

# CUIDADO É FUNDAMENTAL

Escola de Enfermagem Alfredo Pinto – UNIRIO

RESEARCH

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## PREDICTIONS OF THE NUMBER OF SUSPENDED SURGERIES USING SOFTWARE POWER BI® IN A UNIVERSITY HOSPITAL

*Previsões do número de cirurgias suspensas utilizando o software Power BI® em um hospital universitário*

*Predicciones del número de cirugías suspendidas utilizando software Power BI® en un hospital universitario*

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### ABSTRACT

**Objective:** to analyze the suspended surgeries, making future predictions of three months, starting in October 2022, through a line graph using the Power BI software. **Method:** we used the technique of weighted moving averages, simple exponential smoothing, using the Power BI® line graph tool, with a confidence interval of 95% and predictions of three months. **Results:** the results showed that there are different steps to construct predictions and some prerequisites must be fulfilled, the following predictions were found with their respective confidence intervals: November 134 (97,172), December 141 (102,180), January 147 (106,188). **Conclusion:** the use of forecasts can be a useful tool for decision making, predicting problems and always necessary in the management of a hospital, and can even suppress expenses in anticipation of a variety of problems.

**DESCRIPTORS:** University hospital; Surgeries; Stages; Forecasts.

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## RESUMO

**Objetivo:** analisar as cirurgias suspensas, realizando previsões futuras de três meses, a partir de outubro de 2022, através de um gráfico de linhas utilizando o *software Power BI®*. **Método:** se utilizou a técnica de médias móveis ponderada, alisamento exponencial simples, utilizando a ferramenta gráfico de linhas do *Power BI®*, com intervalo de confiança de 95% e previsões de três meses. **Resultados:** os resultados demonstraram que existem diferentes etapas para construir previsões e alguns pré-requisitos devem ser preenchidos, foram encontradas as seguintes previsões com seus respectivos intervalos de confiança: novembro 134(97,172), dezembro 141(102,180), janeiro 147(106,188). **Conclusão:** a utilização de previsões pode ser uma ferramenta útil para a tomada de decisão, prever problemas e sempre necessário na gestão de um hospital, podendo até suprimir gastos se antecipando a uma variedade de problemas.

**DESCRITORES:** Hospital universitário; Cirurgias; Etapas; Previsões.

## RESUMEN

**Objetivos:** analizar las cirugías suspendidas, haciendo predicciones futuras de tres meses, a partir de octubre de 2022, a través de un gráfico lineal utilizando el *software Power BI®*. **Método:** se utilizó la técnica de medias móviles ponderadas, suavizado exponencial simple, utilizando la herramienta de gráfico de líneas de *Power BI®*, con un intervalo de confianza del 95% y predicciones de tres meses. **Resultados:** los resultados mostraron que existen diferentes pasos para construir predicciones y se deben cumplir algunos requisitos previos, se encontraron las siguientes predicciones con sus respectivos intervalos de confianza: noviembre 134 (97,172), diciembre 141 (102,180), enero 147 (106,188). **Conclusión:** el uso de pronósticos puede ser una herramienta útil para la toma de decisiones, predicción de problemas y siempre necesaria en la gestión de un hospital, e incluso puede suprimir gastos en previsión de una variedad de problemas.

**DESCRIPTORES:** Hospital universitario; Cirugías; Etapas; Pronósticos.

## INTRODUCTION

According to the World Health Organization (WHO), in 2019 the United States Institute of Medicine (IOM) released the report "To err is human", when there was an incidence of 44,000 to 98,000 annual patient deaths due to errors related to hospital care.<sup>1</sup> These results generated a worldwide movement, in which patient safety came to be considered the main factor in all health systems. This has led to a concern about the quality of services provided by health institutions, as well as the awareness of professionals and managers that improving the quality of information available for decision making is essential.

Given this context, in 2020, in a highly complex federal university hospital located in the city of Rio de Janeiro, the need arose to discuss the creation of a surgery system that would computerize the monitoring processes of elective and emergency surgeries performed at the institution. Until then, there was no system that managed these surgeries, and they were performed through Excel® spreadsheets, without integration with other systems. To solve this problem, after months of development, the Surgery Management System (SisCir- HUGG®) started to work from November 2021, initially involving only a few specialties in a trial period, from 04/04/2022, the system started to cover all hospital specialties.

SisCir- HUGG® was created by professionals from Hospital Universitário Gaffrée e Guinle (HUGG) and is initially composed of two modules: surgical list module and surgical map module. It aims to allow the management of surgical procedures of information ranging from the patient's entry into the hospital environment, including the scheduling of the room, the alert to the hospital supply service and pharmacy, until his discharge, that is, the monitoring of the entire process of surgical procedures.

The aim of the system is to demonstrate the reliability and consistency of information on surgical procedures, allowing the obtaining of the reliable data and information through the systematic annotation of the occurrences and events related to the functioning of the surgical center. This led to the need to build indicators.

The use of indicators has become fundamental in several areas, including health, due to the diffusion of information technology and its ability to provide answers on causes and effects. With the help of Self-Service Business Intelligence tools, it was possible to analyze the behavior of variables over time, including the number of suspended surgeries per month. This variable is important to later analyze the suspension rate of surgeries. The initial objective was to analyze the behavior of this number over time and make predictions about its future behavior.

The term Self-Service BI refers to the ability to analyze and manipulate data from a particular area without relying on an information technology professional. In a hospital environment, not everyone has advanced technical knowledge so having a tool that can be used autonomously is a great advantage. The term BI refers to Business Intelligence, which involves collecting and organizing data for analysis.

The great advantage is to provide employees in each area with autonomy to track their own data. This allows a greater level of depth and detail, since no one knows the needs of the sector as well as its own members. In the hospital under study, Power BI® software was used to perform this analysis.

### WHY WE CHOSE POWER BI® (service version 13.0.19866.57)

Business Intelligence software has the ability to transform large volumes of data into summarized analytics dashboards. These tools can be configured to automatically collect, process, analyze and

visualize data. The term BI began to be used as a technology in the late 1950s. It was associated with software capable of transforming the way information was consumed.

The choice of Power BI® software as a BI tool was based on ease of learning, due to the features available in Excel® (Power Pivot and Power Query), a survey published by Gartner, a leading market research and consulting firm, also ratifies this choice. The survey analyzed fifteen critical aspects involving infrastructure, data management, analysis and content creation, discovery and sharing, ease of use and return on investment among others. Power BI® was identified as "MICROSOFT" and is in the upper right quadrant, i.e. it is considered a market leader today.<sup>2</sup>

According to Gartner Research, Power BI® is recognized as one of the most cost-effective software even though it has only been on the market for eight years. It has millions of users worldwide.<sup>3</sup>

The availability of Power BI® with a free version (called Desktop and launched in 2015) has also contributed to its choice as a tool for presenting data analysis. In addition, the software is compatible with several database formats such as: Microsoft Excel®, MySQL®, Oracle®, Google Analytics®. Its interactive interface allows drag and drop operation, offering access to more than eighty-five data visualization applications. The reports generated are simple and informative, and data can be shared between teams on any device.<sup>2</sup>

In addition to offering data analysis capabilities, Power BI® also enables forecasting over time. This functionality is available within the data analysis tools provided by the software, allowing forecasts to be made within time series.

### TIME SERIES WHAT ARE THEY?

They are ordered and sequential sets of events related to a given period, which occur at regular time intervals (daily, monthly, quarterly, annually, etc.). Time series forecasting aims to predict future events based on historical data of that variable, assuming that patterns observed in the past will repeat themselves in the future with certain similarity.

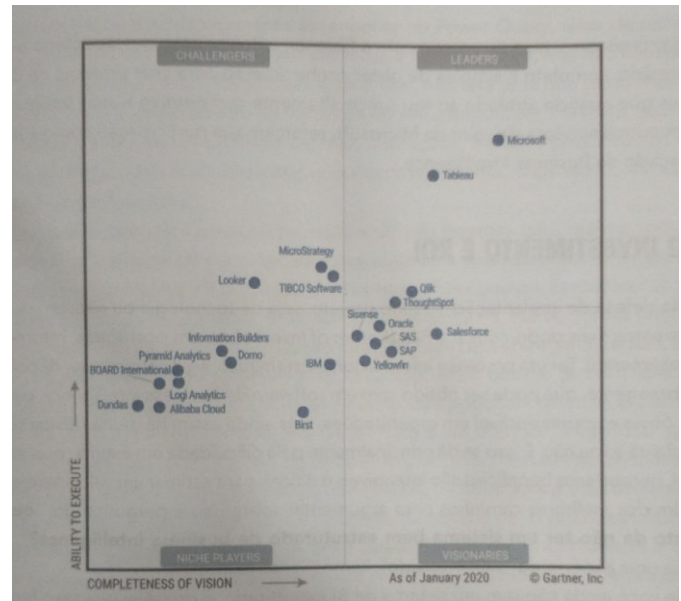
This type of model seeks to identify and analyze fundamental components and patterns present in the time series, such as trends, seasonality, cycles or irregularities, in order to project the behavior of the series for future events.<sup>4</sup>

The trend represents a constant and gradual pattern of increase or decrease in the values of the time series over time. Seasonality, in turn, consists of regular and patterned variations in the data in certain periods or cycles. These variations can be positive or negative. An example would be the behavior of the total number of surgeries performed, which repeats itself in a similar way at monthly or daily intervals.<sup>5</sup>

Finally, irregularities or errors are unpredictable and irregular variations in data over time, which do not represent any specific pattern or explanation.

In the additive form, the description and decomposition of the time series are represented as follows:  $Y = T+S+C+I$ , where we have that Y represents the variable to be predicted, T represents the trend, S represents the seasonality, C represents the cycles and I represents the irregularity component. In the additive model, the

**Figure 1 - Magic Square of Analytics and Business Intelligence Platforms. Rio de Janeiro, RJ, Brazil, 2020**



Source: Lago, K., Alves L.

components are considered independent of each other, allowing them to be added together. In the multiplicative approach, the model is represented by  $Y = T*S*C*I$ . The components have the same meaning, however, in this type of model, it is assumed that they are not totally independent and may even have mutual influence.<sup>6</sup>

Within the time series methods, we can find several different models that can be implemented according to the components and characteristics of the data series to be analyzed. These models can be divided into moving average and exponential smoothing models.<sup>7</sup>

This model is generally used in cases where the data series does not show a clear pattern of trend or seasonality. It uses a smoothing equation for the total series (ST), which represents the smoothed values of the mean of the observations at time t. The model is defined by the constant of the time constant. The model is defined by a smoothing constant,  $\alpha$ , which determines the smoothing factor of the observations. The value of  $\alpha$  varies between 0 and 1, where values close to 1 mean that the model gives greater importance to more recent observations, while values close to zero favor older observations. This choice of  $\alpha$  influences the prediction of the model.<sup>8</sup>

At the end, we will have an equation to calculate the predicted values for the future periods that will be analyzed and are not known. These predicted values will be equal to the smoothed value, which will always be related to the last observed period.<sup>8</sup>

## METHOD

This is a case study, which used a convenience sample of 748 suspended surgeries, sent to the surgical map of the surgery system, in the period from 04/04/2022 to 31/10/2022,

inserted in SisCir-HUGG® by the medical team of each specialty involved in the surgery, including doctors and nurses with prior authorization from the system managers. This information regarding the patients' surgery was inserted in the system's surgical map.

In this study, information was extracted from the surgical map module, which is a tool that enables the scheduling of surgical procedures. Through it, information on patients, materials, medical staff and the operating room is included, which forms the basis of surgical programming.

The surgical map consists of elective surgeries performed from 7 am to 7 pm, Monday through Friday, with some exceptions that can be performed on weekends, but in smaller numbers. In addition, there are also emergency surgeries that could be performed at any time and on any day.

The study was conducted in a surgical center with seven operating rooms (OR) at the Gaffrée and Guinle University Hospital located in the municipality of Rio de Janeiro. The suspended surgeries were distributed among seventeen basic specialties: surgical cancerology, general surgery, neurosurgery, orthopedics and traumatology, gynecology, mastology, surgical endoscopy, ophthalmology, otorhinolaryngology, colon proctology, head and neck surgery, vascular surgery, pediatric surgery, plastic surgery, thoracic surgery, oncologic surgery and urology.

We used a line graph to present the three-month forecast, with a 95% confidence interval.

We considered a suspended surgery as one that was not performed and the patient was not replaced by another surgery that will be performed at a new opportunity.

We extracted the data in Excel® spreadsheets through tables generated by the system. Subsequently, we performed the statistical treatment of these data using the Power BI® software (service version 13.0.19866.57).

## RESULTS

According to Powell and Guilfoyle<sup>9-10</sup> and Microsot<sup>11</sup>, the software provider, the following requirements are necessary to perform predictive analytics with the line graph feature.

1. The value of the x-axis should be in date/time format, not in text, for example
2. You must have a minimum of six data points (coordinates) or provide any other integers.
3. The prediction tool is only available for the line chart and works as a single indicator/line.

By fulfilling these requirements we are ready to create a time series visualization in Power BI® by following these steps:

1. Importing data, using one of several data import options
2. Creating a line chart using the "Line chart" option in the visualizations tab of Power BI®. Dragging the relevant columns to the "x-axis" and "y-axis" fields of the chart.
3. Customizing the visualization to your need by adding and removing elements such as titles, axis labels, legends and trend line.
4. Adding filters and segmentations to the visualization to allow users to interact with the data and analyze different time periods.
5. Publishing the visualizations. It is necessary to create a link in the Power BI® service so that other users can access it and interact with it.

Figure 2 - Surgical map. Rio de Janeiro, RJ, Brazil, 2023

SALA	INÍCIO ESTIMADA	TERMINO ESTIMADO	PROCEDIMENTO	CONGELADO	HEMODERIVADO	PÓS-OPERATÓRIO	FILE CIRÚRGICA	NECESSIDADES DO PROCEDIMENTO/INFORMAÇÕES ADICIONAIS	INÍCIO CIRÚRGICA	INÍCIO MÁGIC CIRÚRGICO
1	07:00	07:25	08:00	09:24	10:00					
1	10:00			08:30						
1	14:00	09:35	10:15	13:07	15:30					
1	14:00			08:14						
5	08:00	08:04	08:30	12:34	14:04					
5	14:00	11:14	14:01	17:30	18:00					
4	08:00	07:39	08:06	10:40	11:25					
4	10:00	10:50	11:18	12:45	12:50					
4	13:00	13:45	13:55	18:00	18:15					
6	08:00			08:35						
6	11:00	08:50	09:37	11:25	12:28					
6	13:00	12:20	12:45	15:35	16:50					
7	07:00			07:31						

Source: Prepared by the authors



**Figure 3 - Power Query editor. Rio de Janeiro, RJ, Brazil, 2023**

	STATUS	SALA	ESPECIALIDADE	DATA CIRURGIA	DATA/HORA DA INTERNAÇÃO	HORA ESTIMADA
1	CIRURGIA REALIZADA		3 ENDOSCOPIA CIRÚRGICA	03/11/2021		31,
2	CIRURGIA REALIZADA		3 CIRURGIA GERAL	03/11/2021		31,
3	CIRURGIA REALIZADA		7 CIRURGIA GERAL	03/11/2021		31,
4	CIRURGIA REALIZADA		3 CIRURGIA GERAL	03/11/2021		31,
5	CIRURGIA REALIZADA		7 CIRURGIA GERAL	03/11/2021		31,
6	CIRURGIA REALIZADA		6 GINECOLOGIA	04/11/2021		31,
7	CIRURGIA REALIZADA		6 GINECOLOGIA	04/11/2021		31,
8	CIRURGIA REALIZADA		6 GINECOLOGIA	04/11/2021		31,
9	CIRURGIA REALIZADA		3 CIRURGIA GERAL	05/11/2021	17/09/2021 21:00:00	31,
10	CIRURGIA REALIZADA		4 MASTOLOGIA	08/11/2021		31,
11	CIRURGIA REALIZADA		4 MASTOLOGIA	08/11/2021		31,
12	CIRURGIA REALIZADA		4 MASTOLOGIA	08/11/2021		31,
13	CIRURGIA REALIZADA		4 GINECOLOGIA	09/11/2021		31,
14	CIRURGIA REALIZADA		7 CIRURGIA GERAL	10/11/2021		31,
15	CIRURGIA REALIZADA		3 CIRURGIA ONCOLOGICA	10/11/2021		31,
16	CIRURGIA REALIZADA		7 CIRURGIA GERAL	10/11/2021		31,
17	CIRURGIA SUSPENSÃO		3 CIRURGIA GERAL	10/11/2021		31,
18	CIRURGIA REALIZADA		3 CIRURGIA GERAL	10/11/2021		31,
19	CIRURGIA REALIZADA		7 CIRURGIA GERAL	10/11/2021		31,
20	TROCA DE PACIENTE		7 CIRURGIA GERAL	10/11/2021		31,
21	CIRURGIA REALIZADA		7 GINECOLOGIA	11/11/2021		31,
22	CIRURGIA REALIZADA		7 GINECOLOGIA	11/11/2021		31,
23						

**Source:** Prepared by the authors

The data used for the construction of the line graph were exported from the surgical map module, through a specific Excel® icon of SirCir-HUGG ® in xls format (Figure 2). This spreadsheet has a weekly frequency of analysis, in which errors or inconsistencies of the data entered by the teams that operate SirCir-HUGG ® in the registration of system operation information are identified.

By using the Power Query Editor, a tool available in Power BI®, it is possible to manipulate, transform, consolidate, enrich, merge and perform various treatments with the data. This tool acts as an ETL (Extract, Transform, Load) process, allowing you to extract data from various sources. In this specific case, we work with an Excel spreadsheet and the data is extracted from this spreadsheet.<sup>2</sup>

The Power Query Editor interface is separate from Power BI® and its window is opened by clicking on the "Transform data" option. The M function language is used to perform the calculations, being this language derived from the term "data mashup", which refers to combining and obtaining data.<sup>2</sup>

After inserting the data into Power BI®, it is necessary to transform them. In this case, the "Transform data" option is used so that the data can be analyzed by the Power Query Editor. Once the data has been transformed, as shown in Figure 3, it can be manipulated in the Power Query editor area. This area allows you to make adjustments to the rows (such as removing blank rows) and filter out unwanted data that should not appear initially.

After processing the data extracted from the surgical map, which includes the number of suspended surgeries, it was necessary

to create a calendar table to perform the study. For this, the surgery date variable needed to be converted into integers.

We used DAX (Data Analysis Expressions) functions, which are expression languages used for calculations and queries in data models. These functions are very similar to Excel® functions, but have a different concept. The term DAX is an acronym for Data Analysis Expressions.

After this step, we use the DAX function "NMES = CALENDARIO[Date].[MonthNo]". where NMES refers to the number of each month under study, in order to obtain integers to perform the forecasts. We are then ready to build the line chart and perform the forecast.

We select the line chart and the axis on which we want to perform the forecast. In this case, we select the x-axis, which is the variable NMES (month number), and the variable "suspended status" (number of suspended surgeries).

Next, we choose the desired forecast options. In the "units" box, we selected "Points". In the "number of months" box, we chose a three-month period for the forecast. In the "ignore the last" box, we select 0, but there is also the option to ignore the last month, in case there is some exceptionality that has affected the value of that variable specifically in that month, which could impact the forecast as a whole (Figure 4).

We also have the option to adjust the seasonality of the points. In the case of this study, we kept the default option "auto", but if there were periods with seasonality, we could select one, two or more points that presented this pattern. (Figure 4).

**Figure 4** - Selecting the forecast. Rio de Janeiro, RJ, Brazil, 2023



**Source:** Prepared by the authors

When analyzing the results (Figure 5), we checked the forecasts with a 95% confidence interval for the coming months. The forecasts were as follows:

Forecast 1 for the month of November: Upper limit (UL) of 172, Lower limit (LL) of 97, Forecast of 134.

Forecast 2 for the month of December: Upper limit (UL) of 180, Lower limit (LL) of 102, Forecast of 141.

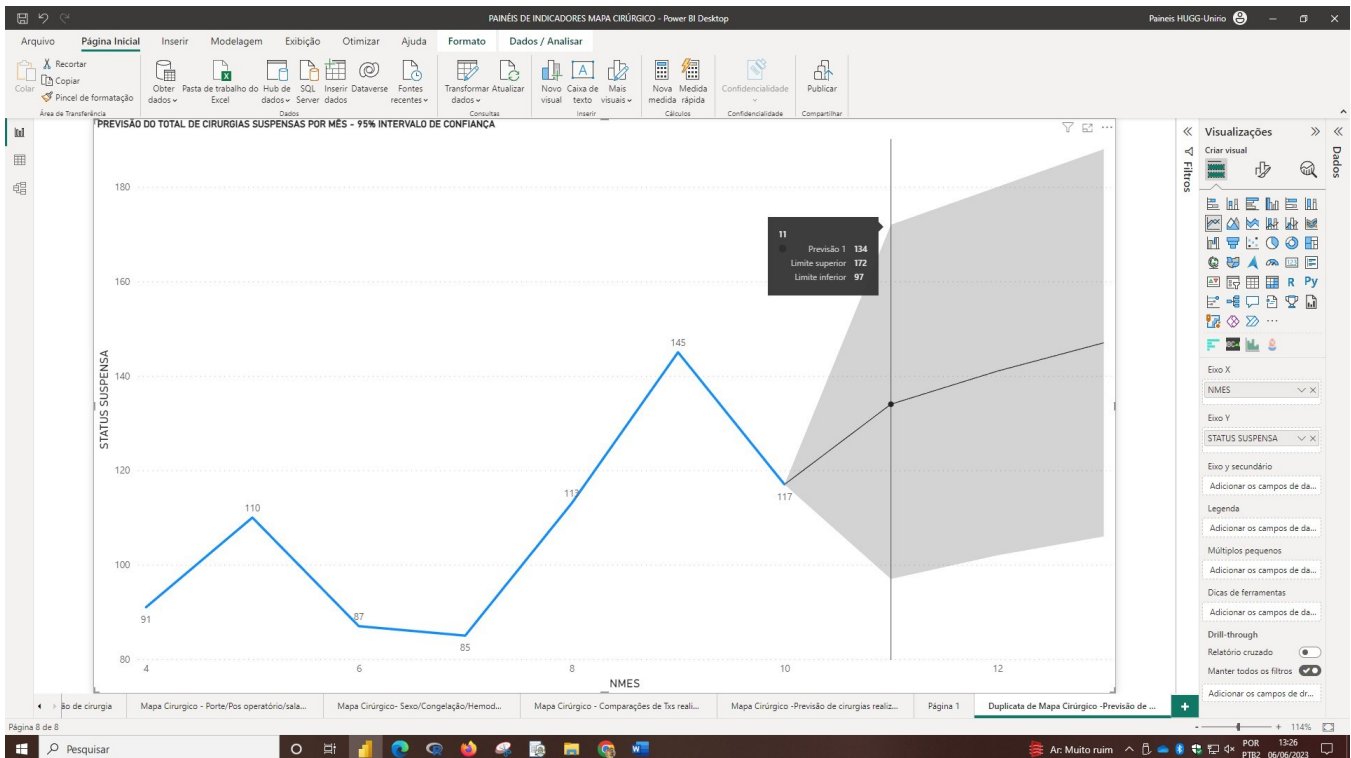
Forecast 3 for the month of January: Upper Limit (UL) of 188, Lower Limit (LL) of 106, Forecast of 147.

After we calculate the forecast of the number of suspended surgeries, we need to publish the results. In Power BI® Desktop, we select the "File" option and then "Publish" in Power BI®, or we can also select "Publish" in the "Home" ribbon.

In Power BI® Desktop, we follow these steps to publish the results:

1. We enter the Power BI® service, if it has not already been done.
2. We select the desired destination, being able to search in the list of available workspaces to locate the workspace in which we want to publish. The search box allows you to filter the workspaces. After selecting the desired workspace, click on the "Select" button to perform the publication.
3. Once the publication is complete, a link will be generated to the report on the Power BI® website

**Figure 5** - Forecast of the number of suspended surgeries. Rio de Janeiro, RJ, Brazil, 2023



**Source:** Prepared by the authors

## DISCUSION

This study demonstrated that there are different steps for the construction of time series in Power BI® using a line chart, and that some prerequisites are also necessary, but its construction is quick and easy to assimilate.

The ease of use of the software in which the research was carried out and a favorable aspect of the use of this software, a limitation was the use of a few months, this made a longer time series impossible due to the lack of old data referring to other years due to the implementation of the HUGG surgery management system where the data were extracted is still very recent.

## CONCLUSION

Power BI®, despite not being the best tool for performing time series analysis, as it does not have many features for this purpose, can be an interesting tool when you want to make a quick forecast about a certain period of study, in this case the forecast for three months of the number of suspended surgeries (STATUS SUSPENSÁ) was performed. The following results were found: forecast 1: November: 134;(97,172) forecast 2: December: 141;(102,180) forecast 3: January: 147;(106,188).

Finally, the use of forecasts can be a useful tool for decision making by managers, predicting problems is always necessary in the management of a hospital. This can suppress expenses and anticipate a wide range of problems.

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