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Towards Electronic Prescription System in a Developing Country

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Abstract
We proposed an architecture for a national electronic prescription system. This work is based on the HL7 CDA standard to represent the prescription, the ABE encryption to encrypt data, the private cloud as a storage solution, and the ABAC model to control access to the system. The proposed system is an adequate solution to solve some common medical errors in developing countries such as Algeria due to paper prescriptions. Our solution allows the integrity and confidentiality of medical prescriptions and offers sufficient flexibility and interoperability level.

Keywords: E-prescription system architecture; Access control; Biometric card; Health Level 7 Clinical Document Architecture Release 2; Interoperability

Introduction

Since the advent of new information and communication technologies in recent years, many researchers have been looking into the possibility of integrating these new technologies to optimize patient care. The medical prescription represents one of the most important acts in the therapeutic process. The use of medicines is at the heart of primary care, and it involves multiple actors. It is the cause of major concerns, particularly in terms of patient safety. Handwritten medical prescriptions generate many problems, such as misinterpretation of medicines, medication errors, legibility, fraud, safety, and confidentiality issues [1-2].

Moreover, according to Roumeliotis et al. [3], it is difficult to follow the handwritten prescriptions; they could be lost, misplaced, forgotten, or ignored. We have found that medical prescription is still the most widely used by doctors worldwide, despite the contribution of information technology in the health field. However, electronic prescriptions (e-prescription) could provide an adequate solution to these problems [4].

In Algeria, all medical prescriptions are frequently handwritten or printed on paper and hand-delivered to pharmacists. It is the case in several developing countries. This situation gives rise to major concerns such as the incidence of prescription errors, which causes problems for patients, including deaths. The use of electronic medical prescriptions enables avoiding most of these problems. In Algeria, e-prescription has not yet been adopted, despite the progress made in information and communication technologies. Therefore, it is essential to improve the processes related to the use of medicines and their prescription. E-prescription has the potential to improve the quality, safety, and efficiency of care [5]. E-prescription is part of the larger movement towards increased use of health information technology [4]. In many countries, e-prescription networks have been designed and established, creating regional and national networks [6]. Today, the use of an e-prescription system in Algeria is a national requirement to improve patient safety and healthcare quality.

The traditional prescription process relies on the manual transfer of a paper on which a handwritten prescription is written and another service provider's ability to decipher what is written on it [7]. According to the literature, there are several definitions of e-prescription. The Centre of Medicare and Medicaid Services in the United States defines the e-prescription process as [8]: « E-prescribing means the transmission, using electronic media, of prescription or prescription-related information between a prescriber, dispenser, pharmacy benefit manager, or health plan, either directly or through an intermediary, including an e-prescribing network. E-prescribing includes, but is not limited to, two-way transmissions between the point of care and the dispenser ».

Benefits of e-Prescription

According to the study by Zadeh and Tremblay [1], the main benefits of e-prescription are: improving the quality of health care services, increasing the efficiency and effectiveness of prescribing and dispensing medications, reducing medication errors, and health care cost savings. These benefits mainly affect prescribers, payers, pharmacies, and patients. In Lanham et al. [4], the authors have classified the benefits of e-prescription into four categories: patient safety, improved prescription, efficiency/workflow, and cost savings. An electronic prescription will reduce the risk of being exposed to the virus due to manipulating paper prescriptions, as in COVID19 [9]. The study by Bruthans [10] found the following benefits: reduced errors, time savings for doctors, pharmacists, and patients, prevention of adverse drug reactions, and more accurate dosage. The work of Thatcher and Acharya [7] specified other benefits: monitoring how prescription drugs get prescribed, prescription abuse, and overprescribing. The work of Lester et al. [11] resulted in a significant benefit; the meaning of the clinical drug product information is communicated correctly to the pharmacy.

E-prescription and Clinical Decision System Support

Sutton et al. [12] have shown the importance of Clinical Decision System Support (CDSS) in e-prescription systems for patient safety. CDSS determines incomplete or unclear ordering, reducing prescribing and dosing errors, drug interactions, and drug-allergy detection. In agreement with Roumeliotis et al. [3], electronic prescribing strategies decrease medication errors and adverse drug events. Prescription support systems have been the subject of numerous studies in recent years. There are several free online systems available.

In Saverno et al. [13], CDSS in pharmacies includes information on drug interactions. This information enables pharmacists to improve the detection of clinically significant interactions. However, work shows that these systems may miss some important interactions. Indeed, Saverno et al. [13] indicate that many clinical decision support systems in pharmacy function less than optimally concerning identifying well-known and clinically relevant interactions. The work of Zamora et al. [14] describes a prototype of a system for discovering, analyzing, and visualizing drug prescriptions. The proposed system offers a decision support tool. Part of the data source used is the table of pharmaceutical prescriptions. This table is part of the electronic clinical history of primary care assistance in Barcelona (Spain). The study conducted Syed-Abdul et al. [15] aimed to improve the electronic prescription system's efficiency by reducing the risk of inappropriate drug selection and physician prescribing time. An intelligent model that recommends the most frequently prescribed drugs for a given disease supports this work. This model is based on analyzing one year's data from national health insurance claims data in Taiwan.

Related Work

According to the literature, the adoption of e-prescription came after a long and arduous process. The e-prescription is just in the early stages of adoption in only a few countries. The difficulty lies in infrastructure and development. Indeed, several solutions have been modified and extended considerably. According to Zadeh and Tremblay [1], doctors are reluctant to adopt electronic prescriptions because of unintentional medication errors that can put patients' health at risk.

In many countries, the healthcare model is based on the public and private sectors. However, the Algerian healthcare model is mainly considered a public sector. Hence, the state is financing this sector. In Algeria, the use of manual prescription is widely adopted in the public sector, while the printed prescription is the most widely used in the private sector. Few prescribers use prescription support software. The Chifa system is based on a smart card. It is part of the modernization of social insurance management procedures [16]. This system does not deal with e-prescription. Its main aim is to increase the speed of reimbursement for care and medicines. A startup specialized in pharmaceutical information systems has proposed a web application [17], which: (i) makes it easier for doctors to enter prescriptions, (ii) avoids any confusion or ambiguity for pharmacists when deciphering them and (iii) allows subscribing pharmacists to find the prescription on the system and to retrieve the equivalence of the drugs prescribed. We have not found any scientific research or studies that address or discuss the problem of the use or adoption of e-prescription in Algeria.

Samadbeik et al. [18] have indicated that developing countries are still using traditional manual prescription systems. Khan et al. [19] shows how physicians in developing countries in general and particularly in Pakistan spend a great deal of time processing manual prescriptions. Bruthans [10] shows the state of the national e-prescription system in 28 European countries; 19 use it daily, one seems functioning, two pilot projects, three at the planning stage, two is not functioning, and one has limited use.

Samadbeik et al. [20] study shows different types of the national e-prescription system's models. This work has indicated that doctors prefer a centralized architecture and a central national electronic prescription database. [18] have reported that some developed countries use a central national database of e-prescriptions. However, the work of Bruthans [10] presents a decentralized application designed to provide a secure electronic prescription system on a privatized Ethereum blockchain.

Kim and Kwak [21] present a Korean national project. This paper aims to propose a framework focused on preventing unlawful prescription practices in an electronic prescription system and a cloud-based national prescription database. The authentication is based on biometrics. Samydurai [22] describes a secure patient-centric data sharing framework for patient medical record systems stored in the cloud. The prescription made by the doctor is encrypted via ABE. Patrao et al. [23] present a patient-centric electronic prescription platform that Portuguese governmental institutions have developed. The patient authorizes access to the prescription through his or her electronic card and the prescription identifier. This system has the advantage of integrating all patients' electronic health records into a centralized system. Omotosho et al. [24] present a steganography and antiphishing technique for securing electronic prescriptions to minimize patients' data theft in Nigeria.

Porrasmaa et al. [25] present an e-prescription system developed in Finland. This paper gives an overview of the prescription process as well as the architecture and technologies used. Emphasis is placed on the use of HL7 standards. Despite the difficulty of implementing the HL7 V3 and CDA R2 standards, this work provides a useful model for the specification of e-prescription solutions. According to Khalili and Sedaghati [26], semantic medical prescriptions are intelligent e-prescription documents. These documents are enriched with dynamic metadata related to the drugs to know their content and possible interactions. This work enables the improvement, integration, and interoperability of e-prescription systems with other e-health services.

Our objective was to realize an e-prescription system architecture capable of resolving the problems encountered with handwritten prescriptions. This architecture facilitates the exchange of information on prescriptions among stakeholders while ensuring patient safety, confidentiality, and information integrity.

Material and Method

General Principle of the Proposed Architecture

The patient presents to the doctor for a diagnosis. He/she presents his electronic card for identification. The patient has the right to decide whether to give access to his electronic health record. After the consultation, the doctor can log into the system with his electronic identity card or a password and username combination. The doctor can then proceed to the composition of the prescription with the help of the system. This latter has a module for medical decision support. This module checks the quality of the prescription to avoid undesirable drug interactions and allergies. Figure 1 gives an overview of our proposal. The general principle is as follows:

1. The patient consults the doctor.
2. The doctor, after auscultation, writes the electronic prescription, signs it digitally, and sends the prescription to the database.
3. The doctor prints the prescription with a barcode containing the prescription's ID and the digital signature and gives it to the patient.
4. The patient presents the paper prescription to the pharmacist and presents his electronic card for identification.
5. The pharmacist scans the barcode of the prescription and requests the database to retrieve it.
   6. The server sends back the electronic prescription to the pharmacist.
6. The pharmacist reads the prescription and dispenses the medication to the patient.
7. After giving the medication to the patient, the pharmacist sends a delivery message to the system.
8. Social Security retrieves patients' electronic prescriptions to reimburse them.

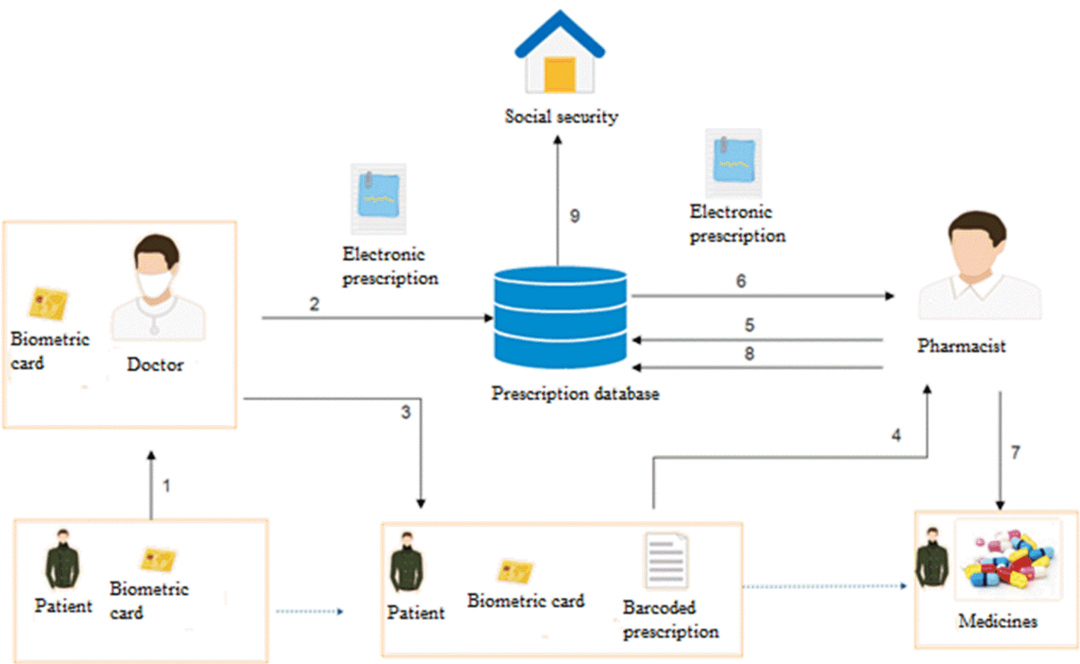

Figure 1. Architecture overview

System Components

Our architecture contains the following components: Actors, a cloud-based storage system, clinical document HL7 CDA R2, an encryption mechanism, and a web service to implement it, as well as an electronic card, the medical authority, prescription database, and a Module Medical Decision Support System (MDSS), and a web portal.

Actors. In the proposed system, the actors concerned are:

- Patient: can access his or her electronic prescription to see some details such as reimbursed prescriptions. He or she can also consult certain remarks made by the doctor.
- Doctor: via a web application, he or she can write prescriptions, or consult the patient's medical record with his or her consent, or add an observation if necessary. In some cases, doctors request tests from patients in the form of a check-up request, in which case the labs retrieve these requests and send back the results to the database.
- Pharmacist: retrieves patient prescriptions to deliver medication to patients. When the pharmacist detects an anomaly, he alerts the prescriber.
- Social Security: manages the patients' accounts that have insurance. It can block the reimbursement of medication and care in the case of non-payment.

National Biometric Card. All actors in the system must use a biometric card to access the system or a user name and password.

Electronic Prescription and Bar-coded Prescription. The electronic prescription will be sent to the system, and a paper prescription with a barcode will be printed for the patient. This solution facilitates pharmacists' work and ensures that the patient keeps the doctor's instructions handy.

Web Portal. The portal is the first level of security. It allows restricting access to certain functions and content to predetermined groups by associating a user name and a password. Patients will access information about their prescriptions and some information that health care providers transmit to them. Other actors have access to the applications intended for them according to their role in the prescription process.

Health Level 7 Clinical Document Architecture Release 2. We have chosen the HL7 CDA R2 [27] standard to represent electronic prescribing. HL7 CDA R2 is a standard used in several countries. It is an essential element for the implementation of electronic prescriptions. The purpose of using standards is to facilitate the integration of other components into our architecture. Above all, CDA R2 is an XML document. We know that the prescription will be exchanged between several stakeholders: insurance companies, hospitals, pharmacies, medical analysis laboratories, and research laboratories. XML is indispensable.

Attribute-Based Encryption Service. It is a web service responsible for transporting the doctor's prescriptions to the cloud and from the cloud to the doctor. It is responsible for encrypting and decrypting information using the encryption mechanism (Cipher text Policy Attribute-Based Encryption CP-ABE [28]). Our solution is an application that can be used with a personnel computer, tablet, or smartphone. The latter have various computing power. The use of web services will help to overcome these constraints. We choose the SOAP (Simple Object Access Protocol) [29] protocol to implement our web service. We have noticed that the REST (REpresentational State Transfer) [29] architecture is more flexible and consumes fewer resources. In contrast, the SOAP protocol is more secure. It is a strong argument, especially in this context where medical data is a confidential resource that requires a high degree of security.

Cipher Text Policy Attribute-Based Encryption Mechanism. The biggest obstacle to the use of e-prescriptions is undoubtedly data security. Indeed, storing confidential information such as the medical health record or medical prescriptions in the cloud requires guaranteeing this data's security and confidentiality. The most commonly used mechanism to protect information is Attribute-Based Encryption (ABE). We have opted for CP-ABE. It is the most appropriate encryption mechanism in a cloud environment, and it is a powerful asymmetric encryption mechanism.

Medical Authority. It is responsible for the system. It manages the administration and registration of the various stakeholders. Its role in our architecture is to deliver public keys and private keys. This authority plays the role of Public Key Infrastructure.

Access Control. It ensures the confidentiality and integrity of health data. The policy-based access control techniques improve the flexibility in access control. Attribute-Based Access Control (ABAC) [30] is one of the most popular models. This model is more flexible, consequently enabling more fine-grained access control. Besides, the ABAC supports dynamic environments with frequent modifications to user permission. Moreover, ABAC resolves RBAC models' role management issues and provides a platform for easier cross-domain authorizations. The dynamism and flexibility of the ABAC model constitute a significant cause of our choice.

Decision Support System. The prescribers must be vigilant. Drug interactions are frequent. The risk of serious drug interaction increases with the number of drugs on a prescription. Many computer programs exist for the verification of drug interactions. This software is mostly paid for. In our work, an electronic decision support system is useful. We have proposed an alert system for drug interactions. This system must be upgraded regularly to help prescribers. This system is part of a project based on artificial intelligence for fraud and anomaly detection in health care.

Prescription database. It is stored in the cloud. It contains electronic prescriptions.

Cloud. Nowadays, prescribers write several prescriptions every day. In addition, the functionalities that an e-prescription system will offer, such as prescriptions' consultation, prescription renewal, and consultation of specific data (e.g., drug data). Therefore, the cloud solution is essential. We have chosen the cloud as a storage solution. The cloud allows gaining reliability, agility, and flexibility. Indeed, many arguments in favor of the adoption of cloud solutions, especially in the field of e-health. Data is vast and, at the same time-critical. We opted for the private cloud. We want to have full control over medical information and enhance patient data security and privacy.

Results

All actors go through the web portal to interact with the system. Figure 2 illustrates these interactions.

1. The patient consults the doctor.
2. The doctor writes the electronic prescription. With his electronic business card signs the document digitally and sends it to the system.
3. The medical decision support module monitors the e-prescription and sends alerts in case of drug interactions.
4. The web service retrieves the e-prescription and encrypts the information contained in CDA R2.
5. After encryption, the web service sends the e-prescription to the cloud to be registered.
6. The physician prints a paper copy of the e-prescription with a barcode containing the digital signature and the prescription code and gives it to the patient.
7. The patient presents the paper prescription to the pharmacist and the biometric card for identification.
8. The pharmacist scans the prescription's barcode and requests the system to retrieve it.
9. The web service retrieves the encrypted prescription and decrypts it.
10. The web service sends the decrypted prescription to the pharmacist.
11. The pharmacist dispenses the medication to the patient.
12. The pharmacist sends a delivery message to the system to indicate that the patient has retrieved the e-prescription.
13. Social security sends a request to the system to retrieve e-prescriptions.
14. E-prescriptions are sent to the web service to be decrypted.
15. The web service transmits the decrypted prescriptions to the SS.
16. Social Security can make changes in patient accounts.
17. The patient consults these prescriptions.

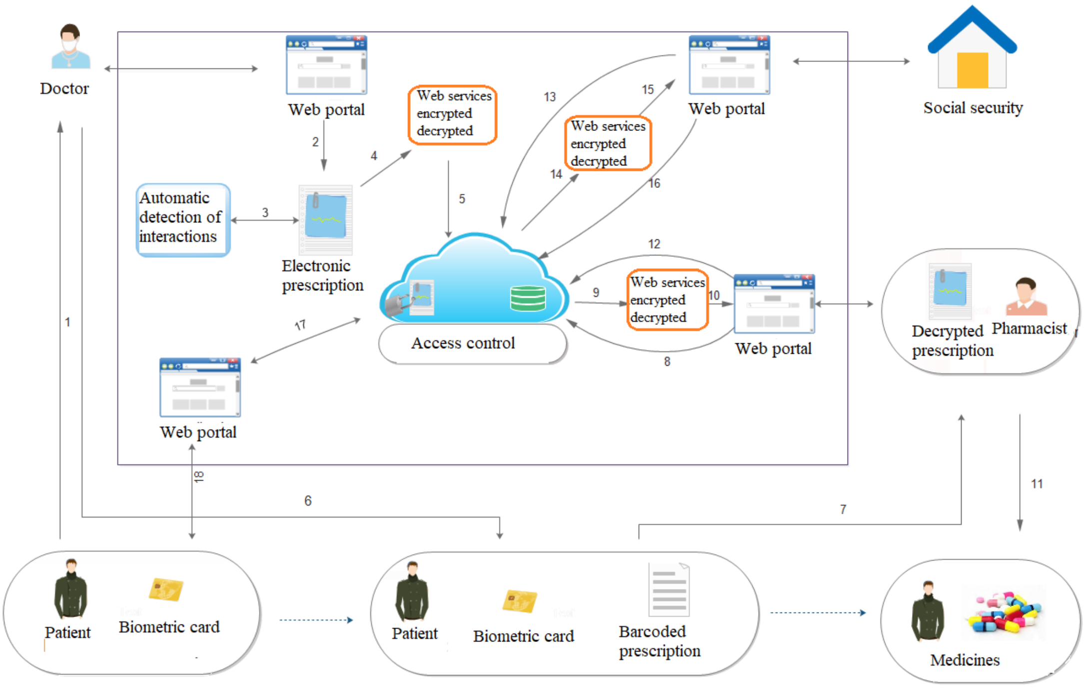

Figure 2. Detailed of architecture

In the case of prescription renewal, the pharmacist sends an alert to the doctor for a renewal. If the doctor accepts, he or she sends the same prescription with a different identifier to avoid duplicates. Another case is the change of prescription. The pharmacist sends a request to change the e-prescription to the doctor. If the doctor agrees to change the e-prescription, they prescribe a new one and send it to the database. Then, the first e-prescription becomes invalid and will be deleted from the database.

Prototype Implementation

In this section, we wish to show the feasibility and practicality of the proposed architecture. We present an illustrative example to explain our proposal. For that, we use the following scenario:

- Patient consults a doctor
- Doctor examines and diagnosis the patient
- Doctor logs into the system
- Doctor inserts the patient's electronic card to collect personal information. If the patient has no card, the doctor enters the patient's personal information manually. Then the doctor can do the following:
  - Prescribe medication
  - Make a guidance letter
  - Add an observation
  - Request analyses
  - Access the old prescriptions and view his health record

When the doctor validates a prescription, an XML code in CDA R2 format is generated. In the case of drug interaction, the system sends an alert. Figure 3 shown the medication prescription form.

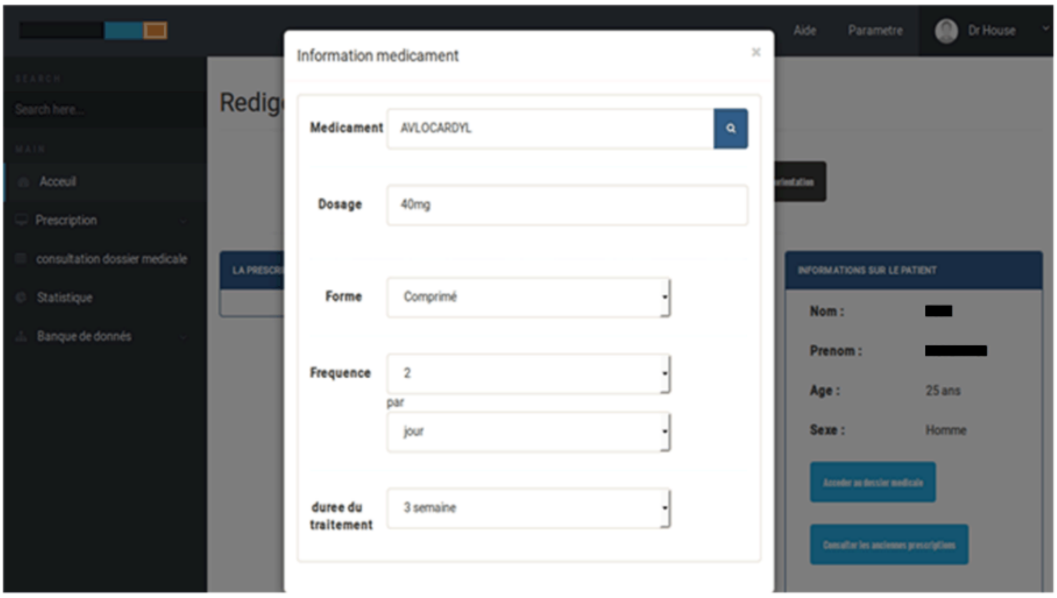

Figure 3. Medication prescription form

Then we use the SOAP web service to transfer and encrypt the file using the CP-ABE library. After that, the system sends the prescription information to the prescription database, and the doctor can print a copy for the patient. Figure 4 illustrates the list of a patient's prescriptions.

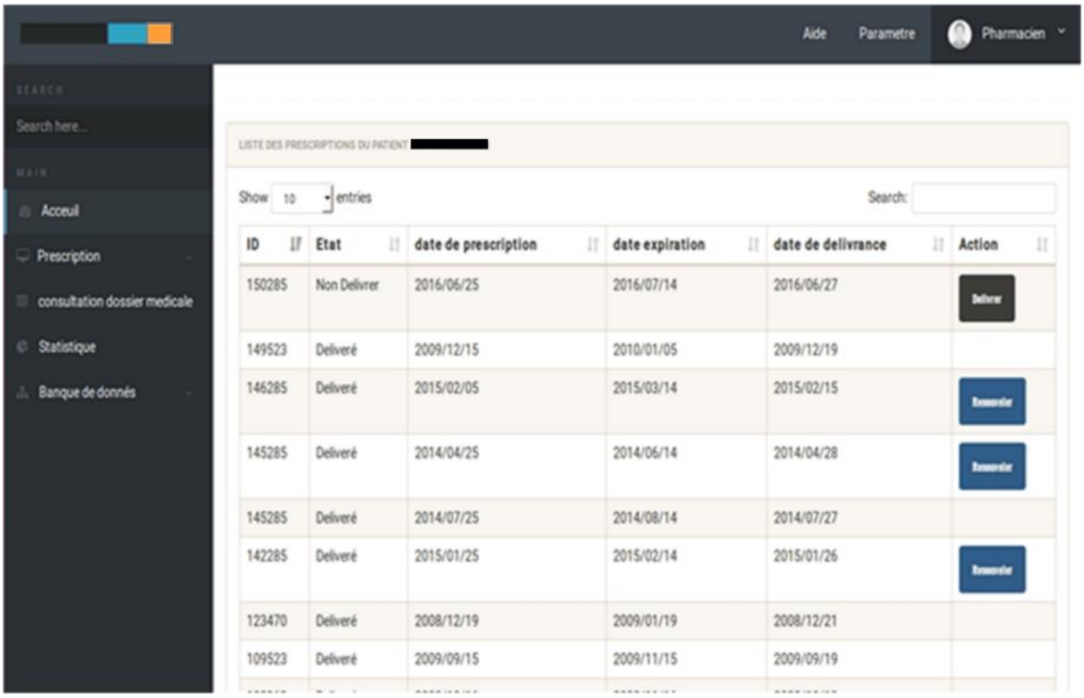

Figure 4. List of a patient's prescriptions

At the pharmacist's, the patient presents his electronic card or a printed prescription. Then the pharmacist begins the delivery phase (Figure 5). Any undelivered medication takes the "undelivered" state, and each prescription has a limited duration. Beyond this time, the prescription takes the invalid state. Besides, the doctor can renew a prescription within a specified period.

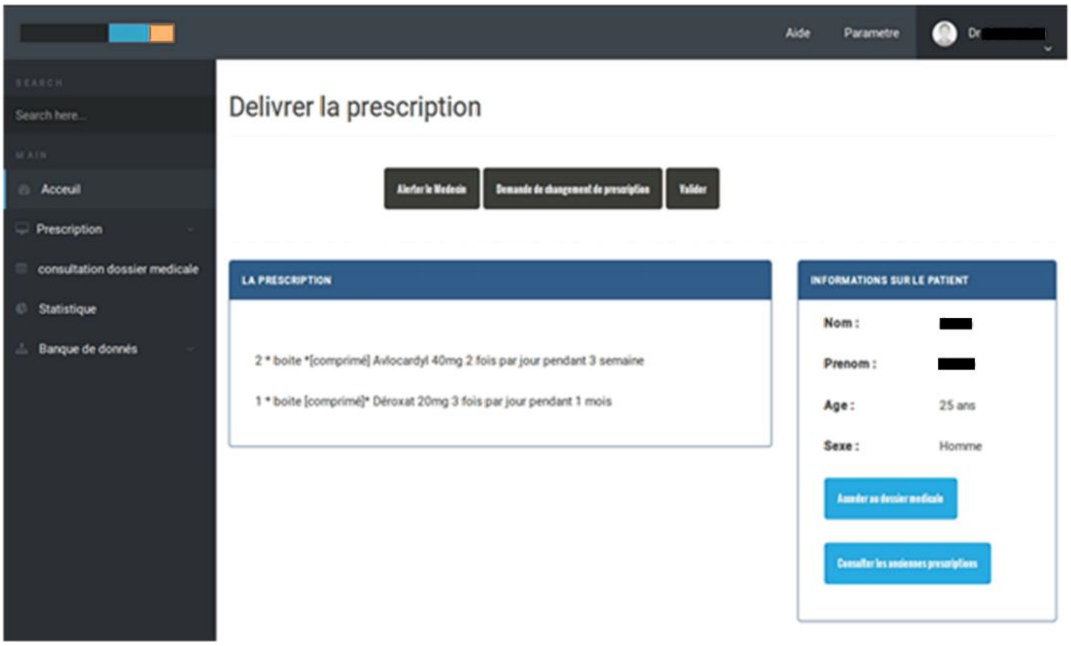

Figure 5. Prescription viewed by the pharmacist

Discussion

This work presented an initiative for the construction of an electronic prescription system in Algeria. The use of e-prescription has a definite impact on improving patient care quality, but to date, its use remains marginalized in developing countries such as Algeria. According to Hanseth and Bygstad [31], e-prescription systems are built after several developed countries' initiatives. Nowadays, these systems are widely adopted.

Depending on the state of the art carried out, the major work's main objective is to improve the prescription process thanks to recent technologies. We also found studies focused on the nature of the architecture [7], models based on data security [9], others on the transmission of the prescription [24], and those interested on how to help the practitioner to make a decision [12]. Indeed, in our solution, we have tried to benefit from the proposals developed in all the works studied since 2016.

A prescriber issues a prescription electronically. It is electronically signed and securely transmitted for dispensing in our system. We have tried to integrate the various components of a secure e-prescription system, such as the digital signature and encryption. We have used the cloud; it is necessary for a large amount of information and the charge to support it. Another strong point is the use of the HL7 CDA R2 standards with soap web services to make our solution as interoperable as possible. For the encryption, we opted for ABE encryption for its flexibility. Indeed, this mechanism is well suited for healthcare in a cloud environment. The bare code helps to secure and authenticate the prescription. It shields stakeholders from the risk of fictitious prescriptions and fake prescriptions. Our e-prescription systems use modern technologies to enable communication and the transfer of information between the stakeholders. On the other hand, the e-prescription system in Algeria is facing many challenges, especially in rural areas such as [32]: (i) unavailability of the required infrastructure (e.g., internet connection) (ii) lack of awareness of the patients and healthcare staff and acceptance of receiving e-prescription system services via the internet.

To situate our work, table 1 gives some differences between the traditional prescription system and the e-prescription system in the Algerian context. Table 2 compares our work with other solutions regarding flexibility, interoperability, data integrity, confidentiality, and access control.

Table 1. Traditional prescription system and e-prescription system

	Traditional prescription system	**E-prescription system**
Legibility	Low	Very high
Drug Interactions	High	Very low
Errors	High	Very low
Security and privacy	Low	High
Pharmaceutical services	Low	High
Traceability	Low	Very high
Information sharing	Very low	High
Dispensing medication	Low	High
Fraud	High	Low
Patient's knowledge of their medication	High	Very low (if the prescription is not printed)

Table 2. Comparison of work

Work	Flexibility	Interoperability	Data Integrity	Privacy	Access control
[7]	✓	✓	✓	✓	✓
[23]	x	x	✓	✓	✓
[24]	x	✓	✓	✓	✓
Our solution	✓	✓	✓	✓	✓

Limitations

Nevertheless, this work has some limitations:

- There is a possibility of intercepting data while it is waiting to be encrypted.
- It is difficult to demonstrate stakeholders' satisfaction empirically due to the diversity of their professional and technological backgrounds and their reluctance to change, which may condition the solution's success.

As future work, we envisage several possible extensions or improvements to our system. We are inclined to study new technologies such as blockchain for a decentralized e-prescription system in the current state. Besides, the future work may produce a system with more functions and higher security and privacy persevering mechanism in a further project.

To sum up, tn this work, we have proposed a national e-prescribing system by developing a new architecture. We have determined our architecture's different components: the HL7 CDA R2 clinical document, a module to treat drug interactions, cloud, and the CP-ABE encryption mechanism to protect medical data. We used the ABAC model to secure access to electronic prescriptions. The proposed architecture guarantees patient privacy and a flexible e-prescription system.

Conflict of Interest

The author(s) declare that they have no conflict of interest.

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References

1. Zadeh PE, Tremblay MC. A review of the literature and proposed classification on e-prescribing: Functions, assimilation stages, benefits, concerns, and risks. Research in Social and Administrative Pharmacy. Res Social Adm Pharm. 2016;12(1):1-19. doi: 10.1016/j.sapharm.2015.03.001
2. Sorwar G, Murugesan S. Electronic medical prescription: An overview of current status and issues. Biomed Knowl Manag Infrastructures Process E-Health Syst. 2010;61-81. doi: 10.4018/978-1-60566-266-4.ch005
3. Roumeliotis N, Sniderman J, Adams-Webber T, Addo N, Anand V, Rochon P, et al. Effect of electronic prescribing strategies on medication error and harm in hospital: a systematic review and meta-analysis. J Gen Intern Med. 2019;34(10):2210-2223.doi: 10.1007/s11606-019-05236-8
4. Lanham AE, Cochran GL, Klepser DG. Electronic prescriptions: opportunities and challenges for the patient and pharmacist. Advanced Health Care Technologies. 2016;2:1-11. doi: 10.2147/AHCT.S64477
5. Hsu CL, Lu CF. A security and privacy preserving e-prescription system based on smart cards. J Med Syst. 2012;36(6):3637-47. doi: 10.1007/s10916-012-9838-y
6. Motulsky A, Sicotte C, Gagnon MP, Payne-Gagnon J, Langué-Dubé JA, Rochefort CM, et al. Challenges to the implementation of a nationwide electronic prescribing network in primary care: a qualitative study of users' perceptions. J Am Med Inform Assoc. 2015;22(4):838-48. doi: 10.1093/jamia/ocv026
7. Thatcher C, Acharya S. RxBlock: Towards the design of a distributed immutable electronic prescription system. Netw Model Anal Health Inform Bioinforma. 2020;9(1):1-11. doi:10.1007/s13721-020-00264-5
8. Centers for Medicare & Medicaid Services (CMS), HHS. Medicare program; e-prescribing and the prescription drug program. Final rule. Fed Regist. 2005;70(214):67567-95.
9. Aldughayfiq B, Sampalli S. Digital Health in Physicians' and Pharmacists' Office: A Comparative Study of e-Prescription Systems' Architecture and Digital Security in Eight Countries. OMICS. 2021;25(2):102-22. doi: 10.1089/omi.2020.0085
10. Bruthans J. The State of National Electronic Prescription Systems in the EU in 2018 with Special Consideration given to Interoperability Issues. Int J Med Inform. 2020;141:104205 .doi:10.1016/j.ijmedinf.2020.104205
11. Lester CA, Tu L, Ding Y, Flynn AJ. Detecting Potential Medication Selection Errors During Outpatient Pharmacy Processing of Electronic Prescriptions With the RxNorm Application Programming Interface: Retrospective Observational Cohort Study. JMIR Med Inform. 2020;8(3):e16073. doi: 10.2196/16073
12. Sutton RT, Pincock D, Baumgart DC, Sadowski DC, Fedorak RN, Kroeker KI. An overview of clinical decision support systems: benefits, risks, and strategies for success. NPJ Digit Med. 2020;3:17. doi: 10.1038/s41746-020-0221-y
13. Saverno KR, Hines LE, Warholak TL, Grizzle AJ, Babits L, Clark C, Taylor AM, Malone DC. Ability of pharmacy clinical decision-support software to alert users about clinically important drug—drug interactions. J Am Med Inform Assoc. 2011;18(1):32-7. doi: 10.1136/jamia.2010.007609
14. Zamora M, Baradad M, Amado E, Cordomí S, Limón E, Ribera J, et al. Characterizing chronic disease and polymedication prescription patterns from electronic health records. IEEE International Conference on Data Science and Advanced Analytics (DSAA) 2015:1-9.
15. Syed-Abdul S, Nguyen A, Huang F, Jian WS, Iqbal U, Yang V, et al. A smart medication recommendation model for the electronic prescription. Comput Methods Programs Biomed. 2014;117(2):218-24. doi: 10.1016/j.cmpb.2014.06.019
16. Chifa. [updated unknown; cited 2021 Jan 17]. Available from https://cnas.dz/fr/chifa/
17. Pharmnet. [updated unknown; cited 2021 Jan 17]. Available from https://pharmnet-dz.com/ordonnance.aspx

18. Samadbeik M, Ahmadi M, Sadoughi F, Garavand A. A copmarative review of electronic prescription systems: Lessons learned from developed countries. J Res Pharm Pract. 2017;6(1):3-11. doi: 10.4103/2279-042X.200993
19. Khan IU, Yu Y, Hameed Z, Khan SU, Waheed A. Assessing the physicians' acceptance of E-prescribing in a developing country: an extension of the UTAUT model with moderating effect of perceived organizational support. J Glob Inf Manag (JGIM). 2018;26(3):121-42. doi: 10.4018/JGIM.2018070109
20. Samadbeik M, Ahmadi M, Sadoughi F, Garavand A. Main Elements of National Model of Electronic Prescription System from Physicians' Point of View: A Case Study in a Developing Country. Iran J Pharm Res. 2019;18(4):2204-15. doi: 10.22037/ijpr.2019.1100801
21. Kim DH, Kwak J. A Framework for Preventing Illegitimate e-Prescribing Practices. InAdvances in Computer Science and Ubiquitous Computing. 2017 Dec 18 (pp. 648-653). Springer, Singapore. doi: 10.1007/978-981-10-7605-3_105
22. Samydurai A, Revathi K, Prema P, Arulmozhiarasi DS, Jency J, Hemapriya S. Secured Health Care Information exchange on cloud using attribute based encryption. 3rd International Conference on Signal Processing, Communication and Networking (ICSCN) 2015: pp. 1-5. IEEE. doi:10.1109/ICSCN.2015.7219826.
23. Patrao L, Deveza R, Martins H. PEM-A New Patient Centred Electronic Prescription Platform. Procedia Technol. 2013;9:1313-9. doi: 10.1016/j.protcy.2013.12.147
24. Omotosho A, Emuoyibofarhe J, Meinel C. Securing E-Prescription from Medical Identity Theft Using Steganography and Antiphishing Techniques. J Appl Secur Res. 2017;12(3):447-61. doi: 10.1080/19361610.2017.1315788
25. Porrasmaa J, Mykkänen J, Tarhonen T, Jalonen M, Kemppainen P, Ensio A, et al. Application of HL7 CDA R2 and V3 messaging for national ePrescription in Finland. In 9th International HL7 Interoperability Conference 2008, IHIC 2008:193-4.
26. Khalili A, Sedaghati B. Semantic Medical Prescriptions--Towards Intelligent and Interoperable Medical Prescriptions. IEEE Seventh International Conference on Semantic Computing 2013:347-354.
27. HL7 CDA R2. [updated unknown; cited 2021 Jan 17]. Available from http://www.hl7.org/implement/standards/product_brief.cfm?product_id=492
28. Bethencourt J, Sahai A, Waters B. Ciphertext-policy attribute-based encryption. IEEE symposium on security and privacy (SP'07) 2007:321-34.
29. Halili F, Ramadani E. Web Services: A Comparison of Soap and Rest Services. Mod Appl Sci. 2018;12(3):175-83. doi: 10.5539/mas.v12n3p175
30. Boumezbeur I, Zarour K. Privacy-preserving access control for sharing health data in cloud environment. 8th International Seminar on Computer Science Research at Feminine. 2018:25-32.
31. Hanseth O, Bygstad B. The ePrescription Initiative and Information Infrastructure in Norway. In: Aanestad M, Grisot M, Hanseth O VP, editor. Information Infrastructures within European Health Care: Working with the Installed Base. 1st ed. London: Springer; 2017. p. 73-87. doi: 10.1007/978-3-319-51020-0_6
32. Zarour K. Towards a Telehomecare in Algeria: Case of Diabetes Measurement and Remote Monitoring. Int. J. E-Health Med. Commun. 2017;8(4):61-80. doi: 10.4018/IJEHMC.2017 100104