

Surgical reoperations in the Hospital Militar Central

Johann F. González, Luis A. Franco y Diego A. Castro

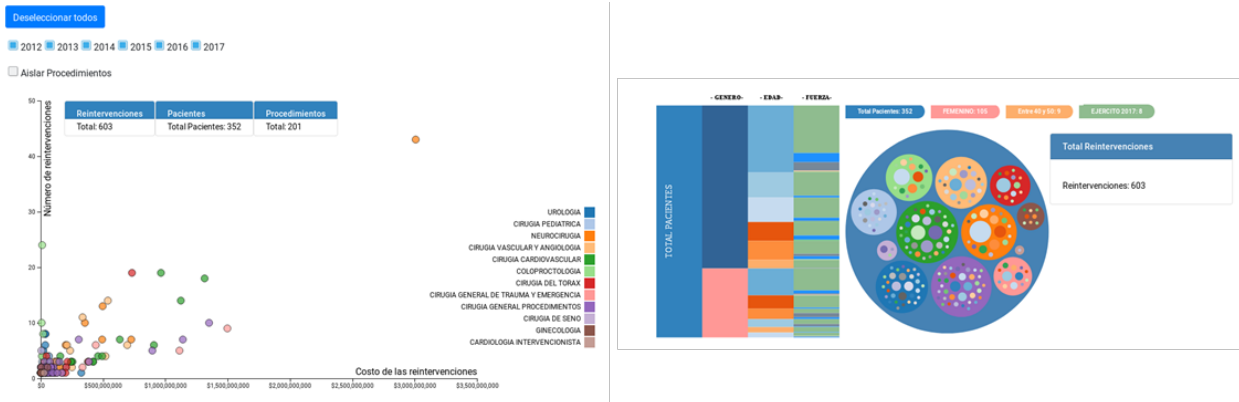


Figura 1. Initial view of the visualizations.

Abstract—This article present the process of building of the visualization for the surgical reoperations in the Hospital Militar Central. The goal is to help them in the analysis of the adverse event in a surgery, and allow them to take decisions from this in order to decrease the cases of reoperations.

Index Terms—Reoperation, Hospital, Visual Analytics, Health, Surgery

1. INTRODUCTION

The Hospital Militar Central from its mission has focus their effort in services of high and middle complexity that are provide to the Military forces and their family. All the services with different frequencies and in whichever specialty, are in capacity to make surgical procedures inside of the treatment that follow every one of the patients from the Urgency service or the same as the scheduled procedure. The complications of every surgery are defined as an unexpected process in the evolution of the operated patient, that alter the scheduled treatment giving way to a possible reoperation in any of the specialties that require him.

The hospital has been monitoring the reoperations from periodic surveys to the specialist that made the procedures, of which has obtained some conclusions like the 0,5 % - 15 % of the surgical interventions a reoperation occurs and the 90 % corresponds to a emergency surgery with a risk of reoperation of 6 times in comparison with an elective surgery (scheduled). Likewise, the hospital has an information system where is registered every event (surgery procedure) with a series of field that permit to make a more effective evaluation in terms of cost, day of stay, patient characterization and even morbidity associated to the reoperation.

With this way is planned for this project based on the knowledge and the expertise of the expert in epidemiology and scientific investigation of the Hospital Militar, as well as the data registered in the system information and the knowledge acquired on the course Visual Analytics, it could be possible make a visual representation of the data, so we can observe the behavior of the surgery reoperation through long periods of time defined by the user with respect to different variables like surgery service (general surgery, cardiology, urology, etc) cost, died and days of stay, and finally generate insights that can be use to take decisions and create policies that benefit the hospital as well the patient and the

doctors.

2. STATE OF ART

The proposed tasks are gradually carried out in the hospital based on periodic surveys of the specialists who perform the surgical procedures. These data are presented in spreadsheets and do not yet have an important value in the decision making and generation of hospital policies.

Some visualizations have been developed in the medical field, they are related to the visualization of different scenarios and times of the surgeries, presenting some important challenges such as the presentation of a general panorama that explains from the beginning the quantity of variables to the problem. In [4] is discussed the problem of a visualization that presents the waiting time for surgeries, exploring all the possible facets of these delays like the selected doctor, the service or the surgery site. The associated data are temporary data similar to those in the project of the Hospital Militar Central. The display chosen in [4] contains idioms such as an array of scatterplots, maps and barchart, associated with the same data filtered by the user. In this visualization there is a geographic data component that does not apply to the context of this project. However, it shows an alternative in the presentation of temporary information that is useful for the purpose of this project.

One of the problems associated with the tasks is the clear representation of the costs of the reinterventions based on the cost's data by procedures and invoices. In [1] is presented a cost model proposed for the evaluation of the effectiveness of the interventions and their corresponding surgical reinterventions, and also presents a series of simple visualizations that represent this model, which is a good starting point to identify how it has been represented from the clinical point of view and sustainable health models.

In order to characterize reinterventions in the hospital, the problem of having too much information for that purpose is evident. Each re-intervention has information in different categories that is difficult to represent. The language of parallel bars, which allows us to give a summary of the information contained in the database, is shown as a solution to this problem in [5]. This type of view allows us to capture

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data in the same visualization with multiple categories and interact with it.

Another aspect that requires more attention is the handling of events over time. The representation of temporary data is a matter of importance in the medical field. In [2] a visualization for that purpose is presented. Although the tasks to be performed are far from the purpose of this project, its analysis in the handling of temporary events of a medical nature presents the main drawback of this type of data: its variability. The problem arises in the great variety of events which hinders the aggregation of information to generate summaries of data.

3. CHARACTERIZATION

Based on the framework constructed by Tamara Muzner [3], below we present the study of What and Why to make a visualization that responds to the client's requirements.

3.1. What

To use on the visualizations we select some of the attributes available on the data set. Below we explain each of this and classified according to the Tamara's framework [3]:

- ID: Patient identifier, anonymized from the identification card. Categorical.
- EDAD.TOTAL: Age of the patient. Ordered, sequential.
- GENERO: Gender of the patient. Categorical.
- FECHA: Date of the surgery. Ordered, sequential
- NOMPROC: Name of the surgery procedure. Categorical.
- VALORFACTURA: Total cost of the surgery. Ordered, quantitative
- REINT: Number of Reoperations derived from the dataset. Ordered, quantitative.
- FUERZA: Company to which belong the patient. Categorical.
- ESPECIALIDAD: Specialty of the surgery procedure. Categorical.

3.2. Why

After argue with the client, we get the next tasks:

1. **Derive** from time between events what type of procedures effectively correspond to surgical reoperations.
2. **Identify** the procedures that more re-interventions generate and their associated costs.
3. **Compare**, according to the demographic data of the patients, the number of reinterventions for each of the defined characteristics (age, gender and fuerza).
4. **Lookup** the quantity of reoperation by medical specialty and procedure.

4. METHOD

Before being able to use the data, it was necessary to process them because they have many procedures that are not relevant for the analysis and also do not show reinterventions. The first step was to clean the table to eliminate the irrelevant events, in this way we will have the main procedures in a surgery. The next step was to identify which event is a reoperation and what is its mother procedure. The result was saved as a Json file. An example of the structure is showed in figure 2.

```
{
  "id": "ctsxY",
  "edad": "Mas de 60",
  "edad_total": "87",
  "genero": "MASCULINO",
  "fuerza": "FAC FUERZA AEREA COLOMBIANA",
  "reint": 1,
  "cirugias": [
    {
      "fecha": "08/04/2017 11:00:00 AM",
      "tipoAtencion": "Cirugia Ambulatoria",
      "valorfactura": 2607900,
      "procedimientos": [
        { "especialidad": "UROLOGIA", "nomProc": "RESECCION FULGURACION TUMOR VESICAL" },
        { "especialidad": "UROLOGIA", "nomProc": "RESECCION FULGURACION TUMOR VESICAL" }
      ],
      "hijas": [
        {
          "fecha": "08/04/2017 10:26:29 PM",
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            { "especialidad": "UROLOGIA", "nomProc": "RESECCION FULGURACION TUMOR VESICAL" }
          ]
        }
      ]
    }
  ]
}
```

Figura 2. Structure of Json file of the reoperations.

Continue using the Tamara's framework we propose the next three idioms to solve the tasks:

1. **Scatterplot**: To resolve the second task. With this idiom it is possible to show at the same time the reoperations and cost that every procedure generate, using points a mark and positions as channels. Also it can show the specialty of the procedure thanks to the channel of color.
 - **Manipulate**: The user can select the procedure to get the specific information about it.
 - **Reduce**: The user can filter by years to get the information in different years.
2. **Icicle Treemap**: This resolve the third task. Transforming the data to a tree structure, we can present the demography of the patients and with the interactivity it could change the order of the elements and get new information.
 - **Manipulate**: The user can change the order of the nodes and select every one to get the specific information.
 - **Reduce**: At the same as the Scatterplot the user can filter by year.
3. **Bubblechart**: With this is possible to give answer to the last task. This idiom permit to find easily the specialties whit more reoperations and the procedures that generate them.
 - **Manipulate**: The user can select to get more detail about the reoperations produced by the surgery.

5. RESULTS AND EVALUATION

The implementation of the idioms proposed was made using HTML, Java Script and D3. The results are showed below.

5.1. Results

The figure 1 shows the visualization obtained from the data of the reoperations in the Hospital Militar Central. Those are the first view that the user can see when start the page.

For the scatter plot was decided to use the forces of D3 to avoid the overlapping (Figure 3), it can be enable or disable using the check box "Aislar procedimientos". The user can pass over one specialty and the procedures that do not belong to this will be attenuated to highlight the procedures belonging to that specialty (Figure 4). Also if the user pass over a surgical procedure it will show the specific information about the cost and number of reoperations that it produced (Figure 5).

The Icicle treemap and the bubblechart were put in the same section. For the Icicle the user can pass over every node and it will display the number of reoperations of the node and its parents (Figure 6). Also it is possible to reorder the parameters to get different information.

On the other hand, in the bubblechart the user can obtain the number of reinterventions of each of the specialties or of a procedure belonging to a specialty by passing the courses on each of the bubbles (Figure 7).

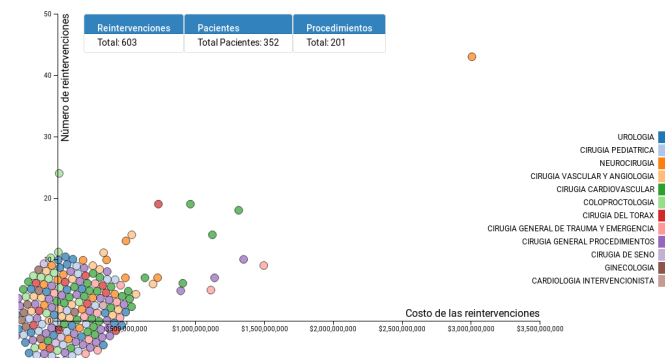


Figure 3. Enable the forces ("Aislar procedimientos").

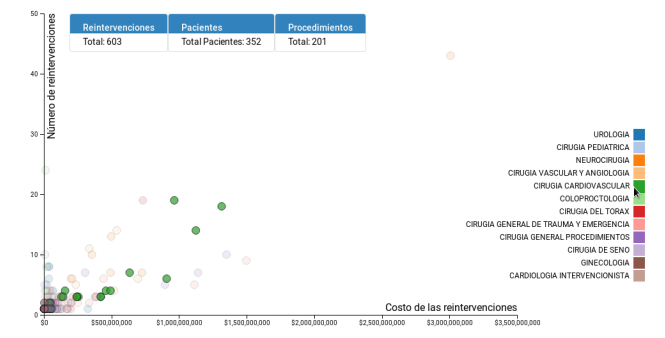


Figure 4. Filter by specialty.

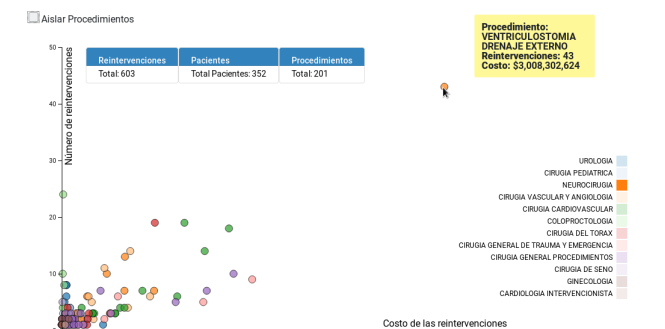


Figure 5. Select a procedure.

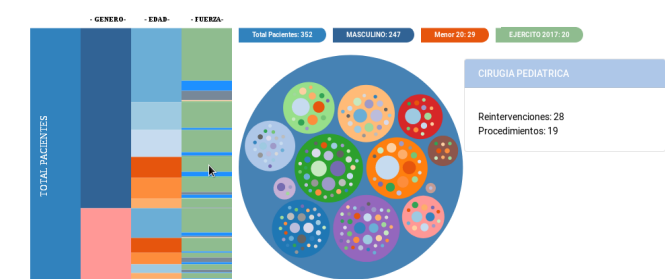


Figure 6. Navigation in the treemap.

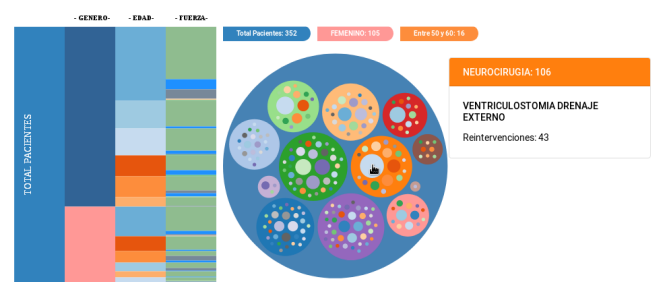


Figure 7. Navigation in the bubblechart.

Finally, it is possible to filter the data for years using the checkbox (figure 8). Those options apply the filter for all visualizations.

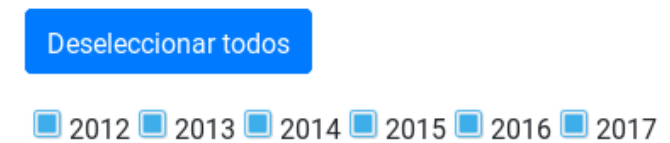


Figure 8. Filter by years.

5.2. Evaluation

Evaluation method used was revision by domain experts who expected to get insights from proposed solution. On this purpose, there were some measured variables to evaluate accuracy and effectiveness of solution. These variables were measured with some questions which are driven on a questionnaire prepared according of questions made on the first meeting with expert. Results of this questionnaire were a good precision on answers and there was time for feedback from experts in order to expose how this solution improves the actual method of evaluate reoperations on the hospital.

6. CONCLUSIONS

After we finished the process of construct a visualization starting from a needed of the Hospital Militar Central and the data set they have, applying the knowledge acquired, we reach to the following conclusions:

- The Hospital Militar Central are going to have a new possibility to analyze the reoperations in a visual way instead on search every clinic history or ask to the services in the hospital.
- From the data set provider by the hospital it was possible to find important insights that will help the organization to take decision to minimize the frequency of reoperation and this way reduce the costs that its generate.

Likewise the following insight were found:

- Faster and more reliable analysis of cost and frequency of procedures.
 - The most expensive and frequent procedure in reoperations is External drainage ventriculostomy.
 - The second most expensive and frequent are Abscess drainage pancreas and Anal fistulectomy respectively.
- Faster and more reliable analysis of the patients characteristics.
 - Confirmation of the direct correlation between the probability of reoperation occurrence and the patient's age
 - Discover that in females, the second group in number of reoperations is "less of 20"

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