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Development and assessment of situation room in a stroke unit using low-code technology

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ABSTRACT
The Health Situation Room (SSS) is a virtual or physical environment that provides a set of data grouped by spreadsheets or systems, to obtain information and monitor indicators, as in the case of Cerebrovascular Accident (CVA). In order to incorporate a new context of SSS application in a hospital environment and to use the concept and application of low-code *or* no-code *technologies in* public health, this study aimed to develop and evaluate SSS in a Stroke Unit of a University Hospital. The research was developed in the following stages: requirements gathering, modeling of use cases, definition of the *low-code* platform, definition of profiles and the SSS panel and production of the final prototype. As a result, the following were made available: the standardized data entry form; connection with the database of the UH hospital information system for patient searches; and, SSS panel for evaluation. This work proved to be very successful in its implementation with the use of the *low-code tool*, due to the robustness in the number of tools provided by the platform. The solution was also very well evaluated by the care team that participated in the study, demonstrating its potential for use in the health area.

Keywords: Public Health Informatics, Cerebrovascular Accident, Basic Health Indicators, Data Analytics

1 INTRODUCTION

The Health Situation Room (SSS) is a virtual or physical space that provides a set of data grouped and organized from various sources, such as spreadsheets or systems1. In this environment, it is possible to obtain structured information, monitor indicators, assist in the decision-making process, and contribute to the situational strategic planning of public health, which in Brazil is offered through the Unified Health System (SUS)[2].

In the literature, SSS has been used, in Brazil and worldwide, for epidemiological monitoring and follow-up of the evolution of certain diseases at the local1,3,4, state5, national6,7 and international levels8, demonstrating its effectiveness in supporting the understanding of situations that impact public health and contributing to the formulation of strategies to cope with health crises. COVID-191 is the most recent, and has a global impact1,3,6.

However, there is a scarcity of studies demonstrating the effectiveness of the implementation of SSS in a unit or department of a hospital for the monitoring of a specific population. Mainly, using low-code *or* no-code *technology as a system for recording hospital information, and a disease with a high impact on society that has been consolidating itself as the main cause of mortality9,10, as is the case of cerebrovascular accident (CVA).*

Cerebrovascular accident (CVA) is one of the leading causes of death worldwide11, mainly affecting individuals over 50 years of age12. Because it is a highly disabling disease, their daily lives will be strongly affected, resulting in their dependence on other individuals such as family members and/or caregivers to perform the most basic activities and removing the possibility of maintaining a full and active life13,14.

With the permanence of stroke as the main cause of disability in adults15 and the consequent increase in the demand for health services with this specialty16, it is essential to generate stroke indicators. In this way, the SSS can provide a holistic view of data related to care, protocols used, target population and other indicators, when applied to a Stroke Unit, aiming at improving the quality of care and the application of more efficient protocols in the treatment of the disease.

The care provided to patients affected by this condition is conducted based on care protocols, standardized in health establishments and has the potential to contribute to the production of indicators that are routinely collected17. These data, which will later be transformed into intelligence information, have the potential to assist in the constant improvement of public health services, as observed in the work of Baptista *et. al.*[17] in which the effectiveness of the implementation of the Stroke Unit (UAVC) was analyzed through the grouping of information using spreadsheets, as well as in the work of De Sá, Grave and Périco[18] with the evaluation of indicators from a hospital in Vale do Taquari/RS in which the incidence and type of sequelae caused by the disease were observed.

To incorporate a new context of SSS application in a hospital environment, such as UAVC, which requires greater resource planning, it is urgent to use the concept and application of low-code *or* no-code *technologies* for public health, seeking to support the implementation of SSS and the Digital Transformation (DT) process in health. The application of DT is closely linked to innovative solutions of technologies applied to health19.

The incorporation of *low-code* technologies in healthcare has been shown to be an innovative approach, since few studies are related to their application20,21,22. However, studies have been found on its use and implementation23. This approach revolutionizes the way information systems are developed and implemented, allowing custom applications to be created quickly and agilely22, even by healthcare professionals with little or no programming experience, reducing the cost of deploying systems24.

By automating data collection and analysis processes, *low-code* technology solutions empower healthcare providers to access accurate and up-to-date information, promoting more data-driven decision-making, optimizing clinical management, and ultimately improving the quality of care provided to patients22.

The objective of this study was to develop and implement an SSS, using *low-code* technology, for the monitoring and control of HCVA patient data, with data entry by application developed on the *Joget Community*[25] platform and evaluation of the system carried out by the care team, through an *online questionnaire*.

The indicators were generated using the *Business Intelligence* (BI) tool, Microsoft *'s* PowerBI, *and integrated with* the Joget Community platform in *the* Urgency and Emergency Unit (UUE) of the Maria Aparecida Pedrossian University Hospital of the Federal University of Mato Grosso do Sul (HUMAP-UFMS) to monitor the prescribed prophylaxis, the target population served, in addition to other data recommended in the ordinance No. 665 of April 12, 201226 of the Ministry of Health (MoH) for the full UAVC.

2 METHOD

The research data have a mixed origin, that is, with primary and secondary data, using both bibliographies and information from the research applied in the field to survey requirements in the development of the system that subsidized the feeding of the SSS panels. The research also has a qualitative-quantitative approach with the application of an *online* questionnaire to evaluate the system to UAVC professionals.

To develop the system at HUMAP-UFMS, it was necessary to register the project in the management system of research developed within the scope of the Federal University Hospitals (HUF) of the Brazilian Company of Hospital Services (EBSERH) network, called Research Network. After registration, also carried out in Plataforma Brasil, the project was submitted to the Research Ethics Committee of the Federal University of Mato Grosso do Sul and approved under CAAE number 64268122.5.0000.0021. At the institution, project number 2402 was submitted to the Executive Board for approval and approved according to Resolution No. 61 of July 20, 2022, published in Service Bulletin No. 446 of July 28, 2022 of HUMAP-UFMS.

The development of the tools that supported this process was divided into five phases: software requirements gathering, modeling of use cases in *Unified Modeling Language* (UML), definition of the *low-code* platform, definition of user profiles, and, in the final phase, definition of the situation room panel and production of the final prototype.

The survey of the *software* requirements was determined by means of spreadsheets that were used to feed the UAVC data, in addition to information provided by the health professionals who fill in the health information of stroke patients, with sensitive data, in the referred files, and also by what is recommended by Ordinance 665 of April 11, 2012 of the Ministry of Health on the indicators to be monitored by the UAVC.

After gathering this information, the modeling of the system's use cases was carried out with the definition of use roles for the modeling of the system that subsidized information for the choice of the *low-code* platform of rapid and open source development, called *Joget Community,* which had the necessary elements for the implementation of the forms for filling in patient data.

With the definition of the platform, the user profiles were defined, configured and imported through integration with the existing user base in HUMAP-UFMS to perform authentication in the system, ensuring secure and traceable access of the care team in accessing patient information.

The development of the form for filling in the data, in order to standardize the information registered in the hospital management system of HUMAP-UFMS, called AGHU, was integrated through a search for the patient's medical record number in the data filling form, importing the personal information related to the patient.

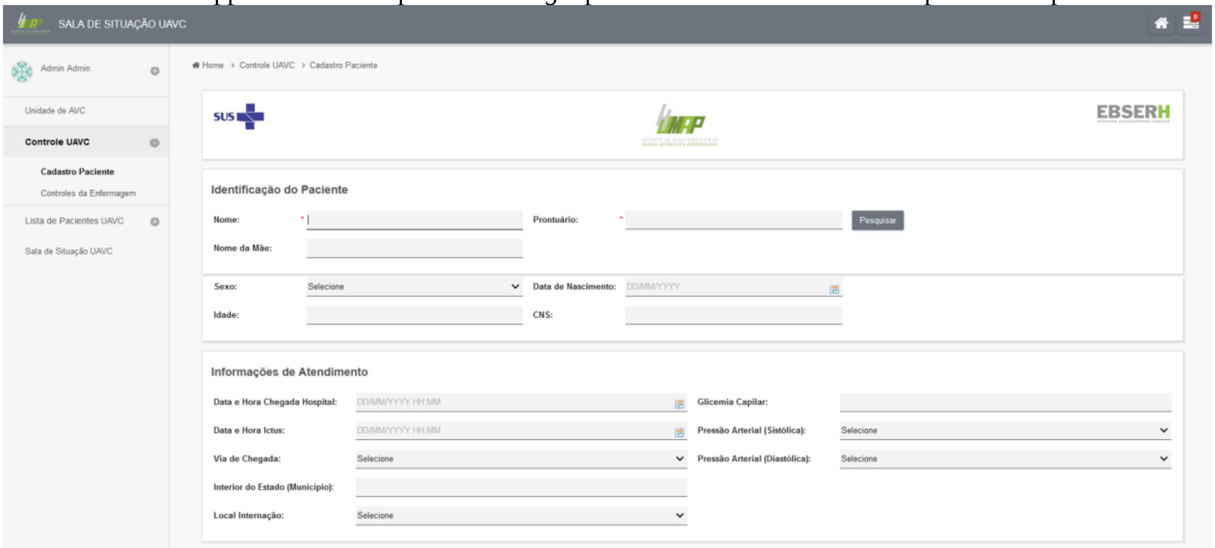
With the development of the form for filling in the sensitive data of the patients completed, both for the nursing controls and for the controls of the medical team, and approval of the care team, the definition and use of an institutionalized *Business Intelligence (BI) tool* that would meet the needs of the project for the implementation of the situation room was defined.

As EBSERH, manager of HUMAP-UFMS, has a Microsoft license agreement, *PowerBI* was defined as the BI platform for the creation and availability of dashboards. The data from the panels were extracted through direct access to the database of the form system created on the *Joget Community* platform, fed with patient data by the care team with a sample of 10 patients. Six screens were created, using the indicators contained in Ordinance 665 of April 11, 2012 of the Ministry of Health, in its Art. 7, § 3. The SSS system was made available through an internal *link* to the team to feed patient data.

3 RESULTS

Figure 1 shows the screen of the form system in which, from the search of the patient's medical record, performed in the AGHU database, the data are imported and filled in automatically by the system and the other control fields are manually entered by the care team. The integration took place through a *plugin* developed for *the Joget Community* that connects to the database, making it easier to fill out and reducing errors.

Figure 1 – Stroke Unit application developed on the *Joget* platform to feed data related to patients hospitalized for stroke.



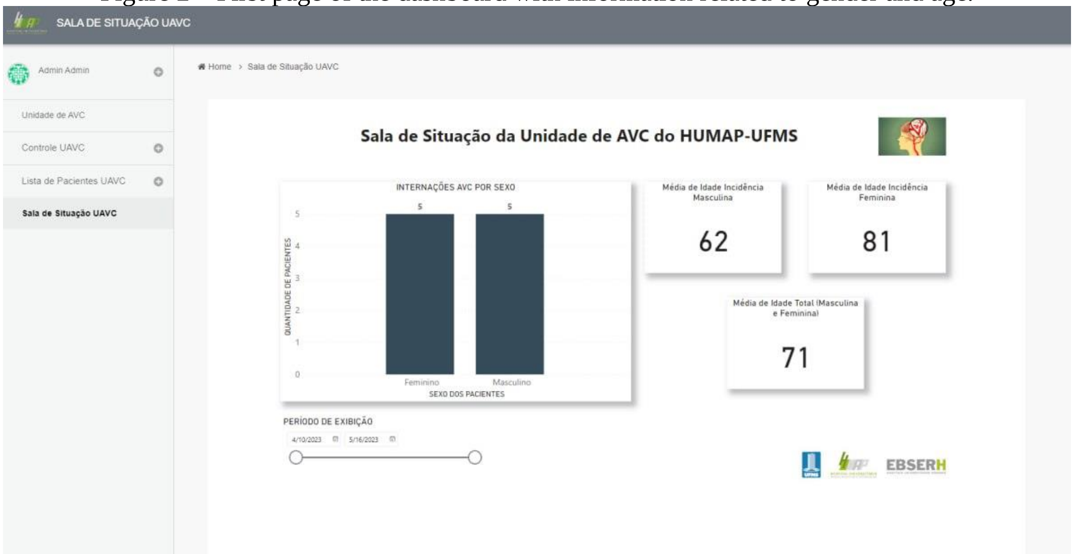
You can see that on the screen shown in Figure 1, there are four tabs that can be accessed. In the "Stroke Unit" tab, there is a home page with some information about the stroke, for informational purposes only and which can later be used to include information about clinical protocols, for example. In the "UAVC Control" tab, it is possible to register the patient with the data related to the stroke and the patient's nursing controls. The fields on the patient screen, imported directly from the database, are: name, mother's name, gender, date of birth, age, national health card and last clinical evolution of the patient.

In the "UAVC Patient List" tab, we can view all patients registered in the system and return to the registration and nursing control screens to include or change previously registered patients. These data, based on the records made in the system, are sufficient to monitor the clinical situation of patients in the Stroke Unit.

The last tab that presents the indicator data in *PowerBI*, called "UAVC Situation Room", has the graphical visual data with the UAVC indicators, consisting of five screens, which will be detailed in the next figures.

The first screen of the UAVC SSS panel, as can be seen in Figure 2, displays data by sex in a bar graph and three cards with the mean male and female age and the total mean considering both sexes. The data can be filtered by a bar in the lower left corner called "DISPLAY PERIOD", which is present on all dashboard screens, making it possible to filter a specific period for displaying the data.

Figure 2 – First page of the dashboard with information related to gender and age.



On the second screen of the panel, the data display information regarding the administration of drugs in the prophylaxis for deep vein thrombosis initiated up to the second day, considering the cases in the UAVC. This indicator is recommended by item I of Article 7, paragraph 3 of Ordinance 665 of the Ministry of Health, since it is essential to know which prophylaxis is prescribed in greater quantity to stroke patients, helping to provide better resources in the treatment of patients. The drugs administered and registered in the period were Enoxaparin and ASA until the second day and Enoxaparin, ASA and Clopidogrel.

The total number of cases found on the second page, with prophylaxis up to the second day, was 08 patients. This amount is lower than that of the total sample of 10 patients, which is the result of the registration of two deaths that were subtracted from the total sample considered. Therefore, there is no prophylactic indication for these cases, as can be seen in Figure 3.

Figure 3 – Second page of the panel that has prophylactic information, according to item I of Article 7, paragraph 3 of Ordinance 665 of the Ministry of Health.

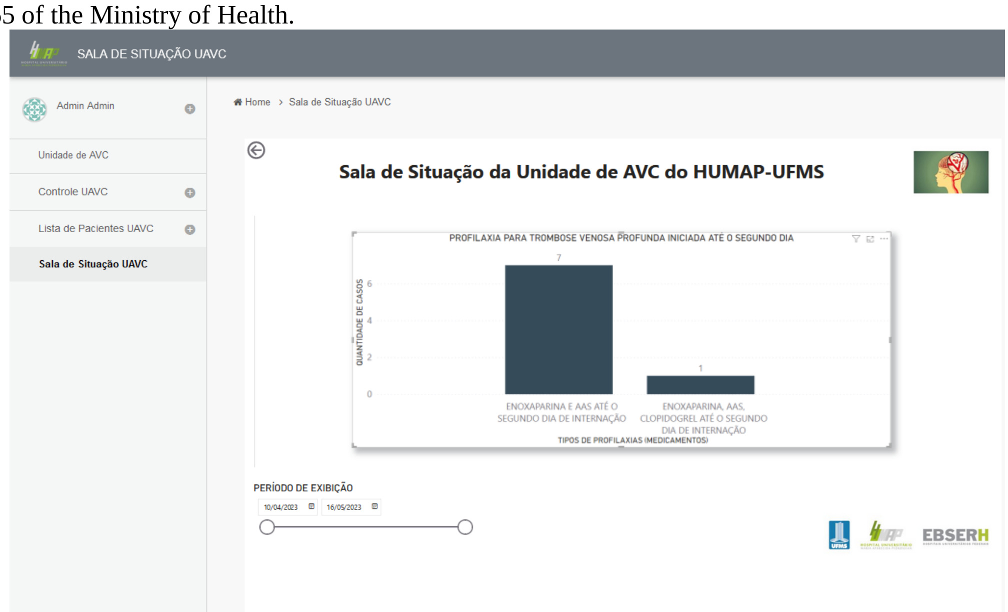
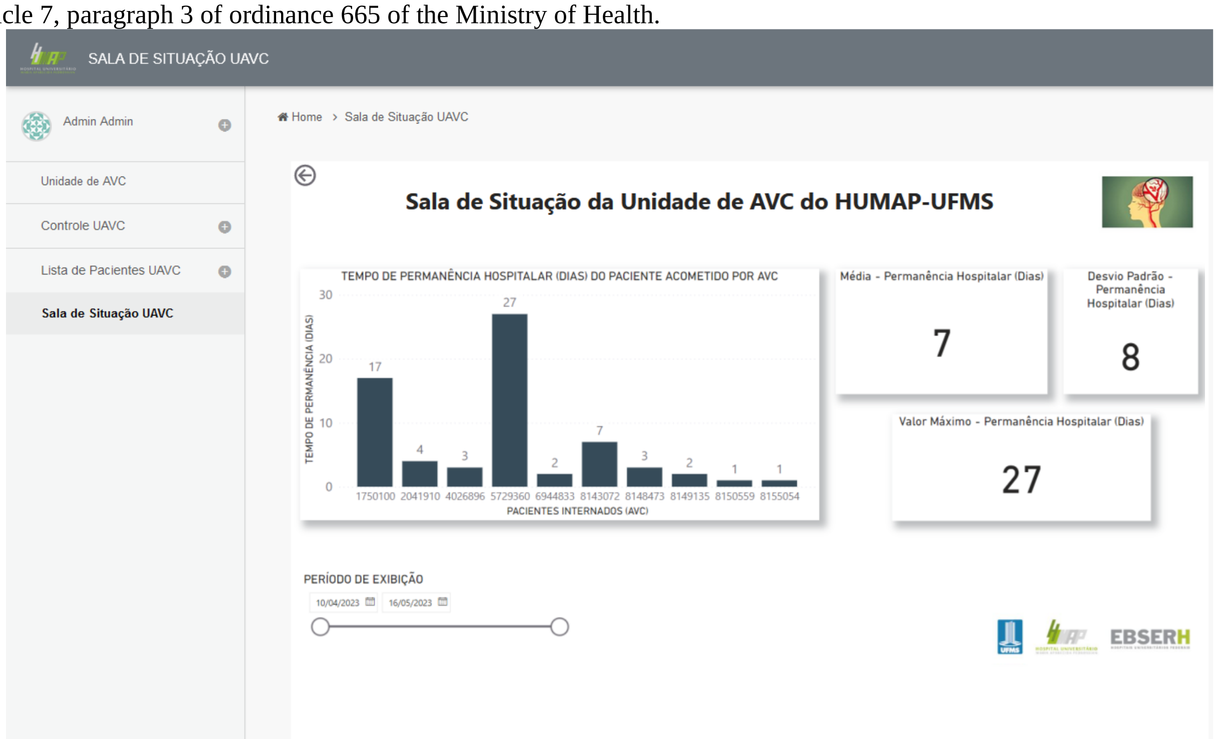


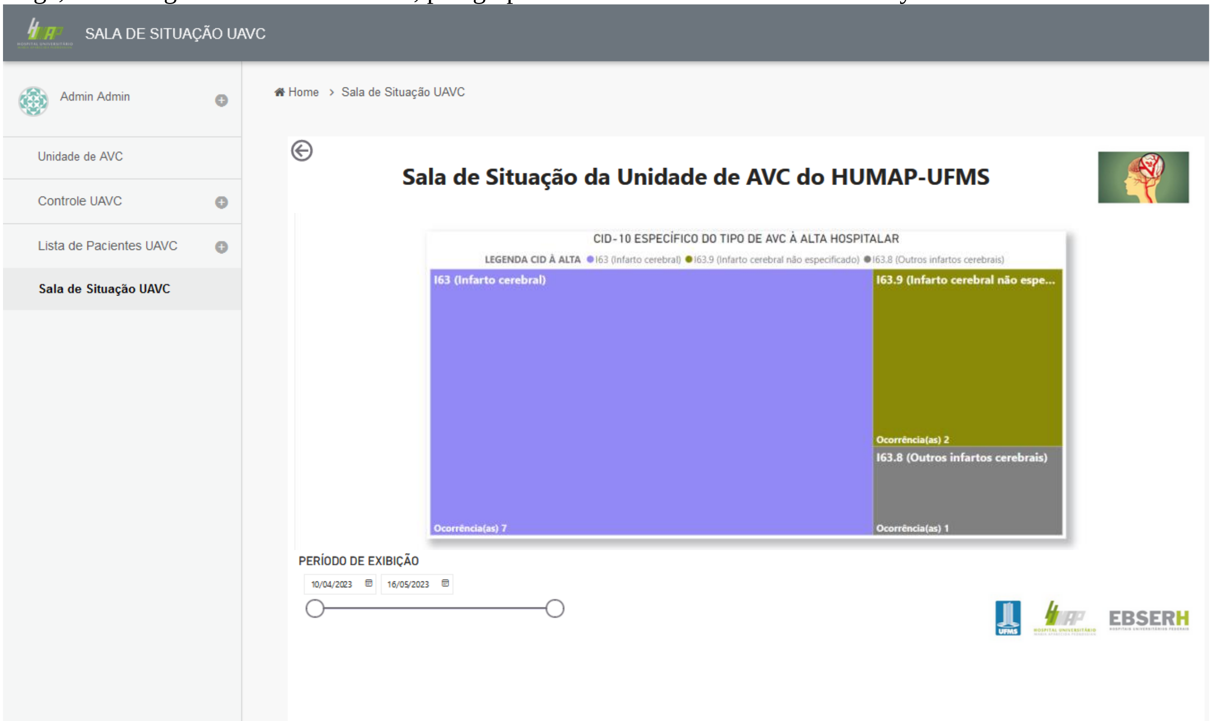
Figure 4 shows a bar graph of the length of hospital stay, the period between the patient's admission to the institution and hospital discharge, in days, for patients diagnosed with stroke. The x-axis displays the information from each patient's medical record and the y-axis the length of time each patient was hospitalized. Three cards complement the length of stay information with the mean length of hospital stay, the maximum length of stay (highest value in the selected series), and the standard deviation of the length of stay. The data represented are contained in item VIII of Article 7, paragraph 3 of Ordinance 665 of the Ministry of Health.

Figure 4 – Third page of the SSS panel with data on the length of stay in days of the patient in the UAVC with a bar graph and two cards that display the average length of hospital stay and the maximum length of stay, according to item VIII of Article 7, paragraph 3 of ordinance 665 of the Ministry of Health.



The fourth screen of the panel, shown in Figure 5, contains a graph called *a treemap*, which provides a visual representation of the ICD-10 classifications associated with patients registered in the system's form system. Specifically, the graph highlights the most prevalent diagnoses among patients and their respective codes as a function of their occurrence in the cases.

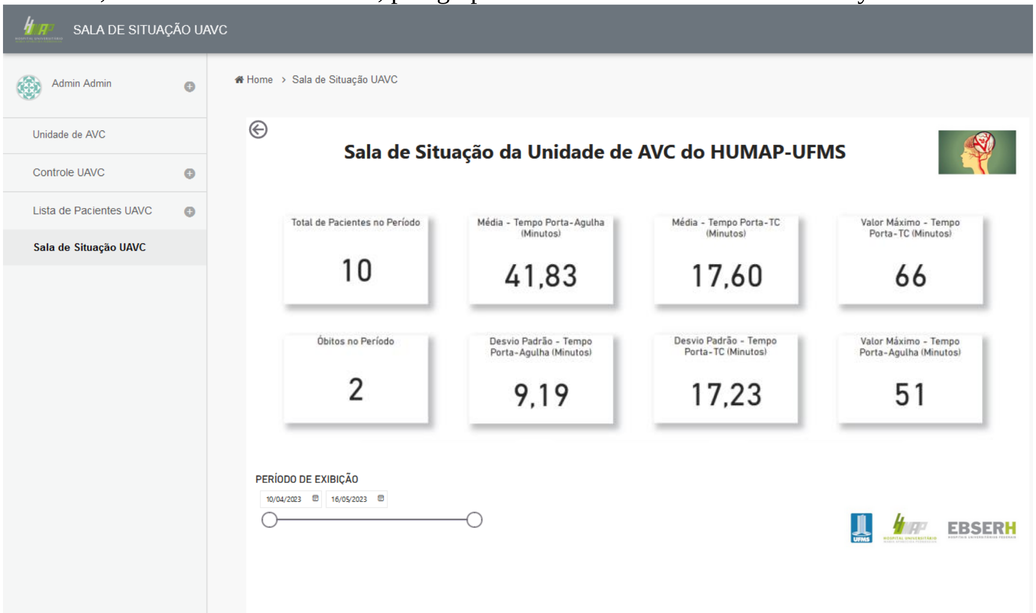
Figure 5 – Fourth page of the SSS panel with data on the incidence of ICD-10 specific to the type of stroke at hospital discharge, according to item X of Article 7, paragraph 3 of Ordinance 665 of the Ministry of Health.



The next section of the panel, made available in the system, encompasses a composition of eight information cards, each playing a crucial role in presenting the results pertinent to the research period. The first card highlights the total number of patients evaluated during the analyzed period, offering a bird's-eye view of the sample size underlying the analysis.

Two of the subsequent cards provide information on the average times associated with specific clinical procedures. The first card shows the mean Door-to-Needle time and the second card shows the mean Porta-CT time, both in minutes. Another critical metric addressed on the screen is the number of deaths recorded during the period analyzed. An important piece of information to contribute to the evaluation of the times of the Needle Holder and CT Holder times is the time means and the standard deviation that show how uniform the evaluated data are, both in minutes. The information described can be seen in the following figure.

Figure 6 – Fifth page of the SSS panel with data on the incidence of complications occurring during hospitalization, according to items XI, XII and XIII of Article 7, paragraph 3 of ordinance 665 of the Ministry of Health.

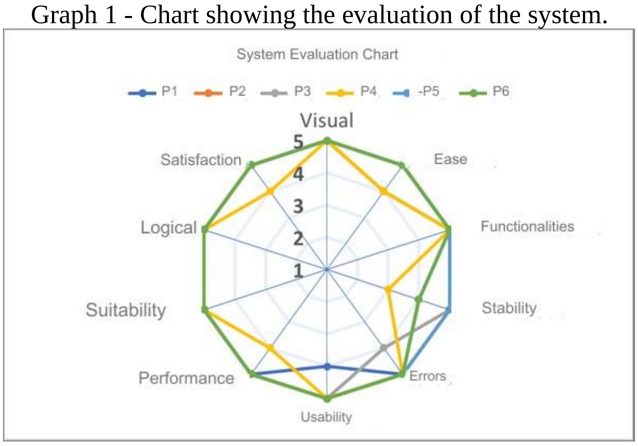


With the availability of the system and the UAVC situation room implemented, the online evaluation questionnaire was sent to the care team and to a representative of the technology sector of HUMAP-UFMS to evaluate the 10 dimensions of the system, namely: visual, ease of use, system functionalities, stability, errors, usability, performance, adequacy (field layout), logic (regarding the sequence of completion) and level of satisfaction with the system.

The participants who judged the platform were: four nurses (one of the Head Nurses of the Urgency and Emergency Unit), a physician (Head of the Critical Patient Sector), all working in the Stroke Unit, and an IT Analyst (Head of the Information Systems and Data Intelligence Unit) of HUMAP-UFMS.

The evaluation used a point system from "1" to "5", with "1" being the lowest grade and "5" being the highest score, evaluated in each dimension, as shown in Graph 1. P1 to P6 represents each participant who judged the system in the 10 dimensions shown in the figure.

Graph 1 - Chart showing the evaluation of the system.



Source: Prepared by the authors (2023).

The evaluation of the system showed good acceptance and, as can be seen in Graph 1, the dimension that had the lowest score was stability, with a score of 3. This is because the system has undergone certain changes throughout the availability process to be in proper operation, which may have negatively influenced stability. However, considering the other dimensions, the system had a good evaluation with maximum marks in the visuals, functionalities, suitable for use and logical in the layout of the fields. The average for the total size of the grades and the total average of the system, with a score of 4.83, can be seen in Table 1.

Table 1 - Average of the evaluation of the system in each dimension and overall average

Dimensions	P1	P2	P3	P4	P5	P6	Average
Visual	5	5	5	5	5	5	5,00
Ease	5	4	5	4	5	5	4,67
Functionality	5	5	5	5	5	5	5,00
Stability	4	5	5	3	5	4	4,33
Errors	5	5	4	5	5	5	4,83
Usability	4	5	5	5	5	5	4,83
Performance	5	5	5	4	5	5	4,83
Suitability	5	5	5	5	5	5	5,00
Logical	5	5	5	5	5	5	5,00
Satisfaction	5	5	5	4	5	5	4,83
Total Average	4,8	4,9	4,9	4,5	5	4,9	4,83

Source: Prepared by the author (2023)

4 DISCUSSION

In his work, Rodrigues-Júnior27 addresses the information cycle and the contribution of systems to the formation of health data intelligence. Data intelligence, in this case, specifically health data, is information collected, structured, and analyzed so that decision-making can be assisted.

Sellera *et. al.*[5] also make clear the importance of developing health information systems for the decision-making process. These tools are capable of providing quality information in the three spheres of government, making it possible to monitor population data and organize health services.

In the case of the UAVC of HUMAP-UFMS, in order to implement the data intelligence platform using *PowerBI*, it was necessary to use the *low-code platform Joget Community* so that patient data could be stored. In the context of the SUS, in which human and material resources are limited, the use of this tool contributed to the development of a solution with much greater agility compared to conventional application development projects, being crucial in the success of the implementation of SSS.

With the implementation of SSS, it is observed that the *low-code* platform was able to provide the necessary elements for the development and implementation of the situation room. Mainly, due to its versatility in the production of filling forms, standardizing care information, in the speed of development, since the platform has all the necessary elements for the development of applications, in the production of *pages in html* format, ease of use and implementation, flexibility and scalability, that is, capacity for growth and meeting the demands of inclusion of resources28.

The screens and elements of the dashboard developed *in PowerBI* provided a comprehensive and detailed approach to the analysis of indicators related to patients hospitalized with stroke, in real time. Visualizing the data through graphs, flashcards, and quantitative metrics allowed for a deep understanding of hospitalization patterns, medical procedures, and clinical outcomes. Hospital stay data are key indicators for monitoring and reducing the patient's length of stay, which has a direct impact on hospital costs.

Ferré *et al*.[29] bring an important approach to SSH, which is the function of supporting strategic planning, as well as knowledge management. These are only possible because the SSS generates evidence from historical data, according to the interest in generating this data. There is also the importance of keeping health-related data stored, especially in the context of HUFs, to contribute to research and generation of demographic and epidemiological data. The recording of historical data can also serve as a subsidy for other research related to the understanding of the target population served in the UAVC and collective health strategies.

A work similar to that of this research was that of the Open Room of Health Intelligence (SABEIS), which used the *treemap* chart used in the study by Ferré *et. al.*[29] in the organization of care by type of disease, making it possible to verify the care provided, diagnoses, procedures and other relevant information. Similarly, this graph was used to monitor ICD stroke care.

The results of this study have significant implications for clinical practice, with the possibility of improving care processes, technological evolution in the medical area, in the application of a technology that is increasingly in use in the industry30, but which can have a great potential for positive impact in the health sector, as it is a new technology28, and in hospital management, providing essential information for informed decision-making and improvement of clinical protocols. In-depth analysis of length of stay and complications helps identify areas of efficiency and opportunities for preventive intervention, contributing to the improvement of care provided to stroke patients.

The analysis of the average procedure times - Door-to-Needle Time and Door-to-CT Time - offers information on operational efficiency and time management in the hospital context. These metrics should be less than 60 minutes and 25 minutes, respectively, according to Article 7, paragraph 3, items XII and XIII of Ordinance 665 of the Ministry of Health, a recommendation that aims to optimize the times for performing tomography and thrombolytic infusion in cases of ischemic stroke.

Recorded deaths should be interpreted as a key metric to assess the severity and complexity of cases. The existence of two deaths, accounting for 20% of the sample, may suggest the need for better clinical control of cases, but it is also necessary to consider that the sample may not be sufficient or extrinsic variables may have affected the outcome. Continued vigilance over the monitoring and management of stroke patients is essential to reduce mortality and improve rates.

As this research sought to bring SSS to a micro view, in the context of the hospital environment, and no other studies were found that addressed the situation room with such specificity, some obstacles were observed in its implementation, even with the active participation of the clinical staff. Despite their engagement in aiding the implementation of the UAVC SSH, this study was not without limitations. The narrow sample of patients may not be representative of the entire stroke patient population, and the lack of complications may be related to specific sample factors or a systematic improvement in quality of care. In addition, the absence of statistical correlations between the results prevents the identification of clear causal relationships. As the data were imported from spreadsheets, there were many errors that did not allow a direct import of data, and the availability of other indicators that were also essential, but only through manual inclusion in the system by the care team.

Due to the lack of standardization in the spreadsheet files, some indicators recommended by Ordinance 665 of the Ministry of Health could not be implemented. Of the thirteen recommended indicators, it was possible to adapt the existing data to generate seven indicators, namely: prophylaxis for deep vein thrombosis started up to the second day; the length of hospital stay of the patient affected by stroke in order to reduce it; ICD-10 specific to the type of stroke at hospital discharge; in-hospital mortality due to stroke, aiming to reduce it; door-to-tomography time < 25 minutes; Needle holder time < 60 minutes.

The turnover of professionals at UAVC also had a negative impact on the development of the platform, which was readjusted to fit the need for new components of the clinical staff, impacting the scope of the project. However, even with the limitations presented, the implementation of the situation room in a UAVC of a public hospital, using the *low-code technology of the* Joget Community *platform,* demonstrated that it is possible to advance technologically, in the direction of DT, contributing to the advancement in the efficiency of the management of public resources, in the provision of a more humanized care and with greater predictability.

Regarding the use of the *low-code* tool for SSS, there are several possibilities for future research and improvements. First, more comprehensive investigations can be conducted to evaluate the effectiveness of this approach in different public health settings, prioritizing the generation of individual indicators in the target populations according to the care service provided within the hospital units. There is great possibility of exploring its potential in optimizing the monitoring of indicators and decision-making, one of them using Artificial Intelligence (AI)[21].

Further studies may focus on customizing the *low-code* platform to meet the specific needs of different areas of healthcare, ensuring proper adaptation and scalability. The development of advanced capabilities, such as predictive analytics and artificial intelligence, within the *low-code* environment also represents a promising area for investigation. Therefore, the continued use and improvement of this tool has the potential to contribute significantly to the improvement of public health management and patient care.

5 CONCLUSION

This study developed and implemented a situation room in the UAVC of HUMAP-UFMS, using the low-code platform, Joget Community*, with the data intelligence tool,* PowerBI, for the layout of the panels. The work proved to be very successful in its implementation with the use of the *low-code* tool, due to the speed of application development, available documentation and robustness in the number of tools provided by the platform. The solution was also very well evaluated by the care team that participated in the study, formed by nurses and a doctor, as well as a professional in the area of information technology at the hospital, demonstrating its potential use in the health area. The solution proposed here can be used as a model by other UAVCs in the HUF network, other departments that provide care services within the institution itself or even in the construction of systems in any SUS hospital unit.

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