Digitization of Patient Records in Maxillofacial and Stomatology Surgery: A Case Study of the Maxillofacial and Stomatology Surgery Unit at Sominé Dolo Hospital in Mopti, Mali

Seydou Golo Barro[1,2(✉)], Aly Abdoulaye Guindo[1], Thioukany David Thera[3], Irénée Bamogo[1], and Cheick O. Bakayoko[4]

[1] Virtual University of Burkina Faso, Master e-Health and Telemedicine, Ouagadougou, Burkina Faso
seydou_golo@yahoo.fr
[2] Nazi Boni University, Bobo-Dioulasso, Burkina Faso
[3] Hôpital Sominé DOLO de Mopti, Sevare, Mali
[4] University of Science, Technology, Bamako, Bamako, Mali

Abstract. In healthcare facilities, data is collected and stored for traceability and subsequent use. The objective of this work is to develop an application for data collection and analysis in maxillofacial surgery. After a preliminary study on the needs. We used the UML language (Unified Modeling Language) to model the system. The 2TUP (Two Tracks Unified Process) process was used for analysis and design. The database created was implemented in Microsoft Access; Power BI was used for statistical analysis and data visualization. We have developed an Access data collection application and a Power BI application allowing easy and reliable visualization of the activity balance. Five hundred and fifty-eight (558) scanned patient records. Average age 30.44. Sex ratio 3.20 in favor of men. 419 patients consulted in emergency. Traumatic pathologies were more frequent 69.89%. 410 patients were operated on, 547 patients were satisfied with the surgical results. 3 theses were realized with the database. Our solution allows you to store, manage, share, and make statistical analyses dynamically and instantly of patient data in maxillofacial surgery and stomatology. The results have improved medical information management, clinical decision-making, and care planning.

Keywords: Numérisation dossier patient · Analyse et Colette de données · Application de chirurgie maxillo-faciale

1 Introduction

The medical approach is built upon patient observation and the monitoring of their condition [1]. In our daily medical practice, the recording of hospitalized, operated, or consulted patients, as well as various pathologies and procedures, is carried out manually, with the inherent risks of errors, omissions, and redundancies [2]. The hospital

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information system is a computerized system designed to facilitate the management of medical and administrative information within a hospital. It can improve and enhance the quality and efficiency of healthcare services [3].

Patient record data in healthcare facilities serve as a written record of clinical, biological, diagnostic, and therapeutic information obtained during a patient's medical journey. It is a tool for reflection, synthesis, planning, care traceability, and even research [4].

In a study evaluating Mali's Health Information System (HIS), it was found that the health information system in place in basic healthcare structures (Community Health Center, district level: Referral Health Center, and central services) collected data on paper before transferring it to electronic formats [5].

We have observed that computerized patient data in our hospitals, if they exist, are very superficial. They do not support adequate decision-making for policymakers, let alone provide specialists with the ability to address various research questions, both for student theses and articles for scientific publications. It is unfortunate that we repeatedly need to refer to the same patient records to extract a small part for specific needs. It is clear that all these processes do not harness the tremendous potential of Information and Communication Technologies (ICT), which are more necessary than ever to hope for a significant improvement in the healthcare system, particularly in computerized patient data [6].

The ease with which ICT can collect patient data, structure it, order it, analyze it, and distribute this information to geographically distant users on a wide range of computers makes it an obvious candidate for a technological solution for patient data collection and analysis systems [7]. Given the scarcity of patient data collection and analysis applications in our hospitals that take into account the specificity of each medical specialty, we propose to develop an application for collecting and analyzing patient data in maxillofacial and stomatology surgery. Specifically, we will focus on the Maxillofacial and Stomatology Surgery Unit at Sominé Dolo Hospital in Mopti, Mali. This will lead to the creation of a medical records database, enabling rapid cross-sectional record retrieval and statistical calculations to facilitate decision-making in maxillofacial and stomatology surgery. We asked ourselves how decision-making in maxillofacial and stomatology surgery could be facilitated by the use of patient data collection and analysis tools. We believe that using ICT tools for patient data collection and analysis can enhance the quality and reliability of rapid decision-making they enable. The goal of our work was to develop a patient data collection and analysis tool and create a computerized patient database to facilitate decision-making in maxillofacial and stomatology surgery at Sominé Dolo Hospital in Mopti.

2 Materials and Methods

2.1 Study Setting

Our study framework was the Sominé DOLO Hospital in Mopti which is the only second reference medico-surgical facility in the 5th Administrative Region of Mali. It is located in the administrative area of Sevaré on the edge of the national road 6 (RN6).

2.2 Existing Study

To be able to give an opinion on the existing system, we first sought to know and evaluate it; by analyzing. We analyzed workstations, patient records, and records (emergency room, operating room and hospitalization), as well as circulating information. This analysis enabled us to confirm that:

- At the end of each month and/or on request, the statistics are done manually before being sent to the hospital's health information system manager.
- And data collection during theses and scientific papers was also manual.

2.3 Criticism and Suggestions

We have identified the difficulties associated with the manual collection and analysis of patient data and propose a computerized solution for the collection and analysis of patient data.

2.4 Méthode de Résolution Problème

Modeling language. For modeling, we chose UML (Unified Modeling Language) is a unified object-oriented modeling language. It is a graphic formalism resulting from notations used in different methods of objects [8].

Analysis and design method. There are a multitude of analysis methods, among which we can mention SADT (Structured Analysis and Design Technique), MERISE (Method of Study and Realization Computer for Business Systems) and 2TUP (Two Tracks Unified Process). For our study, the method chosen is the 2TUP process. The process is structured around three essential phases:

- a technical branch.
- a functional branch.
- a phase of implementation [9, 10].

2.5 System Modelling

Use Case Diagram. Table 1 illustrates the identification of use cases and description of use cases.

Table 1. Identification and description of use cases

Actor	Use case	Description
Cashier and/or Secretary medical	Manage admissions	It allows you to manage different patient admissions
	Create a folder administrative	It allows you to create an administrative file. It allows you to generate a unique patient identifier: IdPatient

(*continued*)

Table 1. (*continued*)

Actor	Use case	Description
Cashier	Pay for the medico surgical procedure	It allows you to pay for procedures (medical-surgical and nursing care) after or before the patient has benefited from these medical-surgical procedures
Doctor specialist or Generalist or the internal	Update patient file	It allows the patient file to be updated during and after hospitalization
	Manage patient file data	It allows you to access patient data, make modifications, add information, or delete the record
	Create a new medical record	It allows the user to create a new patient record in the application This involves collecting all the information in a patient file from admission to discharge
Doctor specialist or generalist	Perform analyzes statistics	It allows statistical analysis and visualization of patient data in the form of a table, disk, histogram, radar, sunbeam, etc
Male nurse	Create a nursing file	Allows you to create a nursing care record
	Update the nursing file	It allows daily updating of the nursing file during the patient's hospitalization
Cashier, Secretary medical, Doctor specialist, generalist, Internal and admin	Authentication	It allows you to grant or not access to the application to a user
	Manage appointments	It allows you to see the available consultation days, make an appointment, make changes, or cancel an appointment
Admin	Managing rights in a hospital	The system analyst in a hospital allows you to manage user access rights according to their access levels in a hospital

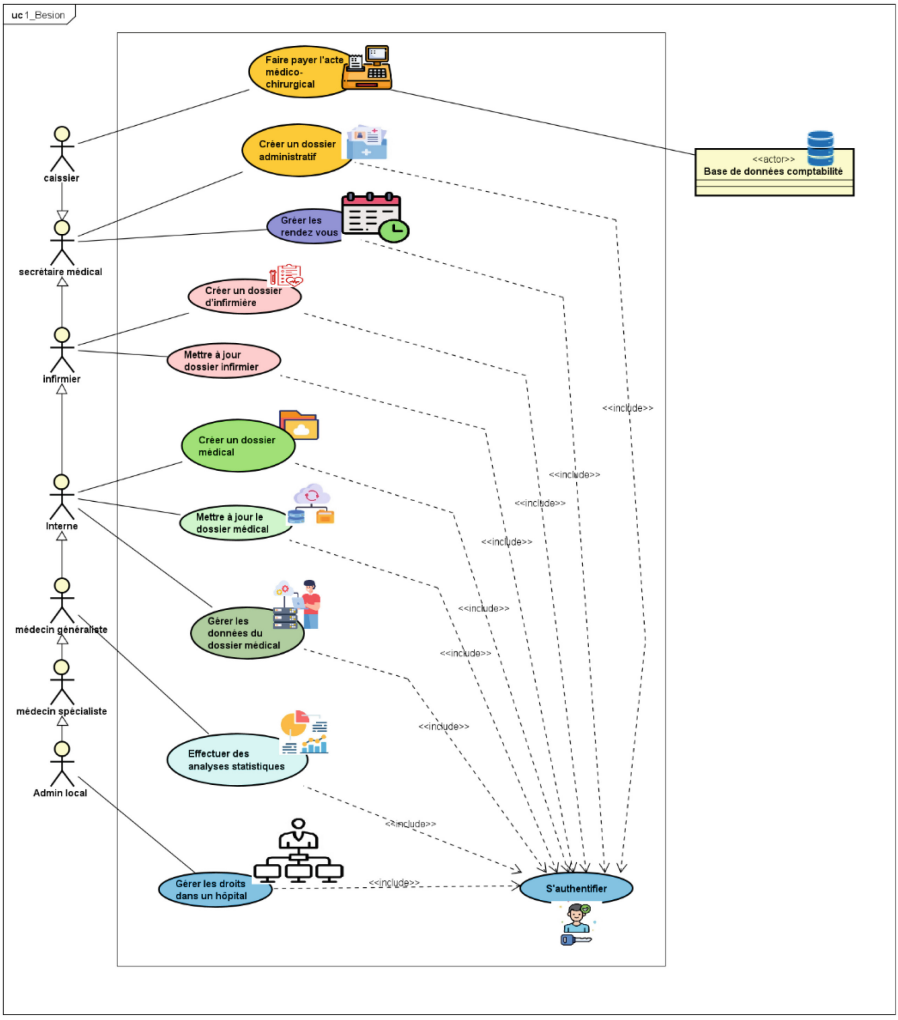

Fig. 1. Use case diagram

The use case diagram is illustrated by (Fig. 1).

Sequence Diagram. Sequence diagrams are the graphical representation of interactions between actors and the system in chronological order [11]. The (Fig. 3 and Fig. 4) illustrates sequence diagrams of normal use cases respectively <<Save a Consultation>> and <<perform statistical analysis statistiques>> (Fig. 2).

Class Diagram. La (Fig. 4) identifies and describes classes.

Package Diagram. Splitting the class diagram into a package makes it possible to group classes according to their functionality or domain, making system design clearer and more organized [12]. The (Fig. 5) shows the package diagram.

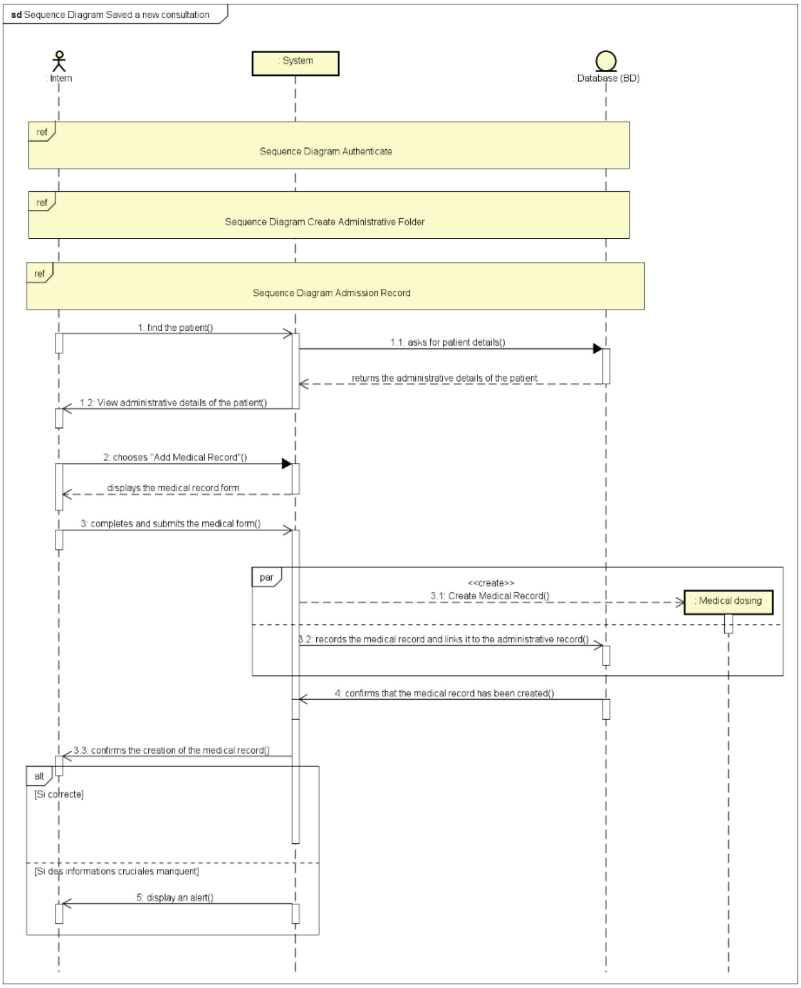

Fig. 2. Use Case Sequence Diagram <<Save a Consultation>>

Deployment Diagram. The deployment diagram is a static view that is used to represent how system components are distributed and their relationships between them [12, 13]. The latter is illustrated by the (Fig. 6).

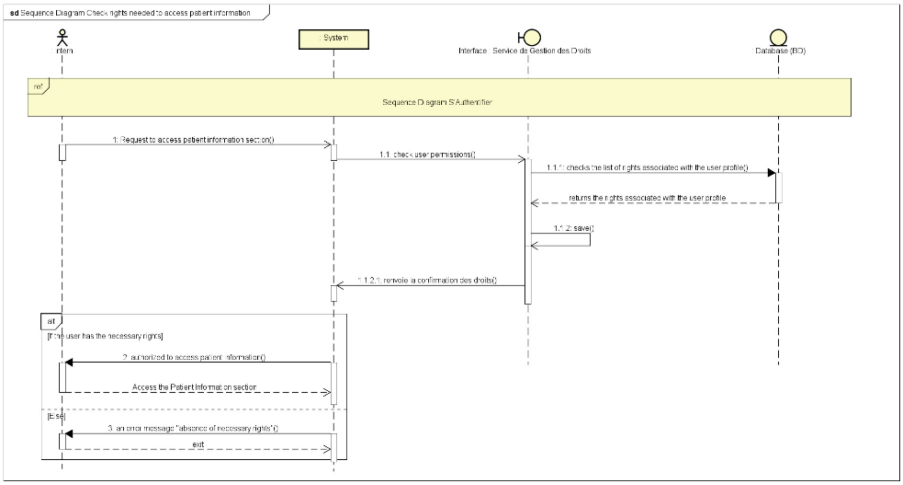

Fig. 3. Sequence Diagram Check rights needed to access patient information

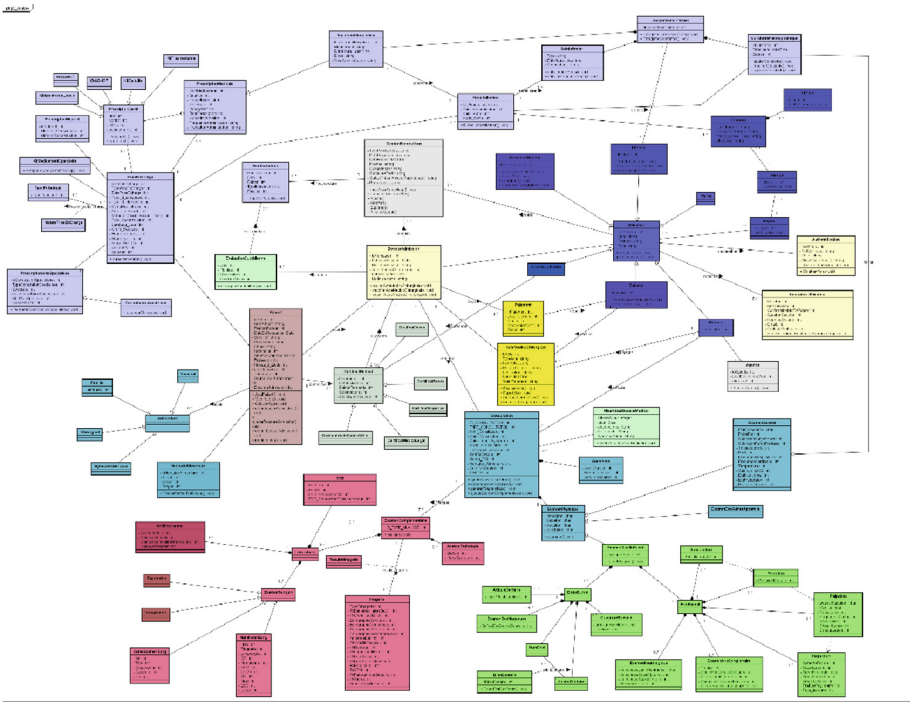

Fig. 4. Class diagram

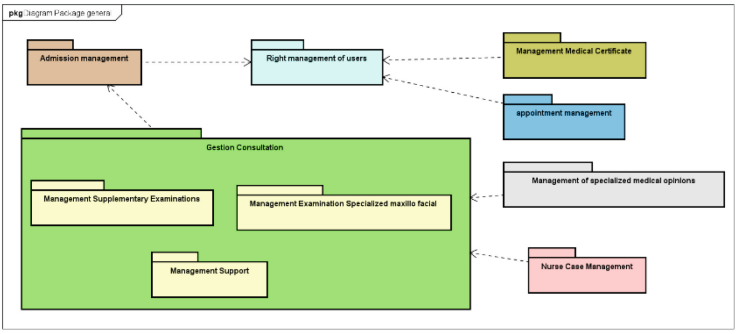

Fig. 5. Package diagram

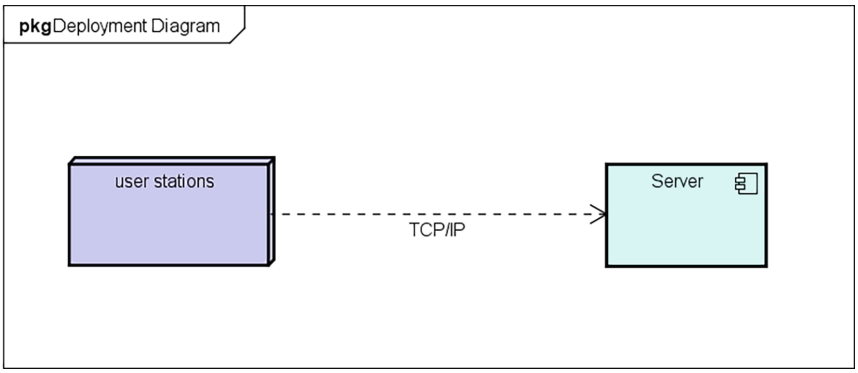

Fig. 6. Deployment diagram

2.6 Technologies Used

Data Collection. We chose Microsoft Access – relational then that it is easy to use and also it is part of the Office range that is essential for any user whether he is a student or professional [14, 15]. After the implementation of the database on Microsoft Access 365; we created forms to facilitate the recording, consultation and management of patient data.

Statistics and data analysis. With our solution we studied several parameters namely: age, sex, socio-economic level, number of patients per diagnosis, by type of intervention, by results of interventions, number of interventions per technique, number of research work by type, by student (theses and thesis) and or by doctor making requests concerning any activity in the department of maxillofacial surgery of stomatology: consultation, operating room, hospitalization and scientific research.

Power BI is a self-service business intelligence platform developed by Microsoft that enables the analysis, transformation and visualization of interactive data, providing advanced analytics and engaging visualizations. It mainly uses DAX (Data Analysis Expressions) for calculations and data modeling, as well as M Query for data transformation and SQL for database queries. By connecting to different data sources, Power BI aggregates data from EMR systems, SQL databases, and other sources, facilitating a comprehensive analysis of medical information. Power BI offers advanced security features, ensuring the privacy of sensitive medical information, as well as collaboration and sharing features, enabling healthcare professionals to work together and make decisions based on reliable, real-time data. In addition to its mobility through mobile applications, Po-wer BI can be integrated with other tools and processes, providing a scalable, automated and extensible solution for data management. For our solution, we chose Power BI to analyze and display our patient record data in maxillofacial surgery and stomatology and it does so in a visually understandable way, thanks to graphical visualizations, interactive dashboards and data segments [16].

For the above reasons; in our solution you expect to combine the power of these two Microsoft applications namely: Access 365 to create our future database that will be dynamically linked to Power BI. Through a Power BI dashboard, we will be able to use tables and graphs, dynamic cross-sections to make decisions in maxillofacial surgery and stomatology. We planned to make these tools functional in the maxillofacial surgery and stomatology unit of the Sominé Dolo hospital in Mopti.

Validation test and application evaluation. Verification and validation of all steps before proceeding to testing.

In order to evaluate the functionality of our application, we will collect patient data from the maxillofacial surgery and stomatology unit of the Sominé Dolo Hospital of Mopti from March 2016 to June 2023. Were included in our test all patients admitted to the unit of maxillofacial surgery and stomatology of the hospital Sominé Dolo of Mopti which we will find the medical record. Patients with incomplete records will be excluded.

We intend to extract data from three medical theses in this database.

3 Résultat

3.1 Patient Data Collection Access Application

Presentation of Some Interfaces. <<Authentication>> interface: It allows users to authenticate to access their personal spaces by entering their username and valid password. As the (Fig. 7).

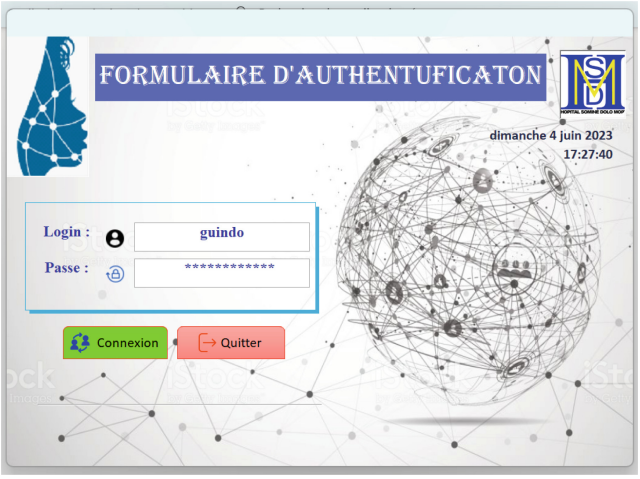

Fig. 7. Authentication

Interface «Home» once the health staff (the cashier or the medical or internal secretary or the doctor) has authenticated; according to its level of access, it accesses its space shown by the (Fig. 8) Next. It can perform the following tasks among others: Saves a new consultation (Fig. 9); follow up and update a patient record (Fig. 11) manage patient data (Fig. 10) and perform statistical analyses (Fig. 12).

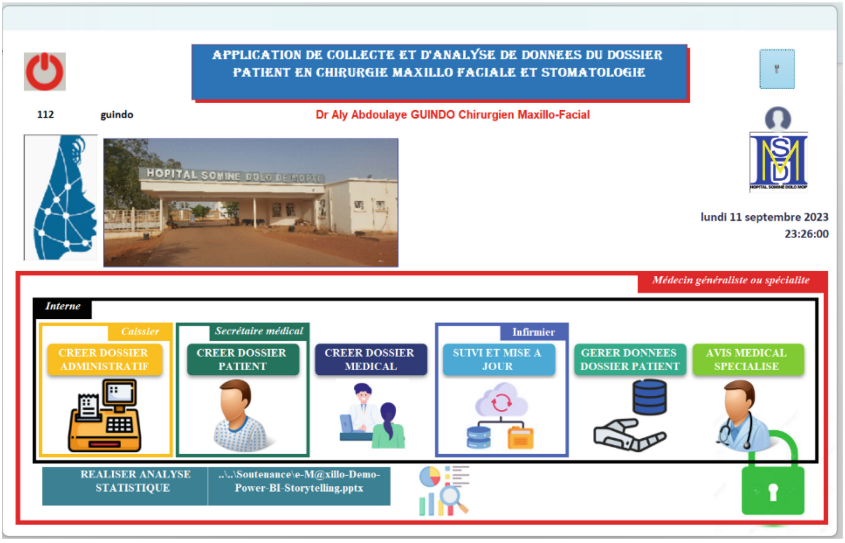

Fig. 8. Authentication

Interface “Main interface for saving a new consultation” (Fig. 9).

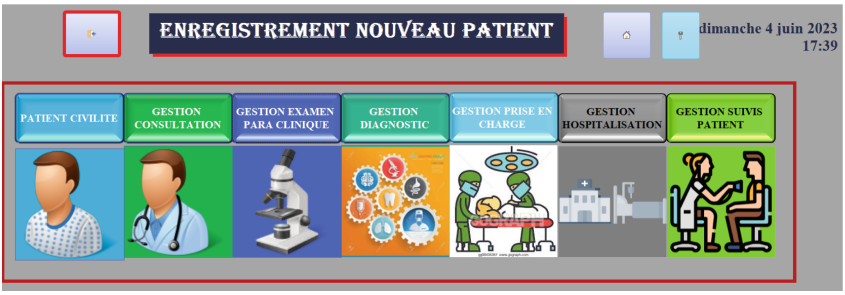

Fig. 9. Main interface for saving a new consultation.

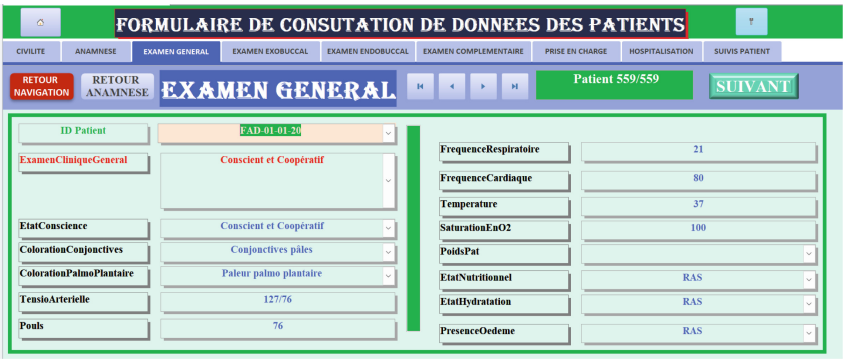

Fig. 10. Consultation of medical data (medical file)

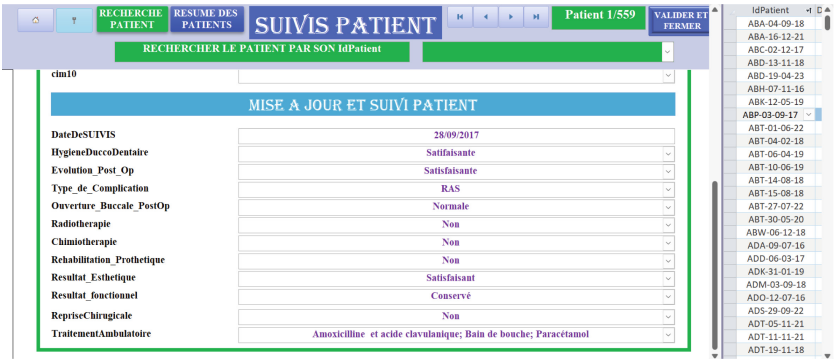

Fig. 11. Patient Tracker Interface for Folder Update

3.2 Power BI Application for Business Balance Visualization

From the <<Home>> interface of the Access application, we can access the Power BI application; in order to perform statistical analyses and display the data of the patient record. Once (the doctor) has authenticated, he can access his space on different terminals (desktop, laptop, tablet or smartphone). They can perform tasks such as:

Global visualization of all quantitative and qualitative patient data variables in the database at a glance through its dashboard illustrated by (Fig. 12).

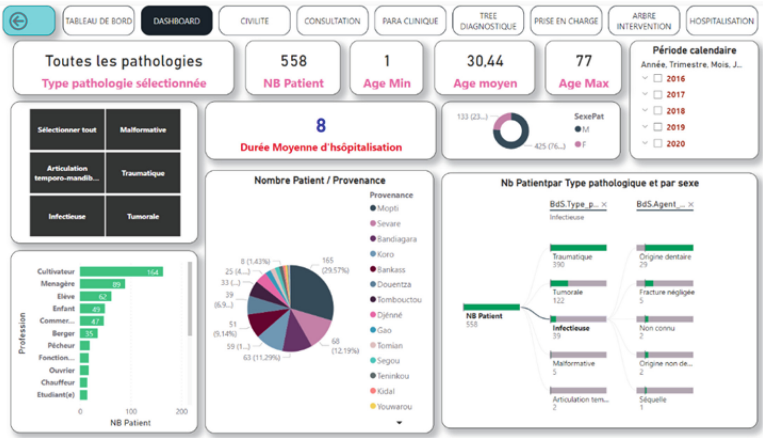

Fig. 12. Overall statistical analysis of patient record data

A click on a view allows you to dynamically analyze and visualize statistics by pathology, causal agent, diagnostic and patient. As illustrated by the (Fig. 13).

Fig. 13. Statistical analysis of patient record data by type of pathology

Clicking on a “type of pathology” (traumatic example) and a “type of causal agent” (firearm example) allows you to dynamically analyze and visualize the statistics of the pathology and causal agent (Fig. 14).

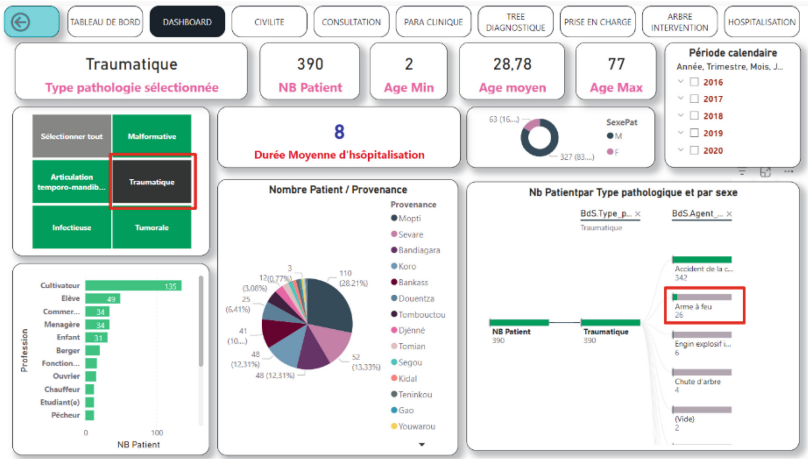

Fig. 14. Statistical analysis of patient record data by causal agent type

3.3 Summary of the Main Results of the Statistical Analyses

Between the 2016 and 2023 patient records, 558 patient records were saved. The age of the patients ranged from 1 to 77 years, with an average of 30.44 years. Men were the majority, with 425 male patients versus 133 female patients with a sex ratio of 3.20 in favor of men. Farmers were the dominant profession among patients, with 164 patients, followed by housewives with 89 patients. The level of education was predominant among out-of-school 316 patients, followed by secondary level 106 patients, primary 89 patients, Superior 25 patients. The majority of patients (89.61%) had their management funded by their fa-mille. Emergency consultations accounted for the majority of cases (419 patients), followed by outpatient consultations (138 patients). Traumatic pathologies were the most frequent (69.89%), followed by tumor pathologies (21.86%), infectious pathology (6.99%), malformative pathology (0.9%) and pathologies of the temporo-mandibular joints (0.36%). We recorded 2 patients with facial paralysis, 3 patients with non-cancerous salivary pathologies. CT scans were the most commonly performed imaging exam (53.05%), followed by X-rays of the lower faces and maxillae with right and left scrolls (10.57%). The majority of patients were blood type (O) and rhesus positive (40.14%), followed by (21.86%) blood type (B) and rhesus (+), (20.61%) were san-guin group and rhesus (A+). Of the patients who underwent surgery, 410 were operated on in an emergency situation, compared with 144 patients who were operated on after the programme. General anesthesia with orotracheal intubation was predominant (43.19%), followed by general anesthesia with nasal intubation (39.78%), local anesthesia (11.29%). The average duration of surgery was 3 h with extremes between (less than 1 to 8 h). The most common route was the endo-oral translesional route alone (99 patients), followed by the endo-oral and exo-oral route (96 patients), and the exo-oral route alone (78 patients). The majority of patients were medically discharged (98.3%), some deaths (0.9%), transfers to other services (0.36%) and (0.36%) discharge against medical advice. During the postoperative follow-ups 547 of our patients were satisfied with the surgical results, insufficient results in 8 patients, 3 failures were observed in our

series. The scientific activity of the maxillofacial unit in 2023 included 3 general medical theses respectfully on ballistic trauma, road traffic accident trauma and odontogenic tumors.

3.4 Security Policies

We have adopted some good practices to ensure the security of digitized data, namely to secure access to digitized data by limiting its access to authorized persons. This by implementing so-called authentication controls; our data is regularly backed up to the cloud since we use the OneDrive of MS office 365 to minimize data loss in the event of a system failure or cyber-securityattacks; access permissions are granted according to the user's needs. Its access authorisations are reviewed regularly to ensure that users only have access to the data they need. This is done through the retrieval of connection histories; users are trained and made aware of good security practices, such as securing their passwords and using Wi-Fi networksSecure fi to avoid the risk of hacking and regular updating of software to fix security vulnerabilities and vulnerabilities.

4 Discussion

The objective of this work was to digitize the patient file data in maxillofacial surgery and stomatology at the Sominé Dolo Hospital in Mopti, Mali, in order to facilitate clinical decision-making. The results obtained highlighted the effectiveness of the patient data collection and analysis tool as well as the computerized database created. In addition, the Power BI application allowed a user-friendly and reliable visualization of the unit's activity balance.

At present, several computer applications specialized in the management of medical records have been studied. For example, the Cake Framework model MVC was used to explore the activity within the maxillofacial and aesthetic surgery department of Ibn Tofail Hospital, CHU Mohamed VI, Marrakech. Although efficient, it allows free text entry in certain fields, which can complicate the analysis of qualitative variables [2]. The eMe-diNexus app in India enables complete digitization of patient records and offers telemedicine features, but its limited geographical availability and telemedicine regulations can be obstacles [17]. Anatomage offers 3D scanning and pre-operative planning solutions, but their high cost can be prohibitive [18]. Other applications like Cinz@n in Mali [19], DHIS2 in West Africa [20], Epic Systems and CareCloud offer medical records management features, but they are not specifically specialized in maxillofacial surgery and stomatology [21, 22].

In our solution, we opted for efficient modeling of patient record data to minimize redundancies, input errors, and facilitate statistical analyses of qualitative variables. Thus, only first and last names and quantitative variables require manual entry, while other information is selected from drop-down lists. This approach improves data quality and facilitates research in maxillofacial surgery and stomatology.

Statistical analyses revealed several important elements. First, the male predominance among patients is consistent with other studies in the field [2, 23, 24]. Traumatic pathologies were the most frequent, followed by tumor and infectious pathologies, thus

emphasizing the importance of trauma and tumor management in this specialty. The frequent use of computed tomography (CT) and radiographs demonstrates the importance of imaging in the diagnosis and planning of interventions. The high level of patient satisfaction with the surgical outcomes is a testament to the effectiveness of the interventions performed within the unit.

The digitization of the patient record has significantly improved the management of medical information, promoting better coordination of care and providing a reliable source of information for health planning and policy. The introduction of the patient data collection and analysis tool as well as the Power BI application greatly facilitated clinical decision making. Dynamic dashboards enabled professionals to quickly visualize activity data, leading to better resource management and more informed decisions.

However, our work has limitations, including Microsoft Access's limited ability to handle large amounts of data and its level of security. In addition, our solution currently only covers the maxillofacial and stomatology surgery unit, and does not support other hospital services and specialties. We plan to correct these limitations by developing a web version of our solution.

This study showed that the digitization of the patient record in maxillofacial surgery and stomatology offers many benefits for medical data management, clinical decision making, and research in this area. Effective data modelling and the use of tools such as Power BI have contributed to the improvement of medical practice within the unit. However, challenges remain for wider implementation and continuous improvement of the solution.

5 Conclusion

The digitization of the patient record in maxillofacial surgery allows a better management of medical data, their centralization, their accessibility and their sharing between the different health professionals involved in the management of the patient. It provides quick and easy access to all the patient's medical information, facilitating diagnosis, management, planning and scientific research. It also reduces the costs associated with patient record management, such as storage, transportation and paper records management costs. Finally, the digitization of the patient record in maxillofacial surgery allows a better traceability of the patient's medical information, which improves the quality and safety of care, and thus contributes to the satisfaction of the patient and all health professionals involved in its management. In addition to the ergonomics it offers, this application provides an innovative solution to facilitate decision-making in maxillofacial surgery and stomatology at Sominé Dolo Hospital from. Mopti.

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