APPLICATION FOR HEALTH RECORD INTEGRATION: A PROPOSAL FOR MICRO-MUNICIPALITIES BASED ON LITERATURE

APLICATIVO PARA INTEGRAÇÃO DE PRONTUÁRIO DE SAÚDE: UMA PROPOSTA PARA MICROMUNICÍPIOS

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ABSTRACT: Health records play a crucial role in organizing healthcare services and ensuring the quality of public care. The computerized integration of these records can bring significant benefits to the sector. **Objective:** To present a proposal for a computerized system for integrating health records in public care, based on a bibliographic review. **Method:** An integrative literature review was conducted to support the proposal. **Results:** Based on the review, a unified architecture utilizing cloud computing and microservices was proposed to optimize healthcare management. This ensures scalability, flexibility, and interoperability, fostering efficient integration among providers, patients, and the government, while meeting the demands of an evolving system. **Conclusions:** The integration of health records is feasible and has the potential to enhance accuracy, speed, and efficiency in healthcare services, underscoring its importance in clinical practice and public health management.

KEYWORDS: Public health. Colletctive health. Application. Medical record.

RESUMO: Os prontuários de saúde desempenham um papel essencial na organização dos serviços de saúde e na qualidade do atendimento público. A integração informatizada desses prontuários pode trazer benefícios significativos para o setor. **Objetivo:** Apresentar uma proposta de sistema informatizado para a integração de prontuários de saúde no atendimento público, com base em revisão bibliográfica. **Método:** Foi realizada uma revisão integrativa da literatura para fundamentar a proposta. **Resultados:** com base na revisão, foi possível propor uma arquitetura unificada baseada em nuvem e micro serviços otimiza a gestão do sistema de saúde, garantindo escalabilidade, flexibilidade e interoperabilidade, promovendo integração eficiente entre provedores, pacientes e governo, atendendo às demandas de um sistema em constante evolução. **Conclusões:** A integração de prontuários de saúde é viável e apresenta potencial para aumentar a assertividade, rapidez e eficiência nos serviços de saúde, destacando sua importância na prática clínica e na gestão de saúde pública.

PALAVRAS-CHAVE: Saúde pública. Saúde coletiva. Aplicativo. Prontuário.

INTRODUCTION

Technology has brought significant advances in various fields, including health. The use of Information and Communication Technology (ICT) has enabled the rapid analysis of large volumes of data, which is essential for the efficiency of health services. In Brazil, the Unified Health System (SUS) offers universal care, ranging from primary care to more complex procedures, distributed across different health institutions that use proprietary registration systems.

However, the lack of integration between these systems results in the dispersion of patient data, stored in non-integrated electronic medical records. This fragmentation hinders a comprehensive view of patients' medical conditions and care processes, as highlighted by Bates (2022). Integrating these records would allow for more efficient management, improved clinical decision-making, streamlined workflows, and reduced operational costs such as printing materials and professionals' time.

Centralizing data in a computerized system not only avoids unnecessary and repeated procedures but also facilitates access to information by doctors and patients, promoting cost-effectiveness in the use of public health resources. This project proposes an integrated health record system based on a bibliographic review, aiming for initial application in micro-municipalities in the Bauru region, São Paulo State, to enhance the management of medical-hospital services in resource-limited areas.

LITERATURE REVIEW

A comprehensive search was conducted using theses, dissertations, monographs, and scientific articles available on digital platforms indexed in databases such as the Scientific Electronic Library Online (SciELO) and the Virtual Health Library (VHL), generating the following theoretical foundations:

PUBLIC HEALTH

Public health in Brazil is a long-standing debate that gained prominence in 1976. The SUS (Unified Health System), established in 1988, represents a model of universal and free public healthcare that aims to promote equity, prevent diseases, and prioritize health promotion (Carvalho, 2013). Despite the challenges, SUS plays a crucial role in improving the quality of life for the population, exemplifying solidarity and care within the country (Carvalho, 2013). The diversity of state and municipal systems in Brazil is recognized, and it is important to gain greater clarity and understanding of this context through bibliographic review (Carvalho, 2013).

INFORMATION SYSTEMS

Information systems are fundamental in transforming data from various sources into applicable knowledge, essential for making equitable decisions. Electronic medical records, technologies derived from these systems, store and organize clinical and healthcare information about patients, facilitating planning, control, coordination, and analysis in organizations (Sampaio, 2017).

The collaboration between informatics and nursing aims to integrate knowledge, information, and technology to ensure effective and humanized patient care (Palomares; Marques, 2010; Mendes et al., 2018; Toledo et al., 2021). The medical record, which means "a place for things necessary at any

moment," gathers crucial data about the health and care of the patient (Patrício et al., 2011; Câneo; Rondina, 2014).

Florence Nightingale, a pioneer in nursing, highlighted the importance of hospital records to assess the efficient use of resources (Patrício et al., 2011). The electronic medical record, accessible to patients and healthcare professionals, centralizes clinical data from multiple sources for quick and organized retrieval (Patrício et al., 2011; Gonçalves et al., 2013; Câneo; Rondina, 2014; Santos; Marin, 2018; Sato et al., 2018).

Although it brings managerial and healthcare benefits, the implementation of electronic medical records faces challenges in large institutions due to resistance to change among staff, highlighting the need for adequate training and capacity building (Silva et al., 2019; Ávila et al., 2021; Gomes, 2021).

The development of electronic medical records must follow regulations such as the Normative Resolution (RN) No. 114 (ANS, 2005b), enhanced by RN No. 153 (ANS, 2007), which standardize the electronic exchange of healthcare information (Viola, 2019; Santos et al., 2021). These regulations aim to facilitate the sharing and exchange of electronic records between different sectors and healthcare service delivery models.

The organization of the Electronic Health Record (EHR) involves structuring sections, formats, and data to ensure portability, archiving, and secondary uses. The data, both structured and unstructured, cover clinical, administrative, reference, and contextual aspects, supporting multiple coding systems and a unique representation of information, including text. Clinical processes such as reasoning, decision support, guidelines, protocols, and quality assurance are integrated into care and services, along with the capture, retrieval, and presentation of data, with scalability and communication assured by message exchange. Privacy and security are ensured by access control, data integrity, and auditing, complying with medico-legal requirements. The identification of actors, such as patients and doctors, is crucial, preserving clinical responsibility and competence, with version control and fidelity in records. Ethics and cultural and consumer issues are also supported, ensuring ethical justification and respect for cultural demands. Finally, there is support for the evolution of the architecture and system of the EHR (Schloeffel et al., 2006).

As mentioned above, data security and privacy are part of the healthcare service and medical record, as these are personal and sensitive information stored (Ricarte, 2020).

The SUS, like other health systems, faces fragmentation that results in discontinuity in care and information, a global concern both health-wise and economically (Gonçalves et al., 2013; Coelho; Andreazza; Chioro, 2021). Studies such as those by Cunha (2005) and Patrício et al. (2011) highlight the importance of integrating health systems, a topic also addressed in Europe and the United States (Gröne; Garcia-Barbero, 2001; Leichsenring, 2004; Sagar, 2006; Cash-Gibson; Rosenmoller, 2014; Stark et al., 2019).

A study applied the Data Integration Process (DIP) to integrate multiple data sources from traffic accidents, improving the management of related activities and providing an integrated accident reporting and healthcare system (Abulatif, 2018). Another study showed that the use of the National Health Registry (CNS) and the Brazilian Individual Taxpayer Registry (CPF) facilitated the relationship between databases for monitoring women with suspicious mammograms (Tomazelli; Girianelli; Silva, 2018). Furthermore, strategies such as the relationship between the SIM (Mortality Information System) and Sinasc (Live Births Information System) improved the quality of database foundations and analysis of infant mortality (Maia et al., 2017).

These examples reinforce the importance of data integration in healthcare, evidenced by the operation of various Health Information Systems (SIS) in Brazil, collecting information through decentralized Information Technology (IT) (Coelho; Chioro, 2021).

MICRO-MUNICIPALITIES

Municipalities in Brazil are classified by the Brazilian Institute of Geography and Statistics (IBGE) as urban (over 25,000 inhabitants), rural (up to 25,000 inhabitants), and intermediate (up to 10,000 inhabitants). Micro-municipalities often face marginalization by federal units, lacking significant support for structural and technological development, including health information systems. This justifies the need for an integrated health information system based on open-source technology.

OPEN SOURCE SYSTEMS

Open source is a publicly accessible model developed from studies and research across various projects and standards, aiming to be a generic and easily applicable model, including data hierarchization such as RES (Dias, 2019). It is versatile, with applications in various fields, including healthcare, such as in electronic medical records (Dias, 2019). Its main objectives include promoting interoperability in health information systems and developing open standards, archetypes, and terminologies, seeking harmonization between ISO, CEN, and HL7 models (Dias, 2019).

METHODOLOGY

STUDY DESIGN

This study is an integrative literature review, a research method that seeks to synthesize the results obtained in previous studies and provide a conclusion on a given topic or guiding question (Mendes et al., 2018).

METHODOLOGICAL FRAMEWORK AND RESPECTIVE STEPS

To construct this review, the following methodological steps were followed: development of the guiding question, search for primary studies in databases, data extraction from studies, evaluation of selected studies, analysis and synthesis of results, and presentation of the review (Mendes et al., 2018). The defined guiding question was: "What is the importance of integrating digital health data and how can it be effectively and affordably achieved?"

National primary and secondary articles, fully available in open-access systems and published between 2010 and 2023, addressing data integration in electronic medical record systems were included. The search was conducted between September and October 2023, excluding articles that did not meet the guiding question after a full reading.

The selected journals were indexed in the Scientific Electronic Library Online (SciELO) and the Virtual Health Library (VHL) databases due to their scope and quality. Descriptors such as data

integration, electronic medical record, and health system were used, combined with "AND" and their synonyms with "OR."

The initial selection of studies was based on the analysis of titles and abstracts, including those meeting the inclusion criteria. The final selection involved a full reading of the articles. For data collection and analysis, a standardized form was used, including variables such as title, authors, year of publication, study design, main results, and recommendations.

Based on the information gathered from the publications, an analysis was conducted of studies that could contribute to the proposal of a computational system for health data integration, which served as the criterion for final article inclusion.

RESULTS

The selection of articles initially included 10,227 studies according to the inclusion criteria applied for this research, as shown in Table 1. Of these, 128 were excluded for being duplicates, i.e., available in more than one database. A total of 28 studies were selected for full reading; however, only 20 made up the final sample, as shown in Figure 1 and Table 2.

Search STRINGs	SCIELO	BVS
Data Integration AND Electronic Health Record	10	343
Data Integration AND Health System	216	983
Electronic Health Record AND Health System	46	8.629
TOTAL	272	9.955

Table 1 – Survey of Primary Studies in the SCIELO and BVS Databases, 2023.
Source: Authors of the study

Regarding the time span of the studies, 2021 stood out with six articles (30%), followed by 2018 and 2019 with four (20%) and three articles (15%), respectively. In 2017, two articles were found (10%), and for the years 2010, 2011, 2013, 2014, and 2020, one article was identified for each year (representing 1% of the articles in each year).
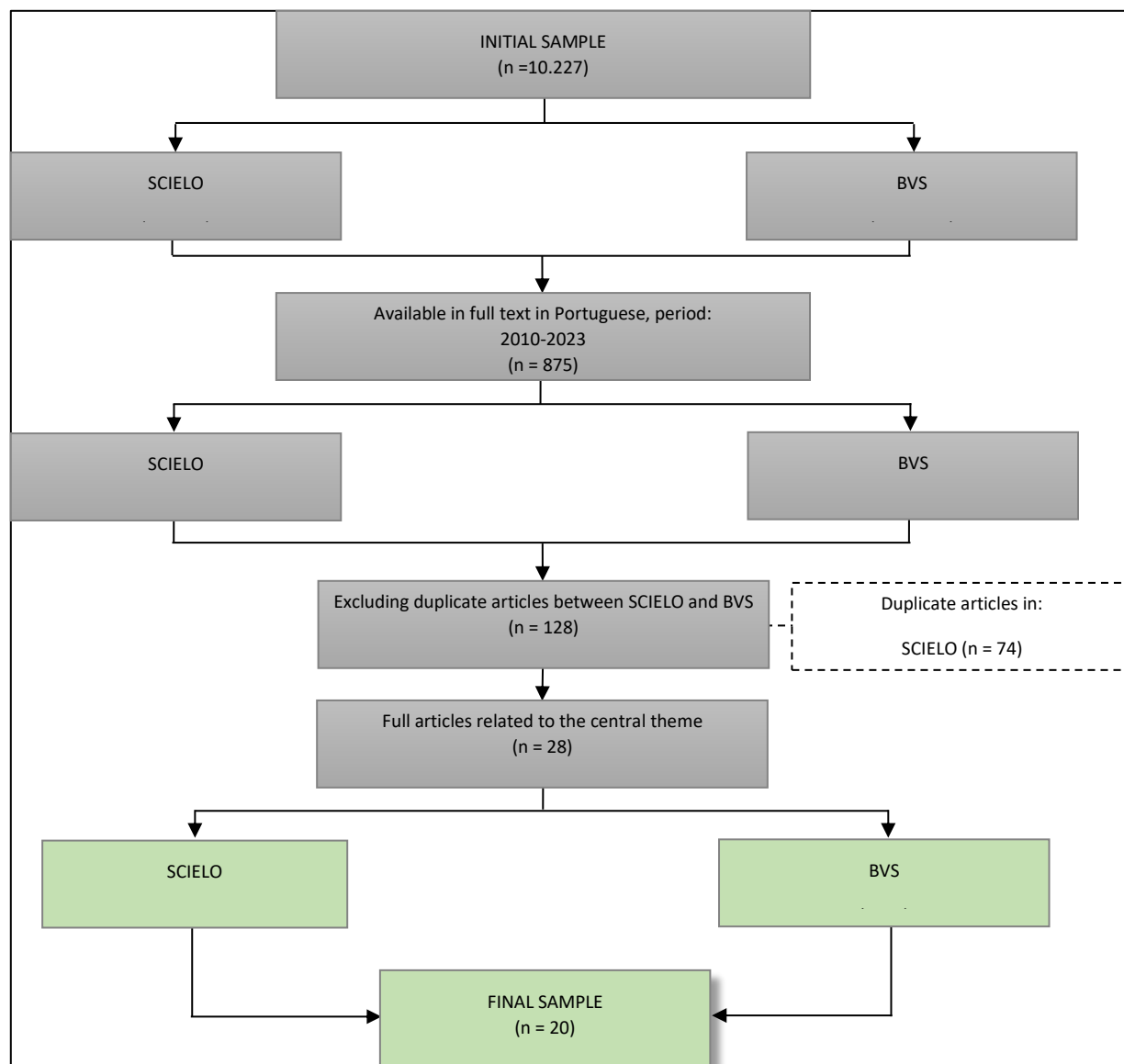
Figure 1 – Flowchart of the selection process for articles in the integrative review
Source: Authors of the study

The main results of the twenty selected studies are presented below, including information on authors and year of publication, article title, objective, study design, main results, and discussions:

Palomares and Marques (2010) - Literature review on computational systems in the Systematization of Nursing Care, highlighting time optimization, organization, standardized language, decision-making support, and multiprofessional integration.

1. Patrício et al. (2011) - Analysis of Electronic Health Records (EHR), discussing advantages such as quick access to patient information and ethical and implementation challenges.
2. Gonçalves et al. (2013) - Quantitative study on the accessibility of electronic health records in primary healthcare, revealing deficiencies in their adequate availability.
3. Câneo and Rondina (2014) - Exploratory evaluation of the advantages and disadvantages of electronic health record systems, emphasizing quick data access and resistance from professionals to technology.
4. Maia et al. (2017) - Contribution of linkage between live birth and infant death databases to improving variable completeness in the Mortality and Live Birth Information Systems.

5. Sampaio (2017) - Development and evaluation of improvements for the Simplified Data Collection (SDC) module of e-SUS AB, focusing on the quality of data entered by community health agents.
6. Abulatif (2018) - Management of integrating multiple traffic accident databases, significantly increasing victim count accuracy.
7. Santos and Marin (2018) - Analysis of hospital managers' use of an information system, showing high satisfaction with the system's utility and ease of use.
8. Sato et al. (2018) - Description of adverse events following vaccination in children and trend analysis, highlighting common event rates and types.
9. Tomazelli, Girianelli, and Silva (2018) - Strategies for linking SUS databases for breast cancer control, achieving high sensitivity in the linkage strategy.
10. Dias (2019) - Qualitative study on the interoperability of the TISS standard and the dual model of the openEHR Foundation, proposing improvements to the TISS standard based on the patient-centered RES.
11. Silva et al. (2019) - Contributions of hospital digitization, emphasizing institutional legitimization and work organization with electronic health records.
12. Viola (2019) - Development and validation of an instrument to analyze the Citizen's Electronic Health Record (PEC) of the e-SUS AB Strategy using the Delphi Technique.
13. Ricarte (2020) - Perceptions of privacy in national electronic health record systems, exploring ethical and security issues.
14. Avila et al. (2021) - Analysis of the diffusion of the Citizen's Electronic Health Record in family health teams, identifying factors that enhance and hinder its adoption.
15. Coelho and Chioro (2021) - Identification and analysis of Health Information Systems (HIS) in Brazil, highlighting different operational logics.
16. Coelho, Andreza, and Chioro (2021) - Evaluation of the integration of the Citizen's Electronic Health Record with other National Health Information Systems, revealing fragmentation challenges.
17. Gomes et al. (2021) - Analysis of factors influencing the diffusion of the Citizen's Electronic Health Record, emphasizing communication channels and professional resistance.
18. Santos et al. (2021) - Experience in implementing the PEC e-SUS AB in Rio de Janeiro, addressing challenges and benefits for managers and health teams.
19. Toledo et al. (2021) - Systematic review on the use of the Electronic Patient Record (EPR), highlighting challenges such as underuse and professional resistance.

These studies provide a comprehensive overview of different aspects related to data integration in health systems and the use of electronic health records, addressing operational benefits as well as ethical and technical challenges. Although all studies adhering to the principles and guidelines of the National Humanization Policy (PNH) were included, they remain incipient.

Based on the analysis of the selected studies and in line with the guiding question, two factors related to the integration of health records were identified: (1) "What is the importance of integrating digital health data?" and (2) "How can it be effectively and accessibly implemented?" (Figure 2).
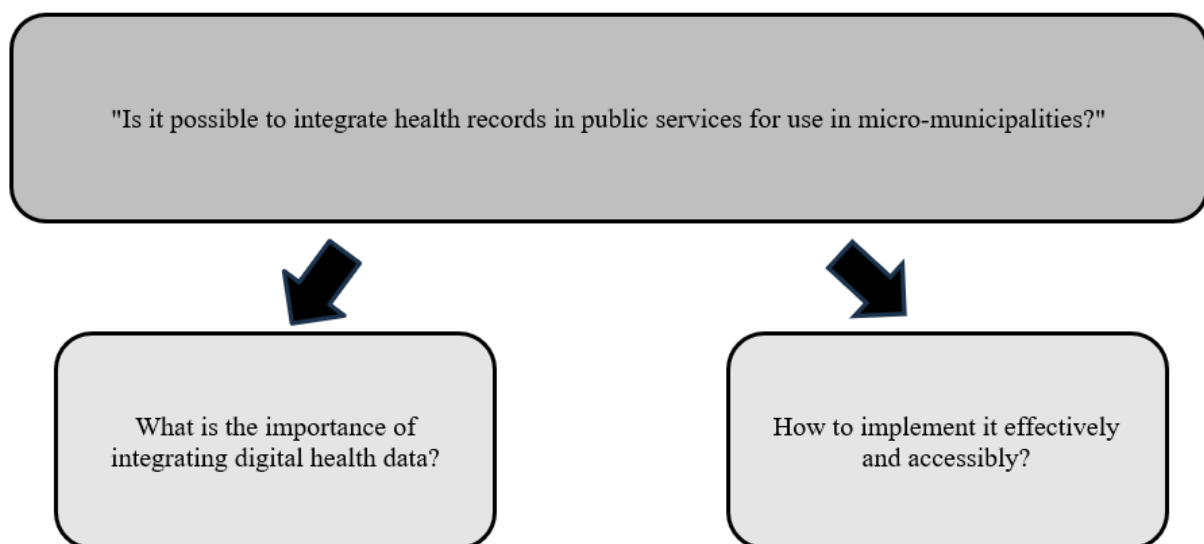
Figure 2 – Flowchart of the grouping of key points. Bauru, SP, Brazil.
Source: Authors of the study

Based on the evaluated articles, a viable system for addressing the demands would be one with a cloud-based architecture and microservices to unify the health system of a country, designed to ensure scalability, flexibility, and interoperability between different systems. A public cloud, such as AWS, Azure, or Google Cloud, would serve as the infrastructure foundation, offering managed services for the storage, processing, and security of health data. The architecture would be divided into microservices, each responsible for a specific set of functions, such as managing electronic health records (EHR), appointment scheduling, e-prescriptions, billing, and hospital administration.

Each microservice would be independent and accessible via RESTful APIs or Google Remote Procedure Call (gRPC), facilitating integration between new and legacy systems. The use of containers, such as Docker, managed by orchestration platforms like Kubernetes, would ensure that these services are easily deployable, automatically scalable, and isolated in the event of a failure, enhancing the system's resilience. To handle sensitive data, cloud security services, such as data encryption both at rest and in transit, multifactor authentication, role-based access control (RBAC), and detailed action auditing, would be essential to ensure privacy and compliance with regulations such as the General Data Protection Law (GDPR).

The use of distributed databases, such as MongoDB or PostgreSQL in clusters, would allow the efficient storage of large volumes of clinical and administrative data. The architecture would also support multiple health coding standards, such as HL7 and FHIR, enabling interoperability between different healthcare providers, laboratories, pharmacies, and government. Additionally, data analysis and artificial intelligence tools could be integrated to provide real-time insights, supporting clinical and public health strategic decisions.

This unified architecture would connect hospitals, clinics, pharmacies, healthcare professionals, and patients, allowing for the efficient and secure exchange of information. Communication between different points in the system would be facilitated by message buses, such as Kafka or RabbitMQ, ensuring the fast and reliable exchange of data between services. Finally, the use of infrastructure as code (IaC), with tools like Terraform or Ansible, would enable the automation of deployments and infrastructure management, reducing operational complexity and allowing for quick adaptation to the evolving needs of the healthcare system.

DISCUSSION

In the healthcare field, the growing presence of technology is evident, especially in electronic health records that facilitate care and in various information and notification systems. However, there is ongoing discussion about the need to integrate these data to improve care and streamline services. As highlighted by Coelho and Chioro (2021a), Brazil has 54 fragmented health information systems, which complicates the application of the holistic care model advocated by the SUS. In countries across the Americas and Europe, the debate is growing about unifying information systems to facilitate the exchange of information and enable more accurate diagnoses (Maia et al., 2017).

In addition to being a technological, legislative, and governmental challenge, the main concern lies in the security of patient data, which could potentially be accessible to all authorized healthcare professionals. Questions arise about the feasibility of translating data between existing platforms or developing a single software with a unified database for both public and private systems. Both approaches are considered ideal but utopian, requiring governmental decisions for implementation.

The creation and development of information systems are neither simple nor economical. It requires a large investment of time and resources to translate all data into a single platform. Although free open-source options exist, they often require technical intervention to meet specific needs and enhance security (Dias, 2019).

A viable strategy would be to start with the creation of a prototype and conduct tests in small municipalities, where the smaller volume of data would facilitate initial collection and evaluation of the system. This approach could serve as a pilot for future large-scale implementations.

CONCLUSION

Based on the results obtained in this scientific research, it is possible to verify the potential for developing an integration of health records and, more than that, the importance of this data integration due to the accuracy of diagnoses, as well as the increased speed and efficiency of healthcare services.

In order to implement it effectively and accessibly, it is suggested to use open-source systems, while considering the need for system adaptations to meet the established goals and ensuring data security, which should only be carried out by IT specialists.

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