

A Comprehensive Review of the Smart Health Records to Prevent Pandemic



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Introduction to a Smart Health Record

The meaning of smart is organized, precise, efficient, measurable, analytical, proscutable, and technology-driven in all manner. We have to use the statistics of a patient in real time to store it on the cloud so that we can interpret the information through various mobile apps and smartphones and find out some patterns, images recognition techniques, and previous records of the patient, e.g., X-ray reports and ultrasound reports, to evaluate these records through machine learning model/techniques with maximum accuracy by accommodating advance health services that have never been existed before [1].

Technology is coming with conviction and zeal and the peoples are obtaining and grasping it openhandedly as it is a powerful and transformational technique to make millions of people's lives better and healthy. The intention behind the technology is to gather real-time data using wearable gadgets like a smartwatch, smart glasses, bio-patch, smart hearing aids, etc. to track the improvement or any implication through the day-to-day monitoring and to collect the real-time data at the

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centralized server and fetch these data through a mobile application in times of emergency [2].

This is the collective exercise between researchers, doctors, specialists, developers, and engineers to implement the machine learning algorithm by recognizing the patterns of previous images of organs and comparing them with a healthy one, so we can easily identify the ramifications with current health statistics of patients and start the treatments as early as possible [3].

Fig. 1 describes the various records smartly stored in any network device. Instead of managing a lot of documentation for a single patient, it is easier to have a single medical record. We are creating huge decentralized records through job cards, patient's admission forms, procedure sheets, evaluation sheet, medication sheets, recovery sheets, etc. as the day in and day out that are at present existing in almost every healthcare institution among health records of outpatient offices, ICUs, and treatments [4].

Physicians, healthcare experts, and medical professionals are spending a lot of time preparing the records of patients who have already been surrounded by chronic diseases or having such kind of history for a long time. They use to create the



Fig. 1 Smart health management

documentation for a large number of patients as per day, week, and month by making files or manual diagnosis through huge previous medical records and repeating the tests to check the health implications of patients [5].

Various Types of Records in Smart Health

Health records are generally classified into four categories:

1. Clinical records: It is the awareness of various cases of patients' seizure, breakthroughs of their betterment, and various types of facilities provided by medical staff and higher authorities. Such kinds of records are having a few salient features like the following:

- (a) Experimental, objective, and authorized.
- (b) Records are prudently handled by medical personnel.
- (c) Proper documentation should be given to patients about their treatments.
- (d) Duplication should also be avoided as it enhances paperwork and a lot of documentation
- (e) Real data on research and other related modules have to be provided by the hospital.
- (f) Better service should be provided in the up-gradation of health.
- (g) Insurance and safety are also major concerns to the staff members, nurses, doctors, and physicians.
- (h) Proper sanitization of a building should be provided to disinfect the people near to patients.

Some of the examples related to clinical records:

- Physician's order form
- Patient's procedure sheet
- Nurse's admission appraisal form
- Medical history of patients
- Physician's annotations/impressions
- Treatment records
- Improvement statistics

2. Staff records: Independent set of records for each staff member. These individual records have to be maintained by producing the details of the particulars of their presence, their medical conditions, e.g., insurance, personal information, experience, etc., in the digital form [6].

Some of the examples related to staff records:

- An individual's appraisal form
- The number of patients handled at a particular time
- Daily attendance records
- Medical history of an individual staff member

3. Department/ward records: It is the kind of records connected with an individual department or ward.

Some of the examples related to ward records:

- Circular of the ward to maintain the records daily.
- Presence and absence record at a particular time or at the time of the round.
- The ward duty of each individual should be checked on frequently.
- The inventory of the ward should be kept in a digital form.
- Patients about that particular ward record.
- Billing of medicine records.
- Records containing the ward's daily activities.
- Numbers of patient's daily procedure records.

4. Administrative records: It is the kind of records in which the administration is responsible to make sure that every activity is under supervision electronically to achieve the goal of the better flow of everything in any organizations [7].

Some of the examples related to ward records:

- The daily basis treatment record
- Discharge record with medications
- Service records
- Organization notice board records of various activities
- The procedure of each manual frequently

Development of EHR Standards for India

The Ministry of Health, Government of India, proposed the EHR standards to recommend a system that is highly flexible in conserving and generating the health records of patients in the country in the long run by healthcare workers. So, in the coming generation of the twenty-first century, the government of India is focused on electronic health records with the mission of digital India. The vision of this new era would be implemented in such a way that in the case of emergency, a person does not need to take any documentation like the previous history of their health treatments, last visit summary reports, etc. So with these standards, a person can go to any hospital having the best medical facilities and physicians, specialists, or experts and start his treatments as early as possible without wasting a lot of time as a fully unified electronic record has already been there at the cloud and anyone can access it at the time of need through connecting devices like software and application-embedded laptops, tablets, etc. [8].

The Ministry of Health had planned to suggest the EHR standards for the country in 2013. Again it was revised in 2016 introducing information technology, machine learning, big data analytics, sensor-based live streaming of data by using the Internet of things, and other technologies to make healthcare system efficient and easy to access in the upcoming years throughout the country by hospitals, researchers, and development centers pertinent to healthcare, various organizations, and medical

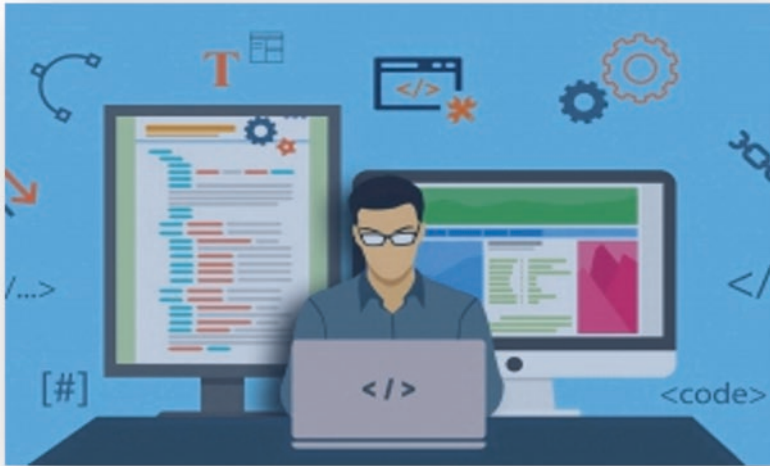


Fig. 2 The advancement of electronic health records through various devices with the help of web networks

institutions and advised them to update the system with new technology and implement the system in such a way that it would be within reach of a common man at the time of urgency with full transparency [9] (Fig. 2).

Traditional Paper Records vs Smart Health Records

Even in today's scenario, hospitals are still using traditional paper records to evaluate the files having the previous summary of their patients. A lot of documentation against the confidentiality of patients and the emphasis of being accessible to the records of patients delinquently the location from where they belong to take huge dominance to make the shift to EHRs. An electronic health record (EHR) is an electronic adaptation of a patient's admission form to any healthcare institution. EHRs belong to live data that proceeds as real-time information on the cloud; these records produce the data by using data analytics techniques which are easily accessible and steadily authorized [10].

Medical staff like nurses, practitioners, and trainers who are using electronic health records have seen a large attrition rate in paper work, patient's admission form, job cards, or other documentation by more than 40%. Electronic health records are one of the most impeccable approaches to get specific information on patients rapidly. Becoming paperless boosts our business. As we all know, in today's



Fig. 3 Electronic health records

cut-throat competition, time is very crucial for all of us, and this has been proved that in various industries especially in the healthcare industry, electronic health records have become the buzzword as they help reduce a lot of time and efforts by using electronic gadgets, smartphones, etc. [11].

In electronic health records, we can get the data in real time by using telemedicine's techniques (Fig. 3).

Comparison Between Paper-Based Records and Electronic Health Records

Paper-based records	Electronic health records
Paper-based records dissipate among several hospitals and care centers and are inadequate as this piles up the records of patients as irrelevant and redundant	Electronic health records smartly curtail the redundant data by taking all information in mobile applications or software using smartphones, gadgets, tablets, etc.

Paper-based records	Electronic health records
Paper-based records are also disorganized as many physicians have to collect the records of the previous history of the patient from a lot of sources like documentation of the last admission submission forms, previous medications, procedures, as well as recovery rates	Electronic health records allow the accumulation of all previous records in one storage so that it can be easily accessible without viewing all previous documentation and a lot of files reducing the time and efforts of medical staff members, e.g., doctors, specialists, physicians, etc.
In paper-based records even if you are taking the records from various sources like email and fax, it will take a lot of time to proceed, and to start the treatment late would be fatal in case of emergency	In EHR, the system takes the complete records of the medical history of the patient, so there is no need to bring the data/information from any other resources and don't even need to fill the partial or full record in the system again
In this type of record, as you are not having the whole medical history of patients at one single location, this is very cumbersome to put all together with the previous medication and treatments	Due to real-time streaming of data/records application can be updated automatically as it can work 24/7 with the help of the internet like ATMs. Thus, we are not bothered about the current scenario of patient health because by wearing some connecting devices, these devices themselves fetch the real-time data and store it on a cloud
Physician's admittance is very less as he or she is only available within their job hours; thus, this can crunch the patient's health at the time of emergency or in any critical situations	In electronic health records, we can get the data live from any cloud platform and doctors can monitor this data from any location even from their home, and by using the telemedicine's techniques, they can prescribe any medicines at the time of any urgency

Interoperability and Standards in the Smart Healthcare System

The bundle of various standards circumscribed in this topic is introducing a cumulative approach:

1. Medical equipment and uses cases should be studied carefully.
2. Various wearables and connecting devices shall accept interoperability and standards.
3. Accepting standards and executing requirements for the flawless exchange of health information between various institutions and IT infrastructure.
4. Consolidate vendors around the domain with mutual medical issues and health-related challenges.
5. Establish various frequently used tools and gadgets and their related services.
6. Develop various phases of the requirement specification process by integrating attempts among public and private sector shareholders, in which vendors are collaborating to create willingness.
7. Various guidelines we should follow proposed by the government for health information networks throughout the country.



Fig. 4 Interoperability and standards in the smart healthcare system

- 8. Technology should be established to achieve the final goal of nationwide health measures so information technology, ICT, and machine learning will work together to fulfill the technical requirements (Fig. 4).

Guidelines for Proposed Smart Health Records

We all aware of the new technology named machine learning through which we are deliberately making our medical history on the server and with the help of RPC API and Google Cloud Vision using ML models to recognize the data with the pattern or recognition techniques and produce electronic health records in a digital form. Whole data would be stored on the cloud and we can access it through mobile apps by using smartphones, and these data or records can be easily accessed and controlled by our physicians, doctors, and pharmacists.

In recent times, many think tanks of the country in the health industry generate movable and “interoperable” electronic health records which means easy to access and understand by masses. Institutions of medical sciences, where a lot of information is participating against healthcare vendors, are amicably the most important domain; the deep-rooted EHR providers assured to intent their information exchange

platforms instead of standards of the industry for partaking unprocessed information [12].

Electronic health records are less pricey to create and store and easy to move everywhere at the time of need. These are the reasons behind the picture of the new healthcare regime that the government is also taking interest to distribute and maintain the sharing regimen nationwide. Without the specialists and healthcare providers filling out the right information in the applications, electronic health records would become personal assets so that we can regulate it on our own at any time and send it to doctors to make urgent appointments or can take the help of telemedicine. Google Health and Microsoft's Health Vault online platforms are among the biggest IT giants in which consumers can accumulate and share their electronic health records.

Security and privacy specialists are concerned about the safeness and aegis of networked information of health records. Several experts, e.g., Center for Democracy and Technology, proposed guidelines that cannot be advocated, e.g., both buyers and consumers of the healthcare industry can share the common interest as their needs and requirements specifications are the same. According to the research, sources stated that the healthcare industry will see a 25% increase in IT jobs by 2022. In many hospitals that are having advanced medical facilities in almost every sector of the healthcare projects, there is a demand for productive smartphone applications and cloud servers for storing real-time data and computerized diagnosis.

Introduction of Machine Learning in Healthcare

Machine learning aggrandizes manual tasks without the intervention of humans. Electronic health records (EHR) are unregulated and enigmatic and opposing computerization so we can be muddled in fetching the information by taking the pricey time. Machine learning algorithms can forecast the data which is adjustable or fit according to patient's health specifications and is majorly on top priority so we can enlist the further steps to take appropriate actions as earlier as possible to save human lives and enhance the life expectancy of patients at the time of emergency. AI with machine learning algorithms work with generative adversarial networks (GANs) and anticipate the more precise shapes of molecules with high accuracy. Statistics uses R language to predict the chart for the remarkable representation of data so we can easily understand the graphs which gradually show the improvement measures of any individual to boost the capability and provide easy access.

Image recognition techniques, using machine learning classifying pathology e.g.: to find out tumors in healthcare modules by showing the images of different patterns showing in the human body so physicians can easily detect the body of having tumors with a healthy body which is showing a different image. Another pathway that is materializing is by using wearables with connecting devices like a smartwatch, Fitbit, etc. With the use of these wearables, we can store the real-time information of an individual, and with the machine learning model, we can

conclude the data as a result, e.g., deterioration or wreckage. Wearables productively take the data while walking, running, and jogging. Because they are collecting data through live streaming module, when this data has reached to a particular danger point, it quickly informs a person or an individual to take appropriate actions before something worse can happen, e.g., a stroke risk, heartbeat enhancement, excessive sweating, etc.

Machine learning algorithms stimulate research in the field of healthcare with huge enthusiasm. Biologists, computer scientists, IT professionals, physicians, and faculties of applied science all are working together and practicing day and night in a collaborative environment to come up with all related technologies and to end up with some creative solutions like outbreak prediction and personalized medicines. And they often use the machine learning models to diagnose and identify the disease before happening. With the help of natural language processing, professionals related to this field can handle a lot of administrative tasks.

Introduction to Vector Machine Techniques

Machine learning (ML) has become the buzzword in almost every industry, and it has been acknowledged as an essential part of AI. Moreover, ML is a data analysis technique that computerizes the declarative structure. Algorithms used by machine learning are captivating all big IT giants in an industry collaborating with all major sectors, e.g., banking, transport, healthcare, etc. Support vector machines are one of the classification techniques that distribute pieces of information varying with patterns matching with supervised learning technique with hyperplanes provided by the machine learning technology. So SVM is well known as the ML technique for classification. SVM is a selective classifier. It generates the result as an outcome of the hyperplane, which organizes new data sets with examples that accept the technique of hyperplane called support vectors.

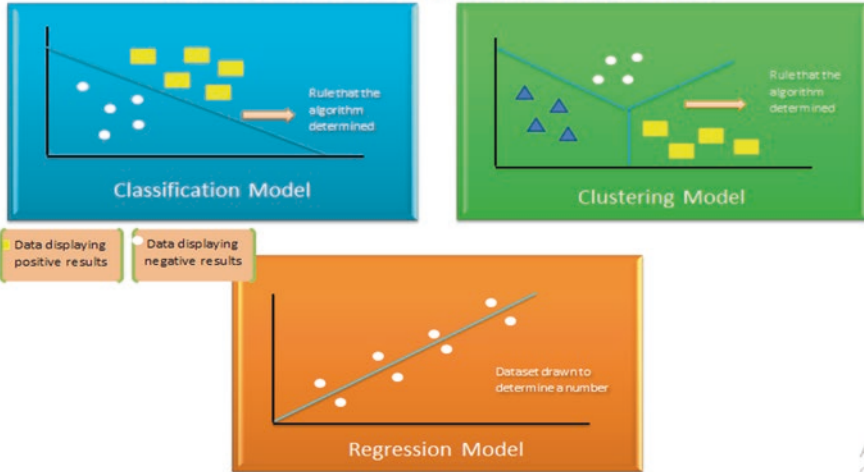
In the two-dimensional (2D) region, this technique is a straight line divided into two sectors wherein each sector is temporal on one side by taking two unique data sets or pieces of information shown in bullets or dots. This graphic representation proposes a confirmative interpretation as shown in the figure. Figure 5 shows various images differentiating sickly from healthy persons.

This visual representation comes up with an acquiescent interpretation (Fig. 5). The table below shows the various data set to analyze the data with the machine learning model.

Fig. 5 Various differentiation of the health categories



MACHINE LEARNING MODELS



Ac
Go

Fig. 6 Various types of machine learning models

Person suffering from obesity

	Fasting	Just after Eating	3 h after eating
Normal	80–100	170–200	120–140
Pre-diabetic	101–125	190–230	140–160
Diabetic	126+	220–300	200+

Data can be displayed through various models, e.g., classification model, clustering model, and regression Model (Fig. 6).

Sometimes we use to make mistakes while considering hyperplane as choosing an optimal one is a tedious job as noise sensitivity and rationalization of different

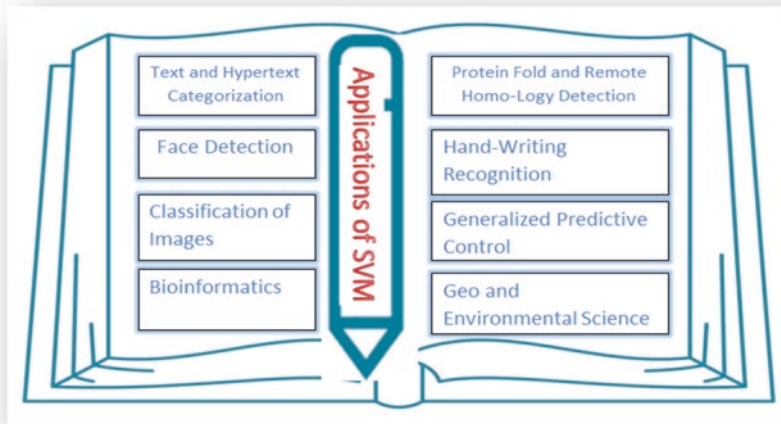


Fig. 7 Illustration of support vector machine

data sets should be in a proper manner with higher accuracy. Support vector machines are trying to upgrade hyperplane that provides substantially less distance to obtain skilled data set (Fig. 7).

Introduction to OCR Techniques in Healthcare

The optical character recognition technique we are using in healthcare is primarily helping us to process and enhance the adaptability of the plan you have taken related to your health status. The number of processes has been performed with the help of an image recognition technology which is used to remove the use of highly intensive data entry process on papers.

We are using the optical character recognition technique extensively in medical science which is based on the proficiency of an optical character recognition scanner. As the same suggests, it can scan alphanumeric characters present in files by recognizing the characters carefully and cache the data as e-files.

Flood of Paper Claims After the Arrival of Optical Character Recognition

In the insurance sector, a simple healthcare plan contains a huge number of individual paper claims which is used to be scanned by an OCR and translated into e-files which is based on the healthcare system's preference with a



Fig. 8 Benefits of optical character recognition

predefined formatted model. We normally use the X.12 format to verify claims related to this technique. Like an electronic data exchange file, we can insert our file into the system. The images residing in the document are saved so that they can be used shortly by referencing the same images and comparing with future incoming data to understand patterns easily with the help of machine learning models. Machine learning models tend to be highly sophisticated so that in this interface our e-files having a lot of images can percolate and bring back quickly and comfortably. The whole process eliminates the use of papers and manual documentation.

The frequently incoming claims with manual documentation or in paper format per day are increasing at a fast speed. With the help of connecting devices like smartphones in a particular network having kiosks, cloud servers, and various apps, saving the electronic information, and transporting these e-files anywhere at the receiver end, has become an effortless system by the use of optical character recognition in healthcare.

Different modules have benefits of OCR using EDI (Fig. 8).

Electronic Exchange of Documents

Another application of optical character recognition in healthcare or medical sciences is that it composes the paper files or documents electronically exchangeable with the EDI module. By generating an on-screen paper module, all manual files that contain images are primarily stored in the system's forms. By doing this, we can easily accessed and simply transfer these files with efficiency. Later on, by using the EDI technique, images and pictures would be transformed into text format and be stored automatically into the databases in a cloud-based server worldwide so that we can retrieve this information easily for use at the time of need in a secure way [13].

Advantages of OCR in Healthcare

1. Tremendous speed to access and retrieve files.
2. Enhanced capacity of storing e-files, thus taking less space instead of storing very cumbersome paper files.
3. The accuracy rate is highly captivated even in a fraction of seconds.
4. Storage is less costly as compared to the storage of manual files for which we have to create a huge space to place the files.
5. Transportation is extremely easy as we are free to transfer the files from one location to another with a single click.
6. Many organizations are assisting with the problem of data loss and damage to unreliability. OCR has been extricating a lot of these problems to diminish errors.

Privacy and Security in Smart Health Records

With the invention of technology, the government of India has initiated a tremendous attempt to revolutionize traditional health records by integrating them with information technology (IT). Electronic health records can produce huge profits and welfare by fixing responsibility and cutting costs. However, by computing and streamlining health records at the cloud, EHR systems have now become vulnerable to security threats as most of the vital information are made available not only in the hands of medical doctors or physicians but also on the cloud server, making them within the reach of hackers, crackers, and cybercriminals. Due to these privacy and security threats in health records, a new measure has emerged named cybersecurity because for policymakers this is an extreme affair for medical science in the era of the digital world. Many journals, articles, and papers have been issuing cyberbullying and security and privacy concerns in healthcare. A lot of research is still going on in recent times to amend the privacy and security in EHR systems [14].



Fig. 9 Introduction to Google Cloud Vision API

Uncompromising security and privacy safeguards are now essential for the everlasting accomplishments of EHR systems. If the trust and belief of patients have evaporated that EHR systems are apprehensive, most probably they are not going to use it and feel hesitant to use it; thus, not a single piece of information should be available to unauthorized person. If a hacker is trying to access the record of any individual or trying to penetrate the medical history of any patient, then security is imposed (Fig. 9).

Google Cloud Vision endeavors the products that adopt machine learning concepts to understand our data as inputs by labeling the objects and after executing providing the result with a high level of accuracy interacting with the algorithms or pre-trained model in between our inputs and the final result. The following are the types of Google Cloud Vision:

1. AutoML Vision
2. Vision API

Let us explain each of them:

1. AutoML Vision: As the name suggests, personalizing our machine learning standard and developing a model, we can use AutoML Vision’s technique which is easy to access with the feature of the API (application programming interface). With the help of code, which we use to perform different classification by using classes and objects concept, we can develop an application which is highly

optimized with the following features: low latency, small size, and maximum accuracy.

Later on, we can transport the complete structure to the application on the cloud and it can also be stored to an array of various connecting network devices at the end user and deploy the model to our apps and comprehend objects to make the difference from which we can easily compare right things to get the result with an optimized manner, e.g., prediction of diseases quickly, emotional intelligence patterns, buying behavior of customers, and business analysis.

- 2. Vision API: In this module, we can use the REST and Remote Procedure Call API, which is known as the elementary form of application programming interface. It helps us to deploy our block of code to another remote server through Remote Procedure call. If we have to take the code block into HTTP through HyperText Markup Language, it can be treated as Web API. By the REST and Remote Procedure Call API, we make our machine learning model as skilled and pre-trained.

Fig. 10 depicts the working of the training data set into optimal result by using AutoML Vision through the proper training of the model by flawless algorithms.

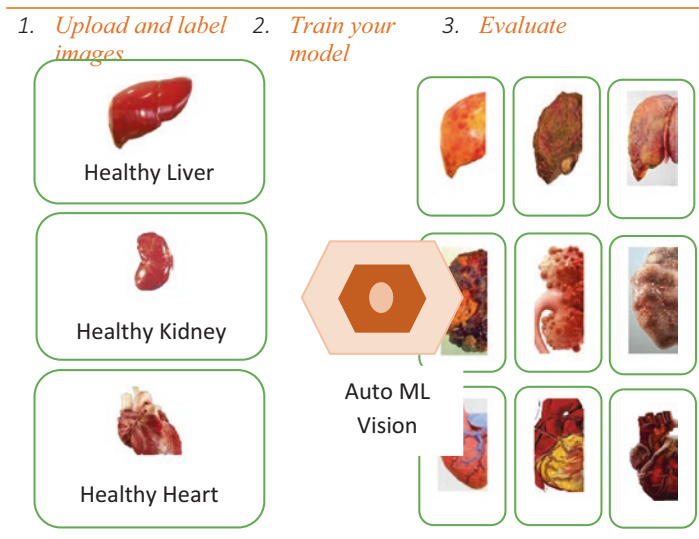


Fig. 10 Machine learning model in the healthcare system through the Google Cloud Vision API

Conclusion

From the above discussions, we have to conclude that as day in and day out, the healthcare system is now gripping into human's life without involving the absolute presence of patients as it has been diversified with a lot of devices and technologies to handle the data of any individual at various remote locations and prescribe them with any medicines with emerging techniques, e.g., telemedicine. As we all know that in the next decade, the number of older adults suffering from chronic diseases will increase, putting the health records and the previous history of their chronic diseases securely with the help of database servers and collecting them any time of urgent need will be of utmost importance so that doctors can give appropriate treatments in a limited time to save lives. The adoption of all the new technologies like smart health records, telemedicine, and virtual prescriptions of the treatments would improve well-being of patients.

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