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Proposed Method for Identifying Emergency Unit Profiles from the Monthly Service Number

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Abstract. The indicators are used to quantify how the results of the public emergency departments (ED) can be classified, with regard to the efficiency and quality of the services provided to its users. In this sense, the objective of this work is to identify typical patterns of the curves of the indicator number of monthly attendance of the procedure "Reception with Risk Classification" in a sample of 50 EDs. For this, a quantitative and exploratory research was carried out that adopted the Machine Learning technique known as Cluster Analysis not supervised by the AGNES "AGlomerative NESTing" method. 10 profiles (groups) of curves for the Reception with Risk Classification were identified in the selected EDs. Group 1 characterizes the standard profile of these EDs (76% of the total) and the other groups characterize the atypical patterns. The results were obtained using the free software R.

Keywords: Emergency Departments, Indicator, Cluster Analysis.

1 Introduction

In Brazil, the National Humanization Policy (NHP) is a cross-cutting public policy that deals with the health work process as a whole, encompassing assistance and management, guaranteeing the protagonism of subjects and collectives, including the provision of services, care technologies and the construction of safe, harmonious environments that offer comfort and well-being to users. The overcrowding of emergency services represents a serious problem in the health system and the spontaneous demand of patients with simple diseases amplifies the number of attendance provided at these units. In view of these conditions, there is an urgent need to plan work routines and implement projects and proposals aimed at guaranteeing an efficient, dignified service, alleviating the pressure of this excessive demand. Thus, humanization is the only way to impact the effects that plague the service routine in the urgency and emergency network.

The fact of dealing with the National Humanization Policy, through a service that supports the quality of the services provided in the public emergency departments (ED), allows ordering the routine of medical care, improving the quality of the services pro-

vided to the population, mitigating the possibilities of users' dissatisfaction and dissatisfaction. In addition, it is possible to prioritize the care of patients in conditions of greater severity, increasing the productivity and efficiency of the Unit's specialized teams, as well as reorganizing the flows and guaranteeing the care provided in a humanized way.

From this perspective, a Lean Thinking research is being developed in the emergency departments, in partnership between the Ministry of Health of Brazil and the Federal Fluminense University since the year 2020. This study aims to promote a new service culture that supports the improvement in the quality and efficiency of the services provided to users of the Unified Health System (SUS) attended at the public emergency departments (ED). The research project prioritizes the following points in the emergency and urgency network: care for patients in conditions of greater severity, reduction of the average length of stay of the patient in the ED, as well as the reorganization of the continuous flow of patients and the guarantee of the care provided in a humanized way.

Within the perspective of difficulty and subjectivity in assessing the quality of health systems, there is a concept in the literature that it is necessary to define appropriate metric criteria for evaluation, with reproducible and comparable indicators. Such criteria bring to the objective plan data that could be lost in the subjectivity of personal assessments, regarding the feeling of quality of the service received [6]. For this purpose, the indicators are used as a tool to quantify how the results of the emergency departments can be classified, with regard to the efficiency and quality of the services provided to its users.

In this sense, the objective of this work is to identify typical patterns of the curves of the indicator number of monthly attendance of the procedure "Reception with Risk Classification" in the EDs. For this, the Machine Learning technique known as Cluster Analysis was used unsupervised with the hierarchical group strategy (implemented by the method AGNES "AGlomerative NESTing") [5].

2 Proposed Method

This section presents the classification of the research and the steps of the quantitative method for obtaining the results.

As for the approach and nature, this research is classified as applied quantitative research, as it aims to generate knowledge for practical application, aimed at solving specific problems, emphasizing objectivity in the collection and analysis of numerical data, as well as the use of statistics in this analysis [1].

As for the objectives, this is an exploratory research, as it aims to provide greater familiarity with the problem with a view to making it explicit, involving data analysis that stimulate understanding [1].

The steps of the proposed method are: Description of the problem; Characterization of the data; Application of Clusters Analysis and Analysis of Results.

3 Application of the Proposed Method

The steps of the proposed method are presented in this section. It is noteworthy that the free software R was used to obtain the results.

3.1 Description of the Problem

The choice of indicators is subject to the definition of the objective of the work to be carried out. Basically, the goal is the expected resolution of a problem that the manager faces in his daily routine. The indicators must lead the manager to act to achieve the expected result.

One of the problems faced by the manager in the urgency and emergency sectors, as in the case of EDs, is the issue of overcrowding of patients. Overcrowding is recognized as a concern, as it affects patients and healthcare professionals. The tension caused by the crowding of patients creates a deficit in the quality of emergency departments. Crowding has been associated with reduced access to emergency medical services, delays in attending to cardiac patients, increased patient mortality, prolonged patient transport time, inadequate pain management, violence from angry patients against staff, increased costs of patient care and decreased satisfaction with the doctor's work [2].

According to Wang et al. [7], Overcrowding degrades the quality of emergency departments due to the increase in ambulance movements, an increase in the rate of patients who leave the emergency room unattended, an extension of the patient's length of stay, a decrease in patient satisfaction.

As a result, one of the overcrowding indicators was analyzed, which is the monthly number of visits referring to the "Reception with Risk Classification" procedure in the EDs.

3.2 Data Characterization

This work is done in a sample of 50 emergency departments (ED) selected as defined in the Lean research project at the EDs.

The EDs are classified according to their size, according to Ordinance No. 10 OF JANUARY 3, 2017, Chapter V of the investment resource, Art. 13 [4]. The EDs enabled in investment until December 31, 2014, maintain the classification in sizes I, II, and III, for the specific purpose of concluding the financing of the approved investment, without prejudice to the granting of the cost, as provided for in Arts. 23 and 24 of this Ordinance, and in the following terms:

Table 1. Definition of sizes applicable to EDs

Size of EDs	Recommended Population for the area covered by the EDs	Minimum number of observation beds	Minimum number of beds Emergency room
I	50.000 - 100.000 habitants	7	2
II	100.001 - 200.000 habitants	11	3
III	200.001 - 300.000 habitants	15	4

From the sample of 50 EDs, there are 3 EDs of Size I (6%), 19 EDs of Size II (38%) and 28 (56%) EDs of Size III. In addition, their types of procedures are:

- Reception with Risk classification: Represents one of the interventions with decisive potential to reorganize the care of emergency services and implement networked health production.
- Urgent care with observation up to 24 hours in specialized care: It includes the initial examination and monitoring of patients in urgent situations. In this case, the service goes beyond the consultation, as the patient remains under observation for a maximum of 24 hours.
- Medical care in an emergency departments: It consists of the attendance in an emergency departments destined to assist patients affected by urgency and emergency situations, performing the initial care, stabilizing the patient and defining the responsible referral when necessary.
- Orthopedic care with temporary immobilization: Comprises medical consultation with temporary immobilization, not including radiological examination.

The data referring to the number of visits for each type of procedure were monthly from January 2019 to April 2020, by selected ED.

It is noteworthy that the data analyzes were performed for the number of monthly attendance of the “Reception with Risk Classification”, as this presents a more expressive quantity than the other procedures.

3.3 Application of Cluster Analysis

In order to identify curve patterns in the number of monthly attendance of the Reception procedure with Risk Classification in the EDs, the Machine Learning technique was used. The technique used was Cluster Analysis not supervised with the hierarchical clustering strategy (implemented by the AGNES “AGlomerative NESTing” method). The results of this grouping are reported through a graphical representation known as a Dendrogram [3].

Fig. 1 illustrates the dendrogram of the cluster analysis, where 10 groups (according to the cut in the dendrogram) of the number of monthly attendance curves for “Reception with Risk Classification” were adopted. It is noteworthy that the red rectangles in the dendrogram identify the EDs in the respective groups.

Agglomerative Hierarchical Grouping

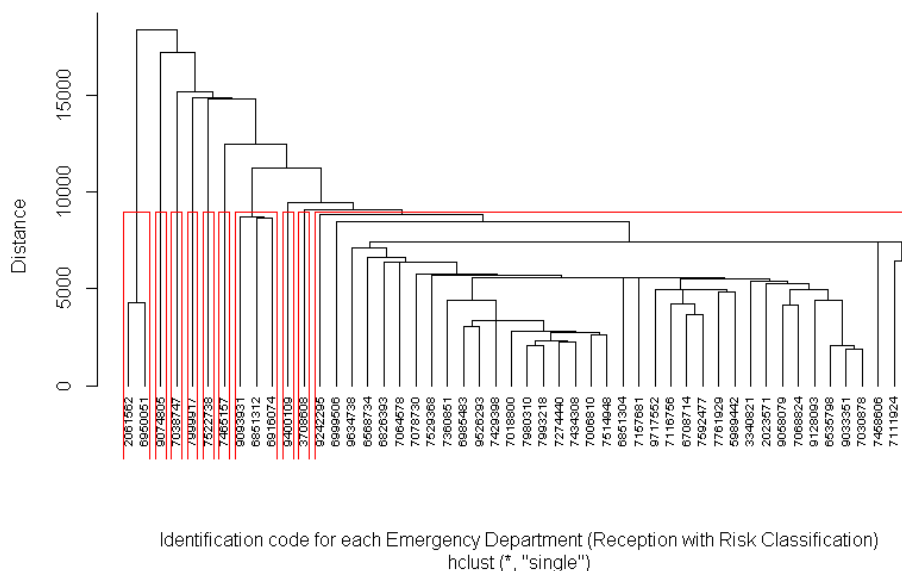


Fig. 1. Dendrogram with 10 groups

Table 2 shows the EDs and their respective size in each group. It is noteworthy that group 1 was not reported in this table because it has 38 EDs. In a next stage of the work, a Group Analysis will be carried out only for the EDs in group 1, in order to find more homogeneous groups.

Table 2. Identification (ID) Code of the Emergency Departments (ED) by group, Federative Unit, City and Size

Groups	Federative Unit	City	ED ID Code	Size
2	Distrito Federal	C1	7465157	III
3	Maranhão	C2	6851312	III
3	São Paulo	C3	9093931	II
3	São Paulo	C4	6916074	III
4	São Paulo	C5	7522738	II
5	São Paulo	C6	9400109	II
6	São Paulo	C7	2061562	II
6	São Paulo	C8	6950051	II
7	São Paulo	C9	7038747	III
8	São Paulo	C10	7999917	II
9	São Paulo	C11	3708608	I
10	São Paulo	C12	9074805	III

3.4 Analysis of Results

This section was elaborated from the results obtained from the Cluster Analysis.

The groups and their respective monthly service number curves are shown in Fig. 2. Group 1 characterizes the pattern of the studied curves (76% of the curves) and the other groups characterize atypical behaviors of the monthly service number curves for the procedure “Reception with Risk Classification”. It is noteworthy that to facilitate visual comparison, all graphics were placed on the same scale.

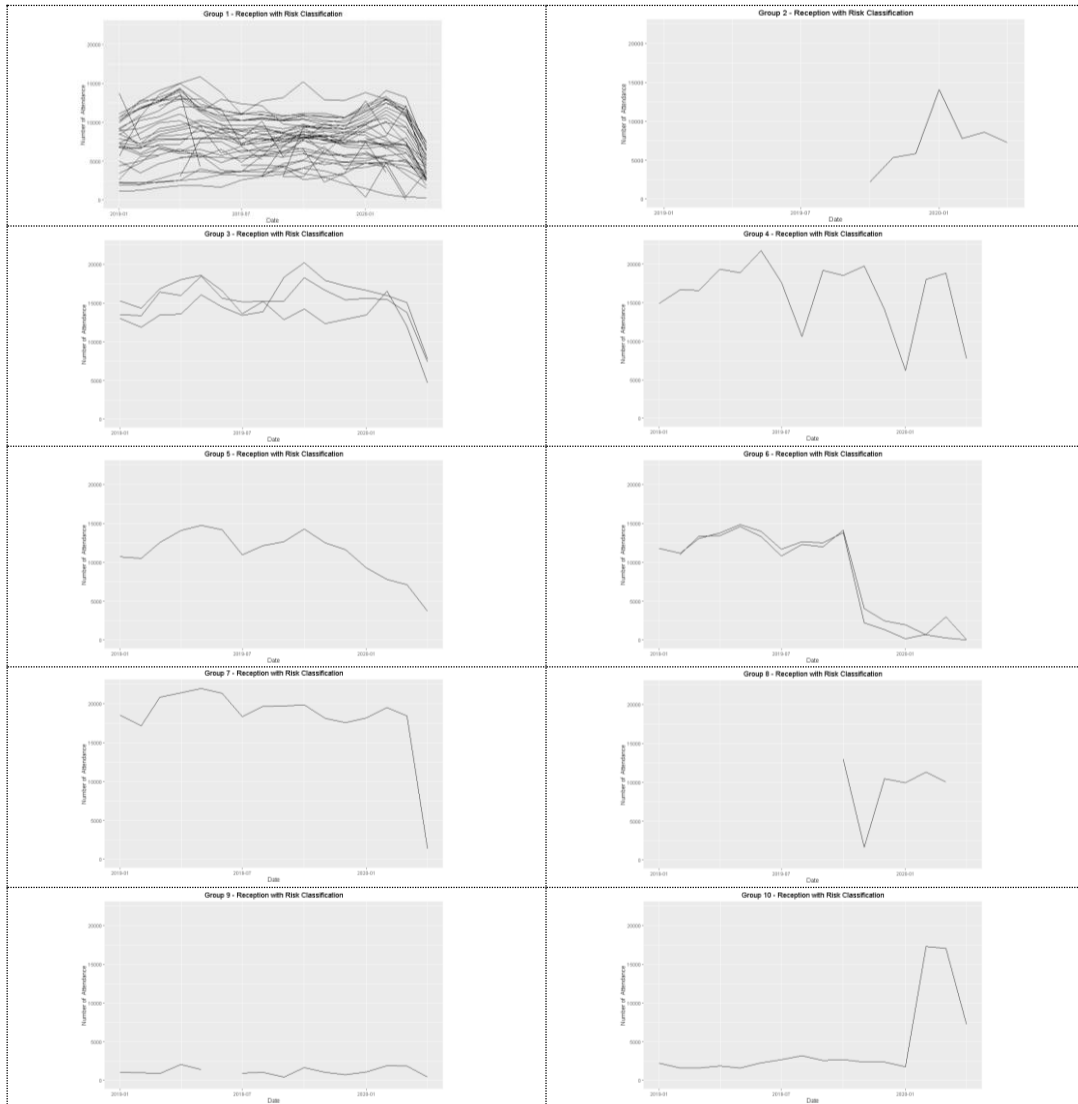


Fig. 2. Profiles of curves of the number of monthly attendance for the procedure “Reception with Risk Classification”

According to Fig. 2, it is noted that groups 2, 8 and 9 have a problem of lack of registration, as there are empty gaps in their respective graphs. However, group 9 presents an expected behavior of ED of size I (number of monthly care lower than the others).

Within the context of the analysis of indicators, the groups of 3, 4, 5, 6, 7 and 10 deserve to be highlighted, as they are considered atypical to the behavior of the other EDs when compared to group 1. For better management, to understand this behavior and making a decision is fundamental to the quality of the services provided. In this case, it is expected that the EDs of size III will have a greater amount of monthly assistance, as they were dimensioned for a greater number of services.

It is observed that all groups showed a drop in the number of attendance in April 2020 (last month reported), due to the Covid-19 effect.

Table 3 reports some descriptive measures by group for the number of attendances in the Reception procedure with Risk Classification.

Table 3. Descriptive Measures of the Number of Reception Assistance with Risk Classification

Group	Number of EDs	Average	Minimum	Maximum	Sum	Standard deviation
1	38	7674,0	0	15892	4159293	3229,13
2	1	6748,1	2181	14088	53985	3733,57
3	3	14751,1	4700	20233	708054	2875,21
4	1	16183,2	6209	21780	258931	4447,09
5	1	11185,9	3697	14765	178974	3000,97
6	2	8431,0	24	14829	261361	5795,26
7	1	18246,5	1379	21981	291944	4723,18
8	1	8055,4	2	12967	56388	5058,49
9	1	1167,6	413	2066	17514	510,75
10	1	4401,1	1600	17303	70418	5162,73

Table 3 shows an inconsistency in the monthly number of consultations for the Reception of Risk Classification, since it obtains minimums below 1000 consultations in a month, mainly in groups 1, 6, 8 and 9.

According to the sum of the entire period studied, group 3 is characterized by having a large number of services (total of 708054 services in the study period), which is an expected characteristic of EDs of size III. Group 9 presents the lowest sum of services (total of 17514 services in the period studied), which is an expected characteristic of EDs of size I.

In addition, the high variability of groups 6, 7 and 8 (standard deviation: 5795.26, 4723.18 and 5058.49, respectively) stands out, as they showed a sharp drop in the number of attendance at some point during the study period. Group 4 also enters the list with a heterogeneous service number, as it presented a curve behavior with three sudden drops in the number of mensal services.

Finally, from the point of view of the average number of services, groups 3, 4 and 7 have the highest averages. Highlight for groups 3 and 4 with EDs of size II that do not have the same physical and work team dimension as EDs of size III.

It is noteworthy that this work was developed from the state of the art that dealt with cluster analysis and indicators in emergency departments. However, among the researched articles, no article identified the typical pattern of the curves of the number of monthly attendance of the procedure "Reception with Risk Classification" in emergency departments.

4 Conclusion

In this work, the number of monthly assistance referring to the "Reception with Risk Classification" procedure of 50 emergency departments (ED) sampled was analyzed. The number of services is one of the overcrowding indicators that makes it possible to assess the quality of service in the urgency and emergency sectors.

For this, the Cluster Analysis technique was used, which made it possible to identify 10 standard curves of this indicator. From the results obtained, it stands out:

- Lack of registration of some information and inconsistency of some values. This situation may have been caused by the lack of a computerized system or by the absence of a protocol for data entry in the EDs;
- Presence of EDs of different sizes in the same group. This characteristic may indicate a problem with the flow of patients, since the size of the ED was dimensioned according to the recommended population for the respective coverage area;
- Suggestion to implement a system to monitor the length of stay (LoS) time in EDs.

Finally, it is recommended as future work: the construction of a computational platform for standardization in data recording; the use of other cluster analysis techniques to improve the accuracy of the method; and finally, a specific cluster analysis in group 1 EDs to create more homogeneous subgroups.

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