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Analysis of Effective Medical Record Storage Formats and Demonstration of Time Efficient Secure Storage Framework

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Abstract— With the tremendous growth in the healthcare system, the number of medical records is increasing. Growth requires extensive management of the storage and processing of medical data. A great deal of research has been done to find the best storage mechanism for medical records. However, storage systems must comply with only a few factors, such as integration with other systems such as the medical insurance management system, clinical diagnostic systems and safety measures. The main problem with integration is the lack of standardization of storage formats. The existence of HL7 for the storage of medical records is available and the benefits provided cannot be ignored. However, the lack of awareness of HL7 is a bottleneck. Medical data collected from diagnostic systems are also noisy and influence the final results in case of disease detection automation. Possible standardization is therefore also essential. In addition, the security issues with sensitive data captured and stored in medical record storage systems cannot be ignored. In recent developments, a number of types of research have proposed multiple encryption techniques for data security. Conversely, highly secure data is prone to a more time-consuming retrieval process. This work analyses the formats of the medical record storage and proposes a new, time-efficient, secure method for storing medical data. This leaves room for a complex analysis of medical records for predictive analysis to solve the various problems faced by clinical studies and government policy makers resulting in the saving of human life.

Keywords— Medical Records, Storage Formats, Secure Storage Framework, Health Level 7 (HL7), Electronic Data Interchange (EDI)

1. Introduction

The extreme growth in the field of medical information analysis and data processing is demanding the advancements of clinical automation. The growth in medical information system management is accumulating more and more patient information, medical reports, diagnosis results and insurance information. Thus the increase in the storage cost and demand for efficient processing is in the verse of demanding new methodologies. Also cost for the information exchange over the internet is budding [1] [2] [3] [4]. The electronic storage of the medical information correspondingly caters benefits as reduction of the duplication of records, reduction in repetitive diagnosis and removal of anomalous patient medical history.

Thus the importance of the maintaining and managing medical records cannot be ignored.

In the US, a total of 56 billion patients have registered for electronic medical information system in the year of 2013 and by the end of 2016 the number of patients registered for the electronic medical information system was 73 billion [5]. Considering the total population of 326 billion, it is natural to understand the expected growth in the medical information storage systems in the US along.

The researchers from various countries propose various research options based on the medical information. However the bottleneck for the research is the cost of storage and requirements for the high processing capabilities. The simple storage formats are cost effective and can be installed with minimal effort and expertise. However the security aspect of the medical information system also cannot be ignored. Thus it is very important to secure the data with encryption methods.

The race between the data processing complexity and security of the data is ever persisting. The increase in security will result into increase in processing time complexity. Thus, the demand of the recent research is to develop and evaluate a timely and secure storage solution.

The rest of the work is organized as in Section II the recent advancement in medical record management system is been analysed, in section III an index based medical record storage system is been analysed, in Section IV the pre-processing of the medical record to reduce the noise is been analysed, in Section V the proposed secure medical record storage framework is been analysed, in Section VI the time complexity of the proposed method is been discussed, the results are been evaluated in Section VII and the work presents the conclusion in Section VIII.

2. Literature Review

Recent development in the healthcare domain demonstrates that the majority of the hospitals have already adopted the electronic medical information system. Nevertheless, the deployed systems in those mentioned hospitals are centralized or only connected to the medical units inside the hospital. Thus, it is impossible to access any patient record in different hospital in situations when the patient needs to get medical support in other hospitals rather than the origination of the information [6]. In some cases, where the patient is shifted from a local medical unit to another medical unit for long term medical care, it is nearly impossible to get the information on time [7]. Recollecting all information causes delay in medical procedure and may result in loss of life.

Several applications for Electronic Data Interchange (EDI) are been deployed by many organizations. Those EDI systems are liberal in terms of standards in connectivity and storage formats, thus makes is highly challenging to integrate.

In order to provide a generic solution for storage of medical information a numerous amount of researches are been carried out. One of the most popular standard, Health Level Seven (HL7), for EDI was been deployed for a long time [8]. Hutchison et al. demonstrated the HL7 method in order to integrate the medical and diagnosis reports for solving various critical problems [9]. The API developed by the Williams at Columbia University for generating HL7 compatible message generation is a key to reduce time for development of medical information processing systems [10]. In the view of storage method enhancement, another landmark is integration of database storage for the EDI systems by Hu et al. and Xu [11] [12]. The conjunction of electronic medical information systems and physical documents handled by the health care related offices are also a challenging task. In order to solve this problem Heitman et al. proposed clinical document architecture as one of the standardization in document structure [13]. Goossen et al. have also made an notable contribution in developing the standards and computing platforms for HL7 enabled medical information exchange systems [14]. For the benefit of light weight storage and faster transfer of medical record, the use of XML storage format is highly effective and is been proven by Rassinoux et al. [15].

The security of the medical information is also at the prime importance. The interconnecting systems, which ever are available, are prone to security leak and may cause the leak of information. Most of the medical information systems comply with X800 security architecture and deploys five categories of secure methods as authentication, access control, data confidentiality, data integrity and finally the nonrepudiation [16]. However the generic security for the medical information is been handled by the most widely use RSA algorithm. The RSA algorithm was invented in 1978 by Ron Rivest, Adi Shamir, and Leonard Adleman [16] [17]. It is to be understood naturally, that the encryption on the medical data adds additional complexity on the processing time, thus increases the time complexity of the querying system. According to Gross and Harris, "A queuing system can be described as customers arriving for service, waiting for service if it is not immediate, and if having waited for service, leaving the system after being served" [18]. This is to be considered as a definition for modelling the medical record exchange systems dealing with high amount of data.

The method introduced by Kendall for estimating the query time and comparable method is highly appreciable for comparing the results from various systems in order to find the highly responsive medical information system [19] [20]. K. Trivedi et al. and D. A. Menasce have modified the proposed model by fine tuning the method for calculating average response time [21] [22].

Henceforth, with the detail understanding of the recent advancements of the research, this work outlines the following short coming of in the existing methodologies:

- An efficient storage architecture for medical record storage to meet the requirements of information exchange
- A pre-processing technique for better predictive analysis is also the demand

3. Proposed Medical Record Storage Format

This work proposes a novel storage method for the medical record systems. This format majorly considers the Indian social identification system called Unique Identification Authority of India (UIDAI) for the primary identification and for the integration with other related systems like medical insurance system. Nevertheless, any social identification number can be accommodated in the system like Social Security Number in the U.S. or My Number in Japan.

The parametric representation of the proposed method is being elaborated here as shown in [Table – 1]. The proposed format collects various details from the patient to map the details to insurance systems and any other assistive partners in emergencies.

While designing the parameters the optimality theory of the information processing is considered. As a result, the further processing of the information is timely.

TABLE 1: Parametric Representation

SNO	Parameter Name	Description
1	UID (Unique Identification Number for integration)	The social identification number
2	PID (Patient Identification Number)	Patient identification number based on the region of registration
3	LFID	Identification number printed on

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	(Life time Identification Number)	the Birth Certificate
4	BI (Biometric Identification)	Finger print of the patient
5	AGE	Age in years
6	SEX	Sex
7	BPS (Blood Pressure)	Resting blood pressure (in mm Hg on admission to the hospital
8	CHOL (Cholesterol)	Serum Cholesterol in mg/dl
9	SMOKE	1 = yes; 0 = no
10	CIGS (Cigarette)	Cigarettes per day
11	YEARS	Number of years as a smoker
12	FBS (Fasting Blood Sugar)	Fasting blood sugar > 120 mg/dl
13	DM (Diabetic)	History of diabetes
14	FAMHIST (Family History of Heart Diseases)	Family history of coronary artery disease
15	RESTECG (Resting ECG)	Resting electrocardiographic results
16	RLDV5	Height at rest
17	RLDV5E	Height at peak exercise
18	NAME	Full Name of patient
19	M1_Data	Details of the medical record in BLOB format

4. Pre-Processing Techniques

The medical records stored in the electronic medical record management system are collected from multiple sources. Thus the data is prone to be noisy and the researches dealing with the data demand the pre-processing. The pre-processing phase demonstrated in this work deals with noise, missing attribute values and finally the inconsistency. Hence a process called data pre-processing is to be applied to normalize the data [23].

The process is demonstrated here [Figure – 1].

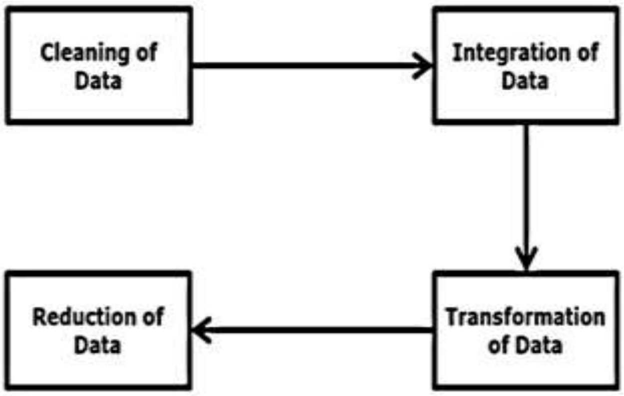

Fig. 1 Pre-Processing of the Medical Record System

The process of data pre-processing the medical records in order to prepare for the data ready for analysis and predictive modelling. The pre-processing is consisting of the following phases:

- Cleaning of Data: The cleaning of data is the process where the initial data has to go through the functions in order fit the missing values as ignoring the tuple completely if the tuple plays less significant role in data modelling. In terms of medical data, every attribute information is very important to decide the severity of the diseases. Missing values should be handled or should be avoided to maintain the accuracy.
- Integration of Data: The integration of data process is used to accumulate all the datasets from sample instances. Patient's information gathered from different clinical reports like Xray, CT-Scan, CBP, Culture determination of Blood or Urine should be integrated into a unique format for easy understanding to the Doctors about patient body functioning.
- Transformation of Data: The transformation of data process is used to consolidate the data matching with different processing decisions. The process includes the transformation of patients' data gathered from different clinical reports into a single coherent format. The final format should support for applying data analysis approaches like consolidation, aggregation and summarization to predict the actual disease symptoms.
- Reduction of the Data: The reduction process of the data is necessary for reducing the data in size causing the higher time complexity of the complete process. In this medical data storage, the key findings of patient symptoms have to be collected and maintained for the futuristic diagnostic purposes instead of maintaining raw data always.

We detect the process of applying for a patient medical record of eventually having received the outcomes in 34 steps. In the medical records interchange ecosystem, nine waiting times are required. The acronym and definition of each queue are shown in Table-II.

TABLE-2: Acronyms of Queue Responses

Abbreviation	Description
QHIS	Queue of querying the EMR from HIS
QGS	Queue of the request gateway
QNS	Queue of the request network
QNSC	Queue of the service center network
QDB	Queue of the database in MRISC
QHCA	Queue of the HCA
QNR	Queue of the response network
QGR	Queue of the response gateway
QHIN	Queue of the HIN(100kb Internet)

QGS: The QGS is a queue of the CPU on the request side.
Generate and encrypt RQC-I05 HL7 messages as well as a decryption and parsing of RCI-I05 messages.

QNS: QNS is a network queue on the LAN request side to send and receive RQC / RCI-I05messages as well as a query for the destination address and the public key to the MRISC.

QHIN: QHIN is a network queue for health information. The backbone of the network. All messages sent from One LAN to the other is waiting to pass through the HIN.

QNSC: The QNSC is the MRISC network queue. Provides services for querying addresses of EISs and the public keys.

QDB: QDB is a database queue for waiting for a service. To request the destination address from the MRISC.

QHCA: QHCA is a database queue for waiting. Public key service of the HCA.

QNR: QNR is a network queue on the LAN. Response side for receiving and sending RQC-I05 messages

QGR: The EIS server CPU queue on the response side of it. The QGR provides a service for generation and encrypting and decrypting RCI-I05 and RQC-CI05 parsing messages.

QHIS: A database queue waiting for a query service. Medical records of the hospital information system.

This understanding of the pre-processing technique will help in demonstrating the enhancement in result and further the reduction of noise during the encryption phase.

5. Proposed Secure Medical Record Storage

The methods used by multiple researchers have demonstrated the importance of using a security for the medical record storage system. The recent advancements also highlights the added complications of processing in terms of time complexity during the store and fetch operations on the medical records due to encryption. Thus reduction of time complexity for the medical record storage systems without compromising the security becomes one of the crucial priorities.

Henceforth, this work demonstrates a novel time efficient encryption technique for medical record storage systems. The detail of the algorithm is been explained here:

Step-1. Accumulation of the Patient Medical Information to be stored.

$$Set(A) = \sum_{i=0}^{n} Det_i \bigcap \coprod_{Patient\_ID} Patient\_Info \quad \text{Eq. (1)}$$

In this step the medical information is been accumulated and the relevance with the patient other information is also been fetched for storage in the relation schema of medical record system.

Here,

$Set(A)$, denotes the first level accumulated data
Det_i, denotes the medical diagnosis report for the medical instance belongs to that patient
$Patient\_Info$, denotes the other relevant information for the same patient

Step-2. Build a ASCII lookup table

$$[ASCII] = \sum_{i=1}^{128} Des_i \xrightarrow{Valid\_range} ASCII_i \quad \text{Eq. (2)}$$

In this step the look up table for ASCII conversion is built. Any valid medical record represented in the textual format will generally not be considering all the special characters. Thus during the build process of the lookup table only the valid characters are been accepted and the remaining characters are been discarded to reduce the time for searching or matching.

Step-3. Conversion of the ASCII medical information into binary format

$$Set(B) = \left| \begin{array}{l} For\ all\ Elements\ in\ Set(A),\ Set(A) \times [ASCII] \\ \text{Otherwise, Set(A)} \longrightarrow Set(B) \end{array} \right. \quad \text{Eq. (3)}$$

In this step using the look up table for ASCII conversation entire string of the medical information is been converted. In some special cases where any new character does not have respective conversion character, the character will be stored in second set without any conversion.

Here,
$Set(B)$, denotes the second level of medical information in ASCII format.

Step-4. Post Padding of the Converted Data

It is recommended by the author of this algorithm to have the total number of characters to be divisible by 6 at this given step. Hence the algorithm checks for the integrity of the data and apply zero post padding.

$$\phi = \frac{Set(\text{B})}{6} \quad \text{Eq. (4)}$$

$$Set(C) = Set(B).\text{Concats}(\sum_{i=0}^{\phi} "0") \quad \text{Eq. (5)}$$

Here,

$Set(C)$, denotes the post padded string of medical record

ϕ, denotes the number of zeros to be padded at the end of the string

Step-5. Segregation of the Converted Medical Information

$$\theta = \lim_{x \to 6} \frac{Set(C)}{x} \quad \text{Eq. (6)}$$

$$Set(\text{D}) = \prod_{i=0}^{5} Set(C_i) \cdot \prod_{i=6}^{11} Set(C_i) \cdot \prod_{i=12}^{17} \; ..... \cdot \prod_{i=\theta-6}^{\theta-1} Set(C_i) \quad \text{Eq. (7)}$$

In this step, the number of hex elements are been calculated and further more segregated in to set of six element groups.

Hence,

θ, denotes the number of groups to be formed with 6 elements

$Set(\text{D})$, denotes the fourth level of medical record string

Step-6. Finally convert the decimals into special text for storage

In this final phase of the algorithm the encryption technique is to be applied. This algorithm in this step uses the standard and widely used RSA algorithm on the BLOB data [20].

$$Set(E) = Set(D)^a.\text{mod}.\text{b} \quad \text{Eq. (8)}$$

In order to generate the public and private keys, this work proposes a novel polynomial based method to increase the security.

$$\begin{aligned}
&P_o(a) = 1 \\
&P_1(a) = a \\
&P_2(a) = \frac{1}{2}(3a^2 - 1) \\
&P_3(a) = \frac{1}{2}(5a^3 - 3a) \\
&...... \\
&P_6(a) = \frac{1}{16}(231a^6 - 315a^4 + 105a^2 - 5)
\end{aligned} \quad \text{Eq. (9)}$$

$$P_o(\text{b}) = 1$$
$$P_1(\text{b}) = b$$
$$P_2(\text{b}) = \frac{1}{2}(3b^2 - 1)$$
$$P_3(\text{b}) = \frac{1}{2}(5b^3 - 3b) \quad \text{Eq. (10)}$$
......
$$P_6(\text{b}) = \frac{1}{16}(231b^6 - 315b^4 + 105b^2 - 5)$$

Where,

$Set(E)$, denotes the final storable medical record
a, b, denotes the public and private key

6. Analysis of Time Complexity of the Proposed method

The major improvement established by this work is to reduce the time complexity for the querying systems for the medical record storage and management systems. In the results section, the statement is being proved. However, the statement is subjected to proof by the mathematical models. Hence in the section, the work establishes the mathematical model to prove the reduction of the complexity.

In order to prove the model, the work establishes few lemmas here.

Lemma 1: Intermediate reduction of the lookup table reduces the total time taken for storage management of the data.
Here,

- *T_build_time* denotes the time to build the lookup table
- *T_build_time'* denotes the time to build the reduced lookup table
- *T_lookup_time* denotes the time for checking the lookup values
- *T_lookup_time'* denotes the time for checking the lookup values
- *dat* denotes the number of elements in the lookup table
- *dat'* denotes the reduced number of elements in the lookup table

Proof: The lookup table has to build for checking the elements during the conversion process. Hence the reducing the number of elements reduces the number of comparisons for the system.

Firstly, the time for building the lookup table is been calculated.

$$\sum_i [ASCII_i] = \sum_{i=1}^{128} dat_i \quad \text{Eq. (11)}$$

$$T\_Build\_time = \sum_i [ASCII_i] \quad \text{Eq. (12)}$$

The algorithm proposes to reduce the number of elements in the lookup table. Hence,

$$\sum_{i}[ASCII_i] = \sum_{i=1}^{128} dat_i' \qquad \text{Eq. (13)}$$

$$T\_Build\_time' = \sum_{i}[ASCII_i] \qquad \text{Eq. (14)}$$

Thus, it is natural to understand that,

$$T\_Build\_time' < T\_Build\_time \quad \text{Eq. (15)}$$

The time for the lookup process depends on the number of elements in the table. Hence,

$$dat' < dat \qquad \text{Eq. (16)}$$

$$T\_lookup\_time' < T\_lookup\_time \quad \text{Eq. (17)}$$

Finally, the total time for build and querying the lookup table is reduced with the reduction of number of elements.

$$T\_Build\_time' + T\_lookup\_time' < T\_Build\_time + T\_lookup\_time \qquad \text{Eq. (18)}$$

Thus it is natural to understand the reduction of time in the storage process.

Lemma 2: The use of polynomial for generating the public and private key reduces the time for encryption.

Proof: The calculation of the polynomial is a recursive process. Hence the time complexity O(n) is bound to reduce. However the heap storage utilization increases to a high extend.

Analysis of Time Complexity Reduction:

With the light of Lemma – 1 and Lemma – 2, the proposes security mechanism is:

$$O(n) = T\_Build\_time' + T\_lookup\_time' \qquad \text{Eq. (19)}$$

Conversely, the traditional systems propose the time complexity as O(n`)

$$O(n') = T\_Build\_time + T\_lookup\_time \qquad \text{Eq. (20)}$$

From Eq. 18,

$$O(n') < O(n) \qquad \text{Eq. (21)}$$

Thus clearly the time complexity of the proposed methodology is less than the existing systems.

7. Results and Discussions

This work compares the result of the proposed medical record storage system with the existing advancements [24] in the past. The results are been discussed here.

Firstly, this work comparer the results of the proposed system with QNSC mode [24] as shown in [Table – 3].

TABLE 3: Analysis of Response Time

Number of Medical Record Query	Response Time (Seconds)	
	QNSC	Proposed Method
100	0.022	0.001
500	0.022	0.003
700	0.022	0.003
800	0.022	0.004
900	0.022	0.006
950	0.022	0.006
1000	0.022	0.09
2000	0.022	0.015
3000	0.022	0.016
4000	0.022	0.017
4300	0.022	0.018
4450	0.022	0.020

The results are also being analysed graphically [Figure – 2].

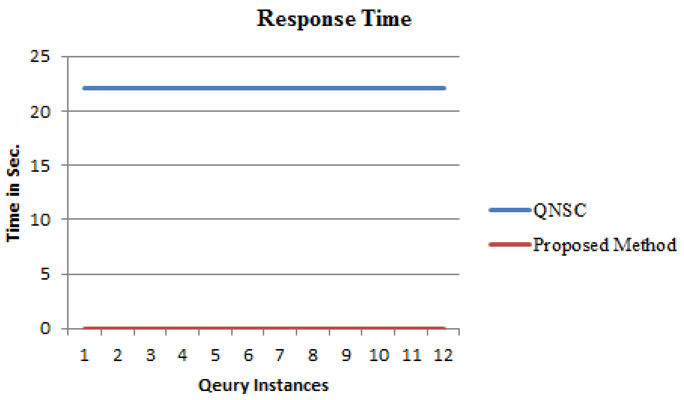

Fig. 2 Analysis of Response Time

Secondly, this work compares the results of the proposed system with QHCA mode [24] as shown in [Table – 4].

TABLE 4: Analysis of Response Time

Number of Medical Record Query	Response Time (Seconds)	
	QHCA	Proposed Method
100	0.82	0.01
500	0.90	0.03
700	0.95	0.03
800	0.97	0.03
900	1.00	0.04
950	1.01	0.06
1000	1.03	0.07
2000	1.44	0.015
3000	2.40	0.016
4000	7.20	0.016
4300	17.99	0.016
4450	17.99	0.017

The results are also been analysed graphically [Figure – 3].

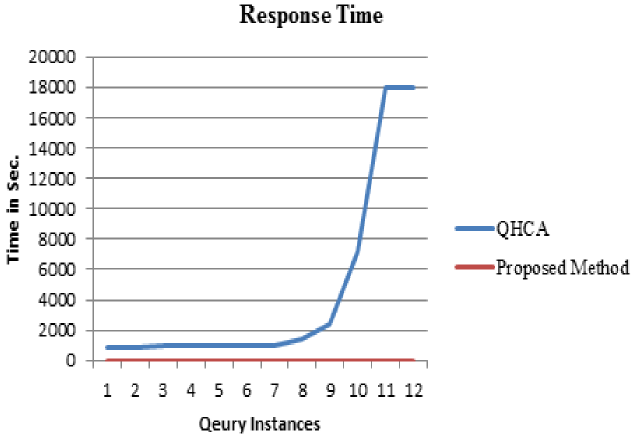

Fig. 3 Analysis of Response Time

Further the work comparers the results of the proposed system with QDB mode [24] as shown in [Table – 5].

TABLE 5: Analysis of Response Time

Number of Medical Record Query	**Response Time (Seconds)**	
	QDB	**Proposed Method**
100	0.08	0.001
500	0.08	0.003
700	0.09	0.003
800	0.09	0.003
900	0.09	0.004
950	0.09	0.004
1000	0.09	0.007
2000	0.09	0.012
3000	0.09	0.012
4000	0.1	0.014
4300	0.1	0.014
4450	0.1	0.014

The results are also been analysed graphically [Figure – 4].

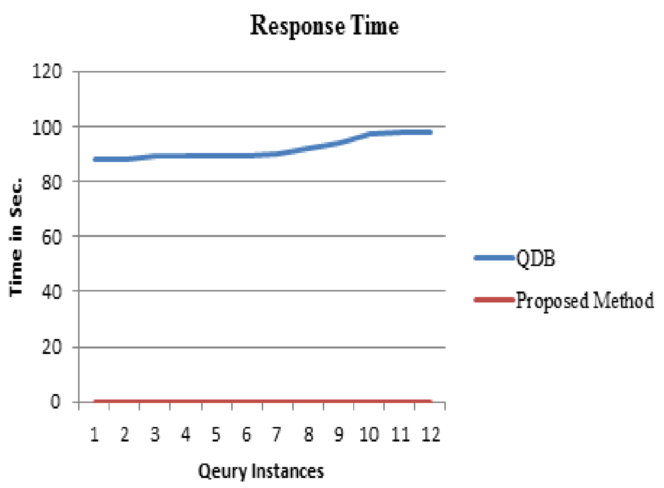

Fig. 4 Analysis of Response Time

Further the work comparers the results of the proposed system with QNS mode [24] as shown in [Table – 6].

TABLE 6: Analysis of Response Time

Number of Medical Record Query	Response Time (Seconds)	
	QNS	Proposed Method
100	0.022	0.001
500	0.022	0.003
700	0.022	0.003
800	0.022	0.004
900	0.022	0.006
950	0.022	0.006
1000	0.022	0.009
2000	0.022	0.015
3000	0.022	0.016
4000	0.022	0.016
4300	0.022	0.016
4450	0.022	0.015

The results are also being analysed graphically [Figure – 5].

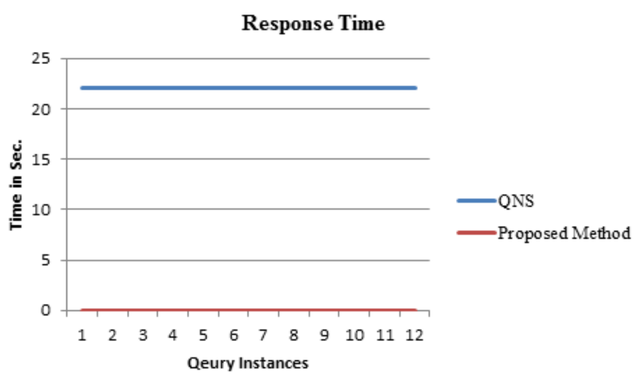

Fig. 5 Analysis of Response Time

Further the work comparers the results of the proposed system with QNR mode [24] as shown in [Table – 7].

TABLE 7: Analysis of Response Time

Number of Medical Record Query	Response Time (Seconds)	
	QNR	Proposed Method
100	0.022	0.001
500	0.022	0.003
700	0.022	0.003
800	0.022	0.004
900	0.022	0.006
950	0.022	0.006
1000	0.022	0.09
2000	0.022	0.15
3000	0.022	0.16
4000	0.022	0.16
4300	0.022	0.16
4450	0.022	0.18

The results are also been analysed graphically [Figure – 6].

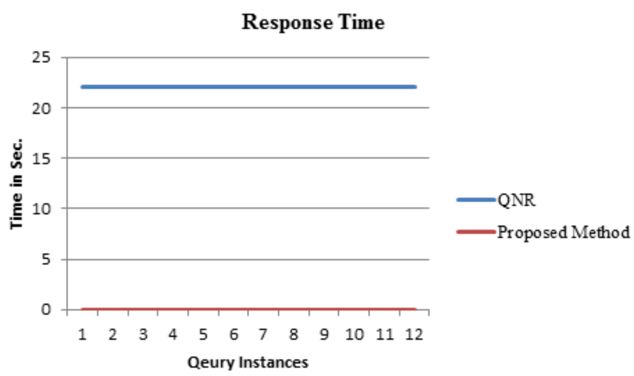

Fig. 6 Analysis of Response Time

Further the work comparers the results of the proposed system with QGS mode [24] as shown in [Table – 8].

TABLE 8: Analysis of Response Time

Number of Medical Record	Response Time (Seconds)

Query	QGS	Proposed Method
100	1.05	0.01
500	1.05	0.03
700	1.05	0.03
800	1.05	0.03
900	1.05	0.04
950	1.05	0.06
1000	1.05	0.09
2000	1.06	0.15
3000	1.06	0.16
4000	1.07	0.17
4300	1.07	0.18
4450	1.07	0.20

The results are also been analysed graphically [Figure – 7].

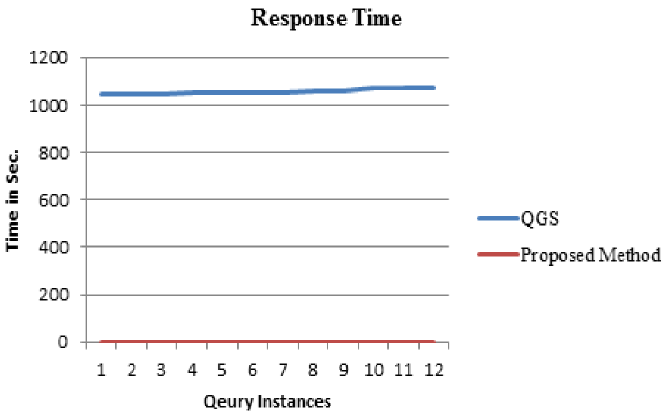

Fig. 7 Analysis of Response Time

Further the work comparers the results of the proposed system with QGR mode [24] as shown in [Table – 9].

TABLE 9: Analysis of Response Time

Number of Medical Record	Response Time (Seconds)

Query	**QGR**	**Proposed Method**
100	1.05	0.01
500	1.05	0.03
700	1.05	0.03
800	1.05	0.03
900	1.05	0.04
950	1.05	0.09
1000	1.06	0.15
2000	1.06	0.16
3000	1.07	0.17
4000	1.07	0.18
4300	1.07	0.20
4450	1.05	0.23

The results are also been analysed graphically [Figure – 8].

Fig. 8 Analysis of Response Time

Further the work comparers the results of the proposed system with QGR mode [24] as shown in [Table – 10].

TABLE 10: Analysis of Response Time

Number of Medical Record Query	**Response Time (Seconds)**	
	QHIS	**Proposed Method**

100	6.90	2.30
500	6.95	2.32
700	6.98	2.33
800	7.00	2.33
900	7.01	2.34
950	7.02	2.34
1000	7.02	2.34
2000	7.16	2.39
3000	7.31	2.44
4000	7.46	2.49
4300	7.51	2.50
4450	7.51	2.50

The results are also being analysed graphically [Figure – 9].

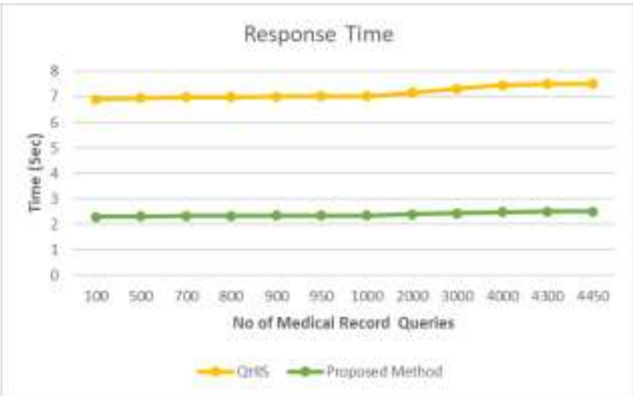

Fig. 9 Analysis of Response Time

Thus, it is natural to understand that the improvement in the performance compared to the existing methods. The improvement is solely achieved by reducing the irrelevant parameters and optimizing the encryption methodology.

The improvement leases the scope of further improvements. However, reducing the bottleneck of implementing the security features into the medical record management system has improved the scope for improvement in the query system.

8. Conclusion and Future Directions

This work analyses the current state of art for medical record storage systems and medical information management systems. During the study the work enhances the understanding on medical record storage methods and government standard compliances. Focusing on the HL7, the deep understanding of implementation is also been demonstrated. In the process of understanding the medical record accumulation system, the work formulates a standard process of normalizing the data. Further this work highlights the bottleneck points of the security issues on the medical records and increase in time complexity in case of adopting sophisticated encryption techniques. In order to avoid the bottleneck and establish a balanced security vs. time complexity paradigm, the work proposes a secure method of storing the BLOB based medical records demonstrates that the time complexity reducing significantly.

The security methodology proposed by this work is tested against multiple popular medical record query system such as QNSC, QHCA, QDB, QNS, QNR, QGS, QGR and QHIS. The improvement is significant. Hence as this work reduces the time complexity of medical record analysis and management systems, thus the demand for high quality and accurate analysis on medical data for predictive analysis is increasing. Now with the reduced complexity it is possible to deploy enhanced rule based techniques to predict the disease severity and plan for the policies and medications accordingly resulting into save of human life.

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