Title Page

Title: Users' perceptions of signage systems at three Portuguese hospitals

Author 1: Rita Rodrigues | PhD in Engineering Design and Advanced Manufacturing | Instituto de Ciência e Inovação em Engenharia Mecânica e Engenharia Industrial, Faculdade de Engenharia, Universidade do Porto, Portugal

Author 2: Rita Coelho | PhD in Design | Invited Adjunct Professor at ESMAD | ESMAD – Escola Superior de Media Artes e Design, Instituto Politécnico do Porto, Portugal

Author 3: João Manuel R. S. Tavares | Habilitation in Mechanical Engineer | Associate Professor at FEUP | Instituto de Ciência e Inovação em Engenharia Mecânica e Engenharia Industrial, Departamento de Engenharia Mecânica, Faculdade de Engenharia, Universidade do Porto, Portugal

Corresponding Author (Author 3): tavares@fe.up.pt | Faculdade de Engenharia da Universidade do Porto, Departamento de Engenharia Mecânica, Rua Dr. Roberto Frias, s/n, 4200-465 Porto, PORTUGAL | +351 93 420 1076 / +351 22 508 1487

Acknowledgments: This work was supported by "Fundação para a Ciência e a Tecnologia" (FCT), in Portugal, through a PhD grant with reference PD/BD/52348/2013 financed by national funds from "Ministério da Educação e Ciência" in Portugal, and by the European Social Fund through the POPH – QREN – Typology 4.1 – Advanced Training. The work was also partially supported by the Project NORTE-01-0145-FEDER-000022 - SciTech - Science and Technology for Competitive and Sustainable Industries, co-financed by "Programa Operacional Regional do Norte" (NORTE2020), through "Fundo Europeu de Desenvolvimento Regional" (FEDER).

Conflict of Interest: The authors declare no conflict of interest.

Human subjects protection approval: The authors declare that they have conformed with the ethical regulations of each of the studied institutions, and that the anonymity of each of the inquired individuals was ensured during the overall study, which is also ensured in the present article.

Keywords: Hospitals; Wayfinding; Signage systems; Users' perceptions.

Highlights

- This article presents, through a research conducted at three Portuguese hospitals, the opinions and perceptions of users concerning the existing signage systems as well as their suggestions to improve their wayfinding in this type of institution.
- The questionnaires, which were applied at the three hospitals, were suitable to clarify the evaluations and perceptions of the users regarding the existing signage systems.
- The article also reviews the literature regarding important concepts inherently connected to signage design for healthcare settings and recommends that pertinent stakeholders should consider these concepts.
- Besides the quantitative data, this article also presents suggestions from the respondents of the questionnaires for improvements in the current signage that they considered to be poorly designed.
- The main findings of this article can help understand the reality of these three Portuguese hospitals, and can be the basis for similar studies of other healthcare institutions in order to improve signage and wayfinding aspects to benefit the users' experience and, consequently, the experiences of the services provided.

Implications for Practice

- This article presents, through a research conducted at three Portuguese hospitals, the opinions and perceptions of users concerning the existing signage systems as well as their suggestions to improve their wayfinding in this type of institution.
- The questionnaires, which were applied at the three hospitals, were suitable to clarify the evaluations and perceptions of the users regarding the existing signage systems.
- The article also reviews the literature regarding important concepts inherently connected to signage design for healthcare settings and recommends that pertinent stakeholders should consider these concepts.
- Besides the quantitative data, this article also presents suggestions from the respondents of the questionnaires for improvements in the current signage that they considered to be poorly designed.
- The main findings of this article can help understand the reality of these three Portuguese hospitals, and can be the basis for similar studies of other healthcare institutions in order to improve signage and wayfinding aspects to benefit the users' experience and, consequently, the experiences of the services provided.

Executive Summary

This article provides an analysis of quantitative data collected through questionnaires applied at three Portuguese hospitals. The data collected covers the evaluations and perceptions of users regarding the signs at these institutions. An analysis was made to understand the most common problems referring to the signage systems of these hospitals. The results showed that the users evaluated the signage as good; however, they made many suggestions for improvements, including on signs that they had initially evaluated as good. The reviewed literature and some of the concepts presented here are useful to set the basis of similar studies and the current results are a major contribution to increase the amount of available literature on the topic. Furthermore, this analysis is useful for stakeholders involved in the process of design of signage systems for healthcare institutions in order to understand and overcome the common problems identified in the current systems.

Abstract

This article is a report on the quantitative data collected from patients, family members, and visitors using the outpatient areas of three hospitals in Portugal. It details the users' views regarding the existing signage and presents suggestions to improve the design and implementation of the signage systems. A questionnaire was used with 1287 respondents. The results showed that almost all users had a positive opinion regarding the current signage. However, some of the users' answers and observed behaviors indicated that the majority tended to ignore the signs and preferred to ask staff for help. Additionally, when asked for suggestions, many of the respondents were able to point out existing problems that affected their wayfinding. Although the signage was generally evaluated as good, many of the users perceived a variety of problems and, as already mentioned, asked the staff for directions, which results in lost time and hidden costs for the institutions.

Keywords: Hospitals; Wayfinding; Signage systems; Users' perception.

The present study examines the perceptions of users regarding signage at three Portuguese hospitals, and proposes to use the results as the basis for possible improvements. This study analyzed the users' perceptions and behavioral responses to signage at three hospitals in Portugal: Hospital A, in *Viana do Castelo*, Hospital B, in *Aveiro*, and Hospital C, in *Porto*, serving 236,270, 390,840 and 728,663 inhabitants, respectively. The article reports on quantitative data collected through a questionnaire concerning the users' perceptions of the signage, and presents suggestions for improving signage layout and design.

Literature Review

The topic of signage must be studied along with the concept of wayfinding. Zijlstra et al. (2016) defined wayfinding as users' ability to navigate in a setting by using environmental cues like signage and landmarks. Although it is a natural ability (Zijlstra, Hagedoorn, Krijnen, Van der Schans, & Mobach, 2016), signage is one of the variables that most affect users' wayfinding, and a poor planning of signage systems can lead to navigational difficulties for the users and a bad experience of the service (Devlin, 2014). Poor wayfinding systems, including the signage, can create difficulties for users, and cause individuals to arrival late for medical appointments, visiting times or inpatient admissions, which can lead to stress in the users (Cooper, 2010). A lack of initial planning together with building expansions, leads to disconnected spaces that pose navigational problems (Rousek & Hallbeck, 2011b). Studies suggest that better wayfinding systems can benefit the patients, the institutions and the medical outcomes in general (Zimring et al, 2013), and an efficient layout and signage can positively impact the patients and reduce negative feelings associated with being at the hospital (Chambers & Bowman, 2011; Ulrich & Zimring, 2004).

The purpose of signage is to help users find their destinations easily, free staff from having to give directions and consequently reduce costs (Potter, 2017). Passini (1996), pointed out that: "The ease of circulation within a building, the time saved by not having to

consult confusing information displays and even the liberation from time consuming directions given by staff, are issues of building efficiency and have financial impacts that, admittedly, are not easy to calculate." (pp. 319-320). Signage communicates information (Calori, 2007) and a good signage system does more than provide directions, as it makes the users autonomous and confident as they navigate their way to their destination.

The implementation of a good wayfinding system begins with understanding the audience, i.e. patients, visitors, friends and relatives, and staff members, and the different needs of each individual (Ministry of Health, NSW, 2014). After setting the users' profile, a careful planning of all the elements involved in the wayfinding system is needed. To do so, it is necessary to understand the frequent routes used by people, the needs of the individuals, as well as to plan any future expansions and rearrangements of the buildings and, of course, one must consider the available budget to spend on the system (Ministry of Health, NSW, 2014).

The planning of the signage system should consider the users' profile, specifically the elderly, illiterate and disabled. Signs should match the pre-visit info given to the patients before they visit the hospital, should use simple language to be easily understood, and create a hierarchy of information revealing the most important information. Furthermore, all signs should be visually consistent (physically and graphically) and easy to maintain or be adapted (Ministry of Health, NSW, 2014). Some studies have shown that signage affects the users' wayfinding behaviors and suggests that they should be planned in the initial stages of the construction (Rousek & Hallbeck, 2011a).

Even when well designed, the signage does not provide for all the users' needs. The variety of users makes it difficult to design a system that can successfully serve everyone. Nowadays, the increase in migration is adding challenges, since there is a huge need to plan all elements so they can serve users from other cultures and languages (Cowgill, Bolek, & SEGD, 2003). For example, a sign that is only a textual message without any other visual

elements can, on one hand, be totally adequate for some users, but, on the other hand, be limiting for others who do not share the same language (Scialfa et al., 2008).

Demographic characteristics, such as educational level, gender and age, can also affect the way users interpret and understand signs. Education is one of the characteristics that can lead to huge difficulties of wayfinding since, for example, people who are unable to read, can not understand signage messages (Campbell & Scott, 2014). Therefore, several studies about the use of symbols and colors on signage have been developed to overcome such difficulties (Campbell & Scott, 2014; Hashim, Alkaabi, & Bharwami, 2014). Young and Wogalter (2000) reported that people have trouble interpreting signs that are oversimplified, while they found that signs showing human body parts performing the action were easily understood. In terms of gender, Devlin and Bernstein (1995), in a study testing seven different kinds of wayfinding information, found that men made fewer errors and felt more confident in finding their way.

Elderly users have also particular needs, consequence of changes in physiological, social and psychological capabilities, which can result in cognitive and mobility difficulties that surely constrain their wayfinding abilities (Carpman & Grant, 1993). Considering the needs of special segments of population can be beneficial since in many cases, the resultant design becomes even more functional for other users too: Universal and Inclusive design.

From the conducted literature review, six categories were defined as the basis for this research, since they can have huge influence on the design and implementation of signage systems: (1) Consistency: Signs consistent with the other wayfinding elements; (2) Planning: Initial planning considering future changes in the buildings; (3) Target Users: Consider users' profiles and their limitations; (4) Information: Analyze the information and typology of the needed signs; (5) Design: Follow the graphical and physical characteristics suggested in the

literature for signs and test them with real users before the implementation on the setting; (6) Finances: Available budget for signage that should be taken into account.

Methods

Sample

This research was conducted through questionnaires applied from June of 2016 until the beginning of 2017 at three Portuguese hospitals. The participants were random patients, family members, and visitors in the waiting rooms of the outpatient departments (Table 1). The outpatient area was selected as is often a place where users experience more difficulties due to the stress and anxiety they feel when entering an unfamiliar place, and due to the large number of destinations branching off from the entrance. Also, a large number of people circulate in these areas, which makes them crowded most of the time. The number of annual outpatient consultations was used to calculate the sample size. The sample was established at 386, for a confidence level of 95% and sampling error of 5%, although more questionnaires were applied to compensate the ones filled improperly; for example, the ones with age, gender or education missing were excluded. The Ethical Committes of the hospitals provided authorization for the research and respondents signed an informed consent with the study objectives; no compensation of anykind was given for filling out the questionnaire.

<Table 1 about here>

The hospitals

The three hospitals are settled in different regions of Portugal. Hospital A is in *Viana do Castelo – Minho* province, Hospital B is in *Aveiro – Beira Litoral* province, and Hospital C is in *Porto – Douro Litoral* province. Figures 1 to 3 depict the buildings of each hospital together with the entrances and outpatient areas studied in this research.

<Figures 1, 2 and 3 about here>

The three hospitals were all built around the same time, under the same building regulations and with the same structural design; however, Hospital C is much bigger than Hospitals A and B. Hospitals C and B are in cities with a higher population density than Hospital A, and where normally the users have a better economic level. Other important aspect was the educational level of the population. As Hospital A is located in a city surrounded by rural areas, the population using this hospital is expected to have lower educational levels than the ones using Hospitals B and C.

Although the hospitals serve different types of populations and differ in size, the signage systems in the three institutions are very similar. With the increase of population served by these hospitals over the years, the signage has suffered some improvements. However, in all hospitals, it is possible to observe signage that is already outdated; for example, with destinations that no longer exist and with new destinations lacking of indication on the signs. Additionally, it can be verified that, in all cases, the current signage no longer fits the majority of the actual users who are mostly elderly people; therefore, the signage should be adequate to the elderly and with an approach of universal and inclusive design in order to serve the majority of the population and enhance their wayfinding. These problems are mainly resultant from expansions and rearrangements of the buildings that were not considered on their initial planning. Nevertheless, some attempts to improve the wayfinding of the users are already visible at Hospitals A and C, where colored lines have been implemented to indicate the paths to follow. The use of symbols is almost nonexistent, while the graphic messages and signs do not fill the real needs of the users today. There is no consistency in the design or implementation of the signage. The height of some of the signs is too high relatively to the common eye-level of an adult, which is of 1630 mm, and some are placed considering only the available space. Most colors used are different from sign to sign even in the same medical departments and many times the colors used do not contrast with

the wall where they are placed. In some areas the signage is insufficient, while in other areas there are too many signs that create information overload. Furthermore, many times the mix of temporary information with permanent information creates more confusion for the users. Figures 4 to 6 give examples of the signage used at the hospitals under study.

<Figures 4, 5 and 6 about here>

Questionnaires

The questionnaire was divided into four sections: Demographic characteristics, Signage system evaluation, Satisfaction with current signage and Suggestions for improvements. The structure and contents of the questionnaire were based on other works in the literature on this topic (Foddy, 1994; Malta, 2013). The first questions were related to age, gender, educational level, vision acuity, and familiarity with the building. These questions aimed to obtain the profile of the respondents, and therefore meet the "Target users" category as defined in the literature review. In the "Signage system evaluation" section, together with other questions, the respondents gave a numerical evaluation of between 1 to 5 (1 – Totally disagree to 5 – Totally agree) to each of the signage characteristics mentioned, in order to meet the categories of "Consistency", "Information" and "Design". The remaining categories, "Planning" and "Finances", are related to the hospital administration and the planners, and so they were not part of the questionnaire[1].

A pre-test was made with 25 users in Hospital A, in Viana do Castelo, to refine the final questionnaire. At Hospital A, a total of 544 questionnaires were applied and 510 were used; at Hospital B, in Aveiro, a total of 410 were applied and 391 were used; and at Hospital C, in Porto, 405 were applied, and 386 were used.

Statistical Analysis

[1] An example of the questionnaire applied at the three hospitals is available at: https://drive.google.com/file/d/1Bia8CVTpm8-ulxXFOCNtGx9UC07ai1gM/view?usp=sharing

The analyses were carried out in the IBM SPSS Statistics 24 software. Statistical post-hoc tests such as Chi-square, Mann-Whitney U and Kruskal-Wallis were applied depending on the nature of the dependent variable, $p < 0.05$ was considered statistically significant, and adjustment for type I error was performed based on the Bonferroni method. The study checked associations between gender, age, and level of education with the answers given, and checked for differences in the way signs were evaluated from hospital to hospital.

Results

Demographic characteristics

Most of the respondents were female: At Hospital A, 72.35% (369) of the respondents were female and 27.65% (141) male; at Hospital B, 70.33% (275) were female and 29.65% (116) male; and at Hospital C, 64.51% (249) were female and 35.4% (137) male. The average age was 39 years old at Hospital A, 37 years old at Hospital B, and 40 years old at Hospital C (Figure 7).

<Figure 7 about here>

There was a higher number of users with secondary school and a bachelor degree or higher, and no relevant differences were found between the hospitals (Figure 8).

<Figure 8 about here>

Only few respondents were visiting the setting for the first time. At Hospital A, 1.37% (7) were making their first visit to the hospital; at Hospital B, 2.30% (9) were first-time visitors; and at Hospital C, 4.90% (19) were first-time visitors. Only 5.09% (25) of the respondents at Hospital A declared they had some visual acuity problem, at Hospital B, 5.91% (23), and at Hospital C, 8.68% (33). The three main reasons to visit the hospitals were medical consultations, emergencies and to visit a patient (Figure 9).

<Figure 9 about here>

The analysis revealed that there were no significant demographical differences.

Signage System Evaluation

The majority of the users evaluated the signage at the hospital entrances as adequate. At Hospital A, 88.5% (452) evaluated the entrances as well signalized; at Hospital B, 64.7% (253) stated "yes"; and at Hospital C, 75.9% (293) said the entrances were well signalized.

At Hospital B, the educational level of the respondents influenced this answer as the group with a bachelor degree or higher revealed a strong relationship with the entrances being poorly signalized (chi-square test, $p = 0.022$). At Hospital C, statistical relationships were found for age and educational level. The chi-square test showed a strong relation between the group from 19 to 25 years old with the perception that the entrances were not well signalized, whereas the group from 46 to 55 years old mostly found the entrances well signalized ($p = 0.021$). Users with the 3rd level of basic education, saw the entrances as well signalized while users with a bachelor degree or higher did not (chi-square test, $p = 0.005$).

Many of the respondents declared that they had not experienced any delays due to getting lost inside the facilities. At Hospital A, only 13.7% (70) had experienced difficulties. A more expressive percentage in Hospital B, 24.8% (97) declared they had had experienced getting lost, and at Hospital C, 20.7% (97) had arrived late at their appointments. At Hospital B, the groups with a bachelor degree or higher, were those who experienced more difficulties (chi-square test, $p = 0.003$). At Hospital C, users from 19 and 35 years old experienced more wayfinding difficulties and some of them had arrived late for a medical appointment (chi-square test, $p = 0.041$).

Most of the users preferred to ask directions instead of trying to find their way. At Hospital A, 48.1% (246) said they would ask for directions, 46.0% (235) would ask for directions and use the signs and 5.7% (29) would only use the signs. At Hospital B, the same happened, with 54.7% (9) of the respondents asking for directions, 41.9% (164) asking for directions and using the signs and 2.3% (9) using only the signs. At Hospital C, 50.5% (195)

would ask for directions, 43.8% (169) would ask for directions and use the signs, and 4.1% (16) would only use the signs. At Hospital A, relationships were found for education and age. The Chi-square test revealed that the respondents with the primary school and 2nd level of basic education were the ones who asked the staff for directions more frequently, while users with a bachelor degree or higher were the ones that most used the signs ($p = 0.016$). In terms of age, the users from 19 to 25 years old were strongly related with the autonomous use of signs. The users from 26 to 35 and 46 to 55 years old asked for help and followed the signs, and the users from 56 to 65 years old asked for directions (chi-square test, $p = 0.017$). At Hospital C, men had a strong relation with the answer "Try to find the destination by using the signs and maps available", which can mean that males are more willing than women to find their way autonomously through the signage available (chi-square test, $p = 0.003$).

An evaluation of eight characteristics of the signage was made through a Likert scale from 1 to 5, where 1 denotes "Totally disagree" and 5 "Totally agree". In all the hospitals, the evaluations had a mean above 3, which means that the eight characteristics were mostly evaluated positively. Table 2 provides the means (μ) and standard deviations (σ_x).

<Table 2 about here>

At Hospitals B and C, the evaluations from 1 to 3 were more frequent than at Hospital A. Maybe these negative evaluations were because these Hospitals have a more complex layout that can give an impression that the signs were not so well designed (Figure 10).

<Figure 10 about here>

At Hospitals A and B, through a Kruskal-Wallis test, a relationship was found for the educational levels. The test stressed that the medians of the population were not the same, which was already expected since the samples for each educational level were not equal. In order to know if these evaluations were dependent on the educational level, we would need to carry out further data collection with equal samples. However, it was possible to conclude

that in both hospitals, the bachelor degree or higher group never used the highest evaluation (5) contrary to people with lower educational levels. Also for Hospital C, two of the characteristics: "the amount of signage is sufficient" and "the signs are well-placed throughout the hospital" obtained *p* values below 0.05. The analysis of the Kruskal-Wallis results verified that the users with a bachelor degree or higher did not evaluate either of these two characteristics with the highest value. However, groups from lower educational levels used the value 5 to evaluate these characteristics, which can mean that groups with lower educational levels may be less demanding in relation to the available signage.

In terms of the use of symbols to facilitate the identification of services, most of the users agreed. At Hospital A, 88.3% (451) answered that they agreed with the symbols, 84.7% (331) of the respondents at Hospital B agreed, and at Hospital C, 83.9% (324) agreed with the use of symbols. The Chi-Square test revealed that educational level influenced this choice in Hospital A. The groups below the 3rd level of basic education disagreed more with the use of symbols than those with a higher education ($p = 0.019$). To the question: "Do you think that signs should have different colors to identify different services or departments?", the majority answered "Yes". Specifically, 85.3% (436) of the respondents at Hospital A, 87.0% (340) at Hospital B, and 83.9% (324) at Hospital C.

Question 7 was about four symbols retrieved from the manual developed by the Hablamos Juntos Project (Berger, 2014). The respondents had to select the symbols they considered to be correct for each of the medical services presented; they could select more than one as being correct. The only symbol that was correctly interpreted by the respondents was Symbol 2, which was the one that represented Dermatology. The services to which the Symbols 1 and 4 represented were considered the last choice. The right medical service for Symbol 3 was the respondents second choice (Table 3).

<Table 3 about here>

At Hospital A, statistical relations were found for age, gender and educational level through the chi-square test. Age was found to influence the choice of Symbol 1 for Physical and Rehabilitation Medicine and for Outpatient Department ($p = 0.025$ *and* $p = 0.000$). People between 36 to 45 and above 65 years old were the ones who found this symbol the most correct for Outpatient Department, while people between 46 to 55 found it appropriate for Physical and Rehabilitation Medicine. Gender was found to influence the choice of Symbol 1 for Physical and Rehabilitation Medicine, as women found this symbol more appropriate ($p = 0.002$). The educational level of the respondents also had some effects. People with the 3rd level of basic education or lower found the Symbol 1 more correct to represent the Outpatient Department ($p = 0.005$). In relation to Symbol 2, people with the 3rd level of basic education found it correct to represent Dermatology while people with a bachelor degree or higher found it inadequate ($p = 0.010$). Also, people with 2nd level of basic education found the symbol used to represent ICU/Burn Unit adequate, while people with a bachelor degree or higher did not ($p = 0.026$). Symbol 3 was selected as more appropriate by people with 2nd and 3rd levels of basic education to represent Radiology, and again, people with a bachelor degree or higher, did not agree ($p = 0.005$).

In the case of Hospital B, statistically significant relationships were found for age and educational levels. Relations with age were found for Symbol 2 as being correct to represent ICU/Burn Unit mainly by people from 0 to 18 years old ($p = 0.039$). For Symbol 3, the selection for Internal Medicine seemed to have a strong relation with the group from 19 to 25 years old ($p = 0.042$). For Symbol 1, those with higher educational levels found this symbol inadequate to represent Orthopedics, and those with lower educational levels selected this symbol as being appropriate for Physical and Rehabilitation Medicine ($p = 0.042$ and $p = 0.002$). For Symbol 2, people with bachelor degrees or higher appeared to disagree with the selection of this symbol to represent Dermatology and ICU/Burn Unit, while people with the

primary school level seemed to find it correct ($p = 0.000$ and $p = 0.003$). The same happened for Symbol 3, where people with lower levels of education, i.e. primary school and 3rd level of basic education, agreed with the use of this symbol to represent Gastroenterology and Radiology, while people with a bachelor degree or higher found it inadequate ($p = 0.001$ and $p = 0.000$). Finally, for Symbol 4, the findings were similar, while people with primary school or 3rd level of basic education found this symbol correct to represent Endocrinology, and people with a bachelor degree or higher found it inadequate ($p = 0.000$).

In Hospital C, statistically significant relations were found. In terms of age, the results revealed that people that most considered Symbol 1 as being correct to represent Outpatient department were the respondents between 26 to 35 years old ($p = 0.005$). In terms of gender, the analysis revealed that females were more willing to associate Symbol 3 to Gastroenterology ($p = 0.001$). Also, for Symbol 4, females were the ones that most associated Symbol 4 with Clinical Hematology and Blood Bank ($p = 0.037$ and $p = 0.025$). For Symbol 1, people with primary school degree found this symbol correct to represent the Outpatient department ($p = 0.002$); however, people with a bachelor degree or higher, found it inadequate. For Symbol 4, the same result occurred for Endocrinology department, which was more associated to this symbol by people with primary school level and inadequate by people with a bachelor degree or higher ($p = 0.003$). Based on these results, we can say that some demographic characteristics, and maybe some of the terminology used together with the symbols, can influence their interpretation, which means that it is crucial to test them in a real context with real users to confirm or not their adequacy for the target audience.

In the question that evaluated the level of stress felt by the users when using the signs to find their way (Table 4), most of the users selected the values 3 and 4 in a differential scale from 1 to 5 (1 - Very Calm and 5 - Very Stressed).

<Table 4 about here>

At all the hospitals under study, the Mann-Whitney U test revealed that women felt higher levels of stress than men (Hospital A, $p = 0.027$; Hospital B, $p = 0.035$; Hospital C, $p = 0.008$). However, the number of female respondents was always higher than male respondents, which indicates that further research is needed with equal samples. The influence of age, at Hospital B, according to the Kruskal-Wallis test resulted in $p = 0.037$. Significant statistical relationships were found between the groups from 0 to 18 years and the groups from 26 to 55 years old, and between the groups from 19 to 25 and the groups from 56 to 65 years old. This was expected since the distribution of population was not equal for the age ranges analyzed. The frequencies of responses of the age groups (Table 5) showed that the groups from 26 to 45 years old, where the ones which had more respondents reporting higher levels of stress compared to the remaining groups. Possibly, we could establish a relationship between the ages from 26 to 45 years old and higher levels of stress; however, further research is needed with groups with equal age ranges to test this hypothesis.

<Table 5 about here>

Satisfaction with current signage

In terms of the difficulty to navigate in the settings using only the signage, the majority of the respondents from Hospitals A and C selected the values 2 and 3 from a differential scale of 1 to 5, while in Hospital B, the majority selected the values 3 and 4 (Table 6).

<Table 6 about here>

The Kruskal-Wallis test revealed statistical differences ($p = 0.005$) for the educational level variable in Hospital B. Significant differences were found between the bachelor degree or higher group with the primary school, 2nd level of basic education, 3rd level of basic education and secondary school levels. The bachelor degree or higher group made evaluations between 3 and 4 while the lowest educational groups marked between 2 and 3. In

the case of Hospital C, the Kruskal-Wallis test also pointed out an influence of the educational level ($p = 0.024$). The bachelor degree or higher group made evaluations between 2 and 4, while the Primary school and 3rd level of basic education groups evaluated the difficulty between 2 and 3. These results suggest that people with higher educational levels consider that the signage is not so easy to follow. This does not necessarily mean that users with the lowest levels of education experience less difficulties, but it can mean that people with higher education are more aware of the problems in the signs.

When asked if the signage available satisfied their wayfinding needs, most of the respondents answered "Yes": at Hospital A, 74.4% (380) replied positively; 55% (215) of the respondents at Hospital B said 'yes'; and 66.6% (257) of the respondents from Hospital C agreed. A relationship was found between education and the answers of the respondents in Hospital A (chi-square, $p = 0.027$). People with the 3rd level of basic education and lower were more satisfied with the signage than the ones with higher educational levels. From the 3rd level of basic education upward, the tendency was for an increase in the frequency of "No" answers: there were 16% (19) "No" answers for the 3rd level of basic education, 28% (56) for the secondary school level and 32% (39) for the bachelor degree or higher group. The result of the chi-square test for Hospital B had a $p = 0.000$, with the groups of the 3rd level of basic education and secondary school perceiving that the signage satisfied their needs, while the bachelor degree or higher group had the opposite opinion. Likewise, at Hospital A, the frequency of "No" answers increased from the 3rd level of basic education upward, with 31% (28) for the 3rd level of basic education, 36% (47) for the secondary school level and 68% (68) for the bachelor degree or higher group, where the frequency of "No" was higher than "Yes". Similarly, through a chi-square test, statistical relationships were found at Hospital C for educational level with a $p = 0.010$. The test revealed strong relationships between the 2nd and 3rd levels of basic education with the answer "Yes", and between people

with a bachelor degree or higher with the answer "No". The frequency of the answer "No" had an increase from the 2nd level of basic education upward, with 16% (5) of "No" for the 2nd level group, growing to 22% (15) in the 3rd level of basic education, to 33% (40) in the secondary school level and finally to 44% (53) for people with a bachelor degree or higher. Hence, we can say that, the higher the educational level, the greater is the awareness of existing issues regarding signage and navigational needs.

Suggestions from the respondents for signage improvement

The suggestions given by some of the 1287 respondents were related to seven topics: 1) Physical and graphic characteristics, 2) Mounting locations, 3) Density and quantity of information, 4) Clarity and simplicity of information, 5) Temporary signage, 6) Standardization, and 7) Maintenance.

Topic 1 (715 respondents) – improve the visibility of the signs by increasing its size, by using high contrasting colors, for example, and improve legibility and visibility of text, including in typography, letter size and colors. They mentioned the use of complementary elements, including colors to reinforce textual or directional information, colors to differentiate services and symbols, and complementary wayfinding systems like lines with colors or symbols to follow, color-add system (for the color-blind), and technologies like interactive maps. Topic 2 (134 respondents) – signage should be placed strategically, for example, at the building entrances (suspended or in the middle of the halls to be visible) and in strategic intersections of common circulation paths. Topics 3 and 4 (558 respondents) – more signs are needed, and maps and directories should be used. Also using simple terminology to keep messages clear and appropriate for people with limitations, like the elderly or illiterate users.

Topic 5 (26 respondents) – there should be specific places for temporary signs, which should follow the same design as permanent signage. Topic 6 (17 respondents) – all the

signage should follow a standard design according to the image of the institution. They also denoted the need to create standard symbols or pictograms to use in all hospitals which will help the illiterate or non-native speakers. Topic 7 (88 respondents) – lack of maintenance as a huge problem as well as outdated signage. There is a huge need to redesign the signage and to redefine their locations to follow the expansions and rearrangements done on the buildings.

Discussion and Conclusions

There are similarities in the way users perceive the signs and on wayfinding behaviors in the three hospitals. One major finding was that the default behavior of the users was to ask the staff for directions as soon as they arrived without consulting the signage available. This is in line with studies that show that people "need the reassurance that it can be obtained only from another human being, regardless of the extent and quality of the overall wayfinding system" (Carpman & Grant, 1993), which can indicate that this behavior is not unique of the Portuguese hospital users, but also of other hospital users across the world. This default behavior often results in financial impacts for the institutions due to the time that is lost by the staff in helping the users, which reduces their productivity. Therefore, it would be important to conduct a research on the impact of this typical behavior on the institutions and how it can be reduced. For the users with higher educational levels, one way to help the understanding of the signs, and to make people use them more, would be using symbols or colors. The creation of standardized symbols and colors, such as claimed by Lee, Dazkir, Paik, & Coskun (2014), could lead people to use the signage.

Often, users who were given verbal directions from staff, **would return without finding their destination,** which results in staff abandoning their working places to guide the users along the hospital. As already aforementioned, these cases lead to monetary additional costs with the staff, but also to negative experiences for the users that feel less autonomous and confident**.** However, this happens **due to an inadequate placement of the signage, and**

to improper design and terminology, especially considering the elderly. It was also found that the **users with higher education showed a more negative perception of the signage**, which suggests that people with higher education are more perceptive of the changes needed and difficulties felt.

Many users that classified the signage as good, ended up giving suggestions for improvements. **The suggestions were related with a more simple, functional and attractive design of the signage that will capture users' attention to entice them to use it.** Although the findings are not new, this study provides important insights on common wayfinding problems and their similarities among hospitals, which allow the establishment of guidelines to help the development and implementation of signage systems centred on the users, like the ones presented in (Rodrigues, 2019).

The current findings should be interpreted according to the limitations. The final sample was not representative of the overall population or the two genders. This happened since we had no information on the number of visitors and family members, and so the sample size was calculated through the number of annual outpatient consultations, which resulted in a lack of comparison between the opinions of the patients, family and visitors. In terms of gender, we were not able to inquire the same number of men and women to allow a proper comparison.

Even with the aforementioned limitations, we were able to identify similarities: (1) The users rely heavily on verbal information. (2) Users with higher education tend to identify more problems in the signage and to be less satisfied. (3) Users ended up suggesting improvements for aspects previously evaluated as good. (4) The elderly users tended to experience higher levels of stress. This study also refers only to standard visual signage within the areas of the hospital where outpatients are normally allowed to go. The hospitals did not make use of technologies or wayfinding aids, such as interactive signage or

wayfinding apps that could improve wayfinding and overcome the habit of asking directions. While most studies investigated the impact of signage on the costs and services, this study investigates the users' perception of the signage and its impact on stress and their wayfinding. Additionally, it confirms that the impact that signage can have on the users' stress and behaviors is huge and reveals that there is a need to consult users during the process of design and implementation.

References

Berger, C. (2010). *Universal Symbols in Health Care Workbook - Best Practices for Sign Systems*. Retrieved from United States: https://segd.org/sites/default/files/segd_hj_00_full_workbook_1.pdf

Calori, C. (2007). Signage and Wayfinding Design: A Complete Guide to Creating Environmental Graphic Design Systems: Wiley.

Campbell, A., & Scott, W. (2014). A Model-Based Study of Concept Development for Hospital Wayfinding to Improve Operating Efficiency (Vol. 17).

Carpman, J. R., & Grant, M. A. (1993). Design that cares: Planning health facilities for patients and visitors (2nd ed.). United States, USA: American Hospital Publishing Inc.

Chambers, M., & Bowman, K. L. (2011). Finishes and furnishings: Considerations for critical care environments. *Journal of Critical Care Nursing Quarterly, 34*(4), 317-331.

Cooper, R. (2010). Wayfinding for Health Care: Best Practices for Today's Facilities: AHA Press/Health Forum.

Cowgill, J., Bolek, J., & SEGD. (2003). Symbol usage in health care settings for people with limited English proficiency. Part Two: Implementation Recommendations. Scottsdale: JRC.

Devlin, A. S. (2014). Wayfinding in healthcare facilities: contributions from environmental psychology. *Behav Sci (Basel), 4*(4), 423-436.

Devlin, A. S., & Bernstein, J. (1995). Interactive wayfinding: Use of cues by men and women. *Journal of Environmental Psychology, 15*(1), 23-38.

Foddy, W. (1994). Constructing Questions for Interviews and Questionnaires: Theory and Practice in Social Research: Cambridge University Press.

Google. (n.d.-a). *ULSAM – Hospital de Santa Luzia*. Retrieved from https://goo.gl/maps/pm1nM87HtQdfuvU96

Google, (n.d.-b). *Centro Hospitalar Baixo Vouga, Aveiro*. Retrieved from https://goo.gl/maps/Zfnso3fHfqrZcQt86

Google, (n.d.-c). *Centro Hospitalar do Porto*. Retrieved from https://goo.gl/maps/p28JoyLqpzRYfThUA

Hashim, M. J., Alkaabi, M. S., & Bharwani, S. (2014). Interpretation of way-finding healthcare symbols by a multicultural population: navigation signage design for global health. *Appl Ergon, 45*(3), 503-509.

Lee, S., Dazkir, S. S., Paik, H. S., & Coskun, A. (2014). Comprehensibility of universal healthcare symbols for wayfinding in healthcare facilities. *Appl Ergon, 45*(4), 878-885.

Malta, Ana Sofia Mateus. (2013). O contributo do wayfinding na melhoria da comunicação interna e externa do Centro Hospitalar Cova da Beira. (MSc Thesis, in Portuguese). Retrieved from https://repositorio.ipcb.pt/handle/10400.11/2348

Ministry of Health, NSW (2014). *Wayfinding for Healthcare Services*. Sydney: Health Infrastructure, pp.15-78.

Potter, J. S. (2017). Best Practices for Wayfinding in a Hospital Setting. (MSc thesis). Retrieved from https://scholarsbank.uoregon.edu/xmlui/bitstream/handle/1794/22565/Potter2017.pdf?sequence=1&isAllowed=y

Rodrigues, R. (2019). *Healthcare Signage Design: Guidelines to support the development of signage systems centered on the users*. PhD. Faculdade de Engenharia da Universidade do Porto. https://hdl.handle.net/10216/120669

Rousek, J. B., & Hallbeck, M. S. (2011a). Improving and analyzing signage within a healthcare setting. *Appl Ergon, 42*(6), 771-784.

Rousek, J. B., & Hallbeck, M. S. (2011b). The use of simulated visual impairment to identify hospital design elements that contribute to wayfinding difficulties. *International Journal of Industrial Ergonomics, 41*(5), 447-458.

Scialfa, C., Spadafora, P., Klein, M., Lesnik, A., Dial, L., & Heinrich, A. (2008). Iconic sign comprehension in older adults: the role of cognitive impairment and text enhancement. *Can J Aging, 27*(3), 253-265.

Ulrich, R., & Zimring, C. (2004). *The role of the physical environment in the hospital of the 21st century: A once-in-a-lifetime opportunity*. Retrieved from Texas, TX: https://books.google.pt/books?id=VRTWNwAACAAJ

Young, S. L., & Wogalter, M. S. (2000). Predictors of Pictorial Symbol Comprehension. *Proceedings of the Human Factors and Ergonomics Society Annual Meeting, 44*(27), 294-297.

Zijlstra, E., Hagedoorn, M., Krijnen, W. P., Van der Schans, C. P., & Mobach, M. P. (2016). Route complexity and simulated physical ageing negatively influence wayfinding. *Appl Ergon, 56*, 62-67.

Zimring, C., Denham, M. E., Jacob, J. T., Cowan, D. Z., Do, E., Hall, K., . . . Steinberg, J. P. (2013). Evidence-based design of healthcare facilities: opportunities for research and practice in infection prevention. *Infect Control Hosp Epidemiol, 34*(5), 514-516.

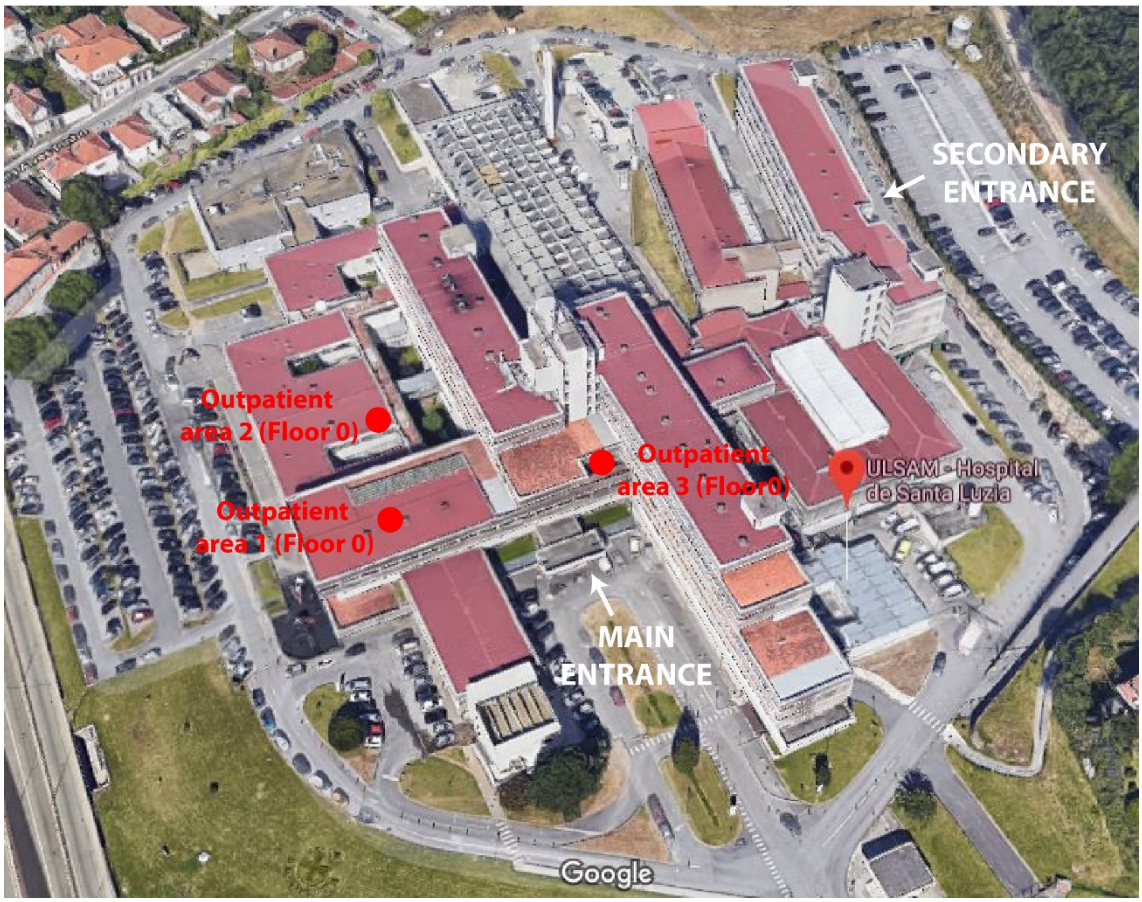


Figure 1 - Entrances and outpatient areas analyzed in the study conducted at Hospital A – Viana do Castelo, Minho province (Google, n.d.-a).

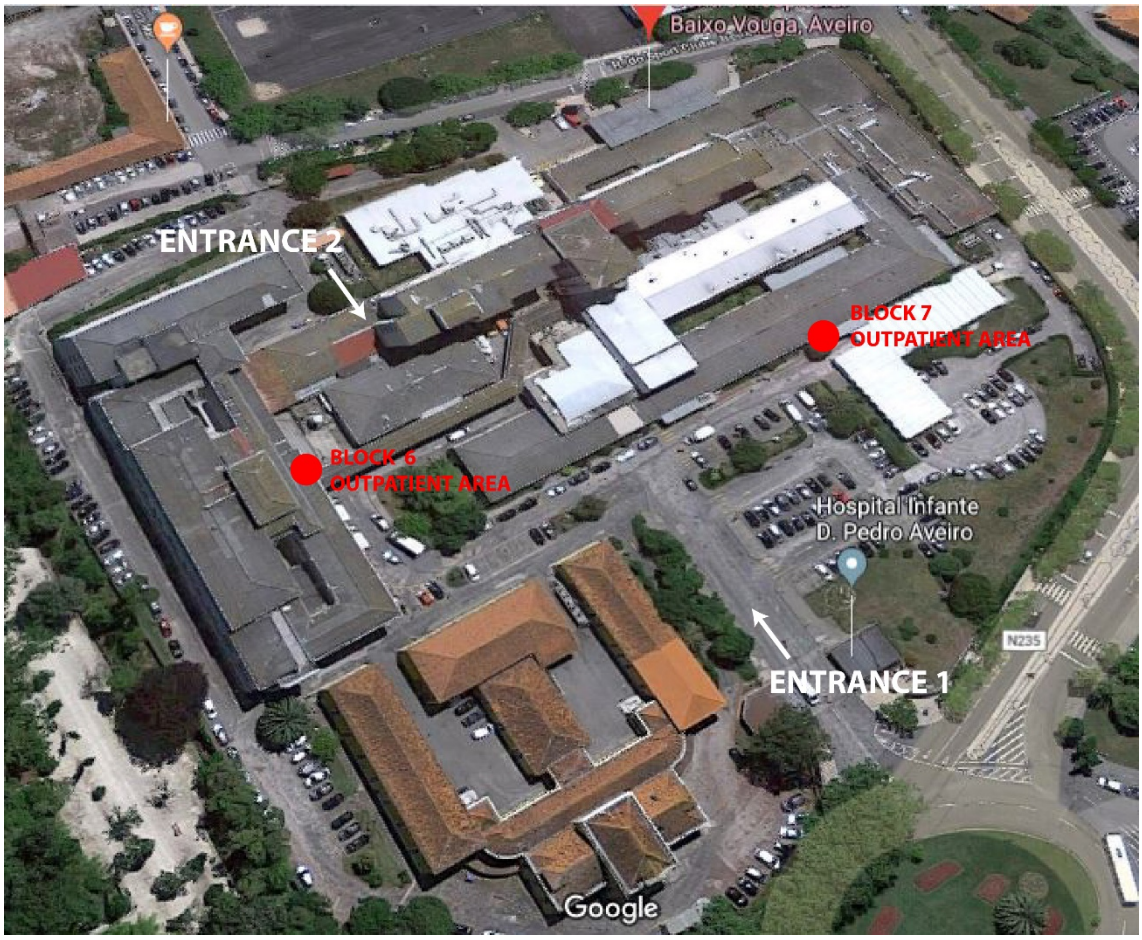


Figure 2 - Entrances and outpatient areas analyzed in the study conducted at Hospital B – Aveiro, Beira Litoral province (Google, n.d.-b).

Figure 3 - Entrances and outpatient areas analyzed in the study conducted at Hospital C – Porto, Douro Litoral province (Google, n.d.-c).

Figure 4 - Signage at Hospital A (Viana do Castelo – Minho province).

Figure 5 - Signage at Hospital B (Aveiro – Beira Litoral province).

Figure 6 - Signage at Hospital C (Porto – Douro Litoral province).

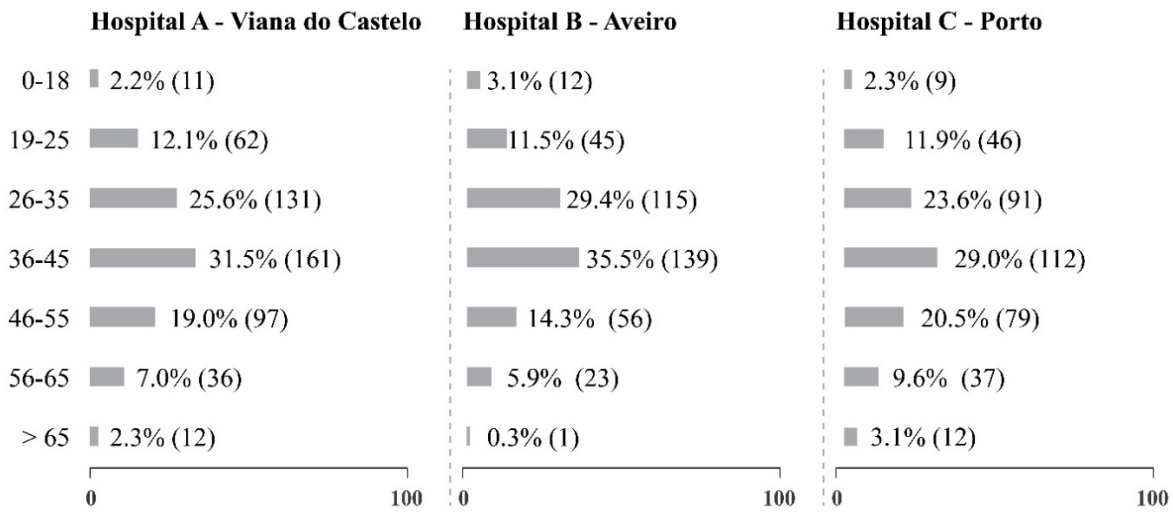


Figure 7 - Age of the respondents at the hospitals under study.

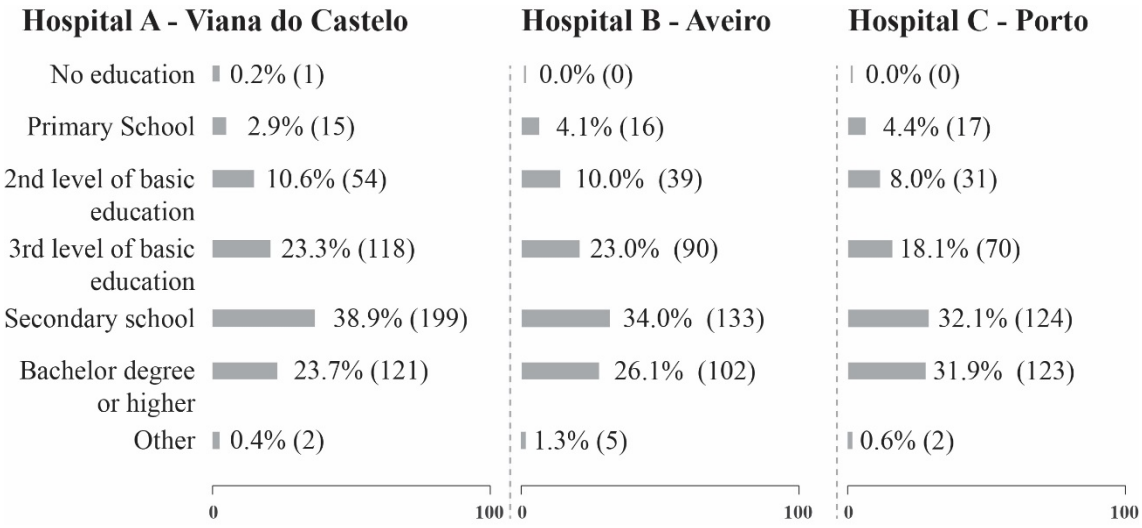


Figure 8 - Educational level of the respondents at the hospitals under study.

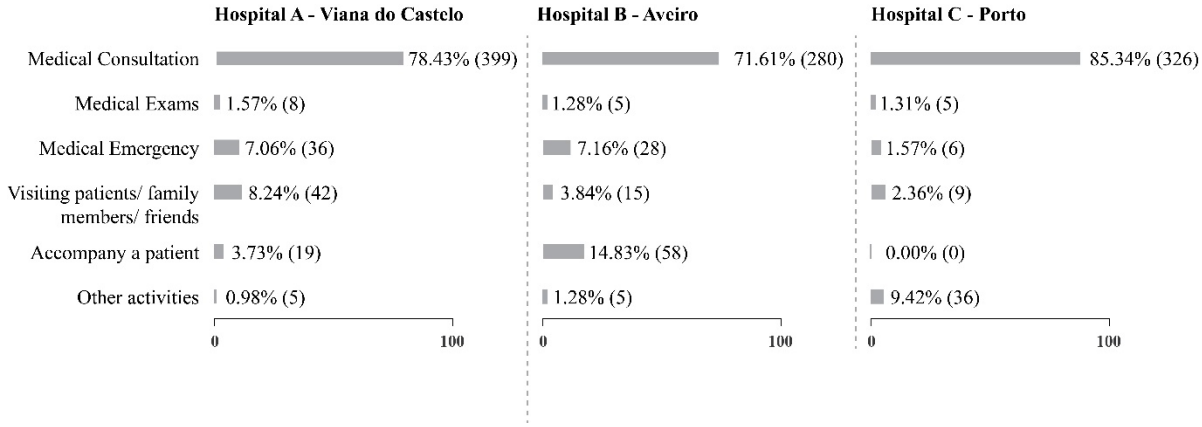


Figure 9 - Reasons given by the respondents for visiting one of the hospitals under study.

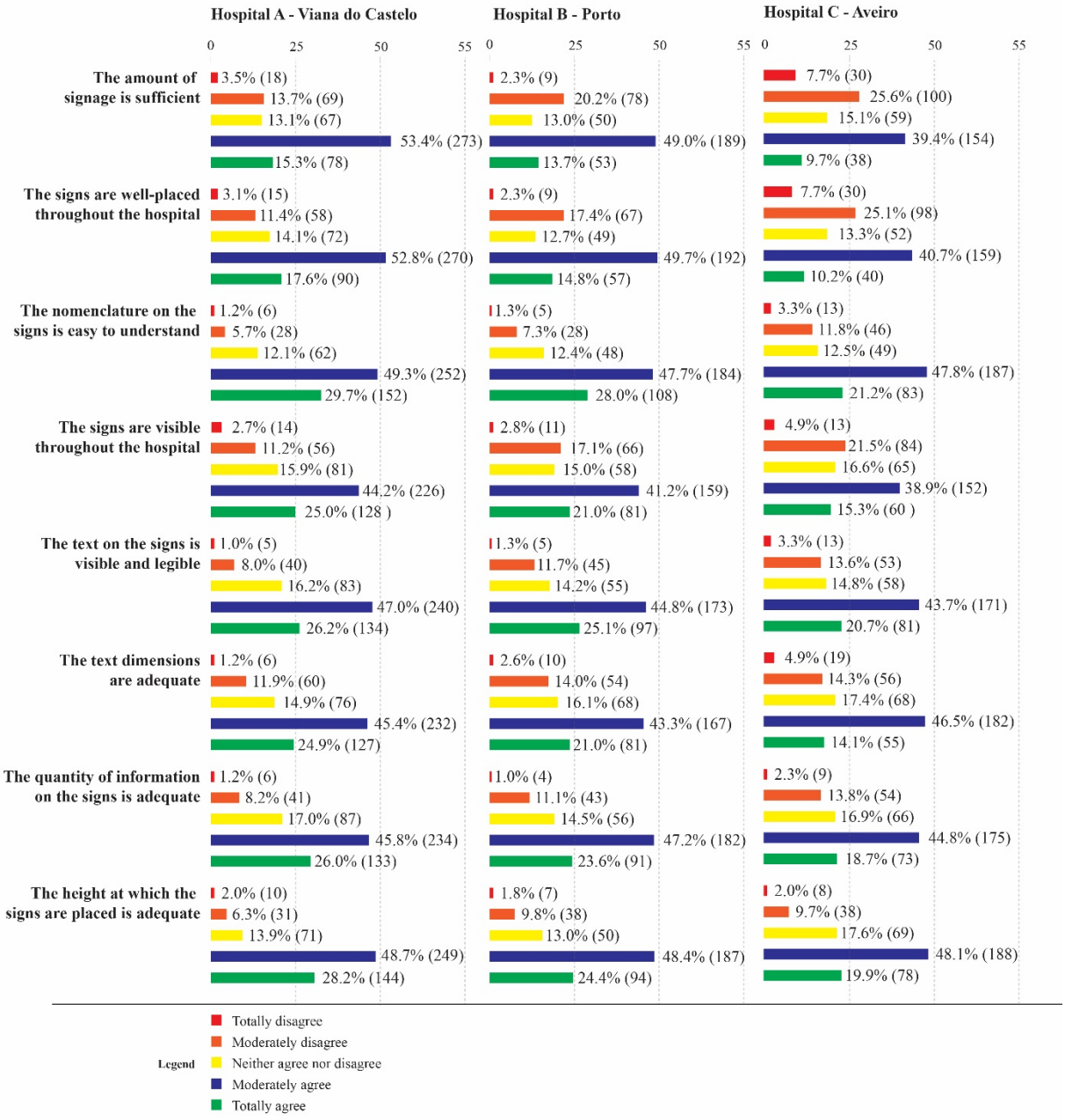


Figure 10 - Evaluations made of eight signage characteristics by the respondents of each hospital under study.

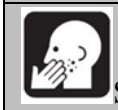
Table 1 - Characteristics of the respondents.

	Gender	Age
Hospital A (Viana do Castelo)	Male: 141, Female: 369 Total: 510	39 years old Mean (μ) = 39.33, Standard Deviation (σ_x) = 1.264
Hospital B (Aveiro)	Male: 116, Female: 275 Total: 391	37 years old μ = 36.97, σ_x = 1.147
Hospital C (Porto)	Male: 137, Female: 249 Total: 386	40 years old μ = 40.04, σ_x = 1.339
Total	1287	

Table 1 - Mean (μ) and Standard Deviation (σ_x) values of the eight characteristics regarding the signage at each hospital under study.

Characteristics	Hospital A (Viana do Castelo)	Hospital B (Aveiro)	Hospital C (Porto)
The amount of signage is sufficient	$\mu = 3.64$ $\sigma_x = 1.016$	$\mu = 3.18$ $\sigma_x = 1.162$	$\mu = 3.53$ $\sigma_x = 1.042$
The signs are well-placed throughout the hospital	$\mu = 3.71$ $\sigma_x = 0.991$	$\mu = 3.21$ $\sigma_x = 1.173$	$\mu = 3.59$ $\sigma_x = 1.026$
The nomenclature on the signs is easy to understand	$\mu = 4.03$ $\sigma_x = 0.876$	$\mu = 3.74$ $\sigma_x = 1.040$	$\mu = 3.97$ $\sigma_x = 0.917$
The signs are visible throughout the hospital	$\mu = 3.78$ $\sigma_x = 1.034$	$\mu = 3.39$ $\sigma_x = 1.140$	$\mu = 3.62$ $\sigma_x = 1.095$
The text on the signs is visible and legible	$\mu = 3.91$ $\sigma_x = 0.917$	$\mu = 3.68$ $\sigma_x = 1.069$	$\mu = 3.83$ $\sigma_x = 0.990$
The text dimensions are adequate	$\mu = 3.82$ $\sigma_x = 0.984$	$\mu = 3.52$ $\sigma_x = 1.066$	$\mu = 3.68$ $\sigma_x = 1.050$
The quantity of information on the signs is adequate	$\mu = 3.89$ $\sigma_x = 0.933$	$\mu = 3.66$ $\sigma_x = 1.022$	$\mu = 3.83$ $\sigma_x = 0.958$
The height where the signs are placed is adequate	$\mu = 3.96$ $\sigma_x = 0.925$	$\mu = 3.76$ $\sigma_x = 0.959$	$\mu = 3.86$ $\sigma_x = 0.968$

Table 3 - Respondents' interpretations of the symbols of the different available medical services.

Hospital A (Viana do Castelo)	Percentage of interpretations
 Symbol 1	Orthopedics: 75.5% (386), Physical and Rehabilitation Medicine: 68.3% (349), Outpatient Department (right answer): 31.1% (150)
 Symbol 2	Dermatology (right answer): 61.4% (314), Infectious Diseases: 47.0% (239), ICU/Burn Unit: 29.5% (150)
 Symbol 3	Gastroenterology: 71.0% (363), Internal Medicine (right answer): 55.6% (283), Radiology: 35.4% (180)
 Symbol 4	Blood Bank: 62.6% (320), Clinical Hematology: 59.9% (306), Endocrinology (right answer): 56.9% (290)
Hospital B (Aveiro)	Percentage of interpretations
 Symbol 1	Physical and Rehabilitation Medicine: 71.9% (281), Orthopedics: 71.4% (279), Outpatient Department (right answer): 21.0% (82)
 Symbol 2	Dermatology (right answer): 59.3% (232), Infectious Diseases: 48.8% (191), ICU/Burn Unit: 27.4% (107)
 Symbol 3	Gastroenterology: 71.4% (279), Internal Medicine (right answer): 63.4% (248), Radiology: 33.8% (132)
 Symbol 4	Blood Bank: 70.3%, Clinical Hematology: 62.1% (243), Endocrinology (right answer): 39.9% (156)
Hospital C (Porto)	Percentage of interpretations

 Symbol 1	Orthopedics: 76.7% (296), Physical and Rehabilitation Medicine: 65.8% (254), Outpatient Department (right answer): 26.4% (102)
 Symbol 2	Dermatology (right answer): 57.8% (223), Infectious Diseases, 52.3% (202), ICU/Burn Unit: 27.7% (107)
 Symbol 3	Gastroenterology: 69.4% (268), Internal Medicine (right answer) – 54.4% (210), Radiology: 36.5% (141)
 Symbol 4	Blood Bank: 67.1% (259), Clinical Hematology: 59.8% (231), Endocrinology (right answer): 37.8% (146)

Table 4 - Levels of stress felt by the respondents at each hospital under study.

Hospital	Very calm	Calm	Neither calm nor stressed	Stressed	Very stressed
Hospital A (Viana do Castelo)	9.0% (46)	16.4% (84)	26.2% (133)	34.6% (177)	11.7% (60)
Hospital B (Aveiro)	8.4% (33)	15.6% (61)	23.0% (90)	39.9% (156)	11% (43)
Hospital C (Porto)	11.4% (44)	19.4% (75)	24.9% (96)	35.5% (137)	7.0% (27)

Table 5 - Frequency of responses regarding the level of stress felt by each age group.

Age	Very calm	Calm	Neither calm nor stressed	Stressed	Very Stressed
0-18	3	1	5	2	0
19-25	1	4	12	24	4
26-35	8	20	22	50	15
36-45	14	24	28	57	12
46-55	3	8	15	19	9
56-65	3	4	8	4	3
> 65	1	0	0	0	0

Table 6 - Difficulty felt by the respondents in following the signs at each hospital under study.

Hospital	Very Easy	Easy	Neither easy nor difficult	Difficult	Very difficult
Hospital A (Viana do Castelo)	7% (36)	27.2% (139)	46.0% (235)	14.1% (71)	4.1% (21)
Hospital B (Aveiro)	4.6% (18)	21.5% (84)	44% (172)	24.6% (96)	3.1% (12)
Hospital C (Porto)	8.5% (33)	26.2% (101)	44.0% (170)	18.1% (70)	1.3% (5)