Manchester triage

Beltrán Vázquez Liniers[1]

Faculdade de Ciências da Universidade de Lisboa, Portugal

Abstract. The paper looks analyse the current situation of the public SNS hospitals of Portugal. There are two research lines, both about emergency healthcare: Utilisation (number of attendances) and emergency level classification criteria. There exists a protocol in which patients are classified in function of the severity of their injuries. Manchester triage. The goal of the investigation is to elucidate if the protocol is optimal or if there is room for improvement.

Keywords: Analysis of priority criteria by region (A/B Testing) · Analysis of utilisation by region and institution (Cluster Classification).

1 Introduction

1.1 Manchester triage definition

Manchester protocol classifies patients through a colour scale depending on gravity and importance of the injuries.

- Red: Urgent emergency. The patient presents high death risk, must be immediately helped.
- Orange: Very urgent. The Patient must be assisted in 10 min max. There is also death risk but more stable.
- Yellow: Urgent. Moderate severity. Maximum waiting time is 50 minutes.
- Green: Bit urgent. Less serious cases. The patient can wait up to 2h.
- Blue: Not urgent. Lowest classification. Most simplest problems. The patient can wait up to 4h.

1.2 Data structure

Data has been gathered from the SNS portal https://transparencia.sns.gov.pt/. The file contains information from 2016 until August 2021. Data counts the number of emergency attendances by month in each institution, differentiated by Manchester triage colour. Also are available region and localisation columns.

There are 33 hospital institutions in Portugal supported by SNS. Divided in five healthcare regions: Norte (13), Centro (8), Lisboa e Vale do Tejo (LVT) (7), Alentejo (4) and Algarve (1).

In average, Yellow emergency level is the most frequent, 48%. Then Green with 38.5%. Red and Blue are the less frequent, 0.39% and 2.1% respectively. At last, Orange counts the 10.9% of the arrivals.

2 Priority criteria by region

It is supposed that the probability of suffer an accident or get sick, and its severity, is equal in every region of the country. The distribution of colours should be equal in each region. If not, that would mean that there are different criteria when classifying the level of emergency of a patient, depending on the region.

With the intention of knowing if the normalization of criteria is needed, it was developed a series of proportion hypothesis tests [1] in which it will be analysed if the proportion of the patients along the colours is equal in every region. For example, if the proportion of Red emergencies in Norte and Centro are equal. These proportions were calculated considering the daily average attendances by colour over the total daily average attendances. Hypothesis test definition:

$$H0 : Pi = Pj \tag{1}$$

$$H1 : Pi <> Pj \tag{2}$$

The significance level is fixed in 0.05

Table 1. Observed proportions (%)

Region	Red	Orange	Yellow	Green	Blue
Norte	0.39	10.6	50.3	36.9	1.7
Centro	0.41	11.2	51.7	34.7	1.8
LVT	0.38	10.5	40.8	45.1	3.1
Alentejo	0.41	11.2	44.4	41.7	2.3
Algarve	0.28	13	40.3	43.4	3

Following the example before, about Norte and Centro, it was analysed if 0.39 is statistically different from 0.41. The table below shows a p value equal to 0.9, so there are not differences in the proportion of Red between these two regions. It can be assumed the same criteria.

Table 2. p-value

Colour	Norte-Centro	Norte-LVT	Norte-Alntj	Norte-Algrv	Centro-LVT
Red	0.9	0.95	0.93	0.64	0.86
Orange	0.46	0.94	0.61	0.06	0.47
Yellow	0.28	0.00	0.00	0.00	0.00
Green	0.09	0.00	0.01	0.00	0.00
Blue	0.75	0.00	0.35	0.02	0.01

Table 3. p-value continuation

Colour	Centro-Alntj	Centro-Algrv	LVT-Alntj	LVT-Algrv	Alntj-Algrv
Red	0.99	0.61	0.91	0.68	0.67
Orange	0.97	0.19	0.59	0.06	0.31
Yellow	0.00	0.00	0.09	0.79	0.11
Green	0.00	0.00	0.11	0.41	0.51
Blue	0.5	0.06	0.24	0.91	0.37

Hypothesis tests show really interesting outcomes. Two conclusions are gathered:

- There exist differences in the criteria between the regions. In fact, they could be joint into two big areas: Norte and Centro on one side, and LVT, Alentejo and Algarve on the other side. The only discrepancies appear when facing these two big areas.
- The good news are that these differences are not shown in the highest emergency levels (Red and Orange). The p values show only different criteria in Yellow, Green and some of the Blues.

3 Utilisation

3.1 By region

INE data was gathered in order to understand if there are some region which its use of the emergency system is higher than the others. So, it was calculated the ratio between the daily average number of attendances between Jan-Aug 2021 and resident population 2011:

As expected, the most part of the attendances are Yellow and Green. In the Norte region there were 55 Yellow attendances per hundred thousand inhabitants. The most several colour level (Red) is also the less frequent. For example, in Centro and Alentejo regions there were only 0.41 attendances.

It is remarkable that Algarve residents use more the emergency system than the residents of any other region. Higher values appear in every colour level. Comparing with LVT, which is the less emergency region, utilisation in Algarve is two times bigger (82.4 vs 166.8).

Table 4. Number of daily emergency attendances (per hundred thousand inhabitants).

Region	Red	Orange	Yellow	Green	Blue	Total
Norte	0.42	11.6	55	40.3	1.9	109.3
Centro	0.41	11.16	51.44	34.57	1.85	99.4
LVT	0.31	8.7	33.69	37.18	2.56	82.4
Alentejo	0.41	11.41	44.98	42.23	2.3	101.3
Algarve	0.46	21.69	67.28	72.37	5.05	166.8

3.2 By institution

As it is exposed above, Portugal count 33 public hospitals divided along the five regions. Looking for understand if these institutions, in terms of emergency healthcare, are enough or if it would be desirable to increase their capacities, it is used the number of daily attendances per hundred thousand inhabitants as utilisation level.

Table 5. Utilisation top 5

Institution	attendances(x100.000)
Algarve	166
Baixo Alentejo	28.5
Litoral Alentejo	26.9
Coimbra	24.8
Norte Alentejo	24.4

Table 6. Utilisation bottom 5

Institution	attendances(x100.000)
S.M. Maior (Norte)	3.8
P.Varzim/V.Conde	4.2
Matosinhos	5.4
Nordeste	5.5
Castelo Branco	5.9

Table 5 shows the top 5 institutions. Algarve is by far the most used hospital. Then, 3 of 4 Alentejo institutions are among the top 5. There is not any institution from Norte or LVT.

Next, **Table 6**, shows the 5 institutions with lowest level of utilisation. 4 of them from the Norte, the fifth from Centro.

In order to calibrate the utilisation level it is built an hierarchical cluster analysis, using Ward distance. 4 levels are created. Then regarding the boundaries of the clusters is defined the scale of: low, medium, high and very high utilisation.

Institutions with less than 9.4 attendances are considered as low. All institutions from 21.5 to 28.5 are grouped as high. Algarve hospital forms a cluster with only one element, due to the big difference with the rest of institutions.

Table 7. Utilisation boundaries

Utilisation level	Min value	Max value	Count
Low	3.8	9.4	14
Medium	9.8	17.9	13
High	21.5	28.5	5
Very High	166	166	1

In order to validate the cluster classification it was used the Silhouette Coefficient, which measures the proximity of each point to its centre and the distance from the closest cluster. The coefficient is equal to 0.53, so it is considered acceptable [2].

Table 8. Number of hospitals by region and utilisation level

Region	Low	Med	High	Very high	Total
Norte	8	5	0	0	13
Centro	4	3	1	0	8
LVT	2	5	0	0	7
Alentejo	0	0	4	0	4
Algarve	0	0	0	1	1
Total	14	13	5	1	33

In **Table 8**, it is analysed the distribution of utilisation along the regions. In Norte and LVT every hospital attends less than 18 patients per hundred thousand inhabitants. The only institution in Centro with high level is Coimbra. The four hospitals from Alentejo are classified as high.

In order to facilitate the analysis, the reader can deploy an interactive map and study several variables by institution such as, utilisation level and daily attendance per 100000 inhabitants. This map is powered by the python library kepler and it is available in the next link:
https://kepler.gl/demo/map?mapUrl=https://dl.dropboxusercontent.com/s/ou235mezzp3b9xs/keplergl_u75be4.json

4 Conclusions

There were analysed data from the public hospital institutions of Portugal. Focused on the attendance of emergency healthcare. Several conclusions were obtained.

Firstly, it was analysed the classification criteria by region. It is important to have the same standards when assigning an emergency level along the country. As it was shown, there are significant differences between regions and its classification proportions. In Portugal can be considered two areas with two different criteria, Norte and Centro on one side, and LVT to the south on the other.

Next, it was analysed the daily attendances per hundred thousand inhabitants. The most noticeable is that the utilisation in Algarve is higher than any other region.

Analysing the utilisation by institution, it was create a scale of 4 levels in which the hospitals are classified. The output shows that Norte, Centro and LVT have low and medium utilisation levels. Besides, Alentejo places its four hospitals in high utilisation level. Algarve institution has its own group with out any other hospital, conforming the highest level.

However, available data is not enough to give real solutions to the exposed situations: classification criteria inequality and high utilisation of several institutions. It would be desirable to have richer information such as, if trauma, infection or if haemorrhage. This data can be helpful to propose ideas in order to reunify the emergency criteria. Until now, it is possible only to assume differences in criteria, but not which regions are doing better. Also it would be possible to obtain conclusions about the high Algarve utilisation of the emergency system. Additionally, it would be interesting to have the information about the real capacity of the hospitals in order to calculate an accurate saturation level indicator.

An interactive map is available for the reader. It allows to have a global vision of the utilisation by institution of the emergency healthcare in the entire country.

References

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