients were admitted to the same type of surgical intervention. For these cases, a simple arithmetic mean was applied to obtain a value for the average time of the surgical procedure [21].

Also in this table, some settings will be customized: o “Estimated time”, which is a metric used to estimate the duration of the hospital procedure based on the experience of the medical team. It is actually a “guess” used as a basis for planning the schedule of surgeries.

“Anesthesia wait” refers to the time the patient waits until the anesthetist arrives; a “Waiting for anesthetic effect” is the time required for anesthesia to reach its due effect, and this time varies due to the type of anesthesia and the intrinsic response time of each individual. The “Real time” is the duration of the surgery, collected via digital technology platform. If for the first time of a sanitary procedure, this time will be equal to “zero”.

Finally, the “Estimated time x Real time” is the difference between these two times and points to the following conclusion: if the result of this difference is a negative number, it means that the surgery time in the planning was overestimated. If the number is positive, the time considered in the planning was underestimated. It is also worth mentioning that the waiting times obtained can be used as an initial reference for the implementation of Lean Healthcare projects [22].

TABLE I: SURGICAL PROCEDURE TIME IN MINUTES

Surgical procedure	Estimated time	Anesthesia wait	Waiting for anesthetic effect	Real time	Estimated time x Real time
Rectosigmoidectomy	150	20	59	204	84
Ventriculoperitoneal shunts	75	14	33	152	62
Surgical treatment of varicose veins	85	14,3	13,67	147	67
Angiography	35	25	11,14	69	9
Inguinal hernia	60	14	16	105,5	34
Hiatus hernia	60	20	43	183	123
Gouty nodule removal	30	5	0	41	11
Reduction mammaplasty	180	19	35	246	66
Laparoscopy for endometriosis	120	30	22	228	108
Anal debridement	60	0	35	85	25
Lumbar Herniated Disc	90	10	46	147	57
Herniated disc	120	10	24	71	-49
Nephrectomy	120	15	23	147	27
Adenotonsillectomy	60	19,6	13,53	56,8	-6
Embolization	74,5	18,25	28,25	127	52,5
Craniofacial reconstruction	90	40	50	79	-11
Oophorectomy	90	15	0	103	13
Myocardial revascularization	240	30	26	304	64
Femoral osteosynthesis	120	20	54,5	310,5	190,5
Femur osteosarcoma	360	25	104	244	-116
Lip excision lesion	60	24	24	95	35
Hysteroscopy	90	36	5	15	-75
Lumbosacral arthrodesis	180	25	83	333	153
Gastrostomy	60	18	13,5	45	-15
Ankle osteosynthesis	60	22	21	50	-10
Double J catheter implant	30	10	4	16	-14
Withdrawal of synthesis material	30	8	13	17	-13
Carpal tunnel decompression	60	30	10	40	-20
Infiltration	30	7,25	29,75	28,5	-1,5
Femur intertrochanteric fracture	120	35	39	106	-14

Surgical procedure	Estimated time	Anesthesia wait	Waiting for anesthetic effect	Real time	Estimated time x Real time
Orchidopexy	60	5	18	30	-30
Scalp lesion removal	60	55	13	137	77
Postectomy	40	10	15	18	-22
Mastectomy and reconstruction	180	25	28	145	-35
Umbilical hernia	60	20	9	33	-27
Expander removal	90	20	25	55	-35
Flexible laser ureterolithotripsy	60	10	22	83	23
Double j stent removal	30	10	1	3	-27
Port implant	30	20	13	40	10
Graft caption	60	8	2	49	-11
Left toe amputation	60	8	27	71	11
Reoperative cardiac surgery	120	0	32	74	-46
Femur biopsy	30	10	29	25	-5
Fistulactomy	30	20	19	10	-20
Hepatectomy	120	20	36	139	19
Urinary tract resection	120	46	20	141	21
Coronary angioplasty	240	5	11	81	-159
Multiple organ captation	360	0	3	128	-232
Awake surgery	240	45	89	254	14
Total gastrectomy	120	20	33	208	88
Aneurysm embolization	40	14	20	140	100
Hand finger osteosynthesis	30	10	19	103	73

V. CONCLUSION

As mentioned above, surgery planning is essential and its effectiveness depends on a coherent alignment with sub-processes such as the supply sector, bed management, ICUs and also depends on the duration of the surgical procedure. To cover this gap, the objective of this article was successfully achieved, as an approach was presented to assertively collect the durations of surgical procedures through a digital technology platform.

Therefore, this research presents an innovative tool to assist in the planning of surgeries, with regard to the collection of surgical procedures and, consequently, to improve the efficiency of hospital management in the studied context. As future works, it would be of great value if this waiting time were properly quantified following the steps of the authors [23].

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CONFLICT OF INTEREST

Authors declare that they do not have any conflict of interest.

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