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RESEARCH

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DEVELOPMENT AND IMPLEMENTATION OF A SURGICAL MANAGEMENT SYSTEM AIMED AT A UNIVERSITY HOSPITAL

Desenvolvimento e implementação de sistema de gerenciamento de cirurgias voltado a um hospital universitário
Desarrollo e implementación de un sistema de gestión de cirugías dirigido a um hospital universitario

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ABSTRACT

Objectives: to develop and implement a surgical management system that includes a surgical list and a surgical map. **Method:** this study is of exploratory and descriptive nature following the applied methodological research type. The methodology used is based on the software development process of the Pressman system for the development life cycle model. **Results:** the system has been developed and made available on all the computers in the hospital's internal network. It was implemented in all surgical areas and the Surgical Center. **Conclusion:** The Surgical Management System provides real-time surgical patient information to all departments involved with surgical patients. **Keywords:** Program development; Surgicenters; Operating room information systems; Surgical clearance; Software validation

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RESUMO

Objetivos: desenvolver e implementar o sistema de gerenciamento de cirurgias contendo a Lista Cirúrgica e Mapa Cirúrgico. Método: este estudo é de natureza exploratória e descritiva do tipo pesquisa metodológica aplicada. A metodologia utilizada baseia-se no processo de desenvolvimento de software fundamentada no modelo de ciclo de vida de desenvolvimento de sistemas de Pressman. Resultados: o sistema foi desenvolvido e disponibilizado em todos os computadores do hospital em sua rede interna. Implementado em todas as áreas cirúrgicas e Centro Cirúrgico. Conclusão: o sistema de gerenciamento de cirurgias disponibiliza informações em tempo real de informações dos pacientes cirúrgicos a todos setores envolvidos com pacientes cirúrgicos.

Descritores: Desenvolvimento de programas; Centros cirúrgicos; Sistemas de informação em salas cirúrgicas; Liberação de cirurgia; Validação de programas de computador

RESUMEN

Objetivos: desarrollar e implementar el sistema de gestión de cirugías que contenga la Lista Quirúrgica y el Mapa Quirúrgico. **Método:** este estudio es de naturaleza exploratoria y descriptiva del tipo investigación metodológica aplicada. La metodología utilizada se basa en el proceso de desarrollo de software fundamentada en el modelo de ciclo de vida de desarrollo de sistemas de Pressman. **Resultados:** el sistema fue desarrollado y puesto a disposición en todas las computadoras del hospital en su red interna. Implementado en todas las áreas quirúrgicas y el Centro Quirúrgico. **Conclusión:** el sistema de gestión de cirugías proporciona información en tiempo real de los pacientes quirúrgicos a todos los sectores involucrados con pacientes quirúrgicos.

Palabras clave: Desarrollo de programa ; Centros quirúrgicos ; Sistemas de información en quirófanos ; Evaluación preoperatoria ; Validación de programas de computación

INTRODUCTION

The progress and benefits of technology are present in the most diverse areas of human activity, and the health sector cannot be excluded from this scenario. It is undeniable that well-described and defined processes provide quality services to citizens, efficiency in the management of health facilities and smart use of available information.¹

The performance of surgical procedures requires planning because it is a complex process that involves several professionals from different specialties, and it is necessary to size materials and physical structure to meet the demand.²

Health managers should disseminate surgical information clearly and transparently to as many citizens as possible.³ It is inferred that one cannot manage an area without an information-based decision support system.⁴

Surgical queues occur when demand exceeds the facility's supply capacity.⁵ A system to manage the surgical processes is particularly important in the quest for efficiency in the hospital environment. Otherwise, the main reasons for surgical queues are high demand and limited resources, as most hospitals face financial and budgetary constraints that limit the amount of resources available for investment. In addition, management problems also contribute, as the lack of integrated and efficient management can lead to inappropriate allocation of resources.

The goal of the Surgical Map is to develop a planning tool that connects the surgical queue, surgical services, and the operating room of a hospital. This map contains essential information, such as patients' personal data and information related to the surgery, including the size of the surgery, the

operating room, the blood components, and the staff involved. This information can be used to extract data for efficient surgical center management.⁶

Therefore, the development and implementation of the surgery management system aims to contribute to the improvement of information management of surgical patients, along with the activities of managers, physicians, surgical center technical staff and others involved in the care of surgical patients.

METHOD

This is an exploratory and descriptive study, following the applied methodological research type, carried out through the development and implementation of the Surgeries System (SisCir-HUGG). The Research Ethics Committee (CEP) of the Hospital Universitário Gaffrée e Guinle (HUGG/RJ) approved the research under CAEE number: 52740521.5.0000.5258, on December 02, 2021, with the opinion number 5.425.123.

The development and implementation of the system took place at the Gaffrée and Guinle University Hospital (HUGG), which is a reference in several health fields. The hospital offers highly complex medical care in several specialties, such as surgery, oncology, neurology and neurosurgery. It is recognized as a reference in Latin America.⁷

In addition, HUGG has a strong academic and research tradition and is an important center for the training of health professionals and the development of scientific research in the area. The institution offers residency and specialization programs in 42 specialties for professionals in the area.⁸

To develop the system, we used the software development methodology based on the PRESSMAN system for the development life cycle model.⁹

Based on this conceptual model, the development team used evolutionary prototyping, which adds new functionality to the prototype built as new needs arise. For this purpose, the development cycles described by PRESSMAN were applied. The study covered its five stages, that include: communication, planning, modeling, software construction, implementation, product delivery and feedback.

The first step in software development is communication. The process started with the identification of the users' needs and the operationalization of the information flow of surgical patients under the direction of HUGG. We held several meetings with care managers, surgical teams, residents, nurses and surgeons to gather information. We observed that the areas and their respective teams were working in isolation, without synergy, and that the lack of information affected the managers, causing problems in the hospital's management.

The second step was to plan the construction of the software. Prior to the actual development, we presented the managers with screen models of the system using the Microsoft Excel® program, based on the information gathered during the requirements analysis. After the approval of the managers,

we developed the system with Visual Studio® software, using dotNet® language.

The system is integrated with the web service, which allows the transfer of data through a communication protocol with the SIGTAP platform (Sistema de Gerenciamento da Tabela de Procedimentos, Medicamentos e OPM from SUS). There is also an integration with the AGHU system (Management Application for University Hospitals). All data is stored in a relational database with support for SQL Server®, installed in a server at HUGG. Access to the system is provided by login and password, which ensure greater security.

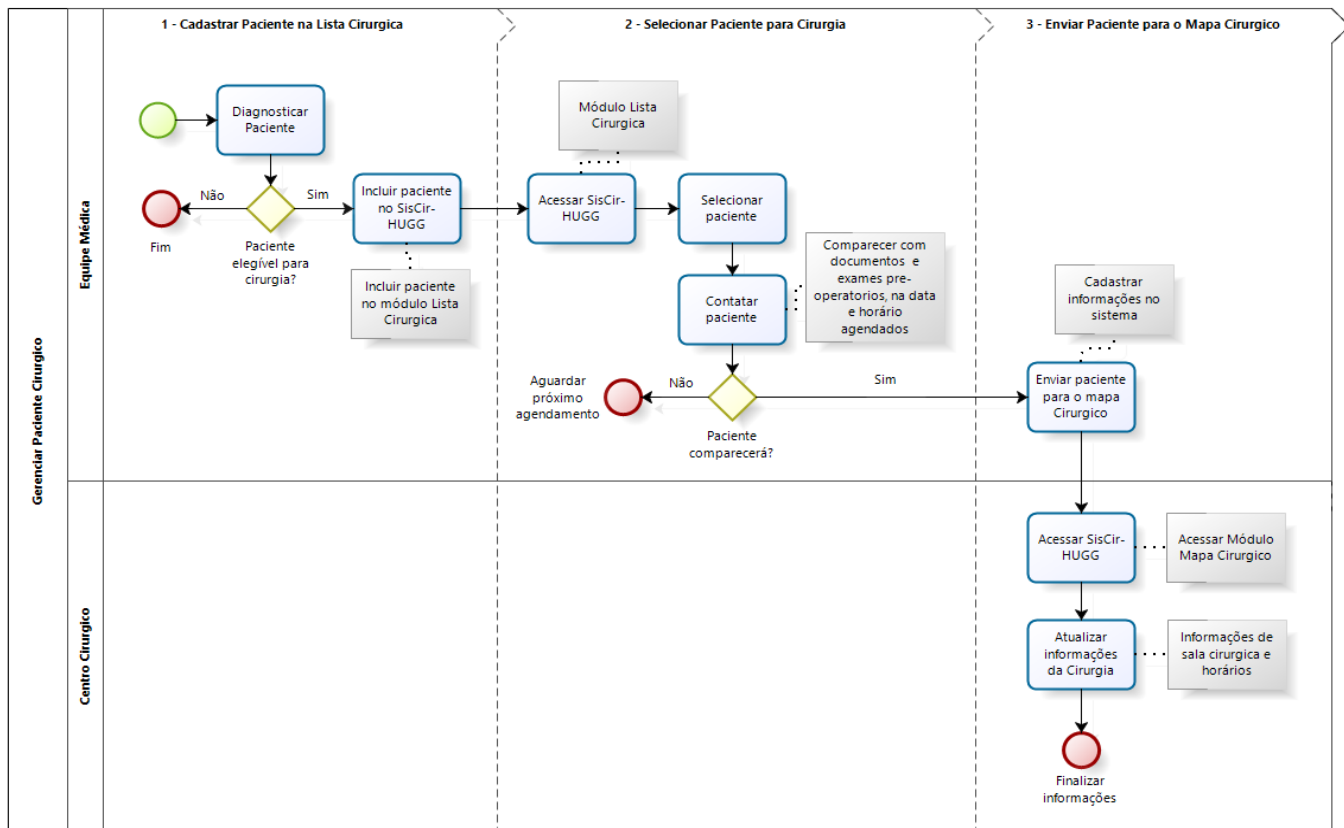
The third stage consists of modeling, that is, designing the user interface of the system. During this phase, we take into account the requirements survey that has been carried out, as well as its functions and specifications.

The fourth stage is the construction of the software. During this stage, we code, compile, verify and test the system.¹⁰

The fifth and final stage is the implementation, delivery and feedback of the product. This phase was carried out in stages, which included: selection of specialties determined by the care manager, user training, development of a system user manual, and creation of specific WhatsApp® groups for each specialty to facilitate communication with users and speed up problem solving.

Figure 1 - Surgical Patient Information Management Flowchart. Rio de Janeiro, RJ, Brazil, 2023

Source: The Author, 2023.



The implementation schedule was set according to the approval of the hospital's health care manager. The feedback provided by users allows for the correction of system errors, as well as the possibility of increasing its functionalities, if approved by the system administrators and the hospital managers, after assessing its feasibility.

RESULTS

Developing the Surgical Queue Module

The Surgical Queue Management System aims to serve the various specialties, seeking to manage patient information not only by the services themselves, but also by the hospital managers. It sets out to be an additional source of information for planning the acquisition of physical and human resources in order to meet the demand for surgical procedures.

The first stage of development began when hospital managers reported problems in the management of surgical patients. From these meetings, we started to collect information in the services responsible for the management of surgical patients.

We developed the Surgical Patient Management Flowchart, as shown in Figure 1, which includes the activities performed by the areas involved in the surgical patient information management process. Discussions were held to find ways to optimize the activities, and the managers decided to implement a system to control the surgical queues, as this would bring benefits to the routine of the professionals involved and the managers.

After defining the activity flow, we presented system screen models for the surgery queue module. These screens contained the information obtained in the requirements survey and aimed to meet the needs of users, managers, and the outlined activity flow. We held discussions with users and managers about all elements of the screens. We described the specifications of each element to ensure that their respective functionalities were met. Importantly, the requirements served as a guide for the first version of the prototype, which was refined as we made presentations to managers.

After the managers of the surgical services approved the screen model of the surgical list, we started the development of the system using Visual Studio® computer program through dotNet® language.

The part of the system responsible for the graphical user interface containing the tasks to be performed is called "front-end". The aim of this part is to provide a user interface that is easy to learn and use, to increase the user's loyalty to the system.¹¹

The system stores each operation performed by the user in a relational database with support for the SQL Server®, installed in a server at HUGG. The data is organized in tables consisting of columns that store information such as text, numbers, dates, etc. in rows. The tables are configured with primary keys to improve data access.

The SisCir-HUGG tables are related to the AGHU system used by all health professionals in HUGG to record patient information. In this sense, SisCir-HUGG has been designed to be integrated with other systems, to allow automatic com-

Figure 2 - Patient registration screen in the surgical list. Rio de Janeiro, RJ, Brazil, 2022

Source: The Author, 2022.

munication between them, in order to optimize the search for information, avoid duplicate entries and optimize user time.

The system is available in all computers connected to the logical network of the hospital. Access to the system is restricted to the HUGG premises, and to access it, the user must meet two requirements: be registered in the AGHU system (University Hospitals Management Application) and be registered in SisCir-HUGG with the appropriate permissions.

After accessing the system, the user can register the patient on the surgical list, as shown in Figure 2. Only patients with a medical record number registered in the hospital are eligible for inclusion in the surgery list. The user inserts the patient's medical record number in the designated field, and all personal information is automatically loaded onto the screen. Then the registration continues by filling in the following fields: surgical specialty, surgical queue (related to the surgical specialty), ICD (International Classification of Diseases) and procedure. These fields are integrated through a web service that allows real-time data transfer through a communication protocol with the SIGTAP platform (Sistema de Gerenciamento da Tabela de Procedimentos, Medicamentos e OPM from SUS). This ensures that the user can update this information in real time. Other fields include surgical risk classification, complexity of surgery, date of surgical risk, laterality of surgery, need for freezing and blood derivatives. The "Additional Information" field is used to record relevant information about the patient's condition related to the surgery.

The patient's position in the surgery list depends on the following criteria: the patient's assignment to a surgery specialty, to a surgery queue, and the date of the patient's registration in the system. The system automatically registers the admission date when the patient is registered, and this information cannot be changed later, which ensures the integrity of the order of patients in the corresponding lists.

Implementing the Surgical List Module

In order to avoid individual registration of each patient in each specialty, which would require a significant amount of time to complete, it was proposed to migrate the registration of patients into the system. This migration is done through a spreadsheet configured with the necessary requirements for importing data directly into the system's database.

After sending the spreadsheets to the service managers of the selected specialties, we imported the data directly into the database of the SisCir-HUGG system. After this migration, was conducted operational training with physicians and residents of the respective specialties.

The training was performed in person for the services that participated in the pilot project. It was separated for each service by sending emails to the physicians and residents with the dates, times, instructors, objective, and location of the training.

The training site was equipped with a projector and a computer connected to the hospital's logical network. This allowed us to present the system in real time during the training, demonstrating all areas of the system and their respective functionalities. In addition, we performed registrations, deletions, and changes to test patient information to simulate all possible situations that users might encounter in their work environment. Each training session lasted 2 hours, and at the end, the professionals had their presence registered by signing a list.

Educators have granted access to the system based on the user's level of activity. For example, surgeons and surgical residents have full access, while users working on the ward have access to only view the information.

The implementation period lasted six months, and the users were followed up in this period. WhatsApp® groups

Figure 3 - Model of the surgical map on the screen. Rio de Janeiro, RJ, Brazil, 2022

Source: The Author, 2022.

SISTEMA CENTRO CIRURGICO							
Cadastro do MAPA Cirurgico	Serviço Médico	Dados do Paciente					
		Prontuario		CNS		Regulação	SISREG
		Nome				Sexo	
		Data de Nascimento		Idade		Telefone	
		Informações da Cirurgia					
		Especialidade	Oncologia	CTI	SIM	Reserva de Hemoderivados	SIM
		Data da Cirurgia	01/01/2018	CID-11	A00 – Cólera	Procedimento	Biopsiaxxx
		Complexidade	ALTA	Risco Cirúrgico	I	Lateralidade	Ambos
		Equipe Cirurgica			Cirurgião Responsável		
Cadastro de Local/Tempo Cirurgico	Centro Cirurgico	Horário da Cirurgia		Sala Cirurgica		Cirurgia Confirmada?	
Cadastro de Tempos Cirurgicos	Centro Cirurgico	Status do Paciente			Descrever motivo nos casos de Cirurgia: Cancelada, Suspensa ou Atrasada		
		Entrada do Paciente no Centro Cirurgico					
		Entrada do Paciente na Sala Cirurgica					
		Saída do Paciente da Sala Cirurgica					
		Saída do Paciente do Centro Cirurgico					

were created for each specialty and their respective specialists to facilitate communication in the event of system issues, assist with operationalization, and provide other relevant information.

According to the managers, the system provides essential data and information for managing the surgical queue. This information is relevant and obtained in real time, which improves the decision-making process, planning for the acquisition of materials, and responding to legal demands from patients and public control agencies.

Therefore, it was necessary to complement the Surgical List module with the implementation of the Surgical Map module. This implementation is essential to allow integration with the operations room in the process of managing the patient waiting for surgery.

Developing the Surgical Map Module

The Surgical Map allows for the planning of surgical procedures, including information about patients, supplies, medical team, and surgical center. These elements form the basis of the surgical plan. The medical team must register the data in advance and maintain constant communication with the operations room staff. In this way, the operations room can analyze the information, clarify any doubts with the medical team, and make the necessary decisions for planning the operation.

With the implementation of the Surgical List module, we started to build the Surgical Map module, considering that the integration between the two modules will facilitate the professionals' routine, giving more agility and efficiency to the process.

The first stage began with an on-site observation of how the specialties participating in the pilot project, such as general surgery, otolaryngology, urology, mastology and gynecology, as well as the Surgical Center, operated the surgical map.

It was found that the surgical specialties used Google Drive® as a means to share patient information with the surgical center, which functioned as a surgical map.

We present screen templates of the Surgical Map module using the Microsoft Excel® program, as shown in Figure 3. These templates contain the information gathered to meet the needs of users, managers, and the activity process. We describe the specifications of each element to meet the system requirements. It is important to emphasize that the requirements served as a guide for the first version of the prototype, which was improved during the presentations to managers.

After the managers have approved the requirements that must be present in the Surgical Card, we implement in the SisCir-HUGG system all the necessary functionalities for the integration between the modules.

This functionality allows the physician or resident to send the patient who is first on the surgical queue, classified according to surgical specialty, surgical queue and registration date, to the surgical map. In cases where the patient is already on the Surgical Board and needs to return to the list, the system is configured to return the patient to the same position as before. However, if a patient at a lower position on the surgical list is sent to the operations room map, the resident or physician must justify why he or she is choosing that patient for surgery over others.

Figure 4 - Patient enrollment screen on the surgical map. Rio de Janeiro, RJ, Brazil, 2022

Source: The Author, 2022.

The screenshot shows a software interface for patient enrollment. The title bar reads "Enviar para o Mapa Cirúrgico". The form is organized into several sections:

- Patient Information:** Fields for "Prontuário", "Nome do Paciente", "Nascimento", "Idade", and "Sexo".
- Family and Origin:** Fields for "Nome da Mãe do Paciente", "C.N.S.", and "Origem do Paciente".
- Surgical Details:** Fields for "Data Cirurgia", "Hora Estimada", "Risco Cirúrgico" (dropdown), "Data R. Cirúrgico", "Congelamento" (dropdown with "NÃO" selected), "Hemoderivados" (dropdown with "NÃO" selected), and "Pós-Operatório" (dropdown).
- Procedure and Laterality:** A search bar for "Procedimento" and a dropdown for "Lateralidade".
- Medical Team and Needs:** A dropdown for "Equipe Médica" with a green checkmark icon, and a text area for "Necessidades do Procedimento".
- Buttons:** "OK" and "Cancelar" buttons at the bottom right.

To complete the surgery, the system automatically opens the registration screen where you can enter the necessary information, as shown in Figure 4.

After all the information has been entered, the system registers the patient in the surgical map, as shown in Figure 5, where the surgical staff can view the patient's data. In addition, the authorized user in the operations room can register the surgical situations by clicking the following button.

Implementing the Surgical Map Module

During the implementation of the surgical map module, HUGG managers held meetings and decided that all specialties, except those that participated in the pilot project, should start the migration process to use SisCir-HUGG.

For the services that were part of the pilot project, was conducted face-to-face training with doctors and residents of the respective specialties, using the SisCir-HUGG system that contained the patient information.

The training was conducted in a room equipped with a projector and a computer connected to the hospital's logical network, which allowed the system to be presented in real time. The trainers demonstrated all fields of the system and their functionalities. During the training, the registration, deletion and modification of the test patient's information were also performed in order to simulate different situations that the users may encounter in their environment. Each training session lasted two (2) hours.

CONCLUSION

During the implementation phase of SisCir-HUGG, several obstacles were faced. These obstacles included resistance to change, as the surgical services were used to having full autonomy in managing information and found it difficult to adapt to the new system. In addition, the initial number of participants in the training sessions was low, which affected the correct use of the system. There were also errors found in the system by users, which affected the reliability of the system, despite the efforts of the development team to correct them and provide feedback directly to users.

It's important to highlight some positive points observed during the implementation of SisCir-HUGG. First, the support of the hospital management was received, which was essential to overcome the barriers to acceptance of the system. In addition, the users were closely monitored through WhatsApp® groups during the surgeries and any questions that arose were responded. Constant communication with everyone involved in the process were maintained to make clear the importance of the system not only to the hospital, but also to each specialty in the management of surgical patients.

For the Operations room team, the development of the system provides improvements in surgical management. This is due to the inclusion of the pre-registered occupancy time of the rooms, which allows a more efficient planning in the availability of the necessary materials for the surgeries. The relevant information is described at least 48 hours in advance of each surgery.

Figure 5 - Patient registration data screen on the surgical map. Rio de Janeiro, RJ, Brazil, 2022

Source: The Author, 2022.

SALA	HORA ESTIMADA	ESPECIALIDADE	DATA/HORA DA INTERNAÇÃO	LOCAL DE INTERNAÇÃO	LEITO	RISCO CIRÚRGICO	DATA AVALIAÇÃO	CID	LADO
1	07:00	UROLOGIA	07/07/2022 13:49:00	ENFERMARIA 03	00517	ASA I	21/03/2022	N20.0	DIREITA
	07:00	UROLOGIA	10:34			ASA I	26/05/2022	N20.0	DIREITA
2	07:22	ORTOPEDIA E TRAUMATOLOGIA	29/06/2022 16:39:56	ENFERMARIA 07	00709	ASA II		T84.5	ESQUERDA
	07:30	OTORRINOLARINGOLOGIA	16:02			ASA I	17/05/2022	J33.9	AMBOS
6	08:00	CIRURGIA GERAL	07/07/2022 15:43:34	ENFERMARIA 06	00608	ASA II	30/05/2022	D48.1	DIREITA
3	08:00	OTORRINOLARINGOLOGIA	07/07/2022 14:22:00	ENFERMARIA 03	00318	ASA II	02/03/2022	J38.7	NÃO SE APLICA
7	08:00	CIRURGIA GERAL	07/07/2022 16:30:00	ENFERMARIA 06	00606	ASA II	12/01/2022	K40	ESQUERDA

The implementation of the system has changed the culture of information handling of surgical patients by the surgical clinics. This was reflected in an improvement in communication between the medical and nursing teams involved in the procedures, and it was possible to observe this change.

Another relevant point is that the implementation of the Surgery Management System at HUGG has enabled managers to have real-time visibility of surgical patient information, giving them immediate access to it.

In summary, based on the results obtained, it can be concluded that the implementation of the Surgery Management System has had a positive impact on the management of surgical patient information by HUGG's managers.

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